Cross-Agency Communication and Information Exchange in Disaster Healthcare

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Abstract

In disasters, emergency management and health agencies usually play the biggest roles in providing healthcare services to the victims. Despite these agencies having common goals and operational similarities, post-disaster analysis exposes frequent communication failures between the two sectors resulting in delayed, substandard, and sometimes unavailable healthcare. Moreover, inefficiencies and the waste of scarce resources are often experienced due to underutilisation of information and communication technologies by both sectors.

This qualitative study investigated the factors that hinder effective communication and information exchange between emergency managers and health professionals in disasters. Social constructivism served as the conceptual framework to ground the study. Semi-structured interviews with emergency managers and health professionals from the UN and the key emergency response agencies in New Zealand were conducted. Thematic analysis of the interviews produced five themes relating to trust, authority and leadership, situation awareness, technology, and legislation.

Two approaches were suggested to address the issues revealed in the interviews: a data-driven approach that offers a prototype for a disaster healthcare MDS, and an educational approach that outlines a framework for a disaster e-health (DEH) curriculum. The MDS contains datasets deemed critical by both emergency managers and health professionals for disaster preparedness and response efforts. A two-round Delphi study was conducted to evaluate the MDS prototype and the DEH curriculum framework.

The outcomes of this research were integrated into a solution-driven communication framework that may significantly improve the quality of healthcare delivered to the victims of disasters.

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Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

Signed by: Reem Abbas

Date: 24/08/2020

Dedication

To my late father, Abubakr Abbas, for everything he has done for me

To my mother, for her endless support and unconditional love

To my daughters Joya, Issu, and Dina; my source of inspiration

To Rasheed, for always understanding

To Salma Abubakr Abbas for being the best sister anyone could wish for

To Yassir Abubakr Abbas and Ammar Abubakr Abbas; my rocks

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Ethics Approval

Ethical approval was granted by Auckland University of Technology Ethics Committee for the first stage of data collection on 27 March 2017 (reference no. 17/69), and for the second stage on 27 February 2019 (reference no. 19/41).

List of Abbreviations

ADPC	Asian Disaster Preparedness Center
CIMS	Coordinated Incident Management System coordination centre
CRED	Centre for Research on the Epidemiology of Disasters
DEH	Disaster e-Health
DHB	District Health Board
EHGI	E-Health Governance Initiative
EMIS	Emergency management information system
EOC	Emergency Operation Centre
FEMA	Federal Emergency Management Agency
FHIR	Fast Healthcare Interoperability Resources
GIS	Geographical information system
HISO	Health Information Standards Organisation
IASC	Inter-Agency Standing Committee
ICT	Information and Communication Technologies
ICU	Intensive care unit
IFRC	International Federation of Red Cross and Red Crescent Societies
ITIL	Information Technology Infrastructure Library
MDS	Minimum Dataset
MoH	Ministry of Health
NEMA	National Emergency Management Agency
NGO	Non-Governmental Organisation
ODESC	Officials' Committee for Domestic and External Security Coordination
PAHO	Pan American Health Organization
SNOMED CT	Systematised Nomenclature of Medicine—Clinical Terms
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
WHO	World Health Organization

Chapter 1 Introduction

1.1 Rationale of the study

A disaster is defined as a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources Guha-Sapir, Hoyois, and Below (2017). In disasters, the focus is mainly on responding to population needs, forecasting potential problems, rebuilding society, and preventing future disasters. These goals require adequate communication between multiple agencies with different mandates and mission statements.

Several organisations, including governmental and non-governmental agencies, private sector companies, and community groups, may all be involved in the aftermath of a disaster at varying levels depending on the type and scale of the event. Despite the existence of coordination frameworks and formal procedures that govern information flow between these agencies, disaster communication remains challenging and highly complex (Eide, Halvorsrud, Haugstveit, Skjetne, & Stiso, 2012; Paton & Irons, 2016; Waardenburg, Groenleer, de Jong, & Keijser, 2020).

There exists a rich literature that focuses on the topic of multi-agency communication, collaboration and coordination in emergencies and disasters (Martin, Nolte, & Vitolo, 2016; Simon, Goldberg, & Adini, 2015; Telfair LeBlanc, Kosmos, & Avchen, 2019). The novelty of this research is that it focuses on communication challenges between emergency managers and health professionals specifically and from a healthcare perspective.

Healthcare is not limited to the provision of clinical care to patients. In fact, it covers the prevention, treatment, and management of illness and the preservation of mental and physical well-being (Rural Health Information Hub, 2019). The broad spectrum of healthcare functions is practised by a similarly broad range of practitioners. In the context of this research, the term ‘health professional’ does not refer to clinical personnel only. It refers to an individual who is responsible for healthcare-related data, including but not limited to medical and clinical data.

The two disciplines concerned with healthcare provision in disasters are normally disaster medicine and disaster management. Disaster medicine is defined as the area of clinical specialisation that deals with the provision of healthcare to disaster survivors and responders and the planning of medically related disaster preparation, planning, response, and delivery (Hogan & Burstein, 2007). Disaster management, on the other hand, deals with all aspects of preparing for, responding to, recovering from, and mitigating disasters (International Federation of Red Cross and Red Crescent Societies [IFRC], n.d.-a). The two disciplines are clearly conceptually similar. Practitioners of disaster management and disaster medicine are normally emergency managers and health professionals who both aim at assisting disaster victims. In 2005, Bissell, a noted figure in emergency health services, commented that "Emergency management and the health sector are natural allies that have, seemingly, only recently begun to recognise each other" (Bissell, 2007, p. 220).

Despite common foci and similar operational characteristics, health and emergency management have mostly failed to share their tools and personnel and have not collaborated smoothly in preparing for and responding to mass emergencies (Bissell, 2007). Moreover, neither discipline exploits the new range of information technologies such as cloud computing, big data analytics or the Internet of Things, or the e-health technologies such as telemedicine and mobile health applications that are revolutionising mainstream healthcare (Homeland Security News Wire, 2018; Topol, 2012).

Despite governments' extensive knowledge and expertise in disaster management, no single agency can manage a disaster on its own (Willis, 2014). Disaster response critics often cite poor cross-agency partnership as an obstacle to effective response and call for more and better communication and collaboration across disaster response agencies (Martin et al., 2016; Russo, 2011).

Since disaster healthcare is a function of cross-agency collaboration, there is an urgent need to address the factors that contribute to communication inadequacy and inefficiencies in information exchange between disaster response agencies.

1.2 Research aim and objectives

The aim of this research is to enhance healthcare provision to the victims of disasters. The objectives of the research are to investigate communication failures between disaster response agencies and, accordingly, to suggest viable approaches for establishing meaningful communication between emergency managers and health professionals responsible for disaster healthcare provision.

The research focuses on the central importance of integrated information flows before, during, and after a catastrophic event, thus contributing to the enhancement of evidence-based decision-making. An evidence-based approach coupled with an educational approach may potentially make a substantial improvement in the appropriateness and quality of healthcare provision in disasters.

The research contributes to the body of knowledge by meeting the following objectives:

a. identifying key issues that hinder smooth communication between emergency response agencies

   There exists an abundant literature claiming the benefits of cross-agency communication and collaboration in disasters and their impact on the quality of response (Bharosa, Lee, & Janssen, 2010; Bunker, Levine, & Woody, 2015; Elikwu, 2019; Kapucu, 2006; Waring et al., 2018). However, the present research focuses specifically on communication between emergency managers and health professionals from a disaster healthcare perspective. Its focus is to investigate the value of a multi-disciplinary approach to disaster healthcare.

b. identifying a baseline for a minimum dataset (MDS) containing essential data deemed critical by disaster managers and health professionals for disaster response and preparedness

   The concept of an MDS is not new to the medical field. However, the MDS under investigation is novel in the sense that it crosses disciplinary boundaries and seeks to specify a common set of data elements that are critical for both medical and non-medical professionals. The suggested MDS can be thought of as a baseline of

common information requirements upon which more refined versions can be designed based on broader consultations and lessons learnt. The multi-disciplinary nature of the MDS potentially has value if it is shared across the two sectors with the aim of striking a balance between information adequacy and overload. Moreover, identifying some of the essential healthcare data may allow the development of a national structured information system for managing disasters. So far, there exists no MDS in the context of emergency response that involves both medical and non-medical information requirements.

c. identifying a curriculum framework for a disaster healthcare educational programme targeting combined groups of emergency managers and health professionals

A disaster healthcare curriculum for emergency managers and health professionals is required to educate disaster response agencies about each other and raise awareness about possible venues for cross-agency collaboration.

1.3 Research questions

The research questions were designed to investigate communication challenges (first research question) and then to investigate viable approaches to tackling these challenges, both human and technical.

1.3.1 Question one

In normal circumstances, and more so during disasters, delivering adequate healthcare services requires effective communication between different agencies within and beyond the health sector (Pourhosseini, Ardalan, & Mehrolhassani, 2015). Effective communication in disasters refers to the availability of relevant and timely information and the ability of the information recipients to interpret and utilise it in making appropriate decisions (Paton & Irons, 2016).

Considering the criticality of effective communication, this research started by investigating the challenges that impact communication between the two main providers of healthcare in disasters: emergency managers and health professionals. The question originally used the term ‘clinical personnel’ instead of ‘health

professionals'. It was later altered to encompass the clinical aspect as part of the broad domain of healthcare. Therefore, the first research question was re-phrased as:

Q1. What are the main barriers to effective communication between emergency managers and health professionals in disasters?

1.3.2 Question two

A humanitarian response to a disaster situation should be delivered in accordance with international standards. The most widely known and commonly used set of standards is *The Sphere Handbook*. It identifies the minimum standards acceptable for water supply, nutrition, hygiene promotion and health systems and services (SPHERE, 2018). Key indicators for planning, implementing, monitoring and evaluating the Sphere standards require both existing and post-disaster health information (Aung & Whittaker, 2012).

An abundance of information is known to be key for better performance, new developments, improved organisation, and future predictions necessary for achieving best disaster response outcomes (Dash, Shakyawar, Sharma, & Kaushik, 2019). According to *The Economist*, the world's most valuable resource is no longer oil, but data ("Regulating the internet giants," 2017). This realisation has led to the collection of massive amounts of data in all aspects of life. The digital data produced, replicated, and consumed annually was predicted to reach 40,000 exabytes by 2020 (Dash et al., 2019).

In disasters, the types of information needed to provide adequate and appropriate healthcare cover a wide range of areas including damage assessments, emergency medical support, shelter locations, and search and rescue (Kotabe, Sakano, Sebayashi, & Komukai, 2014). However, despite the production of massive amounts of data, disaster response personnel still lack knowledge about what data are available, where it exists, and how can it be accessed, leading to inefficient cross-agency information exchange (Erasmuson, 2016).

Acquisition of reliable and timely information is critical for deciding on what needs to be done, and when and how it needs to be done. Be that as it may, it is crucial to avoid information overload, i.e., receiving huge amounts of data that is not relevant to the

recipient. Emphasising the need to prevent information overload, Turoff, Chumer, de Walle, and Yao (2004) argued that emergency response personnel work an average of fourteen to eighteen hours a day and have no tolerance or time for dealing with issues outside the scope of their tasks (Abbas, Norris, & Parry, 2018a). Therefore, it is crucial to restrict 'information' exchange to accurate and timely datasets that are relevant to the needs of response agencies. Critical datasets that determine the quality of health response are not only post-disaster data, but also existing baseline data that may be owned by agencies within and outside the health sector (Aung & Whittaker, 2012).

Therefore, the second research question was intended to identify the datasets deemed critical for disaster response and preparedness by emergency managers and health professionals. Originally, the second research question was formulated as: 'What minimum data sets contain the essential information that these practitioners need to communicate in emergency situations?' As the research progressed, it was clear that the method used did not evaluate the impact of exchanging these datasets. What the method used provided (see section 3.5.3) was validation of the criticality of the identified data elements for both the health and emergency management sectors. Therefore, the second research question was re-phrased for more accuracy as follows:

Q2. Which datasets can enhance the effectiveness of information exchange between emergency managers and health professionals in disasters, and how should these datasets be constructed?

1.3.3 Question three

While the second research question addresses the information exchange side, the third and last question deals with the human factors that impact cross-agency communication. The third question was originally formulated as: 'How can communication between emergency management and emergency medicine practitioners be improved?'. Considering the knowledge gaps revealed through reviewing disaster education (D. Alexander, 2003; Erdur-Baker, Kasapoğlu, & Yılmaz, 2015; FitzGerald et al., 2017), and the responses of interview participants, the idea of exploring an educational approach to enhancing cross-agency communication emerged.

Disaster management can be described as a wicked problem. Wicked problems are multi-faceted problems that require the management of a plethora of diverse stakeholders who often perceive the very same problem differently (Houghton & Metcalfe, 2010; Tatham & Houghton, 2011). Disasters of the same type may require completely different responses. For example, while a 7.1 magnitude earthquake in Haiti resulted in about 230,000 deaths, an 8.8 magnitude earthquake in Chile, which is 350 times more powerful, resulted in 800 deaths due to huge variances in the pre-disaster status of the two countries (Tatham & Houghton, 2011). Therefore, the magnitude of the required disaster response depends to a great extent on the amount of preparedness of a certain community for potential disasters.

Community preparedness works when disaster stakeholders collaborate on both the institutional and individual levels (Telfair LeBlanc et al., 2019). However, cross-agency collaboration itself can be identified as a wicked problem as each stakeholder tries to positively contribute to the whole while faithfully adhering to the interests of their own agency (Waardenburg et al., 2020). Nevertheless, Cabrera and Cabrera (2015) commented that "*interdisciplinarity is important because wicked problems do not respect disciplinary boundaries… Our lack of understanding of how knowledge is created is deeply rooted in our excessive focus on all allegiance to informational content over cognitive structure*" (p. 113). This realisation prompted the idea of exploring a multi-disciplinary approach to disaster education that acknowledges the heterogenous nature of disaster response. Consequently, a disaster healthcare curriculum targeting combined groups of emergency managers and health professionals has been investigated. The aim of the suggested curriculum framework is to strengthen shared understanding and interpersonal relationships between the two sectors. Therefore, the third research question was refined and re-phrased as:

Q3. Can educational curricula be designed to improve mutual understanding and communication between emergency managers and health professionals and what features should these curricula have?

Overall, the research questions touch on the human and technical aspects of communication. Therefore, answers to these questions can be integrated conceptually

and practically to offer a framework for communication in disasters that delivers improved healthcare.

1.4 Significance of the study

Disasters are increasing in both frequency and intensity (Dominey-Howes, 2015) possibly due to the effects of climate change, urbanisation, population growth, and an increase in the proportion of vulnerable societal sectors (FitzGerald et al., 2017). According to the Centre for Research on the Epidemiology of Disasters (CRED), at least 396 natural disasters were reported in 2019 killing 11,755 people, affecting 95 million others and costing nearly US$130 billion (Centre for Research on the Epidemiology of Disasters [CRED], 2020). In New Zealand, the risks of natural disasters are exceptionally high. Statistics (Insurance Council of New Zealand, 2014) show that over the next 50 years, there is a 30% chance of a magnitude 8 earthquake on the Alpine fault, a 50% chance of an earthquake sequence similar to the one that hit Napier (1931) and Wellington (1942), and almost a 100% chance of a central North Island volcanic eruption. There is also a 1-in-20 chance of a volcanic eruption in Auckland. Figure 1.1, below, shows the global increase in natural disaster incidents over the period 2000 – 2019 according to Statista.com (Statista, 2020). In the months prior to the writing of this thesis, tens of millions have been infected by the novel coronavirus worldwide, and the death toll has reached hundreds of thousands (Worldmeter, 2020). These statistics, and the devastating social and economic impacts they represent, emphasise the need to be better prepared for potential disasters.

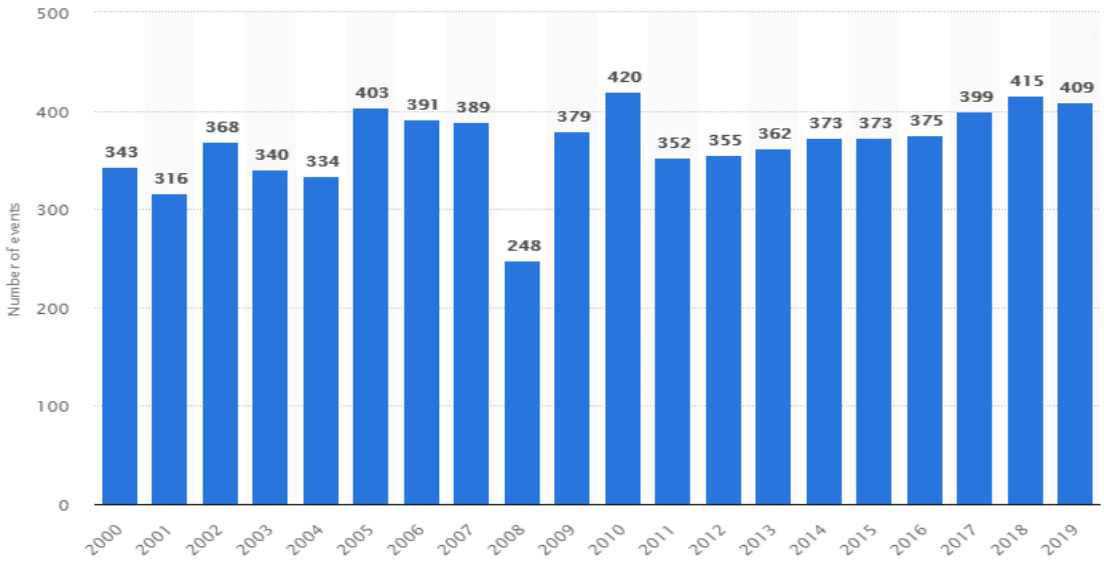


Figure 1.1 Annual number of natural disaster events globally from 2000 to 2019
(Statista, 2020)

The enormous scale, complexity, and destructive power of disasters (Al-Shaqsi et al., 2013) has stimulated international calls to action emphasising the need to take measures to reduce the impact of disasters. In 2015, the United Nations (UN) adopted the Sendai Framework for Disaster Risk Reduction with the goal of reducing the risk of human-made and natural hazards. The Sendai Framework is designed specifically to achieve a substantial reduction of disaster risk and loss of life, livelihoods, and health (United Nations [UN], 2015). The goal of this research is consistent with that of the Sendai Framework: reducing the devastating impacts of disaster through quality and cost-effective provision of healthcare to disaster victims.

Factors such as socioeconomic status, access to healthcare, employment, and physical environment are influencers of health (Artiga & Hinton, 2019). Therefore, effective provision of healthcare in disasters is not restricted to the scope of the health sector (Pourhosseini et al., 2015). In fact, it requires a close relationship among various disaster stakeholders. However, post-event analysis exposes frequent failures of communication (Russo, 2011) that ultimately leads to substandard, inappropriate and sometimes unavailable healthcare. This research aims at contributing to the enhancement of cross-agency communication and information exchange with a core interest in disaster healthcare.

1.5 Related publications

The book chapter, journal article, and conference papers listed below were published during the course of study towards the doctoral degree.

Madanian, S., Abbas, R., & Norris, T. (in press). Mobile technologies in disaster healthcare: Technology and operational aspects. In N. Wickramasinghe (Eds.), *Optimizing health monitoring systems with wireless technology*. Hershey, PA: IGI Global.

Abbas, R., Norris, T., Parry, D., & Madanian, S. (2016). *Disaster e-Health and interagency communication in disaster healthcare: A suggested road map*. Paper presented the meeting of Health Informatics New Zealand (HINZ), Auckland, New Zealand (Awarded Best Student Paper).

Disaster e-health (DEH) is a new discipline that lies at the intersection of disaster management, disaster medicine, and e-health. A roadmap to address the issues that arise when a disaster occurs are suggested in this piece of work. The knowledge presented in this paper has influenced the choice of methodology used in the study and the formulation of the research questions.

Abbas, R. & Norris, T. (2018). *Inter-agency communication and information exchange in disaster healthcare*. Paper presented at the 15th International Conference on Information Systems for Crisis Response and Management (ISCRAM), Rochester, NY.

Key issues that hinder smooth communication and information exchange across disaster response agencies are presented in this paper. The paper is informed by the feedback from the semi-structured interviews conducted with decision-makers in key disaster response agencies. These issues are presented in detail in Chapter 4.

Abbas, R., Norris, T., & Parry, D. (2018b). Pinpointing what is wrong with cross-agency collaboration in disaster healthcare. *Journal of the International Society for Telemedicine and eHealth*, 6(1), 1-10.

This journal article is an extension of the issues identified in the paper on “Inter-Agency Communication and Information Exchange in Disaster Healthcare” paper. The article refines the findings and categorises the identified issues into five main themes.

González, J., et al. (2018). *Towards disaster e-health support systems*. Paper presented at the 15th International Conference on Information Systems for Crisis Response and Management, Rochester, NY.

This paper discusses intelligent adaptation to the changing disaster scenarios in terms of the management and presentation of information, and highlights the characteristics of DEH support systems. These characteristics are further discussed in section 7.2.4.

Abbas, R., Norris, T., & Parry, D. (2018). *Disaster healthcare: An attempt to model cross-agency communication in disasters*. Paper presented at the Information Systems for Crisis Response and Management Asia Pacific (ISCRAM Asia/Pacific) Conference, Wellington, New Zealand.

This paper presents an attempt to come up with a 'best-practice' model for cross-agency communication. At that stage of the research, the mode of thinking was to re-think cross-agency communication flow. However, this task is controversial due to the dynamic nature of disasters which does not comply with a particular structure of communication flow. It was later thought that making incremental changes to already existing models is more practical and acceptable. This is discussed in detail in section 7.2.1.

The following three presentations were delivered at HINZ Conferences in 2018 and 2019 and the ISCRAM Asia/Pacific conference in 2019.

Abbas, R., Norris, T., & Parry, D. (2018). *Disaster healthcare communication: Towards a national structured information exchange system*. Presented at the Health Informatics New Zealand HINZ Conference, Wellington, New Zealand.

The presentation discusses the possibility of identifying a baseline for the information requirements of disaster response agencies upon which a national structured information system may be built. The MDS identified in Chapter 5 would demonstrate the value of the suggested system. Implementation considerations of the suggested structured information system are discussed in section 7.2.4.

Abbas, R., Norris, T., & Parry, D. (2018). *Improving information exchange in disaster healthcare: Is a minimum dataset a viable approach?* Presented at the Information Systems for Crisis Response and Management Asia Pacific 2018 Conference, Wellington, New Zealand.

The construct of the identified disaster MDS was presented and the viability of the MDS approach in striking a balance between information adequacy and overload was discussed. Section 7.2.4 discusses the viability of the MDS.

Abbas, R., Norris, T., & Parry, D. (2019). *Disaster healthcare education: A suggested curriculum framework.* Presented at the Health Informatics New Zealand HINZ Conference, Hamilton, New Zealand. (Awarded Best Quickfire Presentation.)

In this presentation, an attempt to design a framework for a disaster healthcare curriculum targeting combined groups of disaster managers and health professionals was discussed. The suggested framework is discussed in section 7.3.2.

1.6 Thesis structure

The thesis is structured into eight chapters that explore the problem of cross-agency communication and information exchange in disasters from a healthcare perspective. Of the eight chapters, three present the findings of the research.

The present chapter, Chapter 1, sets the scene with the rationale, aim and objectives, and significance of the study. In addition, the chapter explains the formation of the research questions and how the questions evolved over the course of the study. Articles published during the course of the study are presented to engage the reader with the researcher's mentality and the way the current body of work has been conceptualised.

Chapter 2 reviews disaster healthcare through a collaborative lens. Basic concepts of disasters are reviewed including their types, management, and health dimensions. The chapter also discusses the vital role of information and communication technologies (ICTs) in disseminating information and delves into aspects of information sharing. Finally, communication, collaboration and the coordination of disaster management from a healthcare perspective are reviewed.

Chapter 3 discusses the research framework, the methodology followed, and the tools used to investigate the three research questions.

Chapter 4 presents the findings of the semi-structured interviews conducted with disaster response professionals regarding the key issues that impact cross-agency communication and information exchange in disasters.

Chapter 5 presents the results of a Delphi study conducted to seek experts' evaluation of an MDS containing datasets deemed critical for disaster response by emergency managers and health professionals.

Chapter 6 presents the results of the second and final part of the Delphi study that aimed at seeking experts' opinions about a suggested framework for a disaster healthcare curriculum targeting combined groups of emergency managers and health professionals.

Chapter 7 discusses the research findings in light of the three research questions and offers a communication framework for enhancing disaster healthcare.

Finally, Chapter 8 concludes the thesis, suggests recommendations, presents the limitations of the research, and suggests areas for future research.

Chapter 2 Literature Review

2.1 Scope of review

The topic of this research encompasses a wide array of disciplines including emergency management, emergency and disaster medicine, information management, and ICTs, in addition to social sciences and psychology. Communication alone is a discipline that can be considered from multiple social and technical aspects. Each of these aspects can be used to explore more specialised areas of this multifaceted research topic. Hence, this literature review did not finish in the first year of the study. It was an ongoing process that was sometimes carried out simultaneously with other phases of the research. The focus of the literature review was not on the breadth of the articles that covered the topic, but rather on the areas that are most closely related to the problem being investigated. Despite the natural tendency to identify more recent resources, the timeline considered was flexible, spanning between 2000 and 2019 but concentrating on the period 2016-2019. Section 3.5.1 explains the methodology followed in conducting the literature review.

This chapter starts by introducing disaster definitions, types, and key related concepts. To view disasters through an international lens, the Sendai Framework for Disaster Risk Reduction is presented. The review then focuses on core aspects of the research; disaster management, disaster medicine and information exchange. Sections 2.6, 2.7, and 2.8 explain the concepts of disaster management, disaster medicine and the educational and training dimension of each. The content of educational curricula for both disciplines are reviewed, and current educational approaches are presented. Delving towards the focus of the research, the role of ICTs in both clinical and general support is explained including a review of DEH, a new discipline that aims at utilising ICTs to enhance disaster healthcare. The review finally arrives at the research problem: cross-agency communication and information exchange in disaster healthcare. Section 2.10 reviews the activities necessary for a coordinated delivery of healthcare services to disaster victims: communication, collaboration and coordination. These activities are built upon information exchange between response agencies. Hence, the chapter finishes with a review of the storage and exchange of health information including

interoperability aspects such as data standards without which any effort to enhance information exchange cannot be implemented.

2.2 Definition of a disaster

There exist multiple definitions of the term ‘disaster’ (Shaluf, Ahmadun, & Mat Said, 2003) reflecting the different political, geographical and economic considerations of the affected countries (Eshghi & Larson, 2008). A disaster is defined as a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources (Guha-Sapir et al., 2017). The Centre for Research on the Epidemiology of Disasters (CRED) defined a disaster as “a situation or event that overwhelms local capacity, necessitating a request at the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering” (CRED, n.d.). According to CRED, an event qualifies as a disaster if it fulfils one of the following criteria: 10 or more people are reported killed; 100 or more people are reported affected, injured, and/or homeless; the government declares a state of emergency; or the government requests international assistance.

These and other definitions all agree that the common element of all disasters is the inability of the local affected community to respond independently (Goyet, Marti, & Osorio, 2006).

The terms ‘emergency’ and ‘disaster’ are often used interchangeably. An emergency is defined as a situation involving immediate risks to life or property in which normal activities are suspended and attention is focussed exclusively on measures to save lives, protect people, limit damage and return conditions to normal (D. Alexander, 2005). However, emergencies do not necessarily cause a serious disruption of the functioning of a community or society (United Nations International Strategy for Disaster Reduction [UNISDR], 2009b).

2.3 Types of disasters

Disasters are classified into two main categories: natural and human-made. Human-made disasters are defined as disastrous events caused directly and principally by one

or more identifiable deliberate or negligent human actions ("Human-made disaster," 2019). This category includes industrial accidents, shootings, acts of terrorism, and incidents of mass violence (U.S. Department of Health & Human Services, 2019). Examples of human-made disasters include the 1986 Chernobyl nuclear power accident, 9/11 attacks in the United States, 2005 London bombings, and armed conflicts. Natural disasters, on the other hand, are sudden ecological disruptions or threats that exceed the adjustment capacity of the affected community (Reinhardt & Gosney, 2015). Natural disasters include earthquakes, floods, drought, wildfires, and storms (D. C. Alexander, 2017).

According to the Intergovernmental Panel on Climate Change (IPCC), there is an increasing probability that natural disasters occur due to climate change (Field, Barros, Stocker, & Dahe, 2012) which is expected to cause an increase in both frequency and severity of weather events (Banholzer, Kossin, & Donner, 2014). The increase in the number of natural disasters may also be due, in part, to increased reporting over the years. Figure 2.1, below, shows the dramatic increase in the number of natural disasters

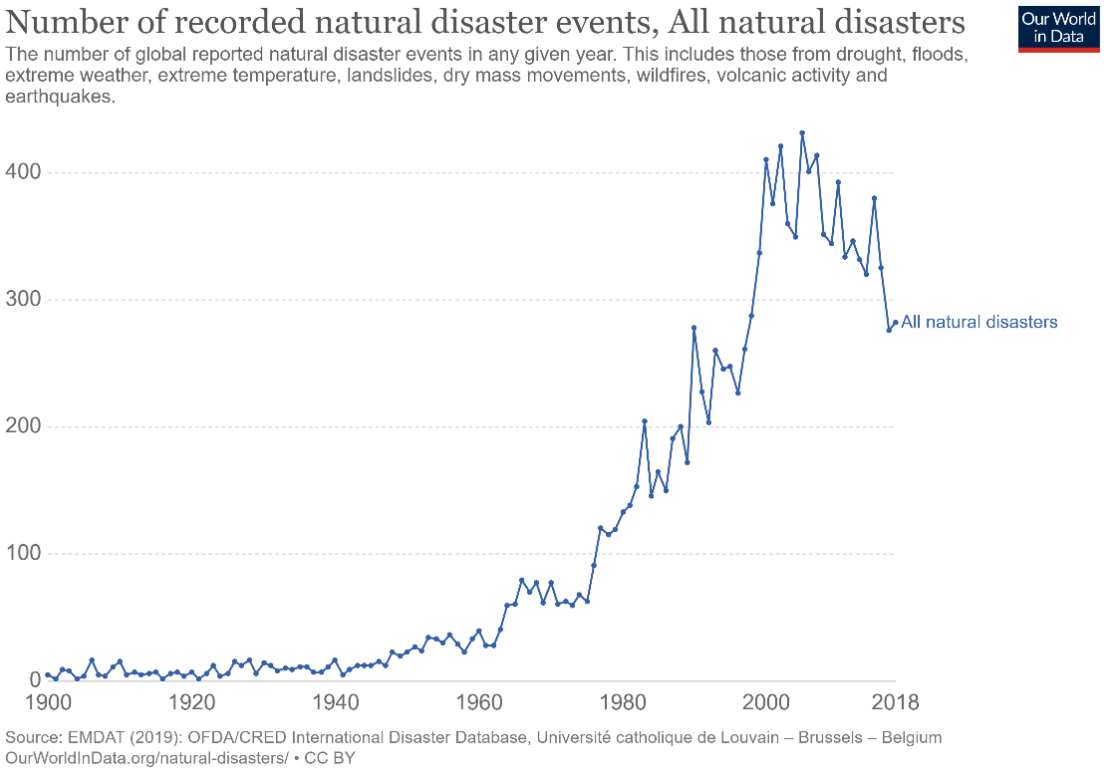


Figure 2.1 Number of natural disasters 1900 - 2018
(CRED, 2019)

In 2018, 315 natural disaster events resulted in 11,804 deaths, with over 68 million people affected, and US$131.7 billion in economic losses across the world (CRED, 2019). In New Zealand, the 2011 Christchurch earthquake of magnitude 6.3 resulted in 182 deaths and 6,659 injuries in its first 24 hours (Beaglehole, Bell, Frampton, & Moor, 2017). The total cost of rebuilding the city of Christchurch has been estimated at NZ$40 billion (Wood, Noy, & Parker, 2016). The rebuild project was described by the Prime Minister of New Zealand at the time as the largest and most complex project in the history of the country ("Investing in Christchurch 'doesn't stack up'," 2013).

The damage caused by disasters could be direct or indirect. While direct damage refers to quantifiable losses such as deaths, illnesses, and destruction of critical infrastructure (e.g., medical facilities and schools), indirect damage negatively impacts basic needs including safe drinking water, adequate hygiene, reliable food, and shelter (Keating et al., 2017).

Disaster costs have seen a steady increase over the last 40 years (National Emergency Management Agency [NEMA], 2019). According to UNISDR, the current average cost of natural disasters ranges from US$250 billion to US$300 billion per year and is expected to reach US$314 in the future for all hazard types (UNISDR, 2015). These data demonstrate the enormous humanitarian and economic effects of disasters. In fact, disaster losses are expected to be much higher due to the difficulty associated with quantifying indirect losses (Global Facility for Disaster Reduction and Recovery [GFDRR], 2014). The following section explains key concepts necessary for understanding disaster impacts.

2.4 Key concepts of disasters

Clear definitions of disaster-related terminology are essential for understanding disasters and their impacts. A report to clarify disaster terminology has been produced by the United Nations' open-ended intergovernmental expert working group on indicators and terminology (United Nations [UN], 2016). In February 2017, the report was adopted by the United Nations General Assembly. This section uses the United Nations (UN) and the International Disasters Database (EM-DAT) definitions to explain basic concepts in the disaster domain.

2.4.1 Hazard

A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards could be biological, environmental, geological, hydro- meteorological or technological processes and phenomena. Hazards are classified into the following three categories:

Natural hazards

Hazards that are affiliated with natural phenomena or processes.

Anthropogenic hazards

Human-induced hazards (except for armed conflicts and social turbulence).

Socio-natural hazards

A combination of both natural and anthropogenic causes.

The occurrence of a hazard in a certain place and at a certain time is referred to as a hazard event. Hazard events, characterised by location, intensity, frequency or probability, may lead to disasters depending on other risk factors. For example, 45% of disasters in 2018 occurred in Asia due to its higher population, large land mass and multiple hazard risks (CRED, 2019).

2.4.2 Exposure

Exposure is the location of people, infrastructure, housing, production capacities and other tangible human assets in hazard-prone areas. Drivers behind concentrating people and assets in unsafe areas include population growth, economic development, migration, and urbanisation (UNISDR, 2009a).

2.4.3 Vulnerability

Vulnerability refers to the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of individuals, communities, assets or systems to the impacts of hazards. Factors that impact vulnerability include demographic growth, settlement in unsafe areas, rapid urbanisation, environmental degradation, climate change, unplanned development, age, gender (this is debatable), and poverty (Buvinic, 1999; Goyet et al., 2006; UNISDR,

2009b). A New Zealand study into poverty revealed that among the most vulnerable are people with disabilities, ethnic minorities, and Māori and Pacific peoples (Plum, Pacheco, & Hick, 2019). Globally, indigenous peoples are among the most marginalised peoples, and the most likely to suffer serious and extreme impacts of natural disasters (Fowler, 2017).

2.4.4 Risk

Risk is defined as the potential risk, loss of life, or damaged or destroyed assets which could occur to a system, society or a community in a specific period of time. Risk is determined probabilistically as a function of hazard, exposure, vulnerability and capacity. It represents the possibility, likelihood, and consequences of a hazard occurrence (Smart, n.d.). However, in the absence of exposure, the existence of a hazard does not represent a risk (GFDRR, 2014). Risk results from the interaction between hazard, exposure, and vulnerability (Field et al., 2012). Figure 2.2, below, illustrates the relationship between factors that influence risk and the determinants of direct damage.

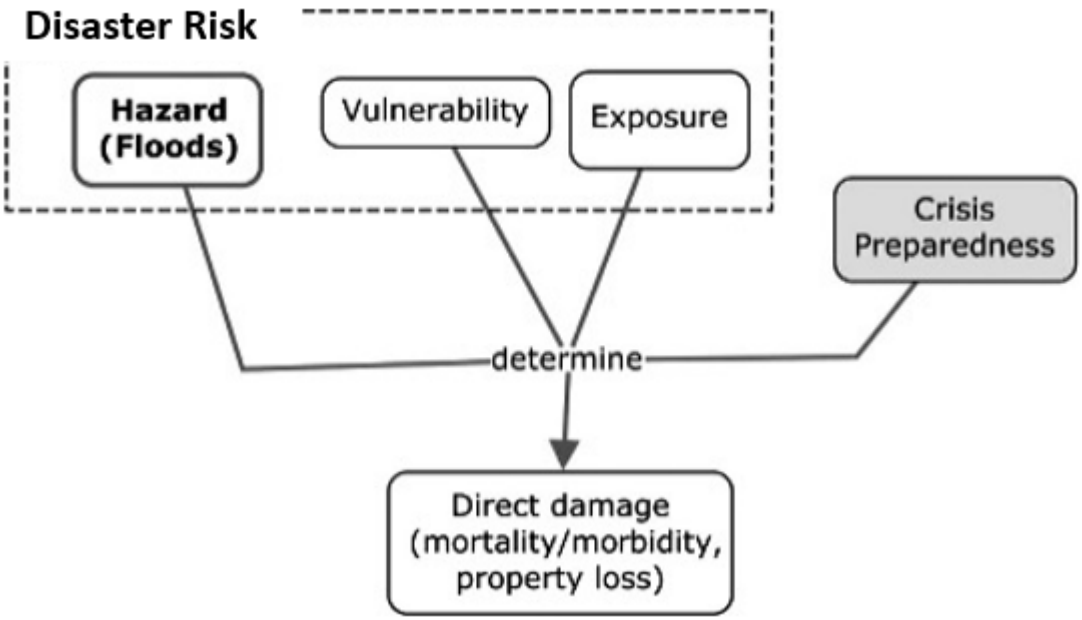


Figure 2.2 Factors influencing disaster risk and determinants of direct damage
(Keating et al. 2017)

Disaster risk reduction (DRR) refers to reducing disaster risks through systematic analysis and reduction of the factors that cause disasters (UNISDR, 2015). A risk that

remains despite having risk reduction measures in place is referred to as residual risk and it implies the need for continuous emergency services (UNISDR, 2009b).

2.4.5 Resilience

Resilience is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner. Political, social, and financial capitals impact a community's resilience to disasters (Himes-Cornell et al., 2018). Consequently, resilience strategies focus on empowering local government and leaders, promoting local disaster education, raising community awareness and investing in infrastructure and communication (Cai et al., 2018). In New Zealand, the national disaster strategy highlights the importance of community engagement and the inclusion of societal sectors that may be disproportionally affected by disasters (NEMA, 2019).

2.5 The Sendai framework for disaster risk reduction

In recent years, global awareness around the importance of adopting a proactive approach towards disaster management has increased. Investment in proactive measures, especially community health and resilience, was found to be cost-effective both financially and in terms of human loss (Institute of Medicine of the National Academies, 2015). In 2015, a major global agreement on proactive disaster management resulted in the development of the United Nations' Sendai Framework for Disaster Risk Reduction with the goal to:

> prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience. (United Nations [UN], 2015, p. 12)

Targets of the Sendai framework include achieving a substantial reduction in global disaster mortality, number of affected people, economic loss in relation to GDP, damage to critical infrastructure and service disruption. In addition, the Sendai Framework targets a substantial increase in the number of countries with local and national disaster risk reduction strategies by 2020, international cooperation with

developing countries, and the availability of early warning systems and DRR information (United Nations [UN], 2015). An early warning system is preparation for and, consequently, a reduction of the impact of adverse events by using ICTs to activate response systems (Waidyanatha, 2010).

2.6 Disaster management

Disaster management is defined as the organisation and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies. In particular, disaster management deals with preparedness, response and recovery in order to lessen the impact of disasters (IFRC, n.d.-a). D. Alexander (2003) defined emergency management as "the process of coordinating an emergency or its aftermath by communicating with participants and organising the deployment and use of emergency resources" (p. 118). However, unlike emergencies, disasters exceed the ability of the affected community or society to cope using its own resources. As mentioned in section 2.2, the terms 'emergency management' and 'disaster management' are often used interchangeably. Coppola (2006), Haddow, Bullock, and Coppola (2013), Lindell, Prater, and Perry (2006), Phillips, Neal, and Webb (2016) all addressed disaster concepts without making a distinction between emergency management and disaster management.

A disaster consists of consecutive phases, namely mitigation, preparedness, response, and recovery. These phases constitute the Disaster Management Cycle (DMC). In New Zealand, DMC phases correspond to four activities known as 'The 4 Rs'; reduction, readiness, response and recovery. Table 2.1, below, explains each stage of the DMC as per the Centre for Disaster Philanthropy (Center for Disaster Philanthropy, n.d.) and compares it to its corresponding activity defined by the New Zealand National Emergency Management Agency (NEMA, n.d.-a).

Table 2.1 The four stages of the disaster management cycle

Mitigation Preventing future emergencies or minimising their negative effects.	**Reduction** Identifying and analysing long-term risks to human life and property from hazards; taking steps to eliminate these risks if practicable, and, if not, reducing the magnitude of their impact and the likelihood of them occurring.
Preparedness Disaster preparedness efforts include plans or preparations made in advance of an emergency that help individuals and communities get ready.	**Readiness** Developing operational systems and capabilities before a civil defence emergency happens; including self-help and response programmes for the public, and specific programmes for emergency services, lifeline utilities and other agencies.
Response Disaster response work includes any actions taken during or immediately following an emergency, including efforts to save lives and to prevent further property damage. Ideally, disaster response involves putting already established disaster preparedness plans into motion.	**Response** Actions taken immediately before, during or directly after a civil defence emergency to save lives and protect property, and to help communities recover.
Recovery Disaster recovery happens after damage has been assessed and involves actions to return the affected community to its pre-disaster state or better – and ideally, to make it less vulnerable to future risk.	**Recovery** The coordinated efforts and processes to bring about the immediate, medium-term and long-term holistic regeneration of a community following a civil defence emergency.

2.7 Disaster management education and training

Recognition of the significance of disaster education began with the start of the International Decade for Natural Disaster Reduction in the 1990s (Sakurai & Sato, 2016). In 2000, the United Nations' World Disaster Reduction campaign introduced the "Disaster Reduction, Education and Youth" theme. This theme was fundamental to the 2005-2015 Hugo Framework that aimed at reducing disaster impacts. Awareness and recognition of the significance of disaster education continued until it became fully integrated in the Sendai Framework for Disaster Risk Reduction 2015 -2030 (United Nations [UN], 2015). 'Disaster education' and 'disaster training' are often used interchangeably. Nevertheless, each one of them aims at a different outcome. Disaster training aims at preparing participants for filling a specific disaster-related role, whereas educational courses are designed to increase participants' understanding about disasters without necessarily preparing them for specific roles (D. Alexander, 2003).

2.7.1 Disaster management education

Successful implementation of disaster education reduces the impact of disasters and results in resilient societies (Torani, Majd, Maroufi, Dowlati, & Sheikhi, 2019). The effectiveness of disaster education requires an implementation of educational schemes that guarantee the inclusion of vulnerable groups including the elderly, people with disabilities, and children. For example, the Sendai Framework for Disaster Risk Reduction is reproduced in a child-friendly version for children aged 10 to 14 years of age. It is believed that when school students are educated about disaster risk reduction measures, they can be involved in problem-solving, the assessment of vulnerability and capacities, and the dissemination of disaster information across their families and communities (Izadkhah & Hosseini, 2005), hence contributing to the resilience of their communities. In Bangladesh, schools were able to develop risk reduction strategies and contingency plans benefiting tens of thousands of children.

Disaster education can be implemented formally or informally. While informal approaches adopt a fun way of delivering disaster knowledge to students, formal education requires considerable effort and time in developing the required curriculum. A curriculum, defined as a planned educational experience on a specific subject, can

last for one or more sessions or up to a year-long course (P. A. Thomas, Kern, Hughes, & Chen, 2016). Formal disaster education can be delivered in one of three modes: extra-curricular integration, curriculum integration, or curriculum infusion (Petal & Izadkhah, 2008).

Extra-curricular integration

Extra-curricular integration is an approach that facilitates delivery of disaster education in schools. In New Zealand, the National Emergency Management Agency (NEMA), has facilitated disaster education in schools by creating a free resource to help both teachers and students develop disaster knowledge and preparedness skills (NEMA, n.d.-c).

Curriculum integration

Curriculum integration utilises units, modules or chapters on disaster risk reduction designed for inclusion in subjects with known duration in specific grade levels. This approach is relatively easy to implement, although it requires training teachers to ensure competence.

Curriculum infusion

Curriculum infusion is a comprehensive approach that uses lessons, readings, activities and problems in disaster risk reduction.

Disaster education curricula have been criticised for efficacy and clarity. A study (Erdur-Baker et al., 2015) examined the objectives of disaster education curricula from the perspectives of 142 trained teachers. The results revealed that none of the objectives examined were perceived totally as clear, achievable and measurable. To facilitate effective disaster education, The United Nations Educational, Scientific and Cultural Organisation (UNESCO) and The United Nations Children's Fund (UNICEF) published a guide to help ministries of education in integrating disaster risk reduction education in their systems (United Nations Children's Fund [UNICEF], 2014).

Recently, educational approaches have shifted from general disaster information to more context-specific material addressing local hazards and exercises in preparedness and response skills (UNICEF, 2014). In Japan, the way disaster risk reduction is taught at the higher education level has been fundamentally changed. A new method adopts

a multi-disciplinary approach that radically shifts the focus of disaster risk reduction teaching towards nurturing creative problem-solving skills (Leleito, 2018). The multi-disciplinary problem-solving approach is based upon the realisation that building key competencies through transferrable skills is essential for cross-agency collaboration in dynamic contexts. To maximise effectiveness, disaster education lectures should be supported by additional methods such as simulation, gaming, disaster drills, and field visits (UNICEF, 2011).

2.7.2 Disaster management training

According to the IFRC, the aim of disaster management training is to improve technical skills and personnel and team management. In addition, disaster management training aims at encouraging knowledge and experience sharing, creating networks amongst disaster managers, improving the coordination of disaster response, and enhancing the availability and quality of disaster management tools (IFRC, 2019). The unsolicited group dynamics created among participants during joint multi-agency training is a factor that facilitates learning among trainees (Van Haperen, 2001). Moreover, joint training can be a tool for resolving fundamental cultural differences that exist between different disaster response agencies. Cultural differences were manifested between emergency managers and decision-makers with limited training in emergency management during the response to Hurricane Katrina. As a consequence, a workshop has been conducted to identify common educational goals between the two groups (Waugh Jr & Sadiq, 2011).

Training programmes not only enhance the dexterity of individuals, they also improve the overall performance of organisations (Kumar & Siddika, 2017). However, the design and delivery mode of such programmes are of immense significance to their outcomes (Khan, Khan, & Khan, 2011). The design of disaster training curricula needs to be evidence-based and informed by industry needs (Britton, 2004; Burkle et al., 2013; Hemstock et al., 2016; Kapucu, 2011). In 2017, generic standards for emergency and disaster management education in Australia were published (FitzGerald et al., 2017). The standards were built upon three domains: knowledge, skills, and application. The knowledge domain consists of three themes: governance and policy frameworks, theoretical and conceptual basis for practice, and contemporary disaster management. The skills domain consists of three themes: leadership, communication

and collaboration. The third domain, the application domain, consists of professional practice and critical thinking. The themes of the three domains are illustrated in Figure 2.3, below.

Figure 2.3 Domains of the generic emergency and disaster management standards (FitzGerald et al., 2017)

Standards are critical for the accreditation of emergency management programmes, and for transforming the field into the fully-fledged profession it vitally needs to become (Crews, 2001; Waugh Jr & Sadiq, 2011). In addition, standards facilitate the promotion of international learning, exchange and comparability among emergency workers (D. Alexander, 2005).

The content of emergency and disaster management curricula used to train future and mid-career emergency managers are debated (Waugh Jr & Sadiq, 2011). A thorough literature review revealed that the topics of these curricula vary depending on the agencies' roles and mission statements. The multidisciplinary nature of emergency management and the uncertainties associated with any given disaster event explain the wide spectrum of topics that needs to be visited when training emergency and disaster responders. However, there seems to be a general agreement on the inclusion of the definitions of disaster terminology such as hazards, risks and vulnerabilities, and basic concepts including disaster types, lifecycle, etc. These topics include but are not limited to:

- Basic concepts including types of disasters, types of emergencies and their associated requirements, key disaster concepts such as hazards, risks, and vulnerability, disaster lifecycle, and disaster terminology (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; A. Norris et al., 2018).

- Leadership and communication aspects including managing interpersonal relations in emergency and disaster situations, problem-solving skills, psychological perception of disasters, negotiation and conflict resolution, mass media liaison and public relations (D. Alexander, 2005; Grant, 2018; A. Norris et al., 2018).
- Use of ICTs in emergencies and disasters including the use of social media, big data and analytics, e-health technologies, communications systems during crises and disasters, and the role of revolutionary technologies such as the 'tsunami of smallsats' in disaster management (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; A. Norris et al., 2018).
- Legal and ethical considerations in emergency management, and knowledge of policy and regulatory dimensions related to emergencies (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; A. Norris et al., 2018).
- Planning aspects including the ability to write, modify and integrate emergency plans, conduct scenario exercises, perform damage assessment, and provide medical, epidemiological, veterinary and psychosocial services (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; A. Norris et al., 2018).
- Understanding of incident management systems, command-and-control processes, organisational structures, roles and responsibilities, and risk management (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018).
- The ability to communicate and collaborate with all stakeholders involved in the management of a disaster including governmental and non-organisations, volunteers, and local communities (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018).
- Knowledge management including library research, use of online resources, and knowledge about how and where to find relevant mobile applications that provide health-related information for facilitating planning for, the response to, and recovery from the consequences of disasters (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018).
- Understanding the international disaster community, including their roles and responsibilities and the information and services they may provide before, during and after disasters. This is in addition to learning from previous events

through presentation, discussion, and analysis of different disaster scenarios both national and international (D. Alexander, 2005; DisasterInfo, 2019).

In New Zealand, content of emergency management training offered by the NEMA is built upon the standard framework used to manage incidents requiring the response of multiple agencies, namely the Coordinated Incident Management System (CIMS) (see section 2.10.3). There are four training levels: foundation, intermediate, coordination centre interface (CCI), and function-specific. The foundation level is an interactive training session that introduces CIMS principles, structure and terminology and the general context of emergencies. The intermediate level focuses on how CIMS is used within a coordination centre. The CCI level contains additional information about CIMS. Lastly, the function level varies in duration and is tailored to specific functions such as logistics, welfare, civil defence centres, and public information management. Additional functions including planning, intelligence, operations, lifeline, recovery and finance are being considered (NEMA, n.d.-b).

Implementing disaster education curricula at the undergraduate level is usually challenged by over-saturation of curricula whereas, at the postgraduate level, programmes can be tailored to the needs of professionals (Franc, Nichols, & Dong, 2012). Disaster education can also be implemented through short courses that, although not as powerful in terms of career progression, can be customisable to the intended audience and can reach a wider range of professionals (Norris et al., 2018).

Courses can be delivered face-to-face with hands-on experience or electronically with the aid of virtual reality simulations (Pfenninger et al., 2010) which may be no less effective than traditional face-to-face delivery modes (McCutcheon, Lohan, Traynor, & Martin, 2015).

According to D. Alexander (2005), training courses should last a minimum of 200 hours for beginners aiming to become general emergency managers, and 50 hours for trained emergency managers whose aim is to improve or update their knowledge, and such courses may take any of the above delivery modes or both.

2.8 Disaster medicine

The foundation of the literature defining disaster medicine is attributed to the efforts of the Swiss physician and forensic pathologist Heinrich Zangger in responding to civilian mine explosions at the beginning of the 20th century (Suner, 2015). Disaster medicine is a medical practice that focuses on the health, medical, and emotional issues of disaster casualties (Hogan & Burstein, 2007). It is defined as the art and science of patient care under circumstances of stress when the number of patients exceeds the normal capacities i.e. during a sudden concentration of casualties that overwhelms the existing medical facilities (R. K. Brown, 1966). Disaster medicine is associated with a broad range of specialities. The American College of Emergency Physicians defines emergency medicine as the medical specialty dedicated to the diagnosis and treatment of unforeseen illness or injury. It includes the initial evaluation, diagnosis, treatment, coordination of care among multiple providers, and disposition of any patient requiring expeditious medical, surgical, or psychiatric care (American College of Emergency Physicians, 2015).

Disaster medicine is also concerned with the preparation, planning, response, and recovery of disaster-related medical needs throughout the disaster lifecycle (Hawley & Matheson, 2010). Hence, the discipline is also associated with disaster management. In fact, disaster medicine is sometimes defined as a discipline resulting from the marriage of emergency medicine and disaster management (Ciottone, 2016). Bradt, Abraham, and Franks' conceptual framework for understanding disaster medicine (see Figure 2.4) visualises the discipline at the intersection of the three disciplines of clinical medicine, disaster management, and public health (Seynaeve et al., 2004). Although both disaster management and disaster medicine have roots in military organisations (Suner, 2015), the tasks of managing disasters and providing medical care to the victims have evolved to come under the responsibility of civilian and governmental organisations. Developments in the field took place during the 1960s and 1970s in West Germany (Stehrenberger & Goltermann, 2014).

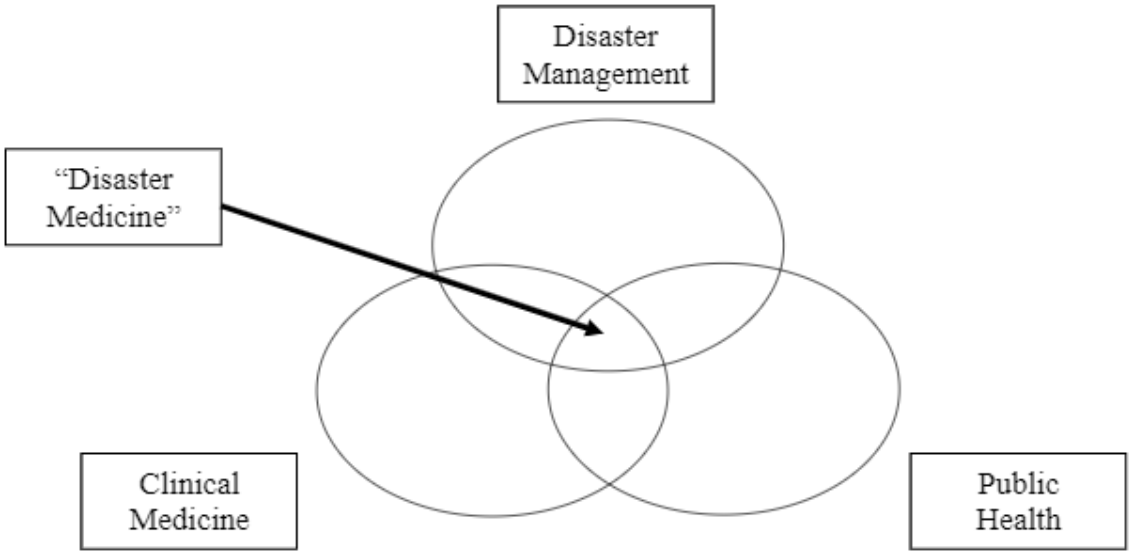


Figure 2.4 Conceptual frameworks for understanding disaster medicine
(Seynaeve et al., 2004)

2.8.1 Key concepts in disaster medicine

Disaster medicine is unique in that it caters for individual disaster survivors, and simultaneously considers recovering from the disaster and planning for future events, thus catering for the healthcare status of the affected population as a whole (Peleg, 2013). The challenges associated with disaster management for both individual and whole population needs require substantial preparedness and training (Peleg, 2013).

The following section explains important terminology necessary for understanding disaster medicine.

Disaster healthcare

Disaster healthcare or disaster healthcare management is a systematic process that utilises organisational, administrative, and operational decision-making capacities and skills to reduce the negative impacts of disasters and improve healthcare provision to disaster victims (Ardalan et al., 2009).

Disaster behavioural health

Disaster behavioural health concerns the application of psychological first aid to help individuals affected by disasters overcome the initial psychological impacts of a disaster event including shock, depression, and denial (Florida Health, 2019).

Medical contingency planning

Medical contingency planning concerns examination of current resources, projected medical needs, management guidelines, and personnel training (Weisdorf et al., 2006).

Medical surge

A medical surge is an influx of patients (physical casualties and psychological casualties), bystanders, visitors, family members, media and individuals searching for the missing who present to a hospital or healthcare facility for treatment, information and/or shelter as a result of a disaster (Shultz et al., 2006).

Surge capacity

Surge capacity refers to the ability, in terms of staff, facilities, and programmes, to deliver medical treatment and healthcare during an unexpected increase in the number of individuals affected by disasters (Sheikhbardsiri, Raeisi, Nekoei-Moghadam, & Rezaei, 2017).

Triage

Triage is the process of sorting patients with the purpose of 'doing the greatest good to the greatest number' when medical resources are insufficient (Haller, Wurzer, Peterlik, Gabriel, & Cancio, 2018; Shiel, n.d.). Different triage systems exist for prioritising patients according to urgency for medical care (Kuriyama, Urushidani, & Nakayama, 2017). The Simple Triage and Rapid Treatment (START) system, for instance, categorises patients into one of four categories: Delayed (Yellow), Immediate (Red), Minor (Green) or Expectant (Black) (Lerner et al., 2008).

2.8.2 Disaster medicine education and training

Having proper education on and training for potential disaster events is becoming increasingly crucial for clinicians and healthcare providers, given the increase in disaster occurrences and the uncertainty about when and where a disaster may happen (Ciottone, 2016). The focus of disaster medicine education is on teaching the competencies needed by clinical personnel (Subbarao et al., 2008). Following the 9/11 terrorist attacks, the Association of American Medical Colleges recommended undergraduate medical training in disaster medicine (Pfenninger et al., 2010). This was followed by an initiative for developing standards and guidelines for disaster medicine

education by the World Association for Disaster and Emergency Medicine (WADEM) (Archer & Seynaeve, 2007). Since then, several institutions have worked on developing disaster medicine competencies, and efforts have been made to integrate these competencies into health professions (Subbarao et al., 2008). Despite these efforts, disaster medicine experts continue to bemoan the low provision of disaster medicine education that leads to situations where health personnel lack even a basic knowledge of disaster medicine (J. Smith, Levy, Hsu, & Levy, 2012).

Competencies are defined as the combination of skills and knowledge necessary to perform a certain task successfully (European Centre for Disease Prevention and Control, 2017). Competencies require contextual measurement and are usually achieved through designing an educational curriculum that involves identifying learning objectives, content and evaluation methods (Walsh et al., 2012). Development of an educational curriculum is a scientific process that involves several stages such as problem identification and general needs assessment, targeted needs assessment, identification of goals and objectives, specification of educational strategies, implementation, evaluation and feedback (P. A. Thomas et al., 2016).

A review of available disaster medicine curricula shows that short in-service courses that can help in reaching a wider group of health practitioners are still lacking (A. Norris et al., 2018). Interestingly, the literature addressing disaster medicine competencies has several intersections with the topics identified in the area of disaster management education. Such intersections include the basics of disaster management, communication skills, incident management systems, and psychological support. Disaster medicine competencies extracted from seven resources produced over the period 2005 – 2019 are shown in Table 2.2.

A critical aspect of disaster medicine education concerns disaster mental health (Math, Nirmala, Moirangthem, & Kumar, 2015). The consequences of disasters may extend beyond initial injuries and loss of lives to serious psychological and mental health issues that may surface years after the occurrence of the disaster (Galea, 2007). The treatment of psychosocial issues such as family separation, loss of property and continued poverty requires the involvement of mental health professionals as well as psychosocial workers (Seto et al., 2019). This blended approach highlights the

criticality of cross-agency cooperation and coordination between disaster response agencies to ensure the effectiveness of mental health interventions in disasters (F. H. Norris, Friedman, & Watson, 2002). Nevertheless, a 2017 study revealed lack of mental health preparedness in the majority of countries, a situation that emphasises the importance of developing context-specific educational programmes (Roudini, Khankeh, & Witruk, 2017).

Table 2.2 Disaster medicine competencies identified in the literature

Competency	**Reference**
Disaster/emergency management and preparedness	(Hawley & Matheson, 2010; Markenson, DiMaggio, & Redlener, 2005; Subbarao et al., 2008; Walsh et al., 2012)
Public health principles	(Council on Linkages, 2014; Walsh et al., 2012)
Public health emergency preparedness, surveillance and response	(Markenson et al., 2005; Pfenninger et al., 2010; Subbarao et al., 2008)
Clinical intervention and patient care for disasters, terrorism, and public health emergencies	(Hawley & Matheson, 2010; Markenson et al., 2005; Pfenninger et al., 2010; Subbarao et al., 2008)
Policy development and programme planning skills, financial planning and management skills, analytical/assessment skills and leadership and cultural competency skills	(Council on Linkages, 2014)
Communication skills	(Council on Linkages, 2014; Hawley & Matheson, 2010; Pfenninger et al., 2010; Subbarao et al., 2008)
Incident management and support systems	(Hawley & Matheson, 2010; Subbarao et al., 2008)
Command and control in the hospital and at the scene, mobile medical teams, press/media training	(Advanced Life Support Group, 2019)
Personal safety and security	(Hawley & Matheson, 2010; Subbarao et al., 2008; Walsh et al., 2012)
Mass casualty triage and psychological triage	(Advanced Life Support Group, 2019; Hawley & Matheson, 2010; Pfenninger et al., 2010)
Public health law and ethics	(Hawley & Matheson, 2010; Pfenninger et al., 2010; Subbarao et al., 2008; Walsh et al., 2012)
Medical contingency, continuity, and recovery	(Subbarao et al., 2008; Walsh et al., 2012)
Coordination, mass casualty management, and evacuation, hospital preparedness plans, and experiences from worldwide disaster assistance	(Pfenninger et al., 2010)

Competency	Reference
Specifics of initial management of explosive, war-related, radiological/nuclear, chemical, and biological incidents emphasising infectious diseases and terrorist attacks, decontamination procedures, stress disorders and psychosocial interventions	(Hawley & Matheson, 2010; Pfenninger et al., 2010)
Medical response to weapons of mass destruction, forensics, situational awareness, and disaster behavioural health	(Hawley & Matheson, 2010)
Roles and responsibilities, surge capacity, and clinical management principles	(Walsh et al., 2012)

2.9 The role of ICTs in disaster healthcare

Disaster healthcare refers to the provision of healthcare services by healthcare professionals to survivors and responders in an area impacted by a disaster as well as at evacuation receiving facilities throughout the disaster life cycle (Bush, 2005). In a medical response, timely access to accurate information can decrease mortality and morbidity (Garshnek & Burkle Jr, 1999). At times of disease outbreaks and pandemics, real-time data collection becomes crucial as decision-making depends to a great extent on the data available only after the start of the outbreak (Callaghan, 2016).

ICTs are crucial for the exchange of information between various disaster response stakeholders (Kotabe et al., 2014). Technology has the potential to accelerate and increase the impact of relief efforts (Yoo, 2018). Humanitarian logistics, for instance, is guided by critical decision-making that relies on the accuracy and timeliness of available information (Ashish et al., 2008). It involves planning, implementation, and control of efficient, cost-effective flow and storage of goods and materials, and associated information, from an origin point to a consumption point, to meet the needs of end beneficiaries (A. Thomas & Mizushima, 2005). In such contexts, connectivity itself is a form of aid as it relays life-saving information and assists with the delivery of critical resources to those who need them (Garshnek & Burkle Jr, 1999).

The reliability of communication technologies is critical to successful disaster management (Arnold et al., 2004). To ensure the effective and reliable use of ICTs in disasters, preparedness efforts should focus on enhancing ICTs' resilience and redundancy, policy development for use during disasters, and the preparation of equipment, sensors and early warning systems, in addition to training and capacity building (Kotabe et al., 2014). In 2011, the Academy of ICT Essentials for Government Leaders published recommendations on the effective use of ICTs in disasters (Asian Disaster Preparedness Center [ADPC], 2011) including:

- Facilitating access by emergency responders to communications
- Conducting drills for information exchange between disaster communication centres and disaster sites
- Familiarising disaster managers with ICT tools

- Involving ICT specialists in post-disaster activities to provide support with the use of ICT tools
- Conducting cross-agency training on the use of ICTs in disasters including social media platforms

The demand for ICTs to perform post-disaster activities, including damage assessment and analysis, cross-agency coordination and building situation awareness, changes over time depending on the stage of response. For example, real-time communication is heavily required in the initial stages of response in order to support time-critical activities such as search and rescue. Figure 2.5 shows the change in demand for ICT services in disasters (Kotabe et al., 2014).

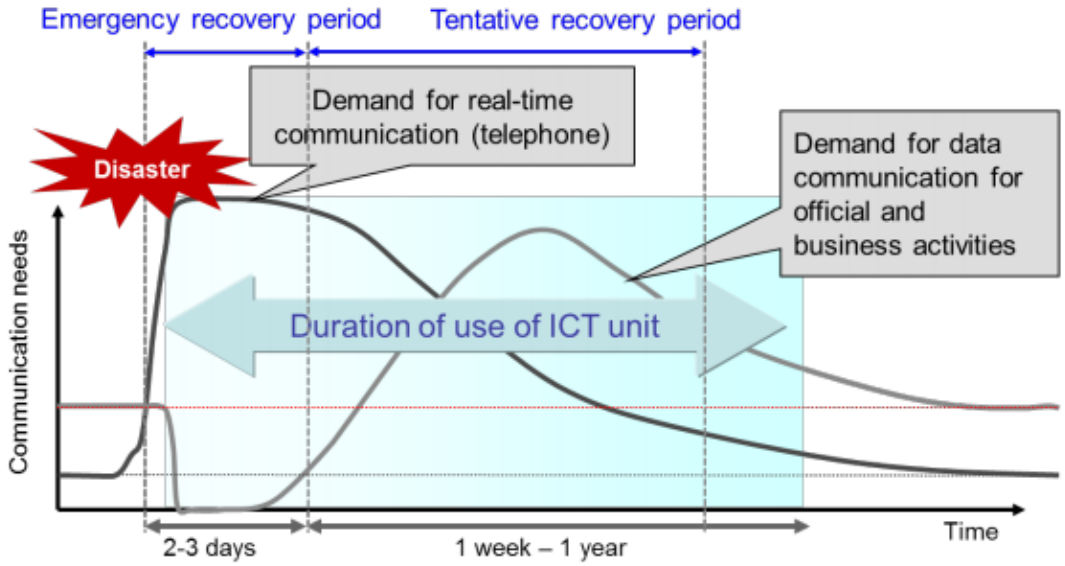


Figure 2.5 Demand for ICTs after a disaster
(Kotabe et al., 2014)

2.9.1 ICTs in direct clinical support (e-health)

E-health refers to health services and information delivered or enhanced directly through the use of the Internet and related technologies (Eysenbach, 2001). As the global demand for a needs-based health workforce approaches 14 million in 2030, the need for scalable cost-effective digital technologies becomes vital ("Next Generation Public Health," 2019). E-health has the potential to transform healthcare systems and improve the quality, accessibility and cost-effectiveness of healthcare services (Ossebaard & Van Gemert-Pijnen, 2016). In particular, the electronic health record, telehealth, and emerging technologies such as artificial intelligence, big data analytics,

the Internet of Things, mobile computing and social media have a huge potential for revolutionising healthcare provision (Wilson, Wang, & Sheetz, 2014).

When implemented and used properly, e-health technologies can provide the healthcare industry with several benefits, including enhanced health information management, timely access to patients' health records regardless of time and geography, better communication between healthcare providers and consumers, and better use of scarce commodities such as healthcare providers (Coiera, 2015).

The ability of e-health technologies to provide remote care where on-site support is lacking (Erikson & Holcomb, 2018) highlights their important role in supporting disaster response (Doarn & Merrell, 2014). Telehealth, for instance, is an e-health component that can facilitate remote healthcare services in disasters. Telehealth concerns the remote delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies (McHaney, Reychev, Azuri, McHaney, & Moshonov, 2019).

Within telehealth, telemedicine uses medical information exchanged from one site to another to improve consumer health status using electronic communications (Demaerschalk et al., 2017). Telemedicine involves at least a clinician at one end of the communication link (Wyatt & Sullivan, 2005). Telestroke, for instance, is a telemedicine service that enables neurologists to remotely communicate with other expertise and resources for the treatment of stroke patients (Demaerschalk et al., 2017). In 2017, the telemedicine industry was valued at US$29.6 billion and is expected to grow at an annual rate of 19% between 2017-2022 due to the increase in chronic diseases incidence, growing geriatric population, and shortage of medical professionals, in addition to governmental initiatives (Research and Markets, 2019). However, in developing countries, the use of telemedicine is challenged by the lack of communications infrastructure such as internet connectivity and reliable electrical supply (Scott & Mars, 2015).

E-health applications that are executed via mobile technology are known as m-health (Van Dyk, 2014). The benefits of m-health include the expansion of healthcare coverage, enhancing decision-making, as well as providing healthcare services in

emergencies (Varshney, 2014). The innovation of entirely mobile systems that allow the rapid acquisition of data such as multiple charting, vital-signs monitoring, and image collection for multiple patients from disaster sites is made possible through e-health. Such data can be sent securely to a hospital's intranet, where they can be viewed on a web browser by control personnel (Hristidis, Chen, Li, Luis, & Deng, 2010) thus enhancing the efficiency of disaster response.

The widespread use of mobile phones has been utilised in providing healthcare services to disaster victims and vulnerable populations (Yarmohammadian, Safdari, & Tavakoli, 2015). In 2019, the rate of smartphone penetration was estimated at 41.5% worldwide (3.2 billion users) (Statista, 2019). In disasters, the use of mobile applications can significantly enhance situation awareness (Tan et al., 2017). For example, the World Food Program (WFP) has reduced the time spent on collecting food security surveys by 75% and saved US$5 million annually through using mobile technology such as mobile phone surveys, telephone interviews, voice response and text messages (World Health Organization [WHO], 2016; Yoo, 2018). Table 2.3, below, shows possible uses of mobile applications in disasters.

Table 2.3 Mobile app contributions in the disaster cycle

Disaster cycle	**Mobile apps contributions**
Reduction	Damage assessment and hazard monitoring via crowdsourcing
Readiness	Disaster risk education and preparedness education, identification of potential volunteers, and broadcasting early warning notifications
Response	Rapid dissemination of information, diffused data gathering (crowd-sensing), fast and timely processing (crowd as micro taskers), and localised distribution of alerts.
Recovery	Post-disaster recovery information, and crowd-sourced disaster impacts/damage assessment

Source: Tan et al. (2017)

Although e-health technologies have a huge potential to enhance healthcare provision (Scott & Mars, 2015), their implementation remains complex (Ross, Stevenson, Lau, & Murray, 2016). Reasons for the slow adoption include the fragmented funding and governance of healthcare services, the resistance of professions to changes in existing models of care, in addition to concerns about the costs and complexities associated with e-health implementation and the need to resolve issues about how it will affect practitioners and consumers alike (Kabashiki, 2013).

2.9.2 Disaster e-health (DEH)

Despite their different origins, priorities and operational modalities, emergency managers and health professionals share the same goal of providing healthcare services to disaster victims including safe drinking water, reliable food, shelter, adequate hygiene and mental health support (Bissell, 2007). Both sectors base their planning and preparedness activities on collecting and using information concerning natural and human-made phenomena that can negatively impact humans (Bissell, Pinet, Azur, & Paluck, 2004).

This, and the opportunities offered by e-health technologies in gathering, processing and disseminating health-related information, has led to a proposal for the establishment of an emerging discipline of DEH. DEH lies at the intersection of three integral fields: disaster management, disaster medicine, and e-health (Russo, 2011; Sieben, Scott, & Palacios, 2013). Figure 2.6 below visualises DEH. Althwab and Norris (2013) defined DEH as "the application of information and e-health technologies in a disaster situation to restore and maintain the health of individuals to their pre-disaster levels".

Figure 2.6 Disaster e-health
(Althwab & Norris, 2013)

DEH aims at establishing meaningful communication between disaster managers and disaster healthcare professionals through the effective utilisation of e-health technologies (Abbas, Norris, Parry, & Madanian, 2016). The integration of medicine,

technology and human capabilities manifested in the DEH approach has the potential to significantly enhance disaster healthcare provision (Hristidis et al., 2010).

2.9.3 ICTs in general support

As well as providing direct medical care via e-health in disaster situations, ICTs can offer support for a wide range of general activities that facilitate disaster healthcare. The dynamic nature of disaster response emphasises the need to make efficient and precise decisions in minimal time (Sinha, Kumar, Rana, Islam, & Dwivedi, 2019). Timely access to information concerns rapid collection, processing and distribution of information (Arnold et al., 2004; Garshnek & Burkle Jr, 1999). Technology and informatics applications have had significant impacts on disaster communication, information management and bio surveillance (Weiner & Slepski, 2012). This section presents the revolutionary technologies that can be utilised in facilitating disaster healthcare.

Artificial intelligence (AI)

AI refers to intelligence displayed by a non-natural entity to automate tasks that require intelligent behaviour such as natural language, speech and facial recognition (Ashir & Sugianto, 2007). AI uses sensors, remote inputs and digital data to gather data from various sources, rapidly analyse the data and act upon the output, resulting in sophisticated decision-making capabilities (D. M. West & Allen, 2018). The analytical capabilities of AI and machine learning algorithms can now provide more accurate predictions about disease spread and population needs (“Next generation public health,” 2019). Nevertheless, machine learning technologies can only process data that is input by humans and therefore can assist with but not replace human decision-making (Guikema, 2019). Despite the accuracy and efficiency of AI algorithms, their use in decision support is controversial due to possible bias ("Government world leader in artificial intelligence," 2019). An example of such bias concerns the possibility of using AI algorithms in targeting individuals who have specific DNA traits with viruses and autonomous weapons (Oroz, 2017).

Internet of things (IoT)

IoT refers to a global network of interconnected objects with unique identifiers that can transfer data without human-to-human or human-to-computer interaction

(Weber, 2019). By embedding sensors within 'things', IoT technology enables objects to be sensed and controlled remotely and makes it possible for the sensed objects to communicate without human intervention (Blantz, 2010). IoT, coupled with AI algorithms, can create accurate machine learning models (Kubara, 2019).

Big data

Big data, which refers to very large and highly complex and diverse data collections that exceed traditional storage, processing and analytical capacities, enable data mining to reveal inherent patterns and associations (Dash et al., 2019; Kayyali, Knott, & Van Kuiken, 2013). This technology has huge benefits for many fields including epidemiology, where chronological data helps predict the onset and spread of infectious diseases such as influenza and SARS (Bartolomeo, 2014).

Remote sensing

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object (Bala, Tom, & Shinde, 2017). In addition to automation, remote sensing assists with creation of maps, thus enabling disaster responders to understand the geographical nature of disaster-affected areas, locations and the severity of damage, and the type of resources required for possible evacuation (Johari, 2018). Applications of this technology, including aerial robotics and RFID tags, explained next, have been useful in supporting relief operations.

Aerial robotics

Aerial robotics, including unmanned aerial vehicles (UAVs), are capable of performing real-time damage assessments effectively as well as increasing situation awareness through capturing and processing aerial imagery much faster and with significantly higher resolution than satellites (Beck, Teacy, Rogers, & Jennings, 2018; Chowdhury, Emelogu, Marufuzzaman, Nurre, & Bian, 2017; Ofli et al., 2016). UAVs have timely, cost-effective and rich data acquisition capabilities that make them suitable for use in restricted environments and time-sensitive situations, and in scenarios that require high resolution transition of information (Hildmann & Kovacs, 2019). Their ability to reach remote and dangerous areas with limited or no human intervention enables them to facilitate search operations, reconnaissance and mapping, structural inspection, and estimation of debris (Chowdhury et al., 2017).

Radio-frequency identification (RFID) technology

RFID technology uses electromagnetic fields to automatically identify and track tags attached to stationary as well as moving objects (Ashir & Sugianto, 2007). RFID resembles a powerful automation tool that requires minimal human intervention. Its ability to reliably authenticate and track objects makes the technology suitable for use in disaster situations where first responders are often challenged by the need to monitor and track overwhelming numbers of disaster victims (Ashir & Sugianto, 2007).

Geographical information systems (GIS)

GIS are used to store, analyse, and visualise digitised maps (Johari, 2018). The production of GIS maps has certainly had a huge impact on the provision of disaster healthcare (Nelson & Greenough, 2016). A 2007 report (National Research Council, 2007) concluded that underutilisation of GIS in disasters is itself disastrous and can cause loss of life and damage to property and the environment.

Social media

Social media are being increasingly used in different disaster stages due to the faster, easier, cheaper and wider dissemination of information (Stieglitz, Bunker, Mirbabaie, & Ehnis, 2018; Velev & Zlateva, 2012). With 2.4 billion Facebook users and WhatsApp and YouTube having more than one billion users each (Ortiz-Ospina, 2019), the significance of social media platforms as powerful communication platforms is evident. These platforms have proved to be useful in coordinating relief activities, mapping damaged areas, identifying people in need, disseminating information and guidance, and attracting donations (Harrison, 2015). Disaster planners can utilise these platforms to connect with ordinary citizens and engage them in developing disaster management strategies (Althwab & Norris, 2013). Response agencies can develop a deeper understanding of the public's needs by collecting their opinions and creating a feedback loop (Yoo, 2018). In 2015, during the South Carolina floods, residents were tweeting at a rate of 3,000 tweets per hour (Karami, Shah, Vaezi, & Bansal, 2020); an influx of information that necessitates matching analytical capabilities. Despite their positive impact, social media can disseminate rumours, promote terrorism, and undermine authorities (D. E. Alexander, 2014). These drawbacks, in addition to the growing volume and complexity of information on social media platforms, makes it necessary to identify and verify new information (Schifferes et al., 2014; Sheridan

Libraries, 2019). The widespread use of social media in today's societies indicates that that these platforms should be central to the development of disaster response strategies (D. E. Alexander, 2014).

Crowdsourcing

Crowdsourcing in disasters refers to the ability of individuals to self-organise, communicate as a network, and continuously assist each other during the event (Auferbauer, Ganhör, & Tellioglu, 2015). Crowdsourcing, performed on connectivity platforms such as smart phones and social media, has the ability to gather information quickly, accurately and cost-effectively (Wazny, 2017). During the 2010 Haiti earthquake response, crowdsourcing enabled volunteers, experts and organisations to rapidly integrate information resulting in the production of highly accurate maps (Heinzelman & Waters, 2010).

The roles of ICTs in disaster response are increasingly being recognised especially after the Haiti earthquake in 2010. Post-Haiti earthquake, experts agreed on the need for more collaboration around an integrated framework for the use of multiple channels of information during disasters, better ICT preparedness, and public education on the use of alternative communications channels during an emergency (Blantz, 2010). The technological advances and multi-disciplinary approaches to disaster relief will play a significant role in enhancing disaster response as well as empowering disaster-affected communities in future (Nelson & Greenough, 2016).

2.10 Cross-agency communication in disasters

Health is defined as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity (WHO, 2006). In disasters, healthcare provision requires the simultaneous involvement of different organisations or agencies within the same sector (Hick et al., 2004). This situation entails substantial cross-agency collaboration and coordination in order to minimise response time and avoid duplication of tasks (Al Saadi, 2018).

The IFRC is a global humanitarian organisation that acts before, during and after disasters and health emergencies to meet the needs and improve the lives of vulnerable people. Founded in 1919, IFRC has 192 member national societies that

serve 160 million people annually (IFRC, n.d.-b). Given its rich and long experience in disaster management, IFRC is a reliable source of disaster healthcare information. According to IFRC, responders work together to achieve a common result through a process of communication of relevant information leading to collaboration and subsequent coordination (IFRC, 2000). These stages were chosen as the basis of the review of the literature related to multi-agency disaster healthcare provision.

2.10.1 Communication

Communication is the process through which an organisation sends a message across a channel to another part of the organisation or to another organisation in the network (Kapucu, 2006). Disaster communication refers to information creation, seeking, and/or sharing among the individuals, organisations, and media in the context of a disaster (B. F. Liu, Fraustino, & Jin, 2016). Information exchange across responding agencies reveals unforeseen risks for which plans can be developed or adjusted to minimise suboptimal decisions such as unnecessary evacuation (Bellamy, 6, Raab, Warren, & Heeney, 2008).

While vertical information exchange ensures information credibility, horizontal information exchange is essential for enhancing situation awareness (SA), minimising cost, and sharing expertise (Abbas, Norris, & Parry, 2018b). SA is defined as all knowledge that is accessible and can be integrated when required into a coherent picture to assess and cope with a situation (Sarter & Woods, 1991). SA is critical for disaster response since it provides cumulative pieces of information which, when interpreted, become the basis for critical decision-making (Abbas et al., 2018b).

Building SA in rapidly changing scenarios requires collaboration between different agencies and the integrated use of information management systems and resources (Soini, Linna, Leppaniemi, & Jaakkola, 2009). This can be achieved through utilising common operating pictures: platforms for gathering and integrating data from multiple sources including satellites, sensors, mobile and geospatial systems (J. M. Smith, 2012). The end goal of SA, and communication in general, is to have the right information sent to the right person at the right time (Abbas et al., 2018b).

Emergency information systems play a significant role in building and communicating SA (Anparasan & Lejeune, 2017). These systems aim at establishing an integrated

communications capability that supports the operations of the disaster management stakeholders (Turoff et al., 2004). Since the management of disaster situations requires regular updates, these systems should be designed to handle real-time information exchange (Sinha et al., 2019). Decision support systems assist disaster responders in the process of evaluating and choosing the most suitable emergency plan for a given scenario (Shan, Wang, Li, & Chen, 2012).

For enhanced SA, emergency responders should be acquainted with information systems before the occurrence of a disaster event (Tan et al., 2017).

2.10.2 Collaboration

Collaboration in the context of a multi-agency response involves a joint needs assessment, sharing ideas on how to overcome problems, and initiating joint practical responses (IFRC, 2000). The joint needs assessment eliminates duplicate information, increases the confidence and the relevance of the assessments for all disaster response stakeholders, and avoids wasting resources on a task that can be done collectively (Inter-Agency Standing Committee [IASC], 2017). According to IFRC (2000), collaboration between disaster response agencies involves:

- Identifying affected population groups and jointly assessing their potential capacities and needs in order to determine high priority groups
- Coordinating assistance standards of health services, water supply and sanitation, nutrition, food aid, shelter and site planning according to the Sphere standards (SPHERE, 2018)
- Mobilisation of relief resources taking into consideration medical supplies, food, communication systems, transport and organisation of deliveries, and the availability of people to render urgent assistance (relief), equipment and sanitation
- Joint training

The goal of collaboration is to coordinate the relief activities of multiple disaster management agencies or alternative solutions to manage the disaster situation (Yang, Lee, Rao, & Touqan, 2009). Collaboration involves several activities, including planning

and training, and requires substantial funding. This highlights the roles these activities play in achieving collaboration.

Planning

According to D. E. Alexander (2017), emergency planning is an art and a science that involves 'thinking the unthinkable'. Emergency action plans contain pre-planned actions that should be implemented immediately when a disaster occurs to reduce its negative impacts (Binder, 2001). To operationalise command-and-control management models, emergency response plans are utilised (Boin & McConnell, 2007). Emergency response plans serve as operational manuals for disaster decision-making in designating authority, specifying operational procedures, and providing guidance for coordinating emergency responders (Lindell & Perry, 2007). While action and response plans focus on the immediate response, disaster contingency plans cover the required procedures and actions that are part of the recovery process (HACCP Mentor, 2018).

Disasters do not impact all members of a society equally (Hobson, Bacon, & Cameron, 2014). Within the affected population, certain groups may be more vulnerable to disasters than the rest of the community such as people with disabilities, elderly people, groups with lower socioeconomic status, indigenous peoples, and migrants. The vulnerability of these societal sectors can be attributed to several factors including income and social status, level of education, employment and working conditions, and access to healthcare (J. R. Lindsay, 2003). Therefore, careful consideration should be given to the needs of these groups when planning disaster response to ensure effective healthcare outcomes. Nevertheless, the uncertainty associated with disaster events certainly complicates the ability of local agencies to assess the required response and recovery capacity during emergency planning. Hence, flexible disaster planning that accommodates the perspectives of affected communities is pivotal (Steinberg, 2016). Community Based Disaster Management (CBDM) is an example of an approach that empowers communities to be pro-active in disaster management, especially in preparedness and mitigation programmes (PreventionWeb, 2008). The absence of community involvement in disaster planning results in substandard disaster relief, overestimated need for external resources, and frustration about operational performance (Pandey & Okazaki, 2005). Planning strategies should cater for

psychosocial support, and for the needs of vulnerable groups including indigenous peoples, and people with disabilities.

Mental health

Mental health issues are twice or three times higher among disaster victims than the general population (Math et al., 2015). Disaster victims are often at high risk of suffering psychological problems such as anxiety and depression (Thoresen, Birkeland, Arnberg, Wentzel-Larsen, & Blix, 2019). A range of psychiatric disorders including increased risk of post-traumatic stress disorder (PTSD), obsessive–compulsive disorder (OCD), panic disorder, and alcohol abuse were found to be associated with the occurrence of disaster events (Reifels, Mills, Dückers, & O'Donnell, 2019). Unfortunately, the stigma associated with mental patients in many parts of the world (Kc, Gan, & Dwirahmadi, 2019) prevents them from seeking help due to fear of societal rejection (Haddad & Haddad, 2015). Cultural factors related to shame, collectivism, and spiritual beliefs have negative implications on post-disaster psychosocial interventions (Hechanova & Waelde, 2017). Mental illness can have far more life-changing impacts than physical illness, and the provision of adequate support at an early stage could minimise the impacts and make a positive progress towards normality (Kc et al., 2019). Therefore, psychological resilience training is critical for communities vulnerable to disasters (Kc et al., 2019). In the United States, psychological first aid programmes have been developed and adopted by several disaster response organisations to lower the distress of traumatic incidents and to educate people about immediate as well as long-term coping mechanisms (B. Allen et al., 2010).

Indigenous peoples

The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), the American Declaration on the Rights of Indigenous Peoples (Errico, 2017), the establishment of the United Nations Permanent Forum on Indigenous Issues (UNPFII) (Stamatopoulou, 2009), and the Expert Mechanism on the Rights of Indigenous Peoples (EMRIP) (De la Vega, 2014) are some of the declarations and mechanisms that have recognised the rights of indigenous peoples in the past 20 years (World Bank, 2019). Yet, indigenous peoples are among the most marginalised groups, and the most likely to suffer serious and extreme impacts of natural disasters, and their rich

ancestral knowledge and wisdom in managing disasters is still underutilised (Fowler, 2017).

The Sendai Framework explicitly calls for a people-centred approach that engages with indigenous peoples in developing and implementing disaster management policies and strategies that utilise their local knowledge in mitigation strategies (United Nations Office for Disaster Risk Reduction [UNDRR], 2016). While a top-down policy is essential, it is basically the local-level bottom-up policy that provides the momentum for the execution of mitigation strategies (Pearce, 2003) which essentially include risk communication. Risk communication refers to the exchange of real-time information, advice and opinions between experts and people facing threats to enable them to take informed protection decisions (WHO, 2019a).

In New Zealand, a project to improve Māori community engagement in the event of natural disasters and other emergencies was nominated for significant funding in 2019 ("Māori resilience in civil defence study," 2019). This is a positive sign for the increasing awareness about the importance of indigenous peoples' involvement in disaster planning.

People with disabilities

In 2013, a survey conducted by the United Nations on how people with disabilities prepare for and cope with disasters showed that out of 6,000 disabled people from 126 countries, only 20% could evacuate immediately without difficulty, 6% would not be able to evacuate at all, and the rest would be able to evacuate with a degree of difficulty (Turris & Lund, 2013). Although disabled people may be significantly more vulnerable to disasters than the majority of their community due to physical, cognitive, and socioeconomic factors (D. L. Smith & Notaro, 2009), few governmental measures exist to address their needs (United Nations Department of Economic and Social Affairs [UNDESA], 2013). The fact that their voices hardly come to the fore has prompted international calls for inclusive policies and programmes that support the rights of people with disabilities (United Nations Development Programme, 2018).

Non-governmental organisations (NGOs)

A non-governmental organisation (NGO) is an organisation that is independent of the government and whose primary mission is not commercial (Coppola, 2006). NGOs

work towards ideological rather than financial ends (Werker & Ahmed, 2008). Funded by grants and fundraising, NGOs value their independence and neutrality (Coppola, 2006). According to their mandates, NGOs usually provide relief whenever and wherever possible (Eikenberry, Arroyave, & Cooper, 2007). In recent decades, NGOs have expanded significantly proving their existence as powerful actors in disaster response (K. West, 2017). This may be linked to the bureaucracy that hinders prompt governmental response (Eikenberry et al., 2007). The level of collaboration with and reliance on NGOs varies across countries with a notable presence in low- and middle-income countries (Galway, Corbett, & Zeng, 2012).

Training

Training highlights areas for improved inter-organisational cooperation in preparedness, response, and mitigation (Graham & Stephens, 2018). Education and training are vital for clarifying confusion and educating agencies about each other's knowledge, skills, roles, and expected behaviour (Flin, 1996, as cited in Sinclair, Doyle, Johnston, & Paton, 2012; Paton & Jackson, 2002, as cited in Sinclair et al., 2012).

Disaster drills are used to evaluate and enhance the capacity of the local disaster response (Green, Modi, Lunney, & Thomas, 2003). However, these trainings are costly and are usually challenged by resistance to committing resources for low probability events (Lindell & Perry, 2003). Joint training is conducted to reduce cost, to enhance training quality and to establish trust and relations between potential stakeholders (IFRC, 2000).

An important aspect of training concerns disaster terminology. Terminology always adapts to shifts in thinking with new terms adopted or old ones expanded (Twigg, 2007). Therefore, as disaster management approaches evolve over time, so does the set of terminology used by different professional groups. An example of such confusion is the interchangeable use of the terms 'risk assessment' and 'vulnerability assessment'. To avoid misunderstandings and enhance knowledge across various collaborating groups, it is vital that training efforts inform responders of the existing and sometimes contradictory disaster terminology, and highlight the differences that exist in definitions (Thywissen, 2006).

Funding

Assistance for disasters is categorised into emergency response, reconstruction and rehabilitation, and disaster risk reduction (Watson, Caravani, Mitchell, Kellett, & Peters, 2015). Although the level of vulnerability of a certain community depends on the development of and investment in disaster reduction measures (Watson et al., 2015), the majority of disaster finance is dedicated to emergency response while the other two categories remain poorly financed (Watson et al., 2015).

Interestingly, the amount of financial support directed towards a certain disaster may not necessarily be driven by requirements. A study that analysed trade-offs between funding strategies and operational performance in humanitarian operations revealed that responses to severe disasters get over-funded due to extensive public attention and uncertainty associated with the 'expected' needs (Aflaki & Pedraza-Martinez, 2016).

The increasing frequency and severity of disaster events results in an increasing drain on public finances (Clarke, Mahul, Poulter, & Teh, 2017). Limited funds and a preference for funding post-disaster activities prevent many governments from making a national funding commitment towards disaster risk reduction (J Kellett, Caravani, & Pichon, 2014).

Considering the impact of disaster reduction measures on community resilience (Watson et al., 2015), the current funding priorities entail more research into disaster funding strategies. According to the World Bank Group, a comprehensive disaster finance strategy refers to "the bringing together of pre- and post-disaster financing instruments that address the evolving need of funds from emergency response to long-term reconstruction" (Clarke et al., 2017, p. 565).

2.10.3 Coordination

Disasters are characterised by the rapid influx of humanitarian assistance organisations and an outburst of mutual aid from local citizens and highly stressed local governmental and non-governmental institutions. The more complex the incident is, the greater the number and variety of responding organisations (Federal Emergency Management Agency [FEMA], 2019). Coordination refers to the process through which

organisations align their actions with each other to achieve a common objective (Comfort, 2007). It aims at eliminating fragmentation and duplication in services, harmonising separate disaster actions or activities, and clarifying roles and responsibilities to ensure the delivery of humanitarian assistance in a cohesive and effective manner (IFRC, 2000). In a coordinated effort, people and units know "*what they are to do"* and "*when they are to do it"* and they see the relationship between what they do and what the coordinated whole achieves (Denise, 1999).

The complex management of incidents involving agencies with different operational modalities, capabilities and organisational cultures (Abbas et al., 2018b) requires designated structures. Incident management structures are frameworks of standardised structures, functions, processes and terminology used to coordinate the activities of various response agencies at times of emergencies and disasters (Officials' Committee for Domestic and External Security Coordination [ODESC], 2019).

In New Zealand for example, CIMS framework describes how agencies coordinate, command, and control incident responses of varying scales. This includes how the response can be structured, and the relationships between the respective CIMS functions and between the levels of response. CIMS uses the following functions to coordinate response (ODESC, 2019):

Control

Coordinates and controls the response.

Safety

Advices on measures to minimise risks to response personnel.

Intelligence

Collects and analyses information and intelligence about context, impact and consequences as well as distributing intelligence outputs.

Planning

Leads planning for response activities and resource needs.

Operations

Directs, coordinates, and supervises the elements of response in a detailed manner on behalf of the control function.

Logistics

Provides personnel, equipment, supplies, facilities, and services to support response activities.

Public information management

Develops and delivers messages to the public, directly and through the media, and liaises with the community if required.

Welfare

Coordinates the delivery of emergency welfare services and resources to affected individuals, families and communities

Recovery

Starts the recovery management process during the initial response phase and ensures that the recovery process is integrated with the response.

Disaster response coordination in New Zealand is organised across hierarchical levels with each level supported and coordinated by the level that precedes it in the hierarchy. These levels are: national, regional, local, and incident. While being hierarchically orchestrated through the control function, CIMS functions must collaborate and coordinate response activities with each other. This networked hierarchy coordination structure is illustrated in Figure 2.7.

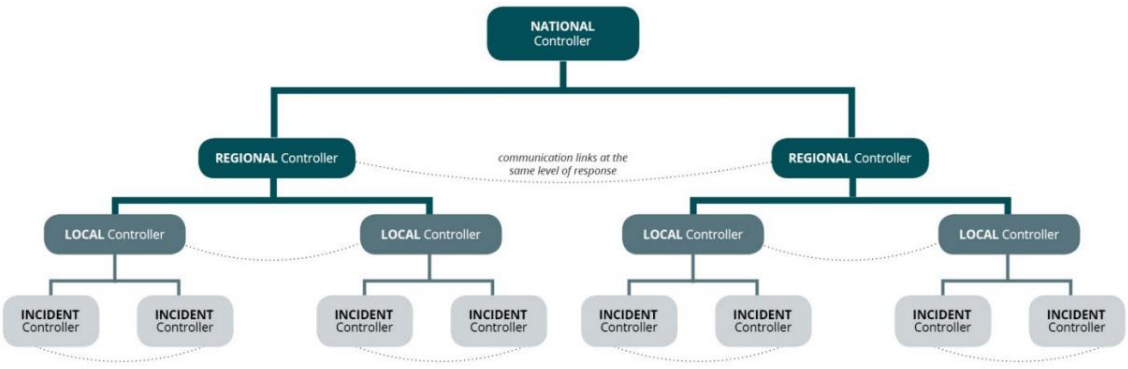


Figure 2.7 Relationship between the different response levels
(ODESC, 2019)

Coordination can be achieved by command where strong leadership is accompanied by authority, by consensus where the leading capacity aims at prioritising and harmonising the various functions and activities, or by default in the absence of formal coordination where it revolves around basic information exchange and division of labour (Donini, 1996). In all cases, coordination aims at utilising available instruments to effectively deliver a cohesive response ("Coordination," n.d.).

2.11 Cross-agency information exchange

2.11.1 Health information exchange

Health information exchange (HIE) is the ability of health information technology (HIT) to share patient data (Shen et al., 2019). HIE eliminates unnecessary paperwork, facilitates coordinated patient care, and assists with clinical decision-making. Moreover, it has the ability to get patients involved in their care, reduce duplications in treatments, and minimise cost (Office of the National Coordinator for Health Information Technology [ONC], 2019a).

Despite these abilities, sharing health information is restricted by the need to protect patients' privacy and confidentiality (Shen et al., 2019). Despite their criticality, privacy restrictions may prevent many health practitioners from cooperating with other agencies or sharing information even within their own organisation (Lips, O'Neill, & Eppel, 2011). In disasters, where various response agencies need to communicate, different interpretations of privacy legislation and a lack of knowledge about how to deal with non-governmental service providers often hinder smooth information exchange (Abbas et al., 2018b). Legal interoperability covers laws, policies, procedures and the cooperation agreements needed to allow the seamless exchange of information between different organisations, regions and countries (E-Health Governance Initiative, 2017). Legal interoperability, including when and how to relax privacy regulations and how to recover from diminished conditions, should be clear to individuals involved in disaster response.

2.11.2 Health data

Health data refers to any data related to health conditions, reproductive outcomes, causes of death, and quality of life (Segen, 2002). Data collected at an individual

patient level are referred to as ‘unit level data’, whereas the sum of these data are referred to as ‘aggregate data’. Unit level data, which are used to support patient care, contain patients’ characteristics, illness, and provided care. Aggregate data, on the other hand, provide information about disease prevalence and distribution as well as assisting with community service planning and decision-making (K. Kerr & Norris, 2008).

Health data can be collected using MDSs. An MDS is a collection of standardised datasets focused on selected aspects of a single topic and supported by a document such as a data dictionary that explains its associated meanings, usage and format (McDaniel, 1993). For example, an MDS on ageing and older persons is a compilation of available data focused on selected aspects of demographic, social, economic and health characteristics of older persons (WHO, 2019b). In nursing, an MDS is a standardised assessment tool that measures health status in nursing home residents (University of California San Francisco Geriatrics, 2018). To standardise reporting, WHO developed the MDS depicted in Figure 2.8 for their emergency medical teams to use when responding to sudden onset disasters (Jafar, Fletcher, Lecky, & Redmond, 2018). A similar MDS is suggested in this research. The WHO’s MDS consists of modules, each of which addresses a specific aspect of the emergency response:

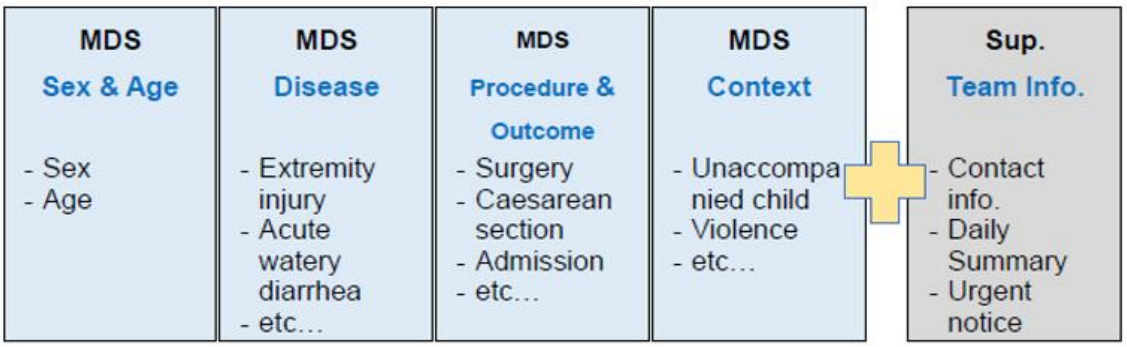


Figure 2.8 WHO MDS for standardised reporting by emergency medical teams
(WHO et al., 2016)

Health data can be organised in different repositories including medical registries, patient records, or electronic health records (EHRs). A medical registry is defined as a systematic collection of a clearly defined set of health and demographic data for patients with specific health characteristics, held in a central database for a predefined purpose (Arts, De Keizer, & Scheffer, 2002). In contrast, a patient record consists of all

data and documents generated or received during the care of a patient at a healthcare institution (K. Kerr & Norris, 2008).

EHRs, on the other hand, focus on continuity of care. They contain retrospective, concurrent, and prospective information and their primary purpose is to support continuing, efficient and quality integrated healthcare (International Organization for Standardization, 2004). EHR patient data is contained in digital form, stored and exchanged securely, and is accessible by multiple authorised users. Authorised users can access EHRs to instantly and securely access patients' medical histories, medications, diagnoses, allergies, immunisation, treatment plans, radiology images, and laboratory results in addition to having the ability to utilise evidence-based tools in decision-making (Office of the National Coordinator for Health Information Technology [ONC], 2019b). Patient data can be stored in the form of unstructured narrative texts or structured coded data that can be used by various healthcare professionals (Häyrinen, Saranto, & Nykänen, 2008). The benefits of EHRs include enhanced communication and care coordination, timely decision-making, cost-effectiveness, public health surveillance and healthcare support during disasters (Kimura, Oku, & Yamamoto, 2011). Nevertheless, widespread privacy and confidentiality concerns among the public impede the adoption of EHRs (Angst & Agarwal, 2009).

In disasters, when evacuation is necessary, victims often leave without taking their medications and documents, forcing healthcare providers at the destinations to treat them without knowing their medical history. In such situations, EHRs can be extremely useful in enabling continuity of care (S. H. Brown et al., 2007). In addition, the ability of EHRs to keep copies of patient records away from disaster sites, including hospitals, allows health professionals to access patient information during and after the disaster event (Kimura et al., 2011). In emergencies and disasters, the availability of a patient summary, i.e., a digital dataset consisting of the most important clinical patient data, can be lifesaving for disaster victims (European Commission, 2017). A patient summary contains critical data such as allergies, medical problems, medical implants, recent surgical procedures, and current medications.

2.11.3 Interoperability

For data from multiple sources to be shared and used, data must be built upon common words, structures, and organisation (Hammond, 2005). Interoperability refers to the ability of two or more systems or components to exchange information and to use the information that has been exchanged (Geraci et al., 1991). E-health interoperability enables e-health systems to use and exchange computer interpretable as well as human understandable data and knowledge (E-Health Governance Initiative, 2017). Interoperability has several aspects in addition to the legal perspective (see section 2.11.1). For instance, if two systems are semantically interoperable, it means that they are similarly structured for data exchange and they both use the same terminology, thus allowing the receiving system to interpret the meaning of the data (Matney, 2016). Unlike semantic interoperability, technical interoperability is not concerned with the meaning of what is being exchanged (Benson & Grieve, 2016). Technical interoperability concerns the ability of two or more ICT applications to accept data from each other and to perform a given task appropriately without the need for extra operator intervention (E-Health Governance Initiative, 2017). Barriers to technical interoperability include incompatibility of hardware or software, mismatched data structures, incompatible database designs, different data and information distribution channels, conflicting data definitions and different terminology (Lips et al., 2011).

The Healthcare Information and Management Systems Society (HIMSS) classifies interoperability into the following four levels (Sullivan, 2019):

Foundational interoperability establishes the inter-connectivity requirements needed for one system or application to securely communicate data to and receive data from another.

Structural interoperability defines the format, syntax, and organisation of data exchange for interpretation.

Semantic interoperability provides for common underlying models and codification of the data including the use of data elements with standardised definitions to provide shared understanding and meaning to the user.

Organisational interoperability concerns governance, policy, social, legal and organisational considerations to facilitate secure, seamless and timely communication and use of data both within and between organisations, entities and individuals.

In healthcare, challenges of interoperability include the difficulty of standardising terminologies, lack of a universal coding systems, and different laws and policies (E-Health Governance Initiative, 2017). Global interoperability cannot be attainable unless global, well defined standards emerge (Bassi & Horn, 2008; Hammond, 2005).

2.11.4 Health data standards

In the context of healthcare, data standards refer to methods, protocols, terminologies, and specifications pertaining to the collection, exchange, storage, and retrieval of information used in healthcare applications (Erickson, Wolcott, Corrigan, & Aspden, 2003). Standards are defined, maintained, and updated by standards development organisations (SDOs) in collaboration with the expected users of the standards. Health data standards are key to the exchange of data across independent sites involved in patient care, to the aggregation of health data, and to creating population databases (Hammond, 2005). In addition to enabling data exchange across different environments, standardisation allows datasets to be stored and used in multiple ways, reducing cost, allowing data conversion, and supporting training needs (ADPC, 2011).

Healthcare concepts are represented as data elements. A data element is a unit of data with a specific code, name, definition, and a set of possible values (Hammond, 2005). The standardisation of data elements concerns defining what to collect, deciding how to represent what is collected, and determining how to encode the data for transmission (Erickson et al., 2003). To preserve the meaning of exchanged data, and to enable the integration of clinical data from multiple sources, it is crucial to cross-map and harmonise healthcare terminologies (Matney, 2016).

Interoperability of health information involves several standards including health record standards, identity standards, information governance standards, laboratory information standards, medicines information standards, mental health information standards, and security standards (New Zealand Ministry of Health [MoH], 2019). Widely-used health standards include Logical Observation Identifiers Names and Codes

(LOINC), Systematised Nomenclature of Medicine—Clinical Terms (SNOMED CT), and Fast Healthcare Interoperability Resources (FHIR).

Logical Observation Identifiers Names and Codes (LOINC)

LOINC is a common language (set of identifiers, names, and codes) for identifying health measurements, observations, and documents. It provides a set of universal names and ID numbers for encoding clinical observations and lab values for use in health information systems or transmission in electronic messages (Matney, 2016).

Systematised Nomenclature of Medicine—Clinical Terms (SNOMED CT)

SNOMED CT is an international standard for coding healthcare data based on a formal terminology model that provides clear definitions of healthcare concepts. With over 340,000 clinical concepts and 1.2 million terms, SNOMED CT contains the most detailed concepts for representing clinical and patient safety information (Erickson et al., 2003).

Fast Healthcare Interoperability Resources (FHIR)

FHIR is the global industry standard for passing healthcare data between systems. The goal of FHIR is to facilitate system-to-system communication through developing application programming interfaces (APIs) suited to programming (Boussadi & Zapletal, 2017). An API is a set of functions and procedures used to create applications that access the features or data of an operating system, application, or other service. FHIR utilises existing logical and theoretical models to provide a consistent, easy to implement, and rigorous mechanism for exchanging data between healthcare applications.

2.12 Chapter summary

The literature review chapter aimed at introducing the reader to the context of disaster healthcare through a collaborative lens. Basic concepts of disasters were reviewed including their types, management, health dimension, and tools that influence information exchange during these critical circumstances. The vital role of ICTs in disseminating critical information effectively and efficiently was highlighted.

By focusing on the subject in greater detail, the need for collaboration and coordination of efforts between agencies with different backgrounds and mission

statements became clear. Hence, communication, collaboration and coordination across response agencies were reviewed. Certainly, these processes, which aim at enhancing the quality of healthcare provision in disasters, are profoundly linked to the effectiveness and efficiency of the exchanged information. Information remains central to healthcare provision as is evident by the unprecedented COVID-19 global pandemic. Therefore, a closer look into disaster information management led to reviewing health information exchange, health data, and data standards used to exchange health data.

The conclusion to be drawn from this literature review is that enhancing healthcare provision is profoundly linked to the quality of communication across disaster response agencies, and is certainly influenced by the information these agencies exchange and build their decisions upon in disasters.

Although the issues of cross-agency communication and of information exchange during disasters are thoroughly researched, there exists a gap in research with regard to investigating communication barriers between response agencies and the health sector specifically. In addition, an approach that utilises health data and technological tools to enhance the efficiency of information exchange between these two sectors is not yet identified. Moreover, ways of building trust between emergency management and health agencies in disasters is a third gap that has been highlighted through this literature review.

Hence, the attempt to investigate possible ways of enhancing disaster healthcare requires questioning viable ways of utilising the two issues pinpointed by the literature review and later formulated by the research questions: trust and healthcare data.

Chapter 3 Methodology

3.1 Philosophical worldview

A worldview, sometimes referred to as a paradigm, is “a basic set of beliefs that guide action” (Guba, 1990, p. 17). It refers to presuppositions about what the world is actually like and what constitutes valid and important knowledge about the world (Cobern, 1996). This research is guided by the constructivist worldview, which is the view that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Bereiter & Scardamalia, 2014). Crotty (1998) assumed that as human beings engage with the world, they construct meanings according to their social and historical perspectives and that the basic generation of meaning is always social, stemming from human communication.

In disasters, scenarios change rapidly. When decision-makers encounter something new, they have to reconcile it with their previous knowledge and experience, sometimes changing what they believe, and sometimes discarding the new data that they find irrelevant. For this reason, it is logical to assume that existing knowledge about how individuals and groups of people interact with changing scenarios such as disasters will always be questioned, explored, and assessed. This view is consistent with the essence of this research: investigating cross-agency communication and information exchange in disasters. More specifically, the research is guided by social constructivism. Social constructivism is a theory of knowledge in sociology and communication theory. It questions the knowledge and understandings of the world that are developed jointly by individuals and assumes that understanding, significance, and meaning are developed in coordination with other humans (Amineh & Asl, 2015). This situation is typical of the disaster healthcare context where policies and guidelines for managing complex situations should consider the views and insights of disaster stakeholders to ensure the effectiveness of disaster response.

3.2 Research approach

While quantitative research tends to focus on ways of describing and understanding reality by discovering general ‘laws’, qualitative research tends to focus on how people

or groups of people can have varying ways of looking at reality (Hancock, Ockleford, & Windridge, 2001). Mixed methods combine both approaches with the aim of seeking convergence across qualitative and quantitative methods (Jick, 1979). The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone.

Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2014). It is well suited for understanding phenomena within their context, uncovering links among concepts and behaviours, and generating and refining theory (Quinn, 2005). The present research aims at understanding the root cause of poor communication between agencies concerned with the provision of healthcare in disasters. In a qualitative strategy of inquiry, the research attempts to broaden and/or deepen the understanding of how things came to be the way they are in the social world (Hancock et al., 2001). Therefore, a qualitative approach is thought to be appropriate for the purpose of this research. In fact, research approaches are not discrete (Creswell, 2014) but rather represent different ends on a continuum (Newman, Benz, & Ridenour, 1998) that can be determined based on the philosophical assumptions of the research and the ways used to collect data (Creswell, 2014).

3.3 Research framework

Global literature reviews supplemented by semi-structured interviews with disaster managers and health professionals were conducted to identify the problems associated with cross-agency communication and information exchange in disasters (first research question). As will be shown, the results of these studies suggest two approaches to ameliorate the communication problems and improve disaster healthcare.

The first approach suggests enhancing the effectiveness and efficiency of information exchange by identifying an MDS constructed from the critical data elements that both disaster managers and health professionals consider critical for healthcare provision in disaster situations (second research question). The second approach recommends an educational framework to improve mutual understanding and communication

between emergency/disaster managers and health professionals (third research question). The MDS and curriculum proposals were evaluated by a Delphi study (see section 3.5.3) involving international authorities with expertise across the target areas. Figure 3.1, below, explains the general framework of the research.

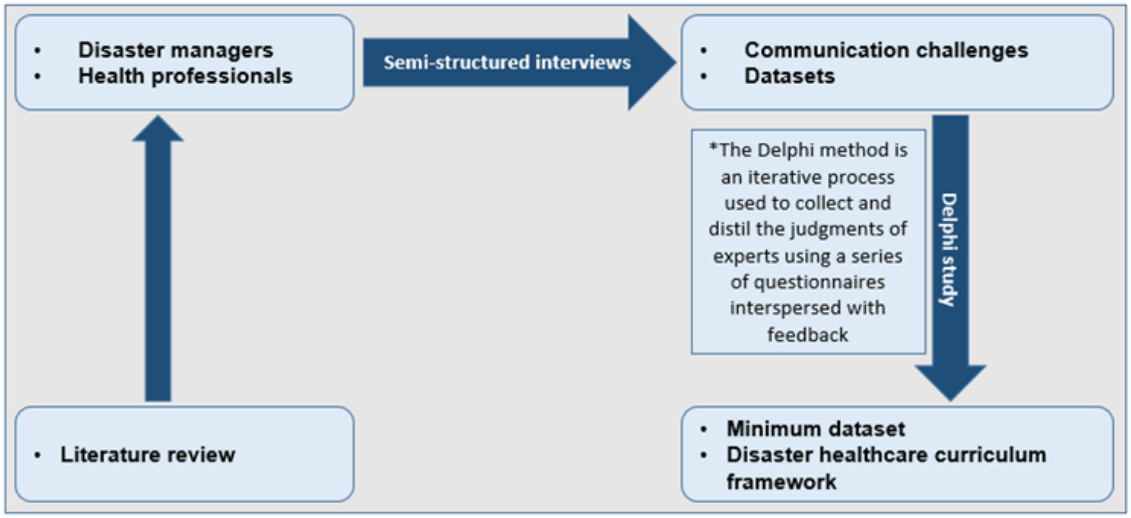


Figure 3.1 Research framework

3.4 Ethical considerations

The design and practice of this research implements the principle of partnership in the interaction between the researcher and other participants. The success of the research depends mainly on the personal views gathered from the interviewees. This has been highlighted to the interviewees to emphasise their crucial role and their impact on the output of the research. Participants who indicated their interest will receive a summary of the research findings and will be acknowledged in the final report.

The privacy and confidentiality of participants has been protected as no personal information other than contact details were collected. Privacy legislation and professional relationships were considered with regard to accessing the contact details provided by participants. Participants were informed that although their names will not be mentioned in the study, given the narrow scope of the study, they may be identifiable from the information they provide, the name of the organisation they work for, or their job titles. Third parties, such as employers or professional organisations, have not been used in the recruitment process.

In accordance with the Privacy Act 1993, there are no plans for the future use of the collected data beyond the purpose of this research. During the data collection and analysis stages, only the researcher and the supervisors had access to the collected data. The data as well as the participants' consent forms will be stored securely for a minimum of six years at the Computer Science Department of Auckland University of Technology City Campus. A professional transcription service was used for some interviews and for this a confidentiality agreement with the service provider has been signed.

Research participants have no formal roles as funders or beneficiaries of the research. They will benefit only from the findings of the research in terms of knowledge. As experienced disaster response professionals, participants are likely to benefit from the findings of the researcher more than from receiving financial inducements. Hence, no payments or other financial inducements were offered as an incentive.

Adequate, clear and truthful information about the research has been provided in formal language to potential participants and a period of two weeks was given to consider the invitation (Appendix C and Appendix F). Consents were provided in writing (Appendix D and Appendix G). Participants were informed of how to contact the researcher and the research supervisors for questions and/or clarification. There were no power imbalances inherent in the relationships between the participants and researcher. Participants did not have any form of benefit or pressure that persuaded or forced them to participate in this research and they had the right to withdraw from the study at any time without being disadvantaged in any way. They were informed that if they chose to withdraw from the study, they would be offered the choice between having any data that is identifiable as belonging to them removed or they would be able to allow it to continue being used.

The researcher considered the possibility of participants experiencing some discomfort as the questions could bring back unpleasant memories of disaster events. Possible ways of counselling, should the need have arisen, were researched but fortunately never needed.

Consultations regarding the design of the study have taken place prior to the commencement of data collection. The research design has been discussed with the

Disaster E-Health Community of Interest (DECOI) during a workshop held at Auckland University of Technology in January 2017. During the workshop, the research plans and procedures were discussed with international researchers who agreed with the general framework. In addition, the researcher consulted Professor Murray Turoff, a key founding father of computer-mediated communication and an expert in the Delphi technique regarding the design of the Delphi questionnaire.

Finally, the researcher does not work for any of the organisations involved in the research nor has personal ties with any of the stakeholders. There are no financial, social, or professional relationships between the researcher and the participants or the supervisors. Hence, no conflict of interest, influences or power imbalances of any type existed at the time the research was undertaken. No cultural or other diversity issues occurred.

Ethical approval was granted by Auckland University of Technology Ethics Committee for the first stage of data collection in March 2017 (Appendix A) and for the second stage in February 2019 (Appendix B).

3.5 Data collection

3.5.1 Literature review

Articles from different disciplines including ICTs, healthcare, humanitarian relief and public policy were searched (see Chapter 2). The focus of the literature review was not on the breadth of the articles that covered the topic, but rather on the areas that are most related to the three research questions. Peer-reviewed journal articles and conference papers were screened by title and abstract.

Articles inclusion and exclusion criteria

Despite the natural tendency to identify more recent resources, the timeline considered was flexible spanning the years 2000 and 2019 but concentrating on the period 2016-2019. Articles were selected according to perceived relevance to the research questions although the list of references has expanded over time to accommodate new relevancies and aspects of the revised research questions. For example, the search initially focused on governmental agencies. However, topics around certain societal sectors such as people with disabilities and indigenous peoples

were later retrieved as the need to for an inclusive approach to disaster planning became evident.

Studies published in a language other than English and those that are more than 20 years old (with some exceptions that were consulted for definitions and basic concepts) were excluded from this research.

Figure 3.2 below shows a breakdown of the reference sources based on year produced.

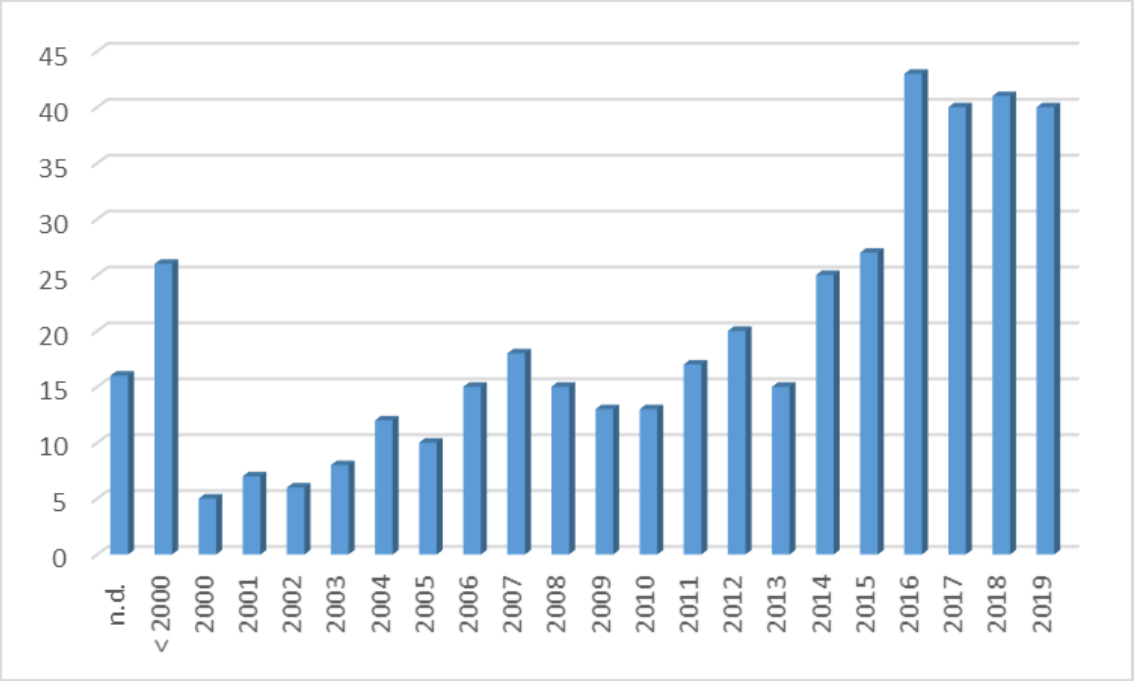


Figure 3.2 Referenced resources

Search keywords

Considering the broad spectrum of topics related to the subject of this research, many keywords were used to search for relevant information sources. Keywords used included:

- Disaster medicine
- Emergency medicine
- Public health

- Disaster management
- Disaster mitigation
- Disaster planning
- Disaster preparedness

- Disaster resilience
- Disaster response
- Emergency management
- Emergency response

- Core competencies
- Disaster curricula
- Disaster management education
- Disaster medicine education
- Emergency management education
- Emergency medicine education

- Cross-agency collaboration
- Cross-agency communication
- Inter-agency collaboration
- Inter-agency communication
- Inter-agency coordination
- Multi-agency collaboration
- Multi-agency communication
- Multi-agency coordination

- E-health
- Emergency information requirements
- Emergency information systems
- Information and communication technologies
- Information exchange
- Information management
- Mass-gathering
- Minimum dataset

Information sources

The databases searched included: The Public Health database; TRACIE: Healthcare Emergency Preparedness Information Gateway; Disaster Lit: The Resource Guide for Disaster Medicine and Public Health (National Library); EM_DAT: The International Disaster Database (EM-DAT); Google Scholar; Scopus; ProQuest; PubMed; IEEE, and Cochrane.

Journals with aims and scopes that are relevant to emergency and disaster preparedness, emergency ICTs, e-health, disaster medicine and disaster management were used. These journals include but are not limited to: *The American Journal of Public Health, Information Systems Frontiers, International Journal of Emergency Management, American Journal of Disaster Medicine, Disaster Medicine and Public Health Preparedness, Journal of Public Administration Research and Theory, Policy*

Studies Journal, The British Medical Journal (BMJ), Prehospital and Disaster Medicine, and *Public Management Review*. The list of journals consulted in the literature review can be found in (Appendix J).

Conference proceedings including Health Informatics New Zealand (HiNZ) and The Information Systems for Crisis Response and Management (ISCRAM) conferences were consulted.

Grey literature used included government and humanitarian organisations' reports, guidelines, policy statements, and issues papers.

Information was retrieved from reputable governmental websites and websites of international humanitarian organisations including but not limited to: The International Federation of Red Cross and Red Crescent Societies (IFRC), The United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), NIH Disaster Research Response, The Federal Emergency Management Agency (FEMA), New Zealand Ministry of Health (MoH), New Zealand National Emergency Management Agency, and the World Health Organization (WHO).

3.5.2 Semi-structured interviews

From a social constructivist perspective, individuals develop subjective varied and multiple meanings of their experiences leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas (Creswell & Creswell, 2017). To achieve this goal, in-depth semi-structured interviews were used to collect data. In-depth interviews are intensive interviews conducted individually with a small number of participants to explore their perspectives on a specific idea or situation (Boyce & Neale, 2006).

In a semi-structured interview, a form of in-depth interview, participants are presented with a series of open-ended questions, with accompanying queries that probe for more detailed and contextual data. The answers provide rich in-depth information based on the respondents' knowledge and experience on the subject under investigation (Gillham, 2000; Ritchie, Lewis, Nicholls, & Ormston, 2013). The primary advantage of semi-structured interviews is that they provide much more detailed information than what is available through other data collection methods,

such as surveys (Piercy, 2004). The inclusion of open-ended questions provides the opportunity for identifying new ways of seeing and understanding the research topic (D. Cohen & Crabtree, 2006). However, in-depth interviews are challenged by what is known as “the interviewer effect”. The interviewer effect refers to the situation where the sex, age, or ethnic origins of the interviewer have a bearing on the amount of information people are willing to disclose and their honesty about what they reveal (Denscombe, 2014). Conscious of the need to minimise this effect, the researcher focused on informing participants of her previous experience in working with disaster response agencies, her current status in New Zealand and the link between her background and the research topic, prior to conducting interviews.

The contact details of participants were obtained through public websites and invitations were sent by email. Some participants were recommended by others for their expertise in disaster response. Most interviews were conducted face-to-face in the participants’ work environments with an exception of two interviews that were conducted over Skype. The interviews lasted between 60-90 minutes and were audio recorded.

Interview participants

In qualitative research, the sample size for collecting data is determined by reaching a saturation point, i.e., when no new perspectives and insights are gathered due to the repetition of themes and comments by participants. However, there is not much research into quantifying saturation (Saunders, 2012). According to Townsend (2013), the sample size for a set of semi-structured interviews should be based on the depth of data rather than frequencies. In this research, the focus of the selection process was to conduct interviews with emergency management representatives of the main governmental agencies, NGOs, and international humanitarian organisations concerned with disaster response. Agencies to which the selected participants belonged are:

- Auckland Metro District Health Boards
- Fire and Emergency New Zealand
- New Zealand National Emergency Management Agency
- New Zealand Ministry of Health

- New Zealand Ministry of Social Development
- New Zealand Police
- The Salvation Army
- The United Nations Office for the Coordination of Humanitarian Affairs

(Creswell, 2007) recommended a minimum sample size of between 5 and 25. Consistently, the approach followed, and the selection criteria yielded, a sample size of 15. All participants are based in New Zealand except a United Nations Humanitarian Coordinator who was based in Liberia at the time of the interview.

Inclusion and exclusion criteria

Job titles coupled with experience in disaster response were used as the criteria for selecting participants. Professionals at senior levels who have actually experienced disaster responses were chosen. For the purpose of this research, a 'health professional' refers to an individual who provides a healthcare service in a disaster setting. Participants who were not comfortable engaging in an interview due to English language constraints, and those who were uncomfortable with the possibility of being identified in the research, were excluded.

The interview questionnaire

Semi-structured interviews were conducted to understand the factors that positively or negatively impact effective communication between emergency management and health agencies in disasters. The interviews were designed with the aim of answering the following research questions:

Q1. What are the main barriers to effective communication between emergency managers and health professionals in disasters?

Q2. Which datasets can enhance the effectiveness of information exchange between emergency managers and health professionals in disasters, and how should these datasets be constructed?

Q3. Can educational curricula be designed to improve mutual understanding and communication between emergency managers and health professionals and what features should these curricula have?

To answer the first research question, a questionnaire composed of five questions was used to collect participants' views.

First, a model namely the 3Cs model (Figure 3.3) made up of three components; communication, collaboration and coordination, was used as a tool to understand participants' perspectives on the meaning and challenges associated with communication and its subsequent activities in disasters.

Figure 3.3 The 3Cs model

Participants were asked to comment on whether the 3Cs model is a valid approach to understanding the inter-agency communication, collaboration, and coordinated action necessary for the assessment and delivery of disaster healthcare, and to point out the strengths and weaknesses of the model. The 3Cs model was used to start a conversation about the challenges associated with these processes in the context of multi-agency response.

Development of the 3Cs model

During disasters, inter-organisational partnering relations include communication, collaboration, and coordination (Martin et al., 2016). There is no clear consensus regarding the definitions of these activities in the literature and the three terms are often used interchangeably.

Kapucu (2006) defined communication as the act of transmitting a message from one organisation to another organisation or part of an organisation. In the context of a multi-agency response, collaboration involves joint needs assessment, sharing ideas on how to overcome problems, and initiating joint practical responses (IFRC, 2000). Comfort (2007) defined coordination as the process through which organisations align their actions with each other to achieve a common objective.

According to the IFRC (2000), the accepted practice of working together in a logical way toward a common result spans from simple information sharing to collaboration

and consequently joint strategic planning. In light of these definitions, a simplified model (Figure 3.4) was developed consisting of communication, collaboration and coordination with the aim of encouraging interviewees to open up about the challenges of poor cross-agency communication in disasters.

The second questionnaire question aimed at identifying the essential data necessary for the assessment and delivery of healthcare in disasters. To help participants answer this question, four MDSs along with examples identified in the literature review were used (Appendix E). Participants were asked to comment on the groupings and the significance of the suggested elements, and to add any data items they considered important.

The third and fourth questions addressed the concept of trust and the barriers to cross-agency information sharing. Finally, the last question investigated whether a disaster healthcare curriculum targeting combined groups of disaster managers and health professionals would be useful in improving communication between disaster managers and health professionals. Participants were asked about the value, content and delivery mode of a suggested curriculum framework for disaster healthcare. The questionnaire can be found in (Appendix E).

3.5.3 The Delphi study

The Delphi method is an iterative process used to collect and distil the judgments of experts using a series of questionnaires interspersed with feedback. The questionnaires are designed to focus on problems, opportunities, solutions, or forecasts. Responses are gathered and analysed to identify common and conflicting opinions. If consensus is not reached, a subsequent questionnaire is developed. This allows participants to re-evaluate their previous responses in light of group evaluation. The process stops when consensus is reached, theoretical saturation is achieved, or when sufficient information has been exchanged (Skulmoski, Hartman, & Krahn, 2007). The Delphi method is built upon the concept that “several people are less likely to arrive at a wrong decision than a single individual” (Hasson, Keeney, & McKenna, 2000, p. 1013). The anonymity of panel experts minimises possible bias and encourages re-consideration of earlier responses. The Delphi method can be used in decision-making

to encourage collaborative decision-making, in policy to create ideas about a specific topic, or classically to establish facts about a specific topic.

The Delphi method integrates elements of both qualitative and quantitative methodologies in answering a specific research question. It does not fall perfectly into qualitative nor quantitative research methods but is rather a hybrid of both (Ogbeifun, Agwa-Ejon, Mbohwa, & Pretorius, 2016).

In the second part of data collection in this study, a classical Delphi method was used to evaluate the importance of disaster-related data elements from the perspectives of experts in disaster management and disaster medicine. Experts were asked to evaluate each data element with regard to criticality to their work in disasters. They were also consulted about a framework for a suggested disaster healthcare curriculum targeting combined groups of emergency managers and health professionals. Participants were informed that the Delphi study would require two to three iterations. The feedback from the first round was analysed and, in light of its findings, a questionnaire was developed for a second round. The design of the questionnaires yielded adequate information, eliminating the need for a third round. Each questionnaire required about an hour to fill manually. However, the use of Qualtrics survey software minimised the cost substantially.

Rationale for choosing the Delphi method

The Delphi method has been previously utilised in designing educational programmes, and in healthcare to develop clinical care protocols and core competencies for advanced nursing practitioners, to establish appropriateness criteria for clinical treatment, and to identify barriers to healthcare performance (Akins, Tolson, & Cole, 2005). The method is particularly useful when “heterogeneity of the participants must be preserved to assure validity of the results” (Hallowell & Gambatese, 2010, p. 1). It is also useful when experts are geographically dispersed (Akins et al., 2005), as in the case of this study. Moreover, a study revealed that in 75% of Delphi-estimated values, the differences from the observed values were less than 10% (Linstone & Turoff, 1975) confirming reliability of the method. The anonymity of the participants which minimises bias, the opportunity for changing previous views in light of group feedback,

and adequacy of time to consider responses before submission are additional factors for choosing the Delphi method for this study.

Panel of experts

In a Delphi study, choosing the right participants is the most important step as it directly impacts the quality of the generated results (Hsu & Sandford, 2007). Therefore, it is critical for this study to have certain measures for identifying someone as an expert. Experience, certification, social acclamation, and behavioural characteristics are all measures that can be used to identify experts (Shanteau, Weiss, Thomas, & Pounds, 2002). A 2012 study exploring the measurement of expertise (Germain & Tejeda, 2012), identified "knows work, knows field, education, qualifications, and training" (p. 223) as criteria for measuring expertise. These criteria were taken into consideration when identifying potential Delphi experts. Table 3.1 displays the expertise of the selected Delphi participants.

Table 3.1 The expert panel

Participant No.	**Participant Information**
1	A physician specialising in disaster medicine and counter-terrorism medicine. The participant is an associate professor of emergency medicine and the author of a renowned book on disaster medicine.
2	Associate professor of disaster medicine and an expert in civil emergency planning.
3	An emergency medicine doctor trained at University College London. The participant worked with Médecins Sans Frontières (MSF) in Iraq, Haiti, South Sudan and other countries. The participant was one of the first to participate in the response to the Ebola epidemic in Sierra Leone leading to featuring their work on a BBC television documentary.
4	Assistant professor in humanitarian health practice and a medical doctor and epidemiologist with extensive experience in public health programming in humanitarian settings.
5	Sexual and reproductive health specialist with extensive experience in disaster response in countries including Syria and Myanmar.
6	A regional emergency coordinator.
7	A resilience manager and ex-Australian Army medical/health planner.
8	A principal welfare response advisor.
9	A district health board emergency systems planner.
10	An emergency management senior advisor and planner at a regional public health service.

The selected experts are affiliated with the following distinguished organisations:

- Harvard Medical School
- NATO Civil Emergence Planning Committee
- Médecins Sans Frontières
- United Nations Population Fund (UNFPA)
- London School of Hygiene and Tropical Medicine
- US Department of Health and Human Services (ASPR)
- RiskLogic
- Auckland Emergency Management
- Auckland Metro District Health Boards
- Auckland Regional Public Health Service (ARPHS)

Figure 3.4 shows the number of years experts have spent in their profession.

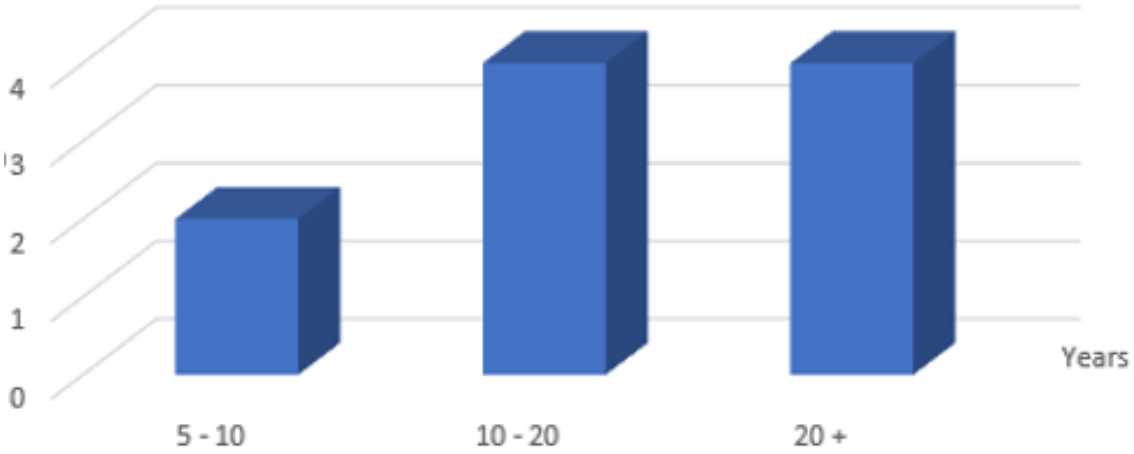


Figure 3.4 Experts' number of years in profession

Inclusion and exclusion criteria

Delphi participants were selected based on the four "expertise" criteria identified by Adler and Ziglio (1996): knowledge and experience with the issues under investigation, capacity and willingness to participate, sufficient time to participate in the Delphi study, and effective communication skills. Participants who were not comfortable with the possibility of being identified in the research or are not fluent in written and spoken English or could not commit to up to three rounds of the study were excluded.

Sample size

There exists no agreement on the optimal number of experts required in a Delphi study nor criteria for judging a sample size (Hsu & Sandford, 2007). This can be attributed to the fact that a Delphi sample is selected depending on the problem under investigation (Shariff, 2015). Delphi studies have been conducted with virtually any sample size (Akins et al., 2005). The panel size is generally determined by the number required to build a representative sample as well the information processing capability of the research team (Ludwig, 1994). Delbecq, Van de Ven, and Gustafson (1975) recommended using the minimum possible number of participants to avoid potential low response rates and long analysis time. Reliable and effective outcomes have been previously produced by samples of experts as small as five (Malone et al., 2004). Needham and de Loë (1990) recommended a minimum of 10 experts and a maximum of 50. A study addressing the stability of response characteristics of a Delphi panel used bootstrap sampling to augment the responses of a small expert panel and concluded that a small group of experts with similar training and general understanding in the field of interest are able to yield stable responses (Akins et al., 2005). De Villiers, De Villiers, and Kent (2005) made a distinction between homogenous and heterogeneous panels and recommended 15 to 30 experts if the panel is from the same discipline, and 5 to 10 experts per professional group if the panel is heterogeneous. In this study, the expert panel consisted of 10 experts: five disaster managers and five disaster healthcare professionals.

The Delphi questionnaire

Two rounds were conducted in this Delphi study. The two questionnaires consisted of the MDS section and a second section about the suggested disaster healthcare educational framework. In the first Delphi questionnaire (Appendix H), three types of data elements were presented along with definitions to ensure clarity about meanings. Participants were asked to evaluate each element based on a seven-point importance scale. Participants had room to add new items that did not appear in the list, suggest a change in the definition that they felt might improve the importance, or even rename the items. If a new item was suggested, the participant was asked to indicate whether the item is completely new, a major reworking of an existing item, or a set of items they recommend putting together. In the second part of the questionnaire,

participants were asked to choose the important topics from a list of suggestions, comment on their choice or add new topics. They were also asked to respond to the value of the suggested curriculum and the preferred delivery mode (online, face-to-face, or both).

In the second Delphi questionnaire (Appendix I), participants were provided with the analysis of round one feedback and asked to confirm their choices. This step was important to detect stability. They were also asked to evaluate new items (and topics) and make changes or add new ones.

3.6 Data analysis

3.6.1 Analysis of semi-structured interviews

Data analysis is an ongoing iterative process that spans the whole research study period. However, no particular method is considered singularly suitable for analysing qualitative data (D. R. Thomas, 2006). Inductive thematic analysis was used to analyse the semi-structured interviews as this analysis method aligns with the social constructivism worldview.

Thematic analysis systematically identifies, organises, and offers insight into patterns of meaning across qualitative datasets (Braun & Clarke, 2012). The focus of thematic analysis is on identifying and making sense of commonalities and shared experiences.

Thematic analysis is built upon the generation of codes and themes. Codes, which are the building blocks of analysis, are labels for important features of the data relevant to the research question. Coding captures the semantic as well as the conceptual dimensions of the data. Codes are then collated to form coherent and meaningful patterns in the data known as themes.

Thematic analysis is flexible in terms of its approach towards data analysis. It can be used to analyse qualitative data inductively as well as deductively and hence is not linked to a particular theoretical framework (Braun & Clarke, 2006). Deductive analysis investigates whether data are consistent with prior assumptions, theories, or hypotheses identified or constructed by an investigator. In contrast, inductive analysis uses detailed readings of the collected data to derive concepts, themes, or a model through interpretations of the collected data (D. R. Thomas, 2006).

There exist three main approaches to thematic analysis: coding reliability, the reflexive approach (Braun and Clarke's six phase approach), and codebook approaches (Braun & Clarke, 2006). Coding reliability approaches focus on the reliability and accuracy of the coding by using more than one coder and measuring the extent to which they agree on the codes produced using a structured codebook. In coding reliability approaches, themes are developed at an early stage and coding aims at finding evidence for the specified themes. Similarly, codebook approaches use structured codebooks and input themes instead of finding them. However, codebook approaches are not concerned with measuring reliability. The reflexive approach to thematic analysis does not conceptualise themes as inputs but rather as analytic outputs created from codes through the researcher's active engagement with their data (Braun & Clarke, 2006).

Since this research attempts to derive concepts and themes from participants' views and perspectives rather than testing existing assumptions, the reflexive thematic analysis approach (Braun & Clarke, 2006) was followed.

In the reflexive approach, Braun and Clarke (2006) identified the following six phases: getting familiarised with the data, identifying codes, constructing themes, reviewing themes, defining and naming the themes, and writing up the analysis.

Table 3.2 below explains the six-phase analysis process that was followed. Analysis was supported by the NVivo software package. NVivo contains tools for fine, detailed analysis and qualitative modelling and was very helpful with data storage and retrieval, and in applying the codes to the data.

Table 3.2 The six-phase approach to thematic analysis

Phase	Description
Getting familiar with the data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas
Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire dataset, collating data relevant to each code
Constructing themes	Collating codes into potential themes, and gathering all data relevant to each potential theme
Reviewing potential themes	Checking if the themes work in relation to the coded extracts and the entire dataset, generating a thematic map of the analysis
Defining and naming themes	Ongoing analysis to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions and names for each theme
Producing the report	Selection of vivid compelling extract examples, final analysis of selected extracts, relating back to the research question and literature, producing a scholarly report of the analysis

Source: Braun and Clarke (2006)

Reflexive thematic analysis allows themes to emerge from the data rather than setting up categories in advance based on previous assumptions. Codes were generated while by indexing passages of text relating to a common idea into categories. Using NVivo software, material relating to a specific idea (code) was gathered into a container called a Node. When a node is opened in NVivo, all references coded to the node whether from the interview being analysed or other interviews can be seen enabling the researcher to view and rearrange codes throughout the coding process, thus refining it. The strength of NVivo lies in its ability to present analysed codes and themes as a hierarchical navigation pane to the side of the screen as the coder conducts analysis.

Codes were further grouped into themes that provide a general explanation of the challenges under investigation. Themes were identified by constantly comparing the identified codes and classifying them according to what causes them or how do they impact aspects of communication between emergency managers and health professionals in disasters i.e. themes were created by grouping codes of communication experiences that share root causes or have similar impacts/implications on cross-agency communication.

3.6.2 Analysis of the Delphi study results

To construct Delphi judgements, decision rules must be established. Consensus can be decided if a certain percentage of the votes falls within a specified range (Miller, 2006). One approach to achieving consensus recommends that 80% of participants' votes must fall within two categories on a seven-point Likert scale (Ulschak, 1983). This is the approach followed in analysing the Delphi feedback in this study, with a variation regarding the cut-off percentage.

In addition to identifying important educational topics, the study seeks to identify the data elements that are deemed critical for each group of experts with the aim of exchanging them between the two sectors in disasters. Asking the question: "Do you think it is important to share this data item with other agencies in a disaster setting?" requires the responder to be knowledgeable in all aspects of the agencies involved in disaster response, which is practically impossible. Lacking expertise in the judgement requested results in identifying "experts" who may not really be very "expert" (Weiss & Shanteau, 2001). Therefore, the question was formulated differently: "On a seven-point scale, how critical is this data item to your work in disasters?" Data elements deemed critical by both disaster managers and disaster health professionals were selected for inclusion in a suggested MDS. Such an MDS may be worthy of exchange across disaster response agencies. To identify these data elements, feedback provided by each expert group has been analysed independently meaning that experts were divided into sample sizes of five participants. For a sample size of five participants, the majority constitutes three or more participants which is a minimum of 60% of the group votes.

In his book chapter "Towards a Theory of Group Estimation", Dalkey (1975) questioned the degree of accuracy of specific estimates and highlighted the need for a theory of estimation that enables the assignment of a figure of merit to individual estimates on the basis of readily available indices. In this study, 'criticality' is determined by the top two scale points: 'very important' and 'absolutely essential'. Hence, on a seven-point scale, if a data element is voted for as very important' or 'absolutely essential', it is considered to be critical.

For a data element to be considered critical and hence nominated for inclusion in the MDS, the percentage of votes received for ‘very important’ plus the percentage of votes received for ‘absolutely essential’ by each group of experts needs to be 60% or more. Figure 3.5 below illustrates the analysis process.

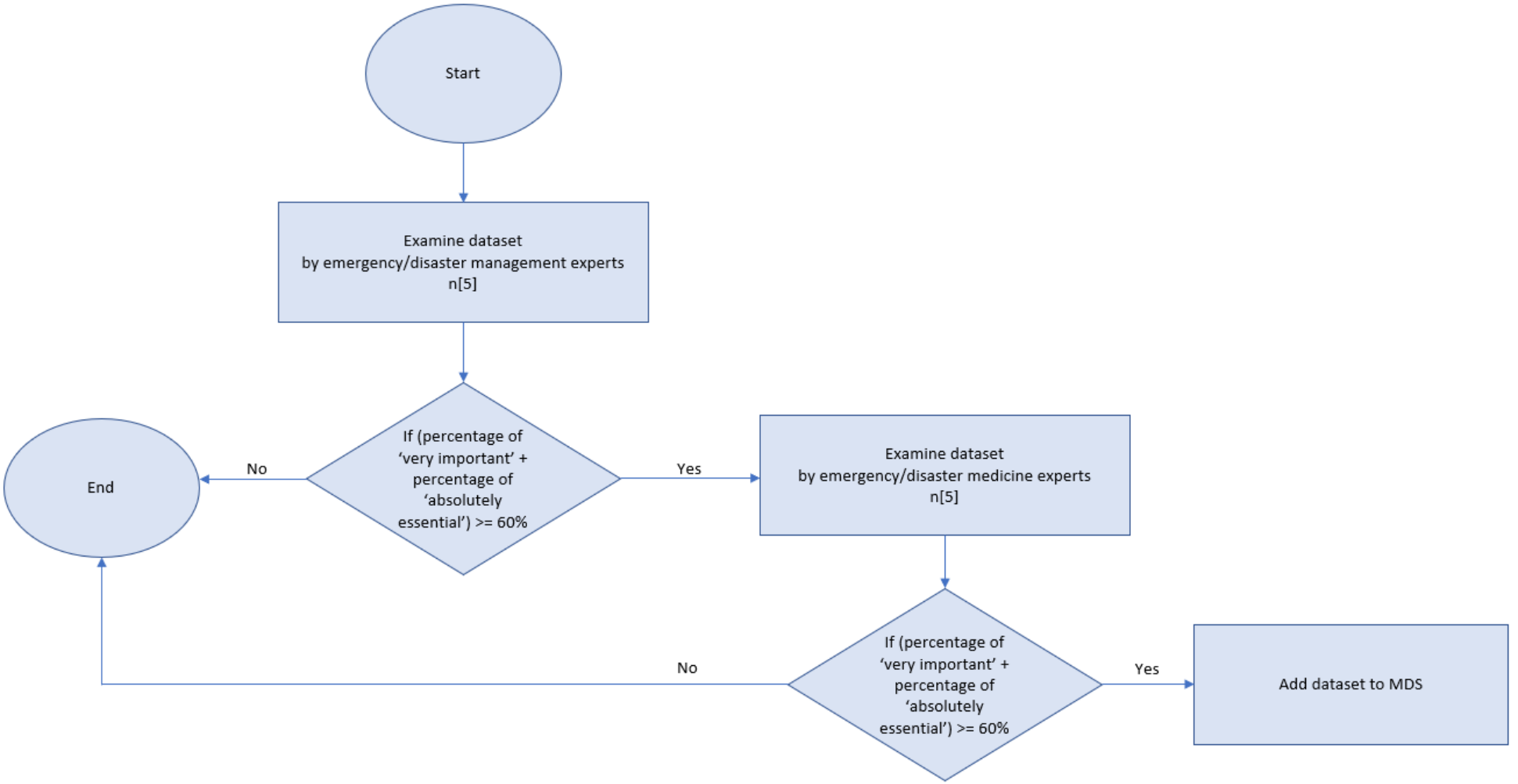


Figure 3.5 MDS datasets selection process

It has been argued that measuring the stability of participants' responses in successive iterations is more reliable than using percentages (Scheibe, Skutsch, & Schofer, 1975). Taking this argument into consideration, participants were asked to confirm their evaluation for the items agreed upon in the first round and only stable responses were selected. Therefore, both the percentage and stability measures were used in the analysis process.

The following seven-point importance scale was used:

1 Not Important at all
2 A little importance
3 Some importance
4 Degree of importance is unknown
5 Some significant importance
6 Very Important
7 Absolutely essential

The literature lacks a standard for specifying the number of points on rating scales and variations exist in common practice (Krosnick & Presser, 2010). Fine-grained distinctions yield more accurate responses that can be used to identify the degree of importance or triviality of certain items for further research and discussion. More data facilitates distinguishing between critical or simply desirable data elements, a finding that may have technical implications when considering the implementation of the MDS. Moreover, some studies support the notion of increased reliability with more scale points up to a maximum of seven scale points (Givon & Shapira, 1984). In this study, the inclusion of two scale points ensures that very important data items that may be critical in some situations are not overlooked.

3.7 Chapter summary

This research is a qualitative study guided by the social constructivist worldview. It aims at enhancing disaster healthcare through understanding the root cause of poor communication between agencies concerned with the provision of healthcare in disasters. Global literature reviews supplemented by semi-structured interviews with disaster managers and health professionals were conducted to identify the problems.

The interviews were thematically analysed and the results prompted the suggestion of two approaches to address the identified problems, thus improving disaster healthcare. A two-round Delphi study was conducted to evaluate the suggested solutions. The rationale behind the methodology that was followed including data collection and analysis has been discussed.

Chapter 4 Barriers to Cross-Agency Communication and Information Exchange in Disasters

4.1 Introduction

Understanding the barriers to effective cross-agency communication and information exchange is crucial for developing strategies that enhance the effectiveness of healthcare provision in disasters. This chapter presents the results of the semi-structured interviews conducted to understand the factors that impact effective communication between emergency management and health agencies in disasters. For information about participants and questionnaire details, see section 3.5.2.

In this study, 15 interview transcripts, about 44,000 words in total after eliminating irrelevant data, were analysed. Analysis of the interviews revealed five main themes: trust, authority and leadership, situation awareness, technology and legislation. Figure 4.1, below, shows a thematic map illustrating the five themes and their concomitant codes. For more information on the analysis process, see section 3.6.1.

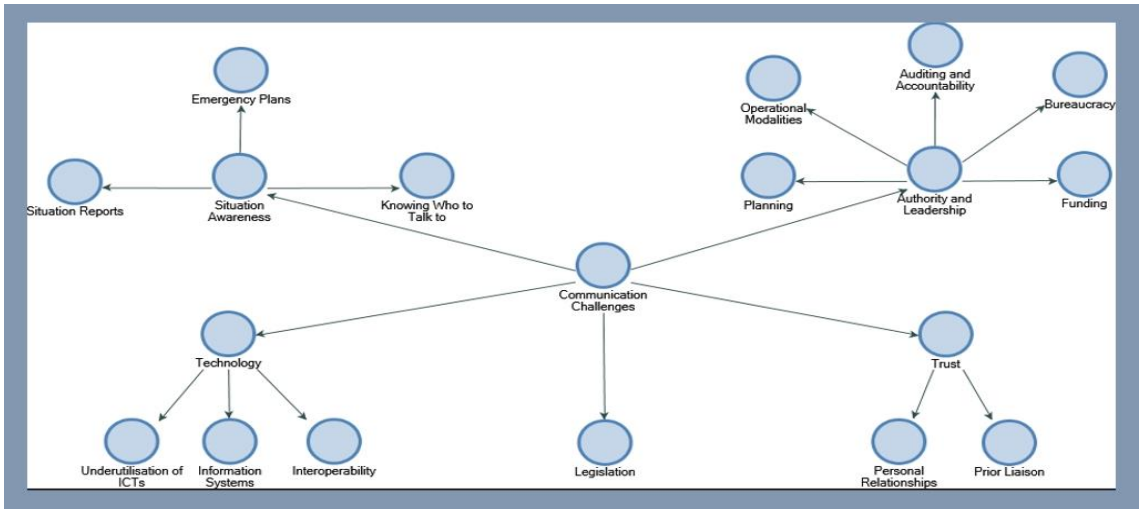


Figure 4.1 Communication challenges thematic map

The five themes, their associated codes, and expressive comments by the participants are presented in the following sections.

4.2 Trust

Trust means that agencies believe in each other's abilities, resources and skills and that they have the will to collaborate and complement each other (Salem & Jarrar, 2009).

When sharing information, trust refers to believing that the recipient of the information will handle the information professionally (Lips et al., 2011). All participants emphasised the central role trust plays in facilitating information exchange and establishing cross-agency collaborations.

> *Participant 12*
> *We have contact lists for everybody but it's not about names. I can't tell if I can predict what that person is going to do with the information I give them. It's about trust.*

> *Participant 1*
> *Trust is based on relationships. You will find more collaborations between certain regions than others will because they know and trust each other more. Therefore, if something happens in the region, we know they are only a phone call away.*

4.2.1 Personal relationships

Personality clashes and poor personal relationships have been highlighted as reasons behind poor communication and can lead to mistrust, faulty communication and the failure of plans. For example, despite all legal plans being in place, the relationship between a city mayor and a senior civil defence official was dysfunctional during Christchurch earthquake disaster, to the extent of having to declare a state of national emergency to enable overruling the two officials who did not get along.

> *Participant 6*
> *Challenging the point of how much is communication an issue, I would daresay that sometimes the ineffectiveness is largely due to personality clashes. If people have a good rapport, they naturally talk and communicate. If they don't get on, then they don't engage, and that's probably their biggest issue.*

The impact of having good personal relationships between decision-makers is extremely influential to the extent that it can, in some cases, substitute for the need to refer to formal agreements or guidelines. Furthermore, the weaknesses and gaps in formal guidelines can be overcome by good personal relationships. A participant attributed the effectiveness of formal agreements and guidelines not to the emergency plans per se but rather to the relationships created in the process of going through them.

4.2.2 Prior liaison

Lack of prior liaison between emergency management and health agencies leads to lack of understanding of operational modalities, priorities, and capabilities. Prior liaison includes sharing preparedness plans which inform decision-makers of where the resources that might be required in a certain disaster scenario reside. Moreover, the efficiency of response is enhanced when connections are already in place with disaster stakeholders at the time of response and each agency has a clear understanding of the roles of other stakeholders.

> *Participant 8*
> *I guess it gets down to each agency's own emergency plan and having those people identified and other agencies knowing whom they are building those relationships with. Everyone not just the key contacts that we don't have to start from scratch.*

> *Participant 1*
> *It's easier to communicate with someone you know and understand. Having good relationships provides clarity about what people do, what they can't do, what they have resources for, what they don't have resources for. That relationship is fundamental for communication.*

Lack of prior liaison is attributed to the fundamental differences in the way emergency management and health agencies are structured and the ways in which they operate. These factors minimise interactions between the two sectors in normal circumstances. As a consequence, inter-agency communication becomes problematic during disaster situations resulting in false expectations and duplication of tasks.

> *Participant 1*
> *Health organisations have a different structure and they operate in a very different way, they don't do a lot with other emergency services in peacetime that is why they don't have smooth relationships with other agencies. It gets frustrating to communicate with them during a disaster.*

> *Participant 7*
> *If there had been a high level of liaison around maybe table top exercises, and the like, that capability would have been better understood. Basically what we're looking for in communication is prior communication.*

> *Participant 10*
> *The Council have got a big group of really keen volunteers that step up from their normal role in Council to take on a Civil Defence role. They really have not much reality of what happens practically. So they imagine that they need to be looking at this, this and this where they don't because it's already been dealt with by the emergency agencies.*

On a lower response level, the public also do not have an adequate understanding of the skills and capabilities of the different response agencies. For example, it is not widely known that fire and emergency services are skilled and equipped to respond to cardiac arrest and, accordingly, the public sometimes prevents them from performing life-saving procedures.

4.3 Authority and leadership

Challenges that impact communication between emergency managers and health professionals can be attributed to the different authority structures that ultimately reflect on aspects including operational modalities and planning approaches.

4.3.1 Operational modalities

In New Zealand, the underpinning factor of emergency management is that many of the business-as-usual structures and much of their content are used but are put into a surge activity. These management changes result in confusion being created about roles and responsibilities and in having unqualified personnel in emergency management roles.

In the health sector, using business-as-usual structures in surge mode means that employees step out of their regular roles to act as disaster responders. Individuals who move out of their normal roles into emergency management roles are not as well-versed in managing disasters as emergency management professionals, although they might have received some level of emergency response training at some point during their career.

> *Participant 7*
> *So, you'd get a senior manager within council. Well, then that senior manager is usually looking after wastewater systems and infrastructure and then suddenly after just one or two days of training, we tell them, 'Oh, by the way now, you're going to be in charge of this massive disaster with only one- or two-days' training'.*

Lack of professionalism reflects on the quality of information exchanged within and across response agencies. During disaster response, information capture and entry by volunteers (staff with management roles who become part of the incident management structure) is often done according to the personal styles of individuals rather than following a systematic approach, resulting in information loss. Moreover, not checking emergency information at the entry point can lead to compound consequences and compromised information quality.

Responders who externally deploy while being physically or skill-wise under-prepared in emergency management become a burden on other responders instead of supporting them. For this reason, some decision-makers are often reluctant to use non-local resources at times of disasters.

> *Participant 7*
> *It is more effective to facilitate the presence of local responders by helping them with family obligations for example, rather than having to deal with under-prepared non-local responders.*

When responders communicate and coordinate tasks face to face, less time is required to interpret and exchange information. Staff shortages prevent response agencies from co-locating their members among representatives of other agencies at emergency operation centres. Co-location requires adequate staff availability, a privilege often unaffordable by many agencies especially emergency services such as fire and emergency agencies in New Zealand.

Under-staffing also hinders the possibility of conducting joint deployments during response. Joint deployment of multi-agency teams that have been jointly trained can significantly improve the effectiveness of response. Nevertheless, joint team collaborations require adequate human resources.

The scarcity of professional emergency responders can sometimes prompt agencies to enrol non-professional personnel for coordination purposes. This approach is risky when the reliability of those enrolled cannot be verified.

> *Participant 6*
> *But I said, "So what stops a convicted sex offender from walking off the streets to volunteering in your centre and obtaining a list of unaccompanied children in that disaster?" And there was a bit of a --!*

People are not sort of thinking about what can happen during disasters.

Participant 11
It's quite interesting, you can have all the plans and preparations in the world but quite often when it comes down to it, people create those plans at the time so having the liaisons in one place that you can communicate just saves so much time.

Participant 10
If we have one of our commanders available to go down and sit there for an hour and pass on information, that's great but we are really short on the ground. We just do not have enough people on the ground to be able to spare someone to put them to those branches.

Participant 7
One of the classic failures that they did was they came together and put together an Emergency Coordination Centre. Instead of dragging the computers and the whiteboards out into one hall and sitting around and looking at each other, they sort of walked into these little offices and closed the doors. So, it took some time, really, for them to become globally focused.

A high turnover rate among civil defence personnel in New Zealand is another factor that impacts cross-agency communication. According to a health professional participant, the issue of the continuous movement of civil defence staff and the fundamental structural changes that take place have a profound impact on information sharing. He explained that communication in the health sector with managers in civil defence is facilitated by the trust they have in the individuals they are familiar with and with whom they have been working for years. Individuals feel reluctant to share information if they do not trust that the person asking for the information is going to treat the information reliably and responsibly.

A challenging aspect of emergency management in New Zealand is the absence of minimum requirements for becoming a professional emergency manager. This creates a negative perception of civil defence officers that makes it difficult for their stakeholders to trust their decision-making abilities in disasters.

Participant 5
I think the struggle for us is that we don't have a single voice guiding us on what does "Best Practice" mean in emergencies. What does it mean to call yourself an emergency management professional? Does

> *that automatically trigger someone to know that you've done a university degree, or a series of courses or had an amount of experience? We don't have that yet!*

A challenge that exists when disaster responders from various agencies communicate, is the different use of disaster terminology. Although there are practical reference tools such as the *Dictionary of Disaster Medicine and Humanitarian Relief* (Gunn, 2012), which covers over 3,000 disaster medicine and humanitarian relief definitions, disaster responders still have different ways of viewing what is referred to as the family of emergency management disciplines, including process and risk communication, crisis management, business continuity management, and risk management. The confusion stems from what the terms mean, the differences between them and how they work together. Moreover, the terms used by one agency may not necessarily refer to the exact meanings perceived or processes followed by another. For example, the understanding of the term 'risk' varies across different agencies. While some agencies may have a risk-averse approach to a certain aspect of their role, others may be more practical.

> *Participant 8*
> *Everyone's opinion or identification and understanding of risk is different. When you start to talk about risks, people very quickly shut off. So I changed the conversation from "risk" to "consequence" cos the consequence of whatever has been the case is often the same.*

> *Participant 2*
> *Standardised terminology is key to collaboration. If you parachute people from different backgrounds, cultures, institutional frameworks and force them to work together because there is a crisis, what will happen is that the first few days will be spent in meetings to familiarise people with the languages other speak while people are dying outside the meeting rooms.*

Operational modalities and organisational cultures are influenced by the authority structures of an agency. A bureaucracy is a type of organisation defined by hierarchical control and a strict chain of command based on rules rather than charismatic authority. Communication challenges linked to bureaucracy are presented next.

4.3.2 Bureaucracy

Civil defence is often perceived as an authoritative agency that lacks easy lines of communication. Some interviewees shared their frustration about the existing unilateral approach to problem-solving. Local decision-makers explained that, despite spending considerable time and effort on developing response plans according to the situation on ground, they sometimes feel disappointed when their plans are rejected by regional authorities who do not have enough understanding of the situation at hand.

This negative perception of civil defence can have serious impacts on coordination, such as resisting its guidelines and systems including CIMS.

A lack of open lines of communication with civil defence is another challenge during disasters. Several participants explained that it was not easy to communicate with the Ministry of Civil Defence when they were most needed. A Māori leader explained that during the 2011 Christchurch earthquake, the Māori community effectively made a damage assessment survey and were able to prioritise needs. However, the damage and needs assessment process was duplicated since there was no open line of communication between government agencies and community representatives. This not only impacted the cost and efficiency of the response efforts; it also added much stress on the already stressed victims as they needed to provide the same information to different response agencies which obviously were not sharing information. Another district command officer said that during the 2017 Port Hills fires, he could not get confirmation that the issues he raised to civil defence were being tackled.

> *Participant 8*
> *I think the biggest problem in New Zealand is that the Ministry of Civil Defence actually think they know much better than everybody else. A council down in Westport would know better than the Ministry of Civil Defence how to manage its own emergency if they've got the resources and training.*

> *Participant 14*
> *At the marae level, given that most of us will immediately open their doors to take in people, to act as welfare centres, we need a geared-up relationship where we're talking. Where we have protocols and communication lines in place so that we can immediately start to engage.*

> *Participant 10*
> *I couldn't communicate with the Civil Defence team that was running the fire. The only way I could communicate was via cell phone and they would answer it probably every tenth call.*

The situation in disasters cannot be fully predicted. Often, problems are not identified until the event actually occurs, a situation that requires creativity and flexibility.
Often, in disasters, out-of-the-box solutions can make a significant difference in the quality of response. However, leading agencies tend to disregard approaches that are not included in the original response plans. A classic example is the important role played by the Student Volunteer Army; a New Zealand student movement born from a Facebook page following the 2011 Christchurch earthquake. Initially, the Ministry of Civil Defence was totally against involving members of the student movement. However, as the disaster unfolded, the movement, which has never been a solely disaster-response focused organisation, proved to be a vital player in both response and recovery phases.

Assuming a generic template for provision of disaster relief is a typical mistake that government agencies follow in disasters. For example, storms in the Pacific regions are usually associated with an increase in fish activity closer to the coast which facilitates fishing. Instead of providing the affected population with food, it is more practical and cost effective to supply them with materials for fishing. Therefore, listening to the perspective of communities on how response should be planned and utilising their resilience knowledge enhances the efficiency and effectiveness of response.

> *Participant 2*
> *You cannot have a fully effective response without engaging the concerned community because they always know better. Communities need to be engaged in the planning for disaster response rather than enforcing the response on them.*

> *Participant 14*
> *We (Māori community) sent the wardens out into the eastern suburbs; go door-knocking. Find out who's staying in every house, do they have water, do they have power, do they have surge. We documented it all.*

Different agencies have different ways of operating and they use sector-specific terminologies, a situation that requires having a common framework for emergency

response such as CIMS (see section 2.10.3). A major drawback in the coordination of disaster response in New Zealand is the lack of training and absence of compliance with CIMS.

Despite the criticality of CIMS, a significant number of emergency management personnel do not use it. Reasons include preference for another incident management framework such as UK's Gold-Silver-Bronze structure with which some responders are familiar, a lack of training on CIMS, and sometimes out of a belief that the response effort can be better coordinated without external guidance. In addition, CIMS is falsely perceived by emergency managers as a disaster framework and hence is not used organically, causing responders to be unfamiliar with it during disasters.

The lack of adequate awareness about CIMS results in unnecessary communication. For example, in an emergency operation centre (EOC) during Christchurch earthquake, responders were making phone calls to their equivalents in a different region regarding spaces for evacuees. Such communication is usually dealt with at a higher managerial level because district or national responses are different from local ones. As the response becomes global, information requirements become more about understanding capabilities than getting into the details. CIMS is helpful in getting responders familiar with the command-and-control top-down coordination structure during response.

> *Participant 7*
> *Emergency responders absolutely hate attending those exercises because they see them as sort of theoretical and nebulous. They see them often as enthusiastic volunteers pushing paper around the table.*

Considering the need for following coordination frameworks and other command-and-control guidelines, it becomes clear that some auditing mechanism needs to be in place to ensure compliance and impose accountability measures.

4.3.3 Auditing and accountability

In New Zealand, the complete absence of a mechanism to check the quality and, more seriously, the existence of emergency plans translates into the absence of rigid civil

defence auditing. Even when an emergency plan exists, the absence of compliance with the specified plan incurs no consequences or liability on the agency.

Similar to emergency plans, there is no mechanism that ensures a response agency is trained on or will be using CIMS when required. New Zealand also lacks processes and mechanisms to assess emergency managers.

The absence of a consequence for failure in following coordination frameworks is not only found among New Zealand agencies but also in international response organisations including the United Nations agencies. The primary mechanism for inter-agency coordination of humanitarian assistance used by UN agencies is the Inter-Agency Standing Committee (IASC) instructions. IASC is a unique forum involving the key UN and non-UN humanitarian partners established in June 1992 in response to United Nations General Assembly Resolution 46/182 on the strengthening of humanitarian assistance. Despite their importance, IASC instructions are often ignored.

> *Participant 6*
> *There is a process called monitoring and evaluation, but the reality is that someone from the Ministry goes down. They get all the key players in the room and basically ask them, "How well do you think you're doing on this?" It's really open to people being honest. If they say: "Oh yeah, we're doing really well. We think we're at 8 out of 10", then it sort of becomes an 8 out of 10. So even if you're found to be not following the requirements or not meeting expectations, basically, you'll be sent a naughty letter and that's all about it.*

> *Participant 1*
> *People think they know what they're doing so there's no need to do this course and there's no compliance across the country to enforce CIMS.*

The call for flexible planning that satisfies the needs of affected populations entails an inclusive attitude towards disaster planning. The voices of various disaster response stakeholders need to come to the fore. Adequate disaster planning is pivotal for successful response outcomes.

4.3.4 Planning

In disasters, creative and flexible approaches towards problem-solving are indispensable. During the response to the Christchurch earthquake, for instance,

health authorities had to call on the Defence Force to help them test the progression of chlorinated water because there was a shortage of community health inspectors. In another example, telecommunication companies were able to inform emergency response services of the locations where groups of people were gathering through picking up communication signals.

Some interviewees have criticised the approach of civil defence agencies towards the utilisation of resources and accused them of lack of engagement with non-governmental organisations (NGOs), people with disabilities, and indigenous peoples.

NGOs

NGOs have vital roles in disaster response. Nevertheless, the level of collaboration between governmental agencies and NGOs in New Zealand is low. For example, the provision of psychosocial support (supporting victims with their state of mental, emotional, social, and spiritual well-being) falls among the responsibilities of the Ministry of Health. Although NGOs such as The Salvation Army are highly skilled in this field, district health boards still follow the conventional approach for delivering psychosocial support through the patient's doctor rather than calling on NGOs to assist. In addition to putting more pressure on the often overstretched disaster health agencies, the waiting time required to receive support through the public system can negatively impact distressed victims. If the psychosocial response is properly done fairly after the occurrence of an event, it can prevent disaster victims from going through mental health related issues at later stages.

> *Participant 5*
> *Emergency management is about being clever with the resources. New Zealand is a small country and as Red Cross has indicated we're all trying to use the same resources at the same time. I would love to see NGO's getting a higher platform.*

> *Participant 4*
> *If you look at the psycho-social pyramid, you only need that bottom layer of; wanna have a cup of tea? Here's a blanket, how're you doing, and we have heaps of people who do that every day!*

People with disabilities

No specific governmental agency in New Zealand is responsible for taking care of people with disabilities in disasters. The responsibility does not lie within the health

sector, the argument being that the responsibility of the health sector in disasters is to concentrate on receiving the injured and to ensure that patients who are already housed are managed and moved out to enable taking the next wave that comes through. The needs of people with disabilities in disasters are different from those offered by the health sector. Such needs include organising a collection point, facilitating transfer to that point and moving people to safety zones. However, the Ministry of Health owns the information about disabled people including who they are and where they reside.

> *Participant 5*
> *People that live in a community with disabilities would argue that it's just about understanding their needs especially in evacuation.*

Indigenous Peoples

A Māori leader who was also the chair of a district health board shared the experience of the Māori community during the response to Christchurch and Kaikōura earthquakes. He stated that the built-in culture of Māori hospitality can form a strong platform for collaboration in welfare. In the Kaikōura earthquakes, for instance, marae were instantly opened and people from all backgrounds were received without the need to go through civil defence arrangements. Given the huge role that indigenous people can play in disaster response, this participant emphasised the need for establishing communication protocols between indigenous people and civil defence authorities to accelerate and boost the efficiency of disaster response efforts.

At the institutional level, a sense of uneasiness is experienced by an indigenous emergency manager about the low representation of Māori in disaster management governmental organisations country-wide. Under-representation of Māori leads to sub-optimal decisions during disasters due to the absence of an important stakeholder: indigenous peoples.

> *Participant 4*
> *You might have this group of people sitting at the table and they think the issues are these. But this is cos these people aren't at the table. If they were at the table, we'd have another sort of view of what the issues were and then we'd create different solutions.*

The quality of disaster planning strategies, and of other stages of the disaster lifecycle, depends on the funding and resources committed to their implementation. Disaster funding is a focus point of policy-makers due to its central role in managing disasters.

4.3.5 Funding

Although prevention is better than cure, funding disaster preparedness and development programmes remains problematic due to the reluctance of donors to invest in probabilistic scenarios.

Globally, funding countries are usually very willing and ready to fund disaster response efforts when the damage has already taken place. Nevertheless, these countries are often reluctant to invest in institutional capacity or to support countries in following the path of development.

The abundant funding of disaster response activities cannot overcome the lack of preparedness programmes. This was evident in the response to the 2014 Ebola outbreak in West Africa. Despite extensive funding, the WHO's response has been heavily criticised for its lack of preparedness. Moreover, the combination of abundant funds and under-preparedness evidently leads to inefficiencies and wasted resources. Interestingly, a senior UN representative pointed out that when agencies are under-prepared, the more resources flow in, the more uncoordinated the response becomes, and the more duplication exists.

In the context of the United Nations agencies, funding strategies, which are often driven by politics, prevent individual UN agencies from combining into a unified entity that can respond in a coherent fashion. Competition for funding results in a lack of cross-agency transparency and information sharing as some agencies opt to keep sensitive information to themselves in order to use it to apply for funds from donor countries.

Lastly, funding impacts on the level of available training. Due to budget constraints, several agencies do not prioritise training.

> *Participant 2*
> *The question is How willing are we to fund the efforts of mitigating a huge disasters when it's only a probability and not a reality?*

Funding policies need to be based on the available pool of resources and the actual needs of preparedness and response. Nevertheless, in a multi-stakeholder disaster scenario, the challenge is often related to having enough information about the situation and the pressing needs. Decisions based on poor situation awareness, especially in the health domain, can have catastrophic implications. Situation awareness, hence, sits at the centre of disaster management.

4.4 Situation Awareness

Situation awareness (SA) is about building up a holistic picture out of current and reliable information owned by different agencies and ensuring that all disaster response agencies are seeing the same picture. Endsley (1995) defined SA as "the perception of the elements in the environment within a volume of time and space, the comprehension and the projection of their status in near future" (p. 36). It involves being aware of the situation at hand, the pressing needs and the actions required. While SA is impacted by almost every aspect related to disasters, three concepts were conceptually linked by participants to SA: knowing who to talk to, emergency plans, and situation reports.

4.4.1 Knowing who to talk to

To access the right information when the need arises, emergency response personnel need to be aware of who needs to be contacted to provide the required data. Coordination frameworks and emergency plans provide guidelines for identifying roles and responsibilities in emergencies that involve multiple response agencies.

Potential response partners in a given set of circumstances are identified during all-hazard planning, a process that is heavily guarded by legislation. However, the challenge arises when communication is required with a stakeholder who has been missed during exercises and planning. Currently, there exists no 'all-government centralised contact list'. The suggested list would not list individual contacts but rather the right team or section that needs to be contacted and the information that may be needed in a given set of circumstances.

Not knowing who to talk to is a situation often experienced by NGOs when it comes to sharing information. As NGOs operate outside the command-and-control umbrella,

they often experience such confusion which leads them to operate in a silo. Moreover, the lack of a clear understanding of where to direct important information about their activities, or who might be interested in their information in the first place, results in an unintentional withholding of information at their end.

> *Participant 3*
> *Situation awareness is actually about making sure who is where and building that picture up. This information is already available. It's just not all available under one umbrella.*

> *Participant 2*
> *You really have to identify natural actors who join up at times of emergencies - depending on the type of emergency - and they need to accept that the protocols that they will follow in working together will reinforce complementarity in response and maximise its impact.*

4.4.2 Emergency plans

A participant explained that SA, especially in vulnerable regions, starts before the occurrence of a disaster event in the form of prevention or contingency planning. It concerns exchanging information about possible scenarios, the existing response plan, and the role of each agency should a certain disaster occur. Much of this information is included in emergency plans.

Emergency plans are often ignored during disasters. The design of emergency plans was heavily criticised by multiple participants who explained that emergency plans are often too detailed and do not clearly specify roles and responsibilities. At times of distress, decision-makers usually ignore plans that do not provide them with the information they need easily. For example, despite the fact that the response to various disasters scenarios is similar to a great extent, response plans are still designed by analysing individual scenarios. A consequence-driven design approach rather than a risk-driven one may significantly simplify emergency plans, for example by designing a single disaster response plan with sections addressing different hazard scenarios.

Another reason some disaster response personnel are discouraged from using emergency plans is that these plans are not digitised. Plans are mostly saved on paper and, since they are not used regularly, they rarely get updated.

Participant 7
A lot of this information sits in folders on desks or in offices. They sit there and get out of date. We've got to change this concept of large folders and lots of forms to be far more responsive. Could there be an app where some of this resource availability or capability is identified? Everyone uses their phone now for everything, so maybe it is.

Participant 11
If the plans for national and international response has too much information, people won't read them. It's got to be the absolute minimum that they need to do their job instead of wasting time going through sheets. Simple information on what's required for response.

4.4.3 Situation reports

Situation reports are central to the iterative process of SA. A situation report compiles response information from various response agencies to enable effective and efficient coordination. It consists of information about the situation as it evolves, the expected consequences, and their associated challenges. According to participants, planning discussions are held after receiving a situation report to decide on a collective incident action plan. The plan is then executed, monitored and evaluated. Changes are made based on the evaluation and another situation report is compiled and shared. Hence situation reports are accumulative documents that keep increasing in size as the disaster evolves.

As the report gets longer, responders find it difficult to obtain the information they require without going through the whole report.

In addition, the content of situation reports is usually criticised as the agencies responsible for compiling and disseminating disaster information do not consult the recipients on their information requirements. Consequently, agencies usually receive irrelevant information and miss out on important data.

Participant 5
That's the problem we have at the moment as leaders and responders, we've got to scroll through massive documents and situation reports when all we really want to know is a couple of quick numbers to help us make a decision.

Participant 8
They think that they're sharing the information that that person

> *needs rather than asking that person or the other agency what information they require.*

SA is based upon effective information sharing. Considering the sheer volume of information created and exchanged in disasters, humans need to be assisted with technology to comprehend and prioritise what constitutes adequate situation awareness. Therefore, technology is indispensable in disasters.

4.5 Technology

Technology can provide solutions that have the potential to make a noteworthy impact on the quality of disaster response.

4.5.1 Underutilisation of ICTs

Participants from both emergency management and health have pinpointed several processes in disaster preparedness and response that require automation.

A frustration experienced by both emergency managers and health personnel is the lack of real-time reporting. The ability to get real-time updates from disaster scenes is crucial for efficient reporting. Currently, several health agencies lack an automated patient tracking system that reports the number of injured individuals, the priority of their injuries, and the hospitals they have been sent to. Data such as age, presentation, administered drugs, and discharge disposition can make a huge difference to the quality of care provided to disaster victims when reported in a timely manner.

Real-time reporting is also lacking in the emergency management sector, resulting in significant delays in exchanging updates from disaster scenes. The ability to locate potential human resources who can be called upon as the need arises, and the ability to match supply of and demand for materials, are examples of crucial activities that are still being done manually in most agencies.

Mainstream media normally broadcast news on disasters very quickly and continue providing real-time updates. However, these news outlets are not incorporated within the official situation awareness channels of main government organisations. According to a humanitarian coordinator, mainstream media can play a central role in providing the information required to initiate a collaborative response effort.

> *Participant 2*
> *Normally, the media, especially mainstream media, gets the news on disasters very quickly, really fast! A couple of days later you find teams arriving at the reported sites. How can we have a system that connects us with the media that reports real-time events, that can go beyond just broadcasting the catchy half a second news item 'breaking news', to actually engage with them to get more information as to what has happened, who is there, who is responding, to have that initial set of data that you need to define and shape the response you want to deploy not only as individual agencies, but also in a collaborative context that includes everyone involved.*

Victim registration, which involves registering the details of individuals affected in a disaster event, assessing their needs and specifying the agency that is accountable for them, is a process that is still being done manually. This information is collected from scratch and it requires days to be reflected in a database. Automating this process by using existing government databases can make a significant difference in the speed of response.

Another aspect that has been pointed out during interviews is the need to convert emergency plans into a responsive format, using multimedia for example, to encourage disaster responders to use and update them regularly.

> *Participant 3*
> *We need to have a patient tracking system to show us from where we've picked them up because that has significant implications from a public health perspective. You want to track them, you want to know their age cos that has significant implications on whether they're vulnerable or not. If they're under 5 or under 3 or over 60. Where the patients currently are and where they've been within the tracking ability.*

> *Participant 6*
> *That information should have been real-time uploaded. And yet we're still in a situation where people will go out, they may radio back some information. But really, nothing comes back until they come back. And then we're updating our maps on the pin board.*

Multiple participants explained the importance of geographical information systems (GIS) to visualise and retrieve data and gave examples of areas that can be improved through utilising GIS capabilities. GIS can be used in risk reduction by mapping the locations of health providers who are vulnerable to certain types of hazards in addition

to helping them prepare for the possible occurrence of these hazards. In the health context, GIS can be used for gathering, managing, and analysing health data including assisting with disseminating data such as the number of wards, intensive care unit (ICU) beds, and non-functional facilities along with their expected repair time. GIS can also be used to map the locations of individuals who are vulnerable to disasters. GIS can present these data in a visually appealing format that facilitates the process of data retrieval and decision-making.

Despite the huge potential of GIS, the capability is underutilised, and the majority of disaster responders are not trained on its use. Moreover, the costs and complexities associated with its adoption and implementation prevent emergency management and health professionals from harvesting its benefits.

In New Zealand, although the civil defence and the health sectors would both benefit from utilising GIS for disaster information management, the associated cost of implementing the technology prompts the question of who will benefit more from the system and, hence, who should be paying for it.

> *Participant 6*
> *Even though we're in a digital age, we were printing off large land parcel maps with pins and sticking them up and highlighting which ones we had been to. And so, then as someone calls up, you're trying to find the address on the maps, see whether it's been shaded or not!*

> *Participant 8*
> *If you can see it visually it's a lot easier to determine your response impact. You get a little bit more as well and understand what all of the contingencies are in that response.*

> *Participant 5*
> *The GIS functionality is a huge communication tool. People see it as a 'Planning and Intelligence' tool. No, it's a communication tool.*

Social media have the potential to play a significant role in enhancing SA (Tan et al., 2017). Nevertheless, these technologies are hugely underutilised. A health emergency manager explained that social media platforms can be used to: gauge the public's opinion in emergencies, helping decision-makers to re-adjust their recommendations when needed; address communities and assess the clarity of the instructions broadcasted online; use the public's appreciative comments to raise the morale of

disaster responders; or raise awareness about health-related issues, especially during response time when the public's attention is increased.

However, lack of familiarity with social media platforms may be an obstacle for older generations of disaster responders as these technologies are relatively new.

Communities lose trust in governmental agencies when they receive contradictory information. This usually happens when key government figures rely on communication channels such as social media for quick situation awareness. Despite their benefits, social media platforms can be used to disseminate false or exaggerated information. Although government agencies may not be as fast to provide SA, they are compelled to ensure the credibility of crisis information prior to passing information vertically or horizontally.

> *Participant 6*
> *One of the biggest things that will influence the public's behaviour positively is whether the source is trusted. And if they don't have trust in the source they won't listen.*

Trustworthiness of information is critical to authorities and the public in disasters. The public usually rely on trustworthy information outlets for guidance and support in disasters. Information systems play a big role in collecting, refining, and verifying information.

4.5.2 Information systems

Emergency information systems play a significant role in building situation awareness by providing decision-makers with reliable, up-to-date information (Currion, Silva, & Van de Walle, 2007). Nevertheless, many challenges prevent these systems from achieving their intended purpose. In New Zealand, a national emergency management information system (EMIS) is used by the main response agencies: civil defence, health and police. Although EMIS has attractive features, including collaboration pages for documentation, discussion boards, and pages for the collective development of plans, usability considerations regarding text colours, visualisation and functionality are found to be barriers to its uptake.

EMIS users find it very complex and are not encouraged to use it in normal day-to-day activities, which makes them unfamiliar with its use when there is an expectation of them to use it.

Another concern about EMIS is that it does not automate all major functions of disaster response. For example, resource management and national staffing requests are two significant aspects of disaster response that are not automated by the system.

The low uptake of EMIS is also thought to be linked to the fact that it is not owned by the agencies that are expected to use it. For example, HealthEMIS is owned and managed by the district health board. According to Van Alstyne, Brynjolfsson, and Madnick (1995), system owners are more interested in its success than non-owners.

> *Participant 5*
> *Sometimes you just need to see 4 columns with headings and numbers under them. Sometimes you need to see them on the map, it's a thinking preference. It's all about how we take what's happening around us, process it, and then use it to make a decision on it.*

Calls for enhancing the design of information systems to simplify functionality and encourage their uptake are certainly worthy of consideration. However, utilisation of these tools is challenged by their ability to 'talk' to each other and exchange information. Interoperability is, thus, a determinant factor in evaluating information systems.

4.5.3 Interoperability

Interoperability is the most critical issue facing any attempt that involves accessing information from multiple information systems (Park & Ram, 2004). It refers to the ability of two or more systems or components to exchange information and to use the information that has been exchanged (Geraci et al., 1991). Given their need to communicate and exchange situational information in a timely manner, disaster response agencies are certainly negatively impacted by interoperability barriers. For example, EMIS (see section 4.3.2) is designed to be used by the main government response agencies: civil defence, the health sector, and the police. The different versions of EMIS that lie across these sectors are disconnected, as each version sits on a different server.

Legally, response agencies are characterised by having different processes and access controls based on security considerations. Moreover, most agencies are concerned with the need to own and control data. Hence, even when agencies have a genuine will to engage in a collaborative effort, interoperability introduces complex restrictions as with the case of accessing government databases to automate the process of victim registration (see section 4.4.1).

4.6 Legislation

In New Zealand, strict privacy rules around information sharing limit the ability of agencies to make the civil response more efficient. One example is the restricted access to already existing databases of government agencies for collecting victim information during disasters. Access to such information can save disaster responders significant time and resources.

If sufficient reasons to release information during disasters exist, strict privacy and confidentiality measures are often relaxed. However, the relaxation of strict information sharing measures under a certain act does not automatically guarantee that the information will be released, as some information is subject to multiple acts. A major concern in this regard is that disaster responders often lack knowledge about privacy and confidentiality restrictions, the stage at which a relaxation can be implemented, and the process to be followed in requesting the release of sensitive information.

Information sharing is fundamentally built upon trust. The smooth flow of information demands credibility. It requires trust that the information will be used for the purpose for which it has been requested. In New Zealand, withholding information usually happens if the information is deemed embarrassing to a government agency, or is commercially sensitive. In politicised disasters, responders may opt to withhold information for political or security reasons, or to facilitate funding by common donors.

Lastly, fear of being held accountable to emergency plans in situations that require decision-makers to decide not to follow their original plans makes some agencies reluctant to share information regarding their emergency plans.

Participant 3
I'd be comfortable with any data that we capture being shared but what you want to be able to do is make sure that people requesting the data have got it for the right purpose.

Participant 6
In the Civil Defence Act, it says that this act does not affect other acts so that means the privacy act still applies.

Participant 2
It's the competitive nature of funding that makes information sharing very difficult sometimes. You look good when you have information that nobody else has.

Participant 11
There are those issues as well that if something's written down in black and white about another organisation you're going to challenge them about it because it says in there. We've had this before where people have challenged people on their plans.

Effective problem-solving starts with analysing the problem and identifying the key issues that create the problem in the first place. Key issues that hinder cross-agency communication and effective information flow in disasters have been identified in this chapter and analysed into five main themes. Chapters 5 and 6 suggest solutions to address some of the issues identified. Communication challenges and the suggested solutions are jointly discussed in chapter 7.

4.7 Chapter summary

This chapter presented the findings of the semi-structured interviews conducted to identify the barriers to effective communication and smooth information flow between emergency managers and health professionals in disasters.

The results showed that health professionals and emergency managers do not understand each other's capabilities, priorities, and structural and operational modalities. This leads to an underutilisation of resources and sometimes it leads to false expectations.

Poor personal relations appeared to play a significant role in hindering the effectiveness of response and the flow of information despite the existence of formal

agreements and guidelines. Poor personal relations may sometimes lead to the failure of plans and to the wasting of valuable time in disasters.

A problem that kept recurring during the interviews was the difficulty of identifying who to talk to. Even when the right person or destination is clear, it is sometimes difficult to get hold of them during response time.

The lack of minimum requirements for the accreditation of emergency managers and the low profile of emergency managers may be linked to a shortage of emergency management professionals. Compromised leadership, under-reporting and poor quality of the exchanged information were found to be linked to understaffing. The shortage of qualified emergency management personnel forces response agencies to use individuals who do not have the necessary skills and expertise to manage disaster situations.

The changes in roles and responsibilities that result from using business as usual resources during emergencies are another problem that causes confusion about roles and responsibilities.

The research showed that the lack of auditing and the absence of a mechanism to ensure compliance with emergency plans and training requirements on national coordination systems compromises the quality of disaster response.

SA, upon which critical decisions are made during disasters, depends on the quality of information exchanged across response agencies. Most of this information resides in emergency plans and is communicated via situation reports. Situation reports and emergency plans were both criticised by emergency managers and health professionals as wordy and mostly irrelevant.

Disaster response plans to which vulnerable societal sectors do not contribute often provide suboptimal solutions due to gaps in needs expectations. Participants emphasised that inclusive and flexible disaster planning does not only identify response priorities, it also promotes information sharing, eliminates the duplication of tasks, and encourages collaborations with community members who may be utilised in disaster mitigation, response and recovery.

Excluding indigenous groups from participating in disaster preparedness and response results in poor situation awareness which in turn leads to a duplication of tasks and frustration among already stressed community members.

The underutilisation of ICTs was clear in every single interview conducted. Social media, despite its cost-effectiveness and ease of use, is still not being recognised in emergency planning. Social media platforms, GIS systems and mobile applications are among the many technological solutions that require a higher profile in disaster strategies due to their immense impact on the quality of response.

Considering emergency information systems, low uptake due to usability considerations and interoperability problems were found to be challenging factors that negatively impact disaster information exchange.

Finally, for effective planning for future expected disasters, adequate funding that does not favour response projects over preparedness programmes is required.

These results suggest that several aspects of disaster management require solutions that enable governments and communities to be resilient and have the ability to bounce back better when disasters strike. The following chapters present experts' evaluation of two suggested solutions for tackling some of the issues associated with cross-agency communication and information exchange in disasters: the design of a disaster healthcare MDS, and the design of a framework for a disaster healthcare curriculum. The two solutions aim at enhancing the quality of disaster healthcare by improving disaster information exchange and training and educating disaster response professionals.

Chapter 5 MDS Delphi Results

This chapter presents the results of the Delphi study concerning the suggested MDS prototype. The chapter starts with explaining the rationale behind choosing the MDS approach (refer to section 2.11.2) for enhancing cross-agency information exchange in disasters. Datasets considered for inclusion in the suggested MDS prototype have been identified through both literature review (section 5.2.2) and semi-structured interviews (section 5.2.3). The literature review investigated a range of disaster types to identify common information requirements. Literature sources of information include the WHO, the IFRC, the Health Information Standards Organisation (HISO), the Pan American Health Organization (PAHO) and the New Zealand Ministry of Health, in addition to peer-reviewed articles. Results of the first round of the Delphi study (section 5.3.1) are presented, followed by results of the second and final round (section 5.3.2). This chapter mainly present results with minimal interpretation. Full analysis and evaluation are left to the Discussion chapter.

5.1 Introduction

Delivering health interventions in disasters requires coordination between the health sector and other disaster response agencies. For example, if an environment becomes unsafe, clinicians may need to advise responding managers that evacuating some critically ill patients is more dangerous than letting them remain. However, the complexity and uncertainties associated with disaster events complicate the process of developing comprehensive situation awareness (Karami et al., 2020). According to participants, agencies comprehend information differently, and hence the information shared across response agencies is often meaningless.

> *Participant 10*
> *I guess at the moment, some of the information that's coming back doesn't mean anything to half the agencies. That might mean something to these people and these people, but to these people it probably is talk in a foreign language.*

According to interview participants, the command-and-control structure adopted by governments does not suffice for the information needs of most disaster response agencies. Although every agency maintains its own reporting system, SA is critically

dependent on the realisation that data items of limited value to members of one agency can be crucially important to their counterparts in other agencies (Abbas & Norris, 2018).

As the situation evolves rapidly during a disaster event, information becomes outdated, hindering the ability of response agencies to make optimal decisions. Therefore, there is a need for an approach that enhances both the effectiveness and efficiency of information exchange between emergency managers and health professionals in disaster contexts. The notion of an MDS is suggested as a viable data exchange format (Benin-Goren, Kubo, & Norton, 2017) that strikes a balance between adequate situation awareness and controlled information exchange.

An MDS (see section 2.11.2) refers to a coherent set of explicitly defined data elements that are uniformly collected and registered (Ahmadi & Mirbagheri, 2019; Svensson-Ranallo, Adam, & Sainfort, 2011). In addition to efficiency and cost-effectiveness, the MDS approach is appropriate for providing structured reporting based on specific information requirements (Ahmadi & Mirbagheri, 2019).

The goal of the Delphi study was to identify datasets deemed critical by both emergency managers and health professionals, with the aim of using these essential datasets to develop an MDS prototype. Such an MDS may enhance situation awareness if shared across emergency management and health agencies. The suggested MDS prototype would contribute to the provision of evidence-based decision-making in disasters, which would ultimately result in enhanced disaster healthcare.

The suggested MDS prototype contains a limited, defined number of datasets that assist both medical and non-medical decision-makers in identifying the extent of damage, number of affected individuals, required response, and expected complications ahead. Some of these datasets may not be directly related to healthcare. Data such as blocked roads in disaster affected areas, for instance, are also considered for inclusion because they may have the potential to facilitate disaster healthcare provision.

To fulfil its goal, an MDS needs to be collected and shared between all response agencies on a regular basis and, possibly, instantly.

5.2 The disaster healthcare MDS prototype

While a literature review utilises existing knowledge and ideas about the information requirements of emergency and disaster response, semi-structured interviews allow participants to express information gaps that they have experienced in real-life situations. The suggested datasets were identified through both the literature review and the interviews that were conducted.

The suggested datasets encompass a broad range of aspects including a priori data about the geography, infrastructure, and demographics of the region affected by a disaster, as well as relevant health and epidemiological data. The values of these datasets may be comparatively static in non-disaster situations but can be changeable and dynamic when a disaster strike. Datasets that inform response agencies on the status of the disaster, such as damage, prognosis, risks and general priorities, are critical for coordination. Moreover, public health datasets concerning fundamental needs (such as shelter, food, water and evacuation priorities) that, although clearly related to health needs, also apply when healthcare is not the major consideration. These datasets may be generated by and for organisations involved in preparing for and responding to disasters, both locally and internationally. Numbers of casualties, types of injury, triage statistics, resource availability and requirements, etc., are significant to various response agencies. Such datasets are key elements of resilience planning (Stevenson, Bowie, Kay, & Vargo, 2018).

Since every disaster event unfolds differently, the ‘minimum’ approach to the construction of a dataset ascertains generic elements that can be customised for specific circumstances based on experience and lessons learnt. The MDS prototype will consist of datasets that facilitate informed decision-making, track progress, and evaluate the effectiveness of interventions if shared in a timely manner across relevant disaster response stakeholders.

The following sub-sections present the datasets identified in the literature review and through the semi-structured interviews.

5.2.1 Identification of the nominated datasets

In the literature review, classical information needs in a range of disasters have been examined. The identified datasets have been initially classified into four categories:

Baseline datasets

Contain health and epidemiological data as well as data about the geography, infrastructure, and demographics of the region affected by the disaster. Baseline datasets are essential for preparedness and mitigation since they can be made available prior to the occurrence of a disaster event.

Healthcare datasets

Focus specifically on the health situation, embracing numbers of casualties, types of injury, triage statistics, resource availability and requirements, etc.

SA Datasets

Comprise dynamic data on the current status of the disaster: its severity, impact (casualties, damage, etc.), prognosis, risks, and general priorities.

Humanitarian datasets

Describe fundamental needs such as shelter, food, water, evacuation priorities etc.

In the semi-structured interviews, examples of the datasets identified through the literature review have been presented and explained to the participants along with sample data of each category. Participants were then asked about their opinions regarding the groupings and significance of the suggested elements, and any additional items deemed important.

There were two comments about the naming and grouping of the datasets. Firstly, a participant commented that since healthcare embraces all aspects of the four datasets, it would be more appropriate to change the term ‘healthcare dataset’ into ‘medical dataset’. Secondly, the majority of participants commented that the updated values of the baseline, medical, and humanitarian datasets basically describe what the situation is. As a consequence, SA was removed as a separate category from subsequent consideration and the datasets were distributed across the three

remaining categories: baseline, medical, and humanitarian. Participants saw value in the presented data items but focused on stating their own information gaps.

5.2.2 Datasets identified through the literature review

The literature review has been conducted to identify the information requirements of emergency responders in a range of emergencies and disasters. The identified datasets are classified into baseline, medical (clinical and non-clinical) and humanitarian datasets.

Baseline datasets identified in the literature review

Table 5.1 Baseline datasets identified in the literature review

Dataset	Examples	References
Demographics	Deaths, injured	(McDonald, 2010; PAHO, 2000)
	Missing, internally displaced	(McDonald, 2010)
Population statistics	Age, sex, total population by admin level individuals, total population by admin level, number of households, average family size	(McDonald, 2010)
Transportation networks	Roads classified by size, railways, airports/helipads, seaports	(McDonald, 2010)
Geography (hydrology)	Rivers classified by size, water bodies	(McDonald, 2010)
Geography (hypsography)	Elevation, resolution	(McDonald, 2010)
Organisational structures	The roles and responsibilities of each response agency	(IFRC, 2000; MoH, 2015)

Medical datasets identified in the literature review

Table 5.2 Clinical datasets identified in the literature review

Dataset	Reference
Age, sex	(WHO et al., Hedges & Joyce, 1990; Jafar, Norton, Lecky, & Redmond, 2015; McDonald, 2010; Ranse & Hutton, 2012; 2016)
Victim identifier	(HISO, 2018)
Triage category	(Hedges & Joyce, 1990; Jafar et al., 2015; Mohammadi, Ahmadi, & Gharagozlu, 2016; PAHO, 2000)
Type of injury	(Jafar et al., 2015; 2016; Ranse & Hutton, 2012; WHO, 2006)
Date of injury	(Jafar,et al. 2015)
Injury location	(Ranse & Hutton, 2012)
Infectious disease	(Jafar et al., 2015; PAHO, 2000; WHO, 2006; WHO et al., 2016)
Surgical/medical emergency, other	(WHO, 2006)
Procedure/treatment	(Jafar et al., 2015; WHO et.al, 2016)
Mental health	(Jafar et al., 2015; Ranse & Hutton, 2012; WHO, 2006)
Referrer	(HISO, 2018)
Healthcare provider ID	(HISO, 2018; Hedges & Joyce, 1990; Jafar et al., 2015)
Service location	(HISO, 2018; Hedges & Joyce, 1990; Mohammadi et al., 2016)
Health specialty	(HISO, 2018; Hedges & Joyce, 1990)
Diagnosis	(Hedges & Joyce, 1990; Jafar et al., 2015; Mohammadi et al., 2016)
Activity commencement and completion	(HISO, 2018; Hedges & Joyce, 1990; Mohammadi et al., 2016; Ranse & Hutton, 2012)
Discharge destination	(HISO, 2018; Hedges & Joyce, 1990)
Transfer of care	(HISO, 2018; Ranse & Hutton, 2012)

Dataset	Reference
Encounter outcome	(HISO, 2018; Hedges & Joyce, 1990; Jafar et al., 2015; Mohammadi et al., 2016; Ranse & Hutton, 2012; WHO et al., 2016)
Vulnerable child/adult in need of care	(WHO et al., 2016)
Violence, sexual or gender-based violence	(WHO et al., 2016)
Reporter information	(WHO et al., 2016)

Table 5.3 Non-clinical datasets identified in the literature review

Dataset	Reference
Total bed capacity, empty regular beds, empty ICU beds	(WHO et al., 2016)
Average daily census (average number of patients per day in a hospital over a given period of time; admitted patients and outpatients are counted separately)	(WHO, 2006)
Average length of stay of discharged patients, percentage of occupancy of hospital beds	(WHO, 2006)
Hospital perinatal death rate, hospital maternal death rate, foetal death rate, hospital death rate	(WHO, 2006)

Table 5.4 Humanitarian datasets identified in the literature review

Dataset	Examples	References
Coordination	Priority needs	(IFRC, 2000)
	EOC locations	(MoH, 2015)
	Geographical area of operation, purpose of planned activities, individual services or contribution to a joint service package and the specific target group or set of clients with whom each will work	(IFRC, 2000)
Damage to Civil Engineering Structures	Broken mains, damage to water sources, power outages, transportation failures	(PAHO, 2000)
Environmental Damage	Water, soil, and air pollution	(PAHO, 2000)
	Type of damage, extent of damage, remaining operational capacity, location, accessibility and required means of transport to site of damage, estimate of resources needed for repairs personnel, equipment, and materials, and estimated repair time	(PAHO, 2000)
Security Dataset	Critical incident to responder and/or community	(IFRC, 2000; WHO et al., 2016)
Evacuation Dataset	Evacuation requirements	(PAHO, 2000; WHO et al., 2016)
	# of evacuees	(PAHO, 2000)
Shortages Dataset	Human resources	(IFRC, 2000)
	Food shortage	(PAHO, 2000; WHO et al., 2016)
	Non-food items	(WHO et al., 2016)
Risks Dataset	Contamination of water and food, disruption of fuel, overcrowding, disruption of supply waste disposal services	(PAHO, 2000)
Vector Control Dataset	Proliferation of vector breeding sites, increase in human/vector contacts, disruption of vector-borne disease control programmes	(PAHO, 2000)

5.2.3 Datasets identified in the interviews

The following subsections present participants' most crucial information requirements during disasters.

Baseline datasets

Baseline data identified by the interviewees included data that would inform decision-makers in the health sector about shortages or requirements for medical assistance as well as facilities that are no longer functional because of the disaster event. This data includes number of wards, ICU beds, and impacted infrastructure. In addition, skills and details of potential disaster responders, capabilities of each disaster response agency (what they can offer in a disaster event), and an all-government agency contact list that informs disaster responders of contacts in key governmental organisations have been identified as crucial information requirements. An important area often left out during planning is evacuation of people with disabilities. The need for collection information about the locations and evacuation requirements of disabled people has been highlighted by several participants.

> *Participant 5*
> *There's actually an absolute need for us to start having some minimum data sets on all of the people that can potentially work in our EOCs. We need to understand at a glance if we're trying to build a roster, who's done what training. What've they been assessed as in regard to are they any good, what roles have they done in the past, what roles can I ask them to do, how many responses have they done.*

Table 5.5, below, lists the baseline datasets identified by interview participants.

Table 5.5 Baseline datasets identified by interview participants

Dataset	Details
Accreditation Dataset (Health)	Name, training completed, assessments, previous roles, # of responses
All-Government Contacts Dataset	Names and contacts of must-be-contacted persons, might-be-contacted persons
Capabilities, Roles and Responsibilities Dataset	Capabilities, roles and responsibilities of response agencies during both business as usual and disasters
Lessons Learnt Dataset	Key lessons learnt from previous disaster events
Disability Dataset	Locations and evacuation requirements of disabled people

Medical datasets

Health professionals stated that their information requirements in the first stage of response are minimal and do not extend beyond identifying a victim by some serial number, knowing their age, what they presented with, drugs they have been given, where they have come from, their discharge disposition, and where they will be going to from their current location. In addition, knowing where a victim has been picked up has significant implications from a public health perspective.

> *Participant 3*
> *I need to be able to give that patient a central record number so I know what care has been delivered to him in the immediate hours, and at some point, I can convert that across. But it's not a priority of mine to know XOD [national health index]. It's a priority to be able to know what patient 64, what drugs they've been given, what they presented, what are the problems, what's their discharge disposition is and where they'd go.*

Table 5.6 below lists the medical datasets identified by interviewees.

Table 5.6 Medical (clinical) datasets identified by interview participants

Clinical Datasets	Details
	Patient tracking #
	Age
	Sex
	Triage
	What the victim presented
	Care delivered in the immediate hours
	Drugs administered
	Location where the victim was found
	Discharge disposition
	Which hospital(s) the patient has been sent to
	Previous, current, and next location of the victim

Table 5.7 Medical (non-clinical) datasets identified by interview participants

Non-Clinical Datasets	Details
	# casualties
	# of deceased
	# of victims treated at the hospitals
	# of victims treated by ambulance
	Available facilities: # of available bed, # of ICUs (including HDU, PICU), shortages of medical supplies and/or healthcare personnel

Humanitarian datasets

The datasets mentioned in this category were related to management and coordination. Participants mentioned the importance of having SA with regard to impacted areas, priorities, resource management, risks and how their agency would relate to other agencies working in the same space and domain. A participant explained that the content of this dataset should consequently let agencies understand their tasks as well as their boundaries. Another requirement that was mentioned is the importance of triaging affected populations, i.e., prioritising affected populations to identify which ones require a faster response. In addition, several participants mentioned that knowledge gained from previous disaster challenges is not being documented and utilised in subsequent events.

> *Participant 11*
> *I think it's more of the area that's impacted. It's what areas have been impacted? What resources do we have available to us? Who are our partners? How they can assist us?*

Table 5.8 Humanitarian datasets identified by interview participants

Dataset	Details
Coordination	Lead agency/agencies
	Agencies involved in the response, their geographical response area, and their tasks, authority boundaries (who has the authority to do what – clear boundaries)
	Triage of impacted populations
	Immanent issues
Risks	Short-term likely risks (from similar events)
Response resources	Resource shortage, requesting agency, date by which resource is required

5.2.4 Datasets nominated for the MDS prototype

A prototype for a disaster healthcare MDS has been developed by combining 47 datasets identified through the literature review and interviews. These items have been re-arranged and distributed across the three categories of datasets: baseline, medical, and humanitarian. Naturally, the identified items may change depending on the disaster type and associated circumstances, such as the affected country's preparedness and response capabilities. Hence, the MDS will create a foundation for a concise list of essential data items that may be expanded through further consultation, future experiences and lessons learned.

To avoid the unnecessary exchange of information, easily accessible datasets such as locations of rivers, airports, and water bodies have been excluded from the suggested MDS. The inclusion of accessible items will count against the efficiency and usability of the targeted MDS. Hence, crucial but available datasets have been excluded. For further minimisation of the MDS, details about damage to civil engineering structures and vector control have been included under the risks datasets. Some medical datasets, such as the average length of stay of discharged patients and the percentage of occupancy of hospital beds, although present in the literature review have been excluded because they are thought to be of less importance to response agencies outside the health sector. Since this is the initial stage of investigation, it is expected that some of these items may later be included if the Delphi study suggests so.

As mentioned earlier, data items have been re-distributed across the three categories. For example, the number of available beds is perceived by health responders as baseline data. However, since these numbers cannot be predicted prior to the occurrence of an event, they have been included in the medical datasets and the baseline data have been dedicated solely to health status indicators. The final MDS prototype will present a coherent list of data items that is useful for both medical and non-medical decision-makers in identifying response requirements. Accordingly, the majority of the baseline dataset is composed of health status indicators. Health status indicators are statistical datasets that can facilitate evidence-based decision-making processes in the public and private sectors (New Sudan Centre for Statistics & United Nations Children's Fund, 2004). These indicators are used to

reduce health impacts through risk assessment, preparedness, response, and recovery (WHO, 2012). For this reason, these data items have been categorised as baseline.

The following sections present the datasets that were presented to experts in the first round of the Delphi study.

Baseline Datasets

The baseline datasets identified in the literature review are made up of population demographics per geographic region in addition to the health status indicators. The health status indicators used are those listed and defined by the New Zealand Ministry of Health (MoH, 2018).

Table 5.9 MDS baseline datasets identified in the literature review

Data Item	Definition
Individuals	Total number of individuals recorded as living in a given geographical area
Households	Total number of households recorded as living in a given geographical area
Age distribution	Age groups recorded as living in a given geographical area (0 – 14, 15 -24, 25 – 44, 45 – 64, 65+)
Males	Total number of males recorded as living in a given geographical area
Females	Total number of females recorded as living in a given geographical area
Others	Total number of individuals that are neither males nor females recorded as living in a given geographical area
Life expectancy	Life expectancy at birth, by gender, in a given geographical area
Disabled	Total number of disabled people* recorded as living in a given geographical area and their contact information.
Major causes of death	Ranked by age-standardised mortality rates and by gender, in a given geographical area
Cardiovascular disease	Total cardiovascular disease mortality by gender and total cardiovascular disease hospitalisation in a given geographical area
Cancer	Total cancer registrations, and total cancer mortality in a given geographical area
Respiratory disease	Total number of asthma hospitalisations and total number of diagnosed asthma cases in a given geographical area
Diabetes	Total number of diagnosed diabetes prevalence, diabetes complications – renal failure with concurrent diabetes, and diabetes complications – lower limb amputation with concurrent diabetes, in a given geographical area
Malnutrition	Total number of malnutrition cases** in a given geographical area.
Infectious diseases	Meningococcal and tuberculosis notification rates, acute rheumatic fever initial hospitalisation rates
Immunisation	Childhood immunisation coverage information; number of un-immunised children in a given geographical area
Suicide	Suicide rates, by age group and gender in a given geographical area
Interpersonal violence	Intentional self-harm hospitalisations by age group and gender in a given geographical area

Data Item	Definition
Mental health	High or very high probability of anxiety or depressive disorder, by gender in a given geographical area
Infant health	Low birthweight rate, infant mortality rate, sudden unexpected death in infancy (SUDI) rate and sudden infant death syndrome rates in a given geographical area

* Disability is defined as any self-perceived limitation in activity resulting from a long-term condition or health problem lasting or expected to last six months or more and not completely eliminated by an assistive device.
** Malnutrition is the lack of proper nutrition, caused by not having enough to eat, not eating enough of the right things, or being unable to use the food that one does eat.

Two types of datasets have been described by participants as important but time-consuming to manage during response: the contacts and accreditation datasets. Since these items can be made available prior to the occurrence of a disaster event, they have been included in the baseline dataset.

Table 5.10 MDS baseline datasets identified in the interviews

Dataset	Details
Contacts	A comprehensive contact list of positions, email addresses and phone numbers of key contacts in government agencies, NGOs and community groups
Accreditation	Agency-specific lists of emergency responders qualified to cross-deploy, showing training completed, assessments, previous roles, and number of previous responses

Medical Datasets

The need for the following datasets for the provision of clinical support for disaster victims has been identified in both the literature review and interviews.

Table 5.11 MDS medical datasets

Data Item	Definition
Triage	The assessment of a patient to decide how urgent their injury or illness is and how soon treatment is required
Identifier	A number given to a disaster victim for identification
Age	Approximate age of victim in years at time of treatment
Gender	Male or female or other
Location	Where the victim has been found
Details	The date, time and duration of victim's treatment
Presentation type	Injury, illness, environmental or mental health
Presentation details	Details of each type of presentation. For example: Injury: fracture, burn, concussion, etc. Illness: cardiac arrest, respiratory, gastrointestinal etc. Environmental: heat-related, drug-related, etc. Mental health: anxiety, psychiatric disorder, etc.
Outcome	Referred to further health treatment, discharged home, refused treatment or deceased
Total number of available hospital beds	A measure of the resources available for delivering services to inpatients in hospitals in terms of number of beds that are maintained, staffed and immediately available for use, including regular beds, ICU beds, HDU beds, PICU beds

Humanitarian Datasets

Table 5.12 MDS humanitarian datasets

Data Item/ Dataset	Definition
Fatalities	Total number of deaths as a result of the disaster event
Injured	Total number of individuals injured in the disaster event
Missing	Total number of individuals missing since the start of the disaster event
Evacuees	Total number of individuals evacuated
Shelters	Number of shelters in a given geographical area
Vulnerable persons	Total number of vulnerable persons in need of care (elderly, homeless, etc.)
Unaccompanied	Total number of unaccompanied children
Compromised medical facilities	Total number of impacted medical infrastructures
Risks	Long- and short-term expected issues
Priorities	General priorities of response agencies
Coordination	A dataset containing the name of each response agency, summary of planned activities, and location(s) of activities
Accessibility	Buildings and areas that are unsafe to access
Blocked roads	Compromised streets and roads
Traffic zones	Heavy traffic streets or roads
Security	Total number of critical security incidents in a given geographical area (to indicate the level of security)

5.3 Results of the Delphi study

The datasets nominated for the disaster healthcare MDS have been subjected to a Delphi study to seek further granularity through experts' opinions. The Delphi study involved five experts in emergency/disaster management and five experts in emergency/disaster medicine. Refer to section 3.5.3 for full details. For ease of reporting, experts from the first group will be referred to as 'emergency managers', and experts from the latter group will be referred to as 'health professionals'.

5.3.1 Round one results

Experts were asked to evaluate the importance of the suggested data items (see section 5.2.4). Importance refers to the extent to which a certain dataset can be utilised in disaster response, i.e., importance in this context is equivalent to utility. To evaluate each dataset, a

seven-point Likert scale has been used to maximise reliability and validity (Krosnick & Presser, 2010). The criticality of datasets has been determined using two scale points: 'very important' and 'absolutely essential'. If the majority of responders in each sector voted for one or both scale points, the dataset is considered to be critical for the sector. Datasets considered critical by emergency managers and health professionals are nominated for inclusion in the suggested disaster healthcare MDS.

To analyse the importance (and, accordingly, the criticality) of each dataset:

1. Emergency managers' response percentage to the 'very important' scale point is examined
2. Emergency managers' response percentage to the 'absolutely essential' scale point is examined
3. The sum of the two percentages in step 1 and step 2 is calculated
4. If the sum (in step 3) is >= 60% (three experts or more), the dataset is selected. Else, the dataset is excluded
5. For each dataset selected in step 4, health professionals' response percentage to the 'very important' scale point is examined
6. For each dataset selected in step 4, health professionals' response percentage to the 'absolutely essential' scale point is examined
7. The sum of the two percentages in step 5 and step 6 is calculated
8. If the sum (in step 7) is >= 60% (three experts or more), the dataset is considered for inclusion in the MDS. Else, the dataset is excluded

Step 8 will result in datasets deemed either 'very important' or 'absolutely essential' by both emergency managers and health professionals (i.e., deemed to be critical by representatives of both sectors). Selected datasets will be included in the suggested disaster healthcare MDS.

Baseline datasets

Two datasets were deemed critical by emergency managers and health professionals: Contacts and Individuals. All emergency managers and 80% of health professionals believed that the Contacts dataset (a comprehensive contacts list of positions, email addresses and

phone numbers of key contacts in government agencies, NGOs and community groups) is critical. This aligns with what interview participants highlighted regarding the need to know who to talk to.

Table 5.13 Experts' responses to the clinical datasets (N = 10)

	Emergency Managers		**Health Professionals**	
Dataset	Very Important	Absolutely Essential	Very Important	Absolutely Essential
Contacts	40%	60%	60%	20%
Individuals	20%	40%	20%	80%

Comments

Although the suggested datasets were not of critical value to emergency managers, except for 'Contacts' and 'Individuals', some of these datasets were perceived as critical by health professionals. Table 5.14 below shows health professionals' responses to the baseline dataset.

Interestingly, emergency managers did not see value in exchanging information about mental health among the affected population whereas health professionals did, although only 20% believed that these datasets are absolutely essential. The importance of mental health information exchange has been highlighted by medical and non-medical interview participants. The interest of health professionals in mental health cases is understandable given that, under the Civil Defence and Emergency Management Order 2015, the provision of psychosocial support is the responsibility of the Ministry of Health. Nevertheless, the varying perspectives among the emergency managers who participated in the interviews and those who participated in the Delphi study could reflect a rather outdated experience of traditional emergency management practices. The current groundswell of interest in mental health issues evident during the confusion and lockdown imposed due to the COVID-19 crisis reflect the importance of mental health considerations for both emergency management and health. Moreover, the fact that emergency management agencies have not been involved in mental health-related activities may lead to the feeling that such information is irrelevant to their current work.

Among health professionals, 60% were interested in disability-related data, although only 20% perceived it as absolutely essential. According to a senior health personnel, information about resides within the Ministry of Health which, despite owning this information about them, is not responsible for people with disabilities in disasters. On the other hand, the majority of emergency managers did not find the Disabled dataset as critical for their response efforts in disasters.

Table 5.14 Health professionals' responses to the baseline datasets (n = 5)

Dataset	**Very Important**	**Absolutely Essential**
Individuals	20%	80%
Age distribution	60%	40%
Females	20%	60%
Contacts	60%	20%
Disabled	40%	20%
Diabetes	60%	0%
Malnutrition	40%	20%
Infectious diseases	60%	20%
Immunisation	40%	60%
Mental health	40%	20%
Infant health	40%	20%

Clinical datasets

Table 5.15 shows datasets that have been identified as critical by both emergency managers and health professionals.

Table 5.15 Experts' responses to the clinical datasets (N = 10)

	Emergency Managers		Health Professionals	
Dataset	Very Important	Absolutely Essential	Very Important	Absolutely Essential
Identifier	0%	60%	60%	20%
Triage	20%	80%	20%	60%
Presentation type	60%	40%	40%	40%
Presentation details	20%	80%	0%	80%
Details	20%	60%	40%	20%
Outcome	40%	40%	0%	60%

Comments

Interestingly, some clinical datasets were voted for unanimously by emergency managers but not health professionals. For example, the outcome of treatment was evaluated as being critical by all emergency managers while only 60% of health professionals deemed it critical. This reflects the different priorities of response agencies which impacts their information needs. The outcome of treatment may not be critical for health professionals once they know that a patient is no longer in need of medical assistance. In contrast, the outcome of treatment may have further logistical or financial implications that impact the response of emergency managers.

The researcher was intrigued by the interest of emergency managers in individual patient data and sought further clarification. An emergency manager explained that the clinical dataset drives resource allocation. A second expert explained that this information is absolutely essential in managing large pandemics although there would be limits to the extent of data that can be collected.

Humanitarian datasets

Experts unanimously voted for the criticality of the 'Unaccompanied children', 'Number of available hospital beds', and 'Compromised medical facilities' datasets. Table 5.16 below shows datasets that are critical for both emergency managers and health professionals.

Table 5.16 Experts' responses to the humanitarian datasets (N = 10)

Dataset	Emergency Managers		Health Professionals	
	Very Important	Absolutely Essential	Very Important	Absolutely Essential
Fatalities	80	20%	40%	20%
Injured	40%	60%	20%	40%
Shelters	60%	40%	40%	40%
Vulnerable persons	40%	60%	60%	20%
Unaccompanied children	40%	60%	80%	20%
Number of available hospital beds	20%	80%	60%	40%
Compromised medical facilities	20%	80%	40%	60%
Risks	40%	40%	60%	40%
Priorities	40%	60%	40%	40%
Coordination	20%	80%	20%	40%
Accessibility	20%	80%	60%	20%
Blocked roads	20%	80%	20%	60%
Security	40%	40%	60%	20%

Comments

Data about medical capacity in terms of functioning medical facilities and hospital beds has been evaluated unanimously as being critical for the emergency response work of both sectors.

Datasets nominated for the disaster healthcare MDS

Out of the 47 datasets suggested, 21 were identified as being critical for both emergency managers and health professionals. Table 5.17 below lists these datasets and their ratings.

Table 5.17 The critical datasets (N = 10)

Dataset	Emergency Managers		Health Professionals	
	Very Important	Absolutely Essential	Very Important	Absolutely Essential
Contacts	40%	60%	60%	20%
Individuals	20%	40%	20%	80%
Triage	20%	80%	20%	60%
Identifier	0%	60%	60%	20%
Presentation type	60%	40%	40%	40%
Presentation details	20%	80%	0%	80%
Details	20%	60%	40%	20%
Outcome	40%	40%	0%	60%
Fatalities	80%	20%	40%	20%
Injured	40%	60%	20%	40%
Shelters	60%	40%	40%	40%
Vulnerable persons	40%	60%	60%	20%
Unaccompanied children	40%	60%	80%	20%
Number of available hospital beds	20%	80%	60%	40%
Compromised medical facilities	20%	80%	40%	60%
Risks	40%	40%	60%	40%
Priorities	40%	60%	40%	40%
Coordination	20%	80%	20%	40%
Accessibility	20%	80%	60%	20%
Blocked roads	20%	80%	20%	60%
Security	40%	40%	60%	20%

Figure 5.1 and Figure 5.2 below illustrate each sector's evaluation of the initial Delphi output.

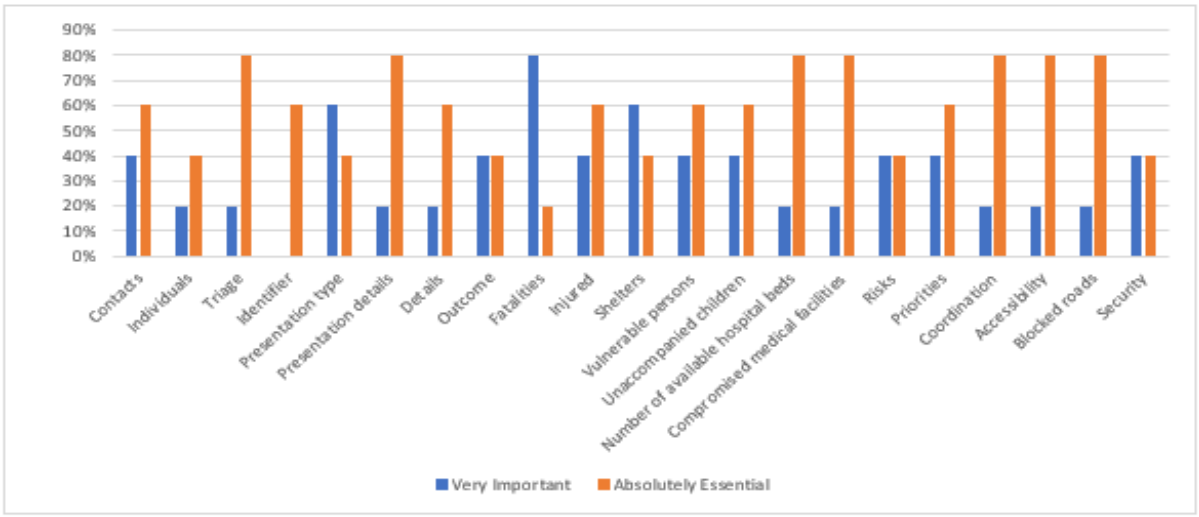


Figure 5.1 Data evaluation breakdown by emergency managers

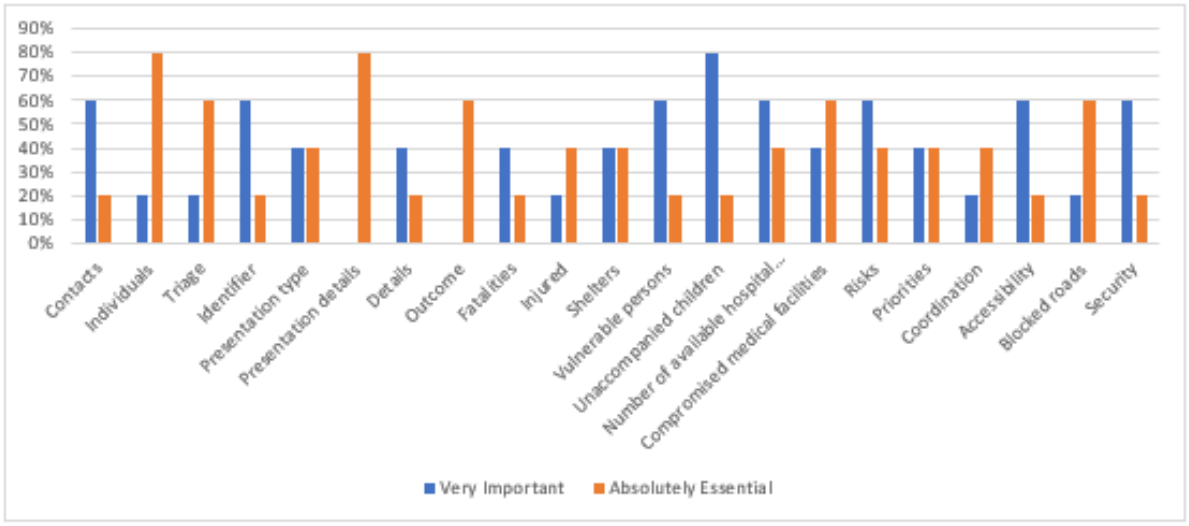


Figure 5.2 Data evaluation breakdown by health professionals

Additional datasets identified in round one

Table 5.18 Additional datasets suggested by experts in round one

Data Item/ Dataset	Importance	Data Type
Common languages in impacted area	Very important	Baseline
Population surges in area (seasonal tourists for example)	Absolutely essential	Baseline
Infant and young child feeding practices Exclusive breastfeeding rates among infants aged 0 – 6 months and proportion of non-breast-fed children under 1 year of age (by gender)	Very important	Baseline
Sexual, reproductive and maternal health indicators (Maternal mortality rates, causes of maternal deaths, contraceptive prevalence, fertility rates)	Very important	Baseline
Health service availability List (and GPS coordinates) of health service delivery points Resources/capacity at health service delivery points	Very important	Baseline
Epidemiological Information (Key data for contact/event tracing if appropriate to the event)	Absolutely essential	Clinical
Law enforcement data Data needed from patients in order to conduct an investigation in law enforcement events	Absolutely essential	Clinical
Adult immunity	Very important	Clinical
Blood group	Very important	Clinical
Diagnosis	Very important	Clinical
Response personnel (staffing issues and needs)	Very important	Humanitarian
Number of attacks on healthcare Attacks on health care facilities (static and mobile), attacks on health workers, intentional prevention of healthcare service delivery	Very important	Humanitarian

5.3.2 Round two results

Based on the results of the first Delphi round, a survey was designed for round two. Datasets identified as being critical were shared and experts were given the chance to re-evaluate the datasets selected in round one in light of group evaluation. Two datasets have been excluded in the second round: 'Unaccompanied children' and 'Details'. This confirms the effectiveness of Delphi's iterative approach as participants make more accurate judgments when they examine the type of data that resulted from a previous round.

Additional datasets suggested by experts in the first round were presented for experts' evaluation in round two. Out of the 12 additional datasets suggested in round one, two were agreed upon by all experts as being critical: 'Health points' (List and GPS coordinates of health service delivery points in impacted areas) and 'Health capacity' (Resources/capacity at health service delivery points).

Table 5.19 Additional datasets (N = 10)

	Emergency Managers		**Health Professionals**	
Dataset	Very Important	Absolutely Essential	Very Important	Absolutely Essential
Health points	40%	40%	40%	40%
Health capacity	40%	40%	60%	20%

These two datasets have been added to the confirmed list of datasets identified in round one. 'Health capacity' refers to resources/capacity at health service delivery points. Since the number of available hospital beds indicates a measure of the resources available for delivering services to inpatients in hospitals, this dataset need not be separate.

The MDS prototype

The MDS approach is used frequently in the medical field. Nevertheless, the novelty of the suggested MDS is that it is multi-sectoral, aiming to cater for the data requirements of both health professionals and emergency managers. The purpose of the suggested MDS is to assist medical and non-medical decision-makers in disasters with identifying the extent of damage, number of affected individuals, required response, and expected complications ahead. The identified datasets can also be used for policy formation, performance monitoring, research and funding proposals. Considering the identified datasets, the size

and relevance of the suggested MDS prototype may strike a balance between information overload and the adequate SA necessary for making optimal decisions. Moreover, the MDS prototype may be used to enhance the effectiveness of situation reports by highlighting reporting aspects that are of interest to all disaster stakeholders and appealing ways of presenting them (e.g., visualisation).

To design a coherent MDS prototype, the identified datasets were rearranged and distributed across four modules. Datasets that cannot be reported accumulatively have been separated in the Administrative module. The remaining aggregate datasets have been classified into three modules: Clinical, Baseline and Humanitarian. As indicated by its name, the Clinical module contains patients' data. The remaining datasets were classified into Baseline and Humanitarian modules based on the ability to acquire the datasets prior to the occurrence of a disaster. Figure 5.3 shows the suggested MDS prototype.

Certainly, the values of baseline datasets (datasets that can be made readily available prior to the occurrence of a disaster) may change according to the way a disaster unfolds, in which case these datasets would reflect SA at any given point during the disaster. These data items should ideally be updated regularly and shared periodically and, possibly, in real time if the available technology allows.

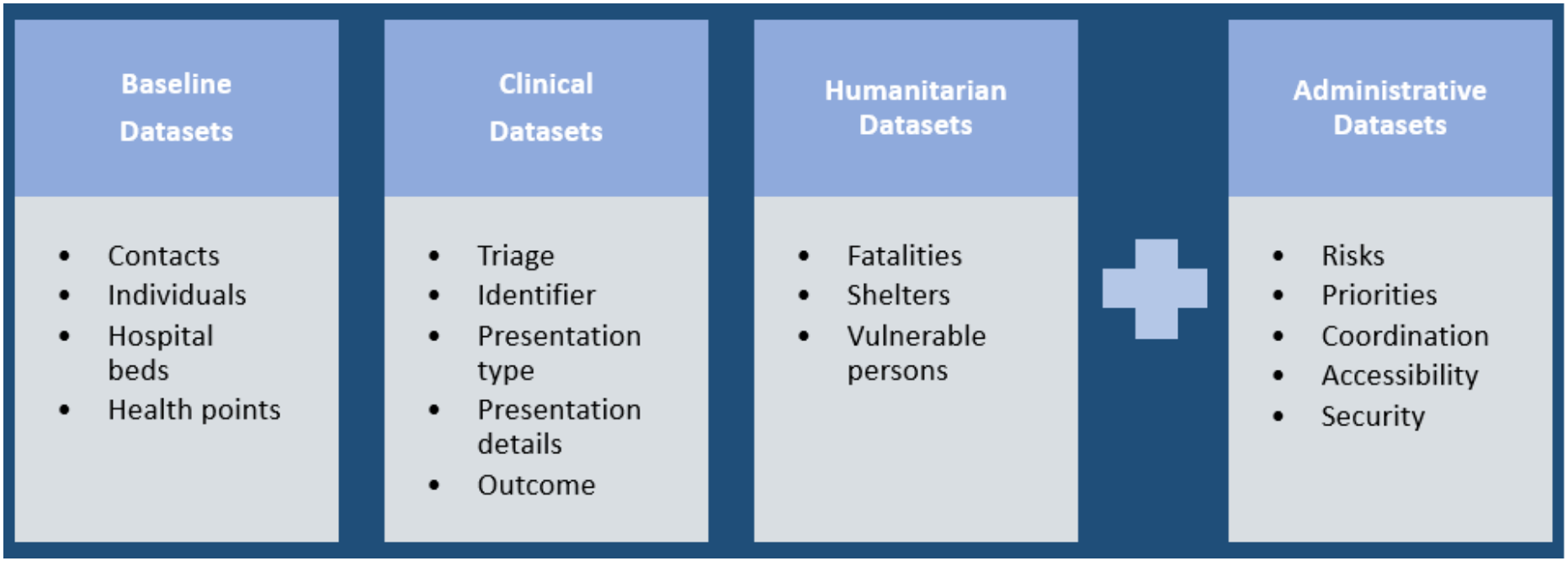
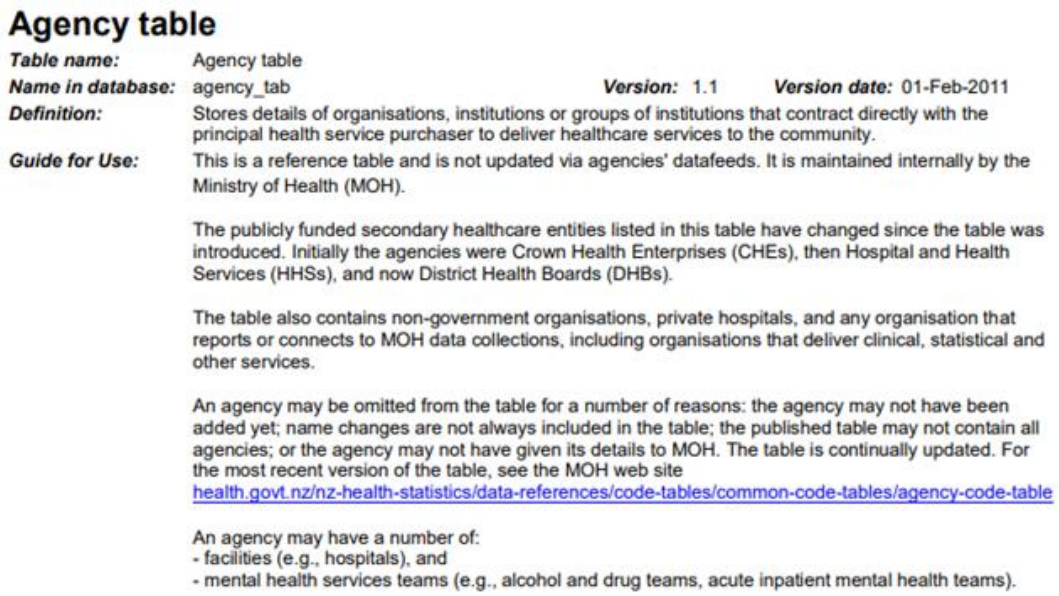


Figure 5.3 The MDS prototype

An MDS, by definition, requires an associated data dictionary that describes the data elements available within the MDS and promotes consistency across the collected data by using agreed-upon protocols and standards. Figure 5.4 shows a section of the New Zealand national MDS data dictionary corresponding to a table used to store details of organisations, institutions or groups of institutions that deliver healthcare services in New Zealand. Within the table, each entry is described separately. Figure 5.5 shows how the agency address, for instance, is described in the dictionary. These figures can be found on the New Zealand Ministry of Health website (MoH, n.d.).



Agency table

Table name: Agency table

Name in database: agency_tab ***Version:*** 1.1 ***Version date:*** 01-Feb-2011

Definition: Stores details of organisations, institutions or groups of institutions that contract directly with the principal health service purchaser to deliver healthcare services to the community.

Guide for Use: This is a reference table and is not updated via agencies' datafeeds. It is maintained internally by the Ministry of Health (MOH).

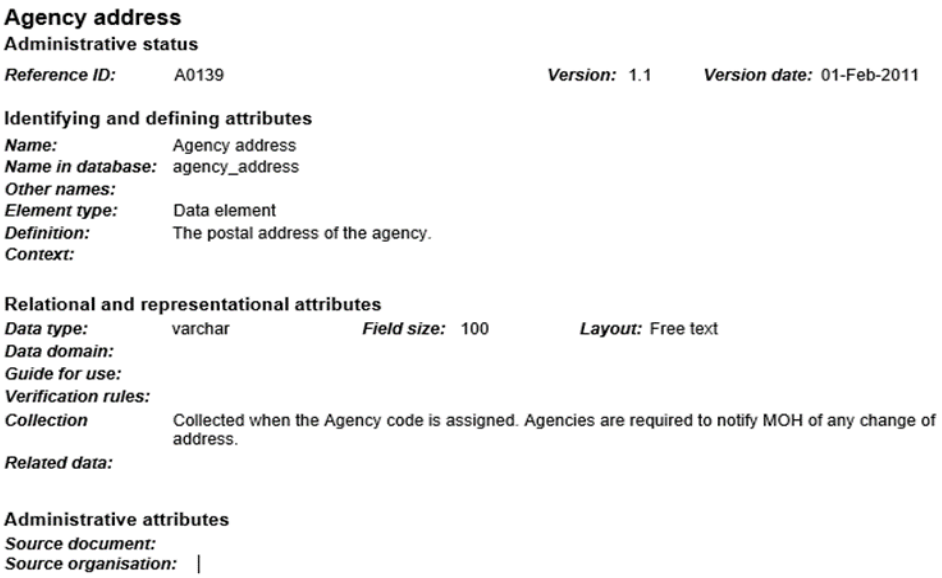
The publicly funded secondary healthcare entities listed in this table have changed since the table was introduced. Initially the agencies were Crown Health Enterprises (CHEs), then Hospital and Health Services (HHSs), and now District Health Boards (DHBs).

The table also contains non-government organisations, private hospitals, and any organisation that reports or connects to MOH data collections, including organisations that deliver clinical, statistical and other services.

An agency may be omitted from the table for a number of reasons: the agency may not have been added yet; name changes are not always included in the table; the published table may not contain all agencies; or the agency may not have given its details to MOH. The table is continually updated. For the most recent version of the table, see the MOH web site
health.govt.nz/nz-health-statistics/data-references/code-tables/common-code-tables/agency-code-table

An agency may have a number of:
- facilities (e.g., hospitals), and
- mental health services teams (e.g., alcohol and drug teams, acute inpatient mental health teams).

Figure 5.4 Data dictionary snapshot of a table dataset
(MoH, n.d.)



Agency address

Administrative status

Reference ID: A0139 ***Version:*** 1.1 ***Version date:*** 01-Feb-2011

Identifying and defining attributes

Name: Agency address
Name in database: agency_address
Other names:
Element type: Data element
Definition: The postal address of the agency.
Context:

Relational and representational attributes

Data type: varchar ***Field size:*** 100 ***Layout:*** Free text
Data domain:
Guide for use:
Verification rules:
Collection Collected when the Agency code is assigned. Agencies are required to notify MOH of any change of address.
Related data:

Administrative attributes

Source document:
Source organisation:

Figure 5.5 Data dictionary snapshot of a data element
(MoH, n.d.)

This Delphi study was completed before the COVID-19 global pandemic outbreak that started in December 2019. The identified list of data elements is not comprehensive and was not meant to be. Considering the identified datasets in light of the current global COVID-19 pandemic, it is probably reasonable to expect a longer list of data elements. For example, the 'Location' data element would have probably been rated as absolutely essential from a public health perspective (as highlighted by an interviewee) had the study been conducted during the current COVID-19 crisis. A comprehensive disaster healthcare MDS requires wider consultation and possibly several more iterations. The granularity of the suggested MDS can be improved by adding and/or removing data items based on periodic consultations and lessons learnt.

For the purpose of this research, datasets that are not in the intersection of health professionals' critical datasets and emergency managers' critical datasets have been excluded. However, data analysis reveals that excluded data items may be absolutely essential for one group of experts but not the other. Excluded datasets can be utilised in designing sector-specific MDSs that aim at enhancing SA within the sector. Moreover, the same approach can be followed in designing scenario-specific MDSs to address the information requirements of specific disaster types such as pandemics or floods.

5.4 Chapter summary

The development of a disaster healthcare MDS has been suggested as a viable approach for enhancing cross-agency information exchange. An MDS prototype consisting of 17 data elements has been identified as a result of the Delphi study. Successful implantation of the suggested MDS may enhance healthcare provision in disasters by ensuring data relevance and accuracy while avoiding information overload.

The implementation of an MDS, which is beyond the scope of this research, takes several aspects into consideration. First, data providers, users who will benefit from the suggested MDS, and the format (electronic files/paper reports) for submitting the collected data elements need to be identified. In addition, security considerations, including the entities authorised to access the datasets and recognition of legislation related to the privacy of health information, are critical for successful implementation.

For example, information available to the public needs to be of a statistical and non-identifiable nature. Finally, compliance with health data standards (refer to section 2.11.4) such as ICD-10-AM/ACHI/ACS (the system used in Australia and New Zealand for coding patient data at hospitals) ensures coding consistency, which in turn results in comparable datasets at national and international levels.

Chapter 6 Educational Programmes

DEH refers to the application of information and e-health technologies in a disaster situation to restore the health of individuals to their pre-disaster levels and maintain health at those levels. Refer to section 2.9.2 for details. This chapter presents the results of the Delphi study concerning the development of a framework for a DEH curriculum targeting combined groups of emergency managers and health professionals. The chapter starts by explaining the need for the suggested DEH curriculum (section 6.1). Topics suggested for inclusion in the disaster healthcare curriculum were informed by the literature review (sections 2.7.1 and 2.8.2) and interviewees' suggestions (section 6.2). The Delphi study sought experts' opinions about the value, content and delivery mode of the suggested curriculum. Results of the first Delphi round are presented in section 6.3. A second Delphi round was required to seek experts' opinions about the inclusion of additional topics suggested in round one. The results of the second round are presented in section 6.4. This chapter mainly present results with minimal interpretation. Full analysis and evaluation are left to the Discussion chapter.

6.1 Introduction

Emergency managers and health professionals are the key responders when a disaster strikes. Although emergency management and health agencies share the same goal of providing healthcare services to disaster victims, their different backgrounds, structures and operational modalities are some of the barriers that hinder their ability to communicate effectively (Bissell, 2007). The lack of a common vocabulary is another barrier between the public health and emergency management communities as public health personnel typically have no training in the vocabulary and concepts of emergency management, and emergency management personnel lack understanding of the concepts and operations of the health sector (Abbas et al., 2018b). Communication under such circumstances is certainly challenging. Therefore, multi-disciplinary educational programmes and joint training targeting clinical and non-clinical disaster responders are vital requirements for enhancing cross-agency communication (A. Norris et al., 2018).

The suggested curriculum (i.e., group of courses) aims at equipping disaster responders with comprehensive skill sets to assist them with delivering healthcare services to victims of disasters. This includes educating emergency managers and health professionals about each other's profession, priorities and capabilities. It also includes filling disaster response workforce gaps through the utilisation of available e-health tools, maintaining effective communication during stressful times and identifying venues for cross-agency collaboration. The novelty of the suggested curriculum stems from its focus on disaster healthcare from a multi-agency perspective.

Implementation aspects include the implementation level of the curriculum (e.g., postgraduate level, in service, full-time, or part-time) and the associated awards system, i.e., certificate, diploma. The award is a key factor in the uptake of the educational programme as participants and employees would naturally be keen on this aspect for career progression and credibility. Nevertheless, the Delphi study focused only on the value, content, and delivery mode.

The suggestion of an educational programme for combined groups of emergency managers and health professionals focuses on disaster preparedness which ultimately results in an enhanced quality of response. Participants were enthusiastic about the development of a curriculum focusing on cross-agency communication as they pinpointed topics for inclusion.

According to participants, it is common to have decision-makers who lack basic communication skills that enable them to share their knowledge and experiences with other responders. Moreover, the terminology challenges associated with the joint deployment of heterogenous response teams result in the wasting of significant time as team members try to familiarise themselves with the terminology influenced by their different backgrounds and organisational cultures. Educating responders about the capabilities and full potential of various disaster response agencies enables them to collaborate and utilise their resources in disasters. The importance of understanding capabilities has been described by a senior civil defence manager as pivotal for coordinating cross-agency coordination. Central to communication is the rapport and trust built between heterogenous teams while receiving education and training.

The suggested educational programme was perceived as an opportunity for building the skills necessary for effective communication during stressful times, and for knowledge promotion and sharing. A senior UN humanitarian coordinator emphasised the importance of such an educational programme on both the tactical and strategic level, i.e., at the global institutional level.

The mode of delivery preferred by interviewees is face-to-face and/or combined online and face-to-face mode. An interviewee pointed out that busy individuals are normally discouraged from taking online courses after spending long hours in front of their office screens. According to the participant, the success rates of people using online materials increase when preceded by taking time off work to actually interact with other individuals. When rapport is established through human interaction, individuals are more likely to continue via online education. As the head of training in her organisation, this participant shared her experience with online education saying:

> *Participant 1*
> *As much as I love technology and ICTs, and I think it's the way to go in the future, in this disaster management space, it is important to have that face-to-face interaction first before you put people on a virtual platform cos that's where you build the relationship, rapport and trust.*

The conversation about the suggested curriculum framework encouraged interview participants to open up about information they often lack in emergencies and disasters. These requirements are presented in the following section.

6.2 Topics suggested by participants

In the first part of data collection, interview participants were asked the following question:

> *Do you think that a course on disaster healthcare involving both disaster managers and clinicians would lead to better understanding between the disciplines that would translate into more effective care? What topics, including those from your own area of expertise, would you see as essential course elements?*

Among the topics discussed, there has been strong emphasis on including material about capabilities, i.e., what agencies can provide in normal circumstances and during emergency/disaster events. Participants explained that most of the confusion that

leads to false expectations and the underutilisation of resources in disasters stems from a lack of knowledge about capabilities. Clarifying roles and responsibilities and learning from previous mistakes to avoid reinventing the wheel were mentioned frequently. Table 6.1 presents topic areas identified during the interviews along interviewees' quotes supporting inclusion of the topics in the curriculum framework.

Table 6.1 Topics identified by interview participants

Topic area	Participant comment
Capabilities	"You need to have an understanding of capability. I think a joint agency curriculum is always gonna be good idea and it gives you an understanding of various aspects of what each or another service want." ~ Participant 3
	"Everybody needs to know everybody else's capabilities. The public don't know what we can do. I guess some other agencies don't quite know what we can do. I guess, one hand isn't quite sure what the other hand is capable of doing." ~ Participant 10
Communication	"You need to have activities or sessions around communication. Who should be communicated with? How? And what should be communicated? Do we have an existing relationship or not? Is there a way to ensure that this information is well-received and understood without confusion? Via which communication medium? Do we have a communication platform? What do we have in place as a communication mechanism?" ~ Participant 1
Legal considerations	"It's about agencies understanding what they legally can share. Cos that's a huge thing." ~ Participant 5
Roles and responsibilities	"There needs to be an idea of what organisations business is as usual and what their roles in a disaster context are and what are the ways in the readiness stage and in the response stage that we can relate to each other." ~ Participant 4
Collaboration venues	"We don't need to know everything the other agencies do, all we need to know is where we intersect." ~ Participant 12
	"Material that specifies what agencies do and how that influences what health practitioners do and how does health practitioners work influence what other agencies do and the benefits of other agencies to the health sector. This needs to be demonstrated by case studies of success and others of bad practice." ~ Participant 1
Code of conduct	"It may also be useful to have a code of conduct that ensures that individuals and institutions with different backgrounds are clear about the rules, expectations and guidelines for conflict resolution when they collaborate in disasters." ~ Participant 2
Terminology	"We all have our different ways of viewing what we call the family of emergency management disciplines. In my opinion, the confusion comes from what they will mean, the differences between them and how do they work together." ~ Participant 5
Emergency response frameworks	"The CIMS concept is that you don't need to know the ins and outs of the other agency. You just need to know how to operate together in a common environment. With the CIMS system, the priorities are established at reasonably high levels. So, if you know that people are playing nicely in the CIMS loop, then that probably addresses a lot of issues." ~ Participant 6
Lessons learned	"In emergencies there's reinvention of the wheel. Lessons haven't been learnt from previous emergencies and it's quite sad. There may be a model developed or a methodology or a process that worked there very well but then it's forgotten." ~ Participant 8

Topics in disaster management and disaster medicine education have been reviewed in sections 2.7.1 and 2.8.2. Table 6.2 lists the topics identified through the literature review and semi-structured interviews, in addition to DEH basic concepts, that were presented in the first Delphi round for experts' evaluation.

Participants were informed that the list of suggested topics is not intended to be comprehensive but is intended to present a coherent picture of DEH and its potential, and to highlight aspects that can facilitate disaster healthcare provision. They were also requested to add important topics that may be missing from the list.

Table 6.2 Delphi round one topics

#	Topic
1	Basic concepts and terminology in disaster management
2	Basic concepts and terminology in disaster medicine
3	Roles and responsibilities of main response agencies in normal and emergency situations, and how agencies complement each other - with emphasis on differences of approach and responsibility that distinguish disaster situations from normal circumstances.
4	Creating opportunities: How can agencies relate in normal and emergency settings
5	Capabilities of health, civil defence, NGOs, and other response agencies (services provided)
6	Expected disease symptoms and health risks education
7	First aid and emergency response
8	Epidemic control
9	Topics in health promotion and prevention
10	Addressing stigma
11	Provision of psychosocial care
12	Enabling community empowerment
13	Lessons learned from previous disasters
14	Organisational structures of health emergency management and civil defence
15	Incident management systems (coordination frameworks)
16	Aspects of developing effective emergency plans
17	Legal and ethical considerations around intra- and inter-agency information sharing
18	An overview of key e-health technologies such as the electronic health record (EHR), telehealth, and decision support systems, RFID technology, data analytics, mobile technologies, cloud computing, social media, etc., their applications in emergencies, and their limitations

#	Topic
19	The potential role of DEH throughout the disaster cycle demonstrating the contributions that DEH could make in disaster reduction, readiness, response and recovery
20	Use cases where collaboration between disaster medicine professionals and disaster management professionals may be established and where e-health technologies may be utilised – a problem-solving approach
21	Scenario evaluations upon which students can recommend improvements in or redesign of existing applications to improve the efficacy and efficiency of care

The Delphi results are presented in the following sections.

6.3 Delphi round one results

The Delphi survey has been distributed to ten experts: five experts in emergency/disaster management and five experts in emergency/disaster medicine. Refer to section 3.5.3 for full details. For ease of reporting, experts from the first group will be referred to as 'emergency managers' and experts from the latter group will be referred to as 'health professionals'. The survey consists of three questions concerning the value, content, and delivery mode of the suggested DEH Curriculum. This section presents round one results.

To seek experts' opinion on the DEH curriculum, the following question has been asked:

> There is a need for meaningful communication between non-clinical disaster managers and health specialists. Do you see value in developing a DEH curriculum for this purpose?

Participants unanimously agreed on the positive value of developing a DEH curriculum. Three delivery options were presented to the Delphi panel: face-to-face traditional place-based classroom methods, online course, or both. Except for one emergency manager, all experts preferred the course to be delivered in both modes. A Delphi participant explained that although individuals value face-to-face interaction, those working in a humanitarian situation usually find it difficult to get time away from work for study. Another expert commented that the nature of an emergency response makes distance learning more appealing for emergency managers due to the limited time available for them (in downtime) to attend workshops. Furthermore, a follow-up period of a few/several months was suggested to help emergency managers and health professionals apply their learning in their real-life jobs.

Similar to the research into MDS datasets, topics selected for inclusion in the DEH curriculum framework are those agreed upon by the majority of emergency managers and the majority of health professionals. If a topic is selected by three or more emergency managers and three or more health professionals (60% in each category), it is deemed important and hence nominated for inclusion in the DEH curriculum framework. Refer to section 3.5.3 for full details.

A total of 13 topics have been selected by six or more experts (three or more from each sector). Table 6.3 shows the nominated topics.

Table 6.3 Topics selected in Delphi round one (N = 10)

#	Topic	Emergency managers	Health professionals
1	Basic concepts and terminology in disaster management	60%	100%
2	Basic principles and terminology in disaster medicine	100%	80%
3	Roles and responsibilities of main response agencies in normal and emergency situations, and how agencies complement each other	80%	100%
4	Capabilities of health, civil defence, NGOs, and other response agencies (services provided)	60%	100%
5	Epidemic control	100%	80%
6	Provision of psychosocial care	80%	80%
7	Lessons learned from previous disasters	100%	100%
8	Organisational structures of health emergency management and civil defence	80%	80%
9	Incident management systems (coordination frameworks)	100%	100%
10	Aspects of developing effective emergency plans	80%	100%
11	Legal and ethical considerations around intra- and inter-agency information sharing	100%	60%
12	The potential role of DEH throughout the disaster cycle demonstrating contributions that DEH could make in disaster reduction, readiness, response and recovery.	100%	100%
13	An overview of key e-health technologies	60%	100%

Three topics that have been unanimously agreed upon by all 10 experts are incident management systems, the potential role of DEH throughout the disaster lifecycle, and lessons learned. This shows that both sectors are interested in cross-agency collaboration, utilisation of technological solutions, and knowledge sharing. Interestingly, experts from each group unanimously selected the topics on the basic concepts and terminology of the other sector. This requirement confirms the lack of understanding between response agencies which unsurprisingly results in silos and uncoordinated responses. An attractive percentage was that of the emergency managers' interest in epidemic control, an area that obviously lies within the health sector's speciality. Further discussion is provided in the Discussion chapter.

An additional 13 topics have been suggested by experts in the first round. These topics are:

- How health is affected by disasters/emergencies – topics highlighting how different aspects of health deteriorate in the presence of different risk factors (e.g., poor shelter, overcrowding, or lack of water and sanitation)
- Epidemiology, including ability to critically appraise research evidence
- Pandemic response data collection and analysis
- Budget management in a resource-constrained environment and how to prioritise needs to optimise public health gain
- How to manage people, especially in a tense or conflict environment
- How to communicate effectively to a range of audiences and in a wide range of settings
- National emergency warning systems
- Mandatory emergency management qualifications
- Multi-text process for data collection (processes used to derive and integrate meaning across multiple documents)
- Crowd sourcing
- National communication platform
- National database system
- National information management system

A humanitarian health expert commented that while most of the suggested health-related topics are too basic for health specialists, they may be too technical for disaster management specialists. She suggested a general approach on how health is affected by disasters/emergencies including how different aspects of health deteriorate in the presence of different risk factors such as poverty, shelter, overcrowding, or lack of water and sanitation. This approach may help non-specialists relate better to reaching a consensus on the concept of risk in relation to health.

6.4 Delphi round two results

The suggestion of adopting an approach that illustrates the impact of different risk factors such as poverty, shelter, overcrowding, and lack of water and sanitation on the different aspects of health has been applauded by all experts unanimously. Moreover, experts unanimously selected the topic of national information management systems. This confirms the skill gap in managing and exchanging effective information during events that require a multi-agency response. Once more, emergency managers unanimously selected the topic of pandemic response data collection and there was great interest (80%) among them in epidemiology. Table 6.4 below shows the DEH topics selected in the second and final round of the Delphi study.

Table 6.4 Topics selected in Delphi round two (N = 10)

#	Topic	Emergency managers	Health professionals
1	Epidemiology, including ability to critically appraise research evidence	80%	60%
2	Topics highlighting how different aspects of health deteriorate in the presence of different risk factors	100%	100%
3	How to communicate effectively to a range of audiences and in a wide range of settings	80%	80%
4	How to manage people in a tense or conflict environment	80%	60%
5	Mandatory emergency management qualifications	80%	60%
6	National communication system	80%	60%
7	National database system, if available	60%	80%
8	National emergency warning systems	100%	80%
9	National information management system	80%	100%
10	Pandemic response data collection and analysis	100%	60%

Therefore, out of 26 topics subjected to experts' evaluation in round 2, the following 22 have been selected for inclusion in the DEH curriculum framework:

- Basic concepts and terminology in disaster management
- Basic principles and terminology in disaster medicine
- Capabilities of response agencies
- Health status in light of disasters
- An overview of key e-health technologies
- The potential role of DEH throughout the disaster cycle
- Epidemic control and the ability to critically appraise research evidence
- Pandemic response data collection and analysis
- Provision of psychosocial care
- Organisational structures of health emergency management and civil defence
- Roles and responsibilities of main response agencies
- Incident management systems (coordination frameworks)
- Legal and ethical considerations around intra- and inter-agency information sharing
- Development of effective emergency plans
- How to communicate effectively to a range of audiences and in a wide range of settings
- How to manage people in a tense or conflict environment
- Mandatory emergency management qualifications
- National communication system
- National database system, if available
- National emergency warning systems
- National information management system
- Lessons learned from previous disasters

These topics are thematically grouped into four main themes: Organisational knowledge, technology, health-related, and personal skills. Figure 6.1 shows the DEH curriculum framework.

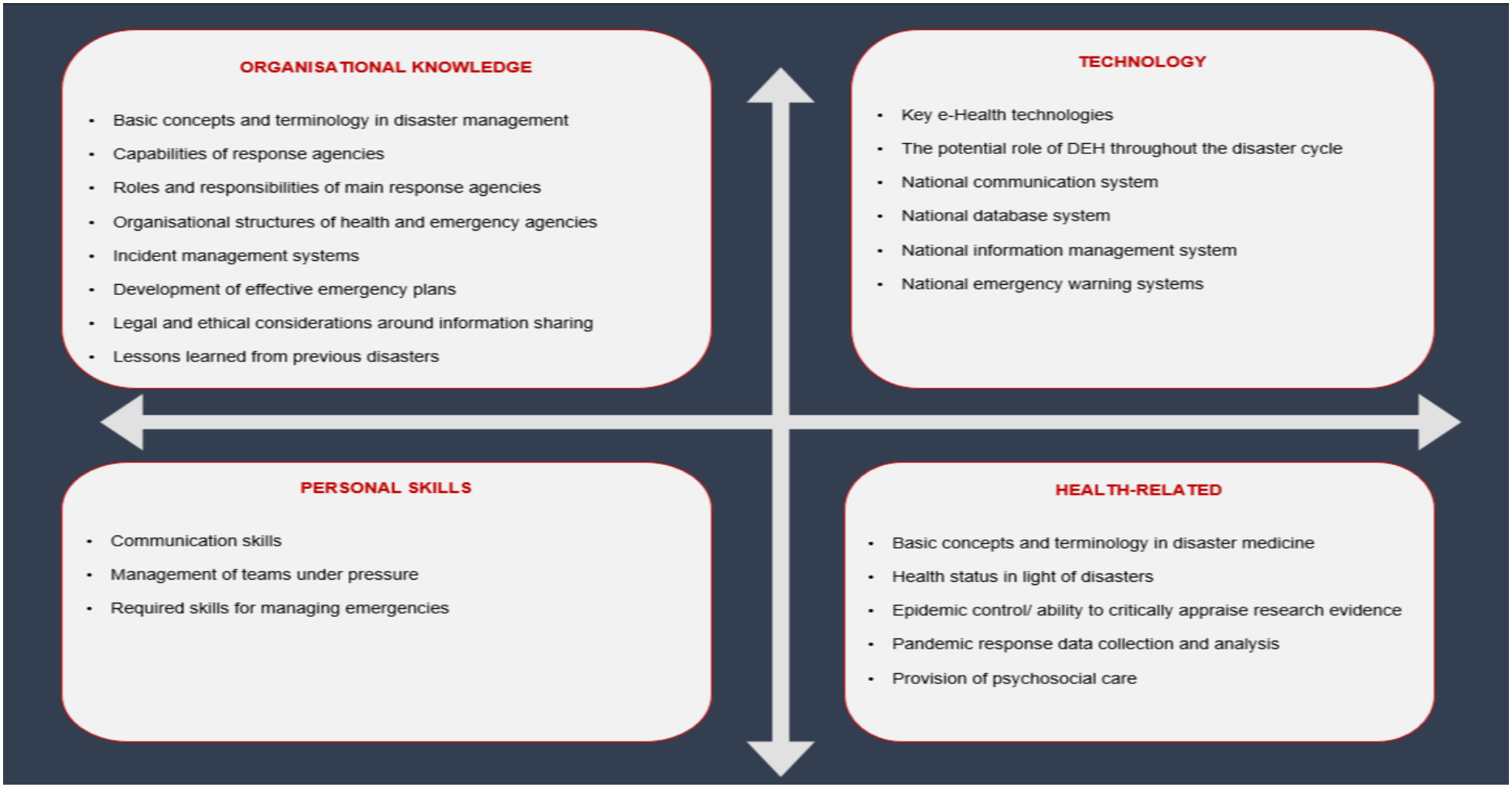


Figure 6.1 The DEH curriculum framework

6.5 Chapter summary

This chapter presented the results of the Delphi study conducted to identify a framework for a DEH curriculum targeting combined groups of responders. The choice of topics was informed by the literature as well as the interviews conducted with emergency managers from various response agencies including health. A DEH curriculum framework composed of 22 topics and topic areas has been identified. These topics can be classified into organisational knowledge, health-related topics, technology, and personal skills. The aim of the DEH curriculum is to equip disaster responders with the skill set necessary for managing disasters in a collaborative context, thus enhancing the quality of care delivered to victims of disasters.

Chapter 7 Discussion

7.1 Introduction

This research set out to investigate the barriers to effective communication between emergency managers and health professionals in disasters, and to provide viable solutions to the identified issues. To achieve these objectives, the following three research questions have been formulated:

Q1. What are the main barriers to effective communication between emergency managers and health professionals in disasters?

Q2. Which datasets can enhance the effectiveness of information exchange between emergency managers and health professionals in disasters, and how should these datasets be constructed?

Q3. Can educational curricula be designed to improve mutual understanding and communication between emergency managers and health professionals and what features should these curricula have?

The present research presents several barriers to effective cross-agency communication and information exchange in disasters.

Disaster response agencies, despite needing to complement each other, were found to have limited knowledge about each other's capabilities, operational modalities, and priorities. Poor SA leading to an uncoordinated response is linked to ineffective information exchange. Information exchange was found to be below expectations with regard to information requirements, and digital solutions that support automation and visualisation remain limited. A need for comprehensive planning including the voices of indigenous peoples, people with disabilities, and NGOs was pinpointed, and policies that ensure compliance with emergency plans and national coordination frameworks were found to be missing. The elephant in the room is the fact that there exists no best practice when it comes to practicing emergency management, signifying the need to professionalise the discipline. Certainly, funding is crucial for bringing all that is highlighted to tangible outcomes. These issues are presented in detail in Chapter 4.

This chapter discusses the challenges to cross-agency communication in disasters, and the solutions suggested for addressing them. The chapter ends by providing a communication framework based on integrating the concepts discussed.

7.2 The refinement of disaster healthcare information exchange

Disasters are characterised by a rapid influx of humanitarian assistance organisations and an outburst of mutual aid from local citizens and highly stressed local governmental and non-governmental institutions (FEMA, 2019). In this networked environment, reliable and timely information sharing across response agencies is critical for building a holistic understanding of the situation at hand, the pressing needs and the required action. Outcomes from this work show that fragmented and uncoordinated information exchange (poor SA) results in false expectations and duplication of tasks. Lee, Smalley, Zhang, Pietz, and Benecke (2009) stated that loss of lives, severe economic impacts, and loss of confidence in government agencies are all consequences of poor SA.

The following sub-sections discuss information exchange in disasters, and highlight the critical need to supplement the traditional vertical approach with a complementary horizontal one that acknowledges the importance of community engagement for enhanced SA and needs identification and assessment. The role of social media in facilitating horizontal information exchange is discussed, and the section ends by discussing the MDS approach suggested to enhance disaster information flow.

7.2.1 Information flow in disasters

SA is directly impacted by the structure of information flow (Abbas et al., 2018b). The traditional flow of information across governmental agencies follows a top-down approach according to the command-and-control modus operandi (S. Luna & Pennock, 2018). Although this vertical approach has the ability to verify information credibility, its inefficiency in managing a multi-agency response is proven (Kapucu & Garayev, 2016; Lee et al., 2009). As increasing numbers of public, private and non-governmental organisations join the response, the boundaries between organisational and collective behaviour usually fade (Kapucu, 2006). Accordingly, vertical information flow falls short of tackling the resulting information surge, a circumstance that creates fragmented views of the incidents and causes poor SA (Bunker et al., 2015).

Researchers agree that disaster response governance cannot be described as a hierarchy (Comfort, 2007; Hardy & Comfort, 2015; Kapucu, Arslan, & Collins, 2010). However, the appropriate governance structure of response is debatable (Nowell, Steelman, Velez, & Yang, 2018). S. Luna and Pennock (2018) presented a comparison between the traditional command-and-control management approach, and a flexible counterpart that acknowledges horizontal relationships with disaster stakeholders beyond government agencies (see Figure 7.1, below). They refer to the latter as the professional approach.

	Traditional Approach	**Professional Approach**
Development	Categorize disasters according to the level of importance. Focus on civilian hazard, war and nuclear. (Cold War US-USSR).	Understand there are more types of disaster scenarios than war and nuclear disasters. Natural disasters are also considered.
Approach	Hierarchical and top-bottom approach.	Horizontal relationships, networks.
Adaptation Level	Rigid strategies do not allow adaptation to new scenarios.	Seek to implement flexible strategies.
Player Perspective	Only one agency participating, the government.	Multiple: Government, citizens, non-profit organizations, etc.
Public	Interfere with responses or not participate at all. Panic behavior.	It is a resource and supports operations.
Information gathered from non-governmental agencies	It is not trusted.	It is acknowledged that information could be beneficial but also it may generate new challenges.
First Responders	Only count for emergency management agencies.	Public might be the first responders.

Figure 7.1 Traditional vs professional disaster management approaches

Current results conform with previous work (Moynihan, 2009; Nowell et al., 2018) in that disasters exhibit both networked and hierarchical characteristics and that cross-agency communication is complex and involves interdependent and interchangeable activities. This was clear from the responses of the interview participants to the 3Cs

model discussed during data collection. To collect participants' perspectives and insights on disaster, a simplified sequential model composed of communication, collaboration, and coordination (the 3Cs) was used (see section 3.5.2). Participants unanimously commented that the sequential depiction of the three activities is not practical and that it is not possible to predict which activity or activities will happen first.

The command-and-control structure followed in emergencies, and the way in which response agencies are coordinated, are described by incident management systems. This research attributes the drawback in coordinating New Zealand's disaster response to the lack of training and absence of compliance with coordination frameworks.

Command and control has the advantages of facilitating the implementation of policies and objectives, and the ability to clarify the division of activities among governmental agencies (Dynes, 1990). Nevertheless, this research highlights communication gaps that demand a professional collaborative approach to complement command and control. In addition to enhancing operational performance, a bottom-up approach to disaster management that acknowledges community engagement will prevent overestimated need for external resources (Pandey & Okazaki, 2005).

7.2.2 Community engagement

Local government agencies usually have the most extensive experience and expertise in disaster management among responding agencies. Nevertheless, they cannot manage risk and respond to catastrophes without the aid of other sectors that are often excluded from planning efforts (Willis, 2014). Needs assessment, for instance, is one of the tasks that must be started as soon as possible after the occurrence of a disaster event to evaluate response requirements. A collaborative approach to needs assessment involving various agencies and community groups increases confidence and relevance, eliminates duplicate information, and avoids wasting resources (IASC, 2017). As they are the ones directly impacted by the disaster and the ones most knowledgeable about their situation and needs, communities are invaluable in gathering damage information and response requirements.

The absence of community involvement in disaster planning results in substandard disaster relief, overestimated need for external resources, and frustration about

operational performance (Pandey & Okazaki, 2005). Current results show that listening to the perspective of communities and utilising their resilience knowledge in disaster planning is more effective and efficient than assuming a generic template for the provision of disaster relief. For example, storms in the Pacific regions are usually associated with an increase in fish activity closer to the coast, thus facilitating fishing. Therefore, it is probably more practical and cost effective to supply these communities with materials for fishing than providing them with food when a disaster occurs. Furthermore, the horizontal exchange of information with communities can be extremely helpful in building SA and avoiding the duplication of tasks. Certainly, flexible disaster planning that results in a range of possible response options is preferred to rigid planning that converges on one 'correct' answer (Brooks, Curnin, Owen, & Boldeman, 2019).

In governance, the citizen-led approach is built upon the belief that citizens understand their communities' dynamics, culture, history and priorities and for this reason they should be placed at the forefront of assessment processes related to democracy (The International Institute for Democracy and Electoral Assistance, 2020). In the context of data sharing, a report by the Office of the Auditor-General of New Zealand stated that there is a need to allow stakeholders to express their perspectives with regard to what a problem is and never to assume that an organisation's understanding of 'the problem' is actually addressing the right problem (Auditor-General, 2018). In the context of disaster planning, the argument put forward here is that adequate disaster healthcare requires hearing the voices of various disaster stakeholders and fulfilling their expected needs. In fact, the outcome of disaster response can be assessed by evaluating the extent to which disaster survivors are satisfied with regard to the fulfilment of their needs (Donahue, Cunnion, Balaban, & Sochats, 2012).

Current findings show that effective disaster planning requires involving multiple sectors beyond government agencies. Collective impact is a cross-sector approach used to solve large-scale problems such as disaster planning. Collective impact revolves around the slow development that brings key stakeholders to the table, as opposed to the governmental top-down approach to planning (Kania & Kramer, 2011). In the context of disaster management, collective impact can be translated into Community

Based Disaster Management (CBDM). CBDM empowers communities to be pro-active in preparedness and mitigation programmes (PreventionWeb, 2008). While top-down policies are essential, it is basically the local-level, bottom-up policies that provide the momentum for the execution of mitigation strategies (Pearce, 2003).

The following subsections discuss the critical need for including indigenous peoples, peoples with disabilities and NGOs in the design of disaster-planning strategies.

Indigenous peoples

Indigenous peoples are bearers of unique languages and knowledge systems, and possess invaluable knowledge of practices for the sustainable management of natural resources (United Nations [UN], n.d.). Their role in disaster risk reduction is emphasised by the Sendai Framework (UNDRR, 2016). Nevertheless, their rich ancestral knowledge and wisdom in managing disasters remains underutilised (Fowler, 2017). Learning from cultural groups that have a strong sense of community such as the Māori communities of New Zealand can open new channels for collaboration and resource management. Māori people honour their strong sense of community and hospitality. This built-in culture of hospitality can form a strong platform for collaboration in welfare. In the Kaikōura earthquakes, for instance, marae were instantly opened and people from all backgrounds were received without the need to go through Civil Defence arrangements. In Christchurch, Māori leaders prepared a damage assessment survey and were able to prioritise needs. This confirms the central role of indigenous peoples in disaster response and risk communication. Risk communication refers to the exchange of real-time information, advice and opinions between experts and people facing threats to enable them to take informed protection decisions (WHO, 2019a).

People with disabilities

The dataset pertaining to the number of people with disabilities per geographical location was suggested for inclusion in the MDS (see section 5.2.3). The suggestion was on the basis that people with disabilities are significantly more vulnerable to disasters than most of their community. This can be due to physical, cognitive, or socioeconomic factors (D. L. Smith & Notaro, 2009). Interestingly, the dataset was not evaluated as critical by either disaster managers or health professionals. This confirms the noted

absence of attention to the special needs of people with disabilities in disaster situations.

A survey conducted by the United Nations on how people with disabilities prepare for and cope with disasters showed that out of 6,000 disabled people from 126 countries, only 20% could evacuate immediately without difficulty, 6% would not be able to evacuate at all, and the rest would be able to evacuate with a degree of difficulty (UNDRR, 2013). Nevertheless, this research revealed that no specific governmental agency in New Zealand is responsible for taking care of people with disabilities in disasters. According to the UN Department of Economic and Social Affairs (n.d.), people with disabilities are likely to be abandoned during evacuation due to lack of preparation and planning, and shelters are rarely prepared for receiving them.

In regard to situations of risk and humanitarian emergencies, the United Nations Convention on the Rights of Persons with Disabilities emphasises the responsibility of governments to undertake "all necessary measures to ensure the protection and safety of persons with disabilities in situations of risk, including situations of armed conflict, humanitarian emergencies and the occurrence of natural disasters" (United Nations Department of Economic and Social Affairs [UNDESA], n.d., p. 10). Yet, many countries lack governmental measures to address the needs of people with disabilities (UNDRR, 2013), leading to inequities in access to an immediate response and long-term assistance (United Nations Department of Economic and Social Affairs [UNDESA], n.d.). This research shows that, in New Zealand, the voices of people with disabilities hardly come to the fore although their participation in disaster planning and preparedness can minimise their vulnerability and enhance the effectiveness of response and recovery efforts.

Not only do people with disabilities have the right to receive adequate support in disasters, they also have the right to actively participate in the various phases of disaster management (Bantekas, Stein, & Anastasiou, 2018). Therefore, their inclusion in disaster management should be mainstreamed.

NGOs

NGOs have significant impacts on a vast range of disaster activities including mitigation and awareness, rescue and relief operations, and rehabilitation and recovery (Shaw,

2003). According to their mandates, NGOs usually provide relief whenever and wherever possible (Eikenberry et al., 2007). In the last decades, NGOs have expanded significantly, proving their existence as powerful actors in disaster response (K. West, 2017). This may be linked to the bureaucracy that hinders prompt governmental responses (Eikenberry et al., 2007). The level of collaboration with and reliance on NGOs varies across countries, with notable presence in low- and middle-income countries (Galway et al., 2012). In Asia, where natural disasters have claimed more lives than any other place in history (Szczepanski, 2018), NGOs provide several services including food relief, temporary shelter, emergency medical aid, debris removal, trauma counselling and the management of separated and unaccompanied children in disasters (Bazeghi & Baradaran, 2010). The Philippines, for instance, has a well-established institutional and legal framework for disaster management that includes built-in mechanisms for collaborating with NGOs (E. M. Luna, 2001) whereas, in New Zealand, NGOs feel underutilised and often set aside by international humanitarian organisations.

Interestingly, some response agencies were found to be reluctant about collaborating with NGOs due to a lack of trust in their capacity to respond adequately. Trust means that agencies believe in each other's abilities, resources and skills and that they have the will to collaborate with and complement each other (Salem & Jarrar, 2009). Therefore, collaboration with NGOs demands the building of trust between them and other response agencies, possibly through joint education and training.

Training collaborations ensure that NGO volunteers have the necessary skills required to deliver clinical and non-clinical services according to international standards. The WHO has an established accreditation programme that ensures medical emergency responders meet the minimum standards for international health workers (WHO, 2015a). Joint training ensures both governmental and non-governmental response teams are well-prepared, self-sufficient, and will not add a burden on other response teams. NGOs can also be valuable stakeholders in building SA through sharing the information they collect for their response. Hence, planning efforts should account for their presence in a way that coordinates their efforts while allowing them to preserve their operational modalities (Eikenberry et al., 2007).

A review of the health and disability system in New Zealand concluded that focusing on treating illness, rather than promoting wellness, is neither effective nor sustainable, both in cost and human resources (New Zealand Health and Disability Review Panel, 2020). The review calls for a collective and collaborative system that acknowledges the specific needs of indigenous peoples and enforces accountabilities. By analogy, prioritising disaster preparedness through engaging communities in disaster planning minimises cost and saves valuable response time.

Community representatives are often pro-active in trying to communicate with authorities. However, given the pressing needs of response and the pressure experienced by response agencies, their communication attempts fail. Moreover, a civil defence agency is often perceived as being an authoritative organisation that lacks easy lines of communication. As the lead agency tasked with supporting and enabling communities in managing emergencies, a civil defence agency should have communication protocols that enable communities as well as other response agencies to reach them easily outside formal meetings. Communication protocols should be in place and agreed upon at both senior and managerial levels to facilitate consistent communication (United Nations [UN], 2008).

Local media channels and contacts for community representatives should be created and maintained during preparedness to facilitate the rapid dissemination of press releases and public health messages (Medford-Davis & Kapur, 2014). However, traditional top-down models of information flow do not adapt smoothly to the increasing amounts of data generated and exchanged by the public in disaster events (Palen & Liu, 2007). This can be achieved by utilising social media platforms to facilitate bi-directional communication with the public (Crowe, 2012; Jennex, 2020; Sykes & Travis, 2012).

7.2.3 Social media

Due to their cost-effectiveness, ease of use and ability to rapidly disseminate information (Stieglitz et al., 2018; Velev & Zlateva, 2012), social media can augment the number of reachable individuals (Hendricks, 2014). These platforms are emerging as powerful tools that can be used to encourage collaborative conversations between people as well as institutions (Keir, Bamat, Patel, Elkhateeb, & Roland, 2019).

Nonetheless, outcomes of this work show that these platforms are still underutilised in disaster healthcare. This is partly due to the lack of familiarity of response professionals of older generations with their use, in addition to the increasing scrutiny around the credibility of information.

Social media have proved to be useful in coordinating relief activities including the mapping of damaged areas, identifying people in need, disseminating information and guidance, and attracting donations (Harrison, 2015). Moreover, they can be used by response agencies to develop a deeper understanding of the public's needs by collecting their opinions and creating a feedback loop (Yoo, 2018). However, unverified and sometimes contradictory information often appears on social media following the occurrence of disasters. This, and the influx of information exchanged via social media platforms, makes it necessary to identify and verify new information (Schifferes et al., 2014; Sheridan Libraries, 2019).

Timely verification of social media information can literally be life-saving (Popoola et al., 2013). The verification of social media information involves collecting and classifying messages and their sources, eliminating dubious messages, and identifying possible associations (Freitas, Borges, & Carvalho, 2020). B. R. Lindsay (2011) argued that standards, regulations, and processes are required to improve the management of social media information.

The usefulness of social media demonstrated in various disaster phases (Velev & Zlateva, 2012) in addition to their widespread use and ability to connect with ordinary citizens indicate a need to integrate these platforms into disaster planning strategies (D. E. Alexander, 2014).

7.2.4 Enhancing disaster healthcare information exchange

The main challenge in a multi-stakeholder disaster scenario is to ensure that each agency has adequate SA (Eide et al., 2012). Decisions made based on inaccurate, incomplete, or too much information may trigger a cascade of counterproductive consequences (Asimakopoulou & Bessis, 2010). Disaster SA is disseminated in the form of situation reports. A situation report compiles information supplied by various agencies during response to enable effective and efficient coordination of activities based on the collected information. As the disaster evolves and the report gets longer,

the process of information retrieval becomes monotonous and time-consuming. The need to go through the whole report to obtain the required information drives decision-makers to ignore the report and respond intuitively – a serious implication that ultimately leads to fragmented response. Therefore, a mechanism that has the potential to restrict data exchange to relevant data, while enabling decision-makers to have adequate SA is vital for disaster response.

The increasing impact of technology and informatics on disaster and humanitarian response (Weiner & Slepski, 2012) prompted an informatics approach to enhance disaster information exchange. This research suggests the development of an MDS as a viable data exchange format (Benin-Goren et al., 2017) for the structured reporting of disaster information. The value of the MDS is based upon the realisation that data items of limited value to members of one agency can be crucially important to their counterparts in other agencies (Abbas & Norris, 2018).

An MDS (see section 2.11.2) is a minimum set of uniformly collected and registered data elements concerning a specific health-related area (Ahmadi & Mirbagheri, 2019). However, the suggested disaster healthcare MDS is novel in the sense that it crosses disciplinary boundaries and seeks to specify a common set of data elements that are critical for both medical and non-medical disaster response professionals. This multidisciplinary approach is consistent with the view of Cabrera and Cabrera (2015) in that “Our old disciplinary approach – where a physicist solves physics problems and a biologist solves biological problems and an economist solves economic problems – won’t do” (p. 113). In addition to efficiency and cost-effectiveness, the MDS approach is appropriate for providing structured reporting based on specific information requirements (Ahmadi & Mirbagheri, 2019). Associated with a data dictionary that describes its data elements, it promotes consistency across the collected data, thus preventing ambiguity and supporting evidence-based decision-making.

By enabling disaster response agencies to identify the data they wish to receive in a disaster event, the MDS strikes a balance between adequate SA and information overload (receiving irrelevant, inaccurate, or incomplete information). Upon accessing the MDS, the datasets can be processed and interpreted by individual agencies to create meaningful information that is useful to their operations.

To fulfil this goal, an MDS needs to be collected and shared between all response agencies on a regular basis and preferably in real time. The format (electronic files/paper reports) for submitting the collected data elements need to be identified. Furthermore, recognising security considerations such as access controls and privacy restrictions is critical for the successful utilisation of the MDS.

The present research identified an MDS prototype that can be refined into a comprehensive disaster healthcare MDS through wider consultations and possibly several more iterations. The MDS should be regularly updated by adding and/or removing or redefining data items based on regular consultations and lessons learnt. Simulation exercises can also assist with assessing the prototype and accordingly add or remove datasets. In the UK, medical data record testing was conducted during a simulation exercise by emergency medical teams (EMTs) leading to significant modifications to the medical record (Jafar et al., 2018).

MDS: The datasets

Emergency managers and health professionals identified 17 datasets as essential for disaster preparedness and response (see section 5.3.2). The identified datasets are classified into four categories (modules): administrative, baseline, clinical and humanitarian.

Administrative datasets

Administrative datasets inform agencies of the impacted areas, priority needs, and risks, as well as agencies responding in a given geographical domain and the services they provide.

Baseline datasets

These datasets can be made readily available prior to the occurrence of a disaster event. Baseline datasets include: a contacts dataset; the size of the population in a given disaster-affected region; number, types and locations of health points; and the number of available hospital beds. An all-government contact list that informs disaster responders of contacts in key governmental organisations facilitates cross-agency communication. Baseline datasets are essential for mitigation and preparedness as well as for response.

Whilst it is obvious that certain data items, such as the number of casualties, clinician availability and site access, can change (dynamic) as a disaster evolves, others were regarded as usually fixed (static), for example, the population of a neighbourhood, and the locations of hospitals. During response, values of a dataset may change based on how the event unfolds. The effectiveness of the MDS is linked to the ability to regularly update dynamic values as the disaster unfolds, thus reflecting SA at any given point in time during the disaster.

Clinical datasets

Clinical datasets focus specifically on the health situation. These are aggregate data concerning the numbers of casualties, types and details of injury, triage statistics, and health outcomes. They reflect a snapshot of the health status at any given point in time during the disaster event.

Humanitarian datasets

These datasets describe the severity of the disaster in terms of fatalities, number of vulnerable persons in need of care, and the number of available shelters and their locations.

The datasets selected to populate these four categories reflect, to a great extent, the status co of disaster healthcare provision. Compared to the body of literature available on the needs of disaster victims, the excluded datasets clearly reflect a gap between theory and practice of disaster healthcare provision. Health status indicators (see section 5.2.4) for instance, are critical for the reduction of health impacts through risk assessment, preparedness, response, and recovery (WHO, 2012) and hence were initially suggested as baseline datasets. Despite their importance, emergency managers and health professionals could not see a direct link between their practical work and these datasets.

Datasets pertaining to mental health and people with disabilities (see section 5.3.1) were also excluded despite being mentioned in the interviews and supported by the literature. Statistics related to and people with disabilities and mental health issues among affected populations were not considered critical by emergency managers, and only 20% of health professionals saw them as absolutely essential. As mentioned in section (5.3.1), this may be attributed to a rather outdated experience of traditional

emergency management practices that do not follow a holistic approach to disaster management. However, the growing awareness of psychological impacts of disasters such as the impact of compulsory COVID-19 lockdown, may be a game changer for following a comprehensive approach to disaster healthcare.

Data should be prudently shared according to privacy and security restrictions to maintain the information owner's trust. In the health context, there is a legal dimension to information sharing that stems from the need to protect patients' privacy and confidentiality (Abbas et al., 2018b). Approved Information Sharing Agreements (AISAs) enable government agencies to collaborate and share data without intruding on individuals' rights or creating legal risk (Privacy Commissioner, n.d.). These agreements enable personal information to be shared within and between organisations for delivering public services.

The majority of the MDS datasets provide aggregate statistics that do not identify individuals or personal information. Accordingly, in the context of New Zealand, neither the Data Protection Act (DPA) nor the Data Sharing Code of Practice apply to the sharing of data in the MDS (Information Commissioner, 2018). As for the contacts dataset, it includes data shared on public websites. Datasets such as locations of shelters can be provided in the form of addresses or geographical coordinates.

The MDS in practice: Towards a national structured information system

The rate of digital innovation has frequently outpaced the adoption of digital technologies in the field of public health emergency preparedness and response ("Next Generation Public Health," 2019). The assessment and integration of national and local medical information and resources are now possible via cloud computing and big data techniques. These technologies can identify and report the availability and location of critical resources as well as report the details of emergency medical supplies (Zhong, Clark, Hou, Zang, & FitzGerald, 2014). IoT sensors can be used to identify and share such information with minimal human intervention (Blantz, 2010). Using cloud computing, fragmented data gathered from multiple sources can be integrated into a single repository accessible by geographically dispersed agencies (AbuKhousa, Mohamed, & Al-Jaroodi, 2012).

Typically, the majority of disaster-related deaths happen within the first 72 hours (Grüne & Nätzker, 2009). Effective disaster response relies on collecting, combining, analysing and distributing information in a useful format (Kapucu, 2006). Therefore, the ability to get real-time updates from disaster scenes can be a game changer for the quality of response. Obtaining real-time data as an incident unfolds can assist response agencies in determining the location of affected individuals, assessing needs, and informing first responders and the public of changing conditions and new risks (B. R. Lindsay, 2011).

Although digital solutions are often used to address the problems of disasters and humanitarian response (Weiner & Slepski, 2012), solutions that automate processes and assist with data visualisation are underutilised. Current findings show that real-time reporting capabilities are often lacking among health and emergency management agencies. For example, patient tracking that reports the number of injured individuals, the priority of their injuries, and the hospitals they have been sent to, is still done manually. Timely reporting of health information including age, presentation, administered drugs, and discharge disposition can make a huge difference to the quality of care provided to disaster victims (Peleg, 2013). Building a dynamic emergency information system that reports critical datasets in real time can, therefore, make a significant impact on the provision of healthcare in disasters.

The disaster healthcare MDS can be used as a baseline for creating a national structured information system restricting disaster information exchange between emergency managers and health professionals to essential data elements only. The suggested structured information system is dynamic in the sense that it collects multimedia data from sensors, official databases and GIS components, and could eventually use AI and adaptive machine learning algorithms to route extracted information between appropriate contacts and agencies. This standards-driven system can enable emergency managers and health professionals to assemble SA on an 'as-required' basis from various trusted response agencies.

The idea of a dynamic structured system based on the MDS is to collect fragmented data from response agencies and make it available for use across all response agencies. Hence, elements of the MDS are not controlled by a single agency. This

triggers the need for a reporting protocol to verify the credibility and timeliness of the supplied data. Figure 7.2 shows the protocol followed in sharing real-time update information over the EMT-MDS (WHO, 2020).

The way of sending mail and content	
Methodology	If e-mail survice is available, the MDS eDATA(Electronic Data) are recommended to be reported to EMTCC by e-mail as attached documents. E-mail address and dedline time will be designated by the EMT Coodination Cell (EMTCC) / Ministory of Health (MoH).
Email form	
To:(recipient)	Email address which is designated by EMT-CC/Ministory of Health.
Subject	The e-mail subject should contaitn MDS and Team name(Abreviation permited) MDS_[Team_name] Ex. MDS_JDR
Body	Contact infromtion of sender including phone number should be written.
Note	In case of re-sending same or modified data (MDS eDATA files), the last data will be employed by EMTCC and previous one will be discarde.

Figure 7.2 The protocol to report the MDS electronic data
(WHO, 2020)

To share and use data from multiple sources, data must be standardised, i.e., built upon common words, structures, and organisation (Hammond, 2005). Standardisation of data elements concerns defining what to collect, deciding how to represent what is collected, and determining how to encode the data for transmission (Erickson et al., 2003). The interoperability of health information involves several standards including health record standards, identity standards, information governance standards, laboratory information standards, medicines information standards, mental health information standards, and security standards (MoH, 2019). Compliance with health data standards (see section 2.11.4) such as the ICD-10-AM/ACHI/ACS system used in Australia and New Zealand for coding patient data at hospitals, ensures coding consistency and results in comparable datasets at national and international levels.

The most critical issue facing attempts that involve accessing information from multiple information systems concerns interoperability (Park & Ram, 2004). Interoperability is the ability of two or more systems or components of a system to exchange and then use information (Geraci et al., 1991). Current results show that the different processes and access controls that are based on security considerations, and the concerns of independent agencies to own and control their data, introduce

complex restrictions on data sharing. A 2018 report by the Auditor-General of New Zealand on data sharing echoes these results (Auditor-General, 2018).

Taking interoperability challenges into consideration, the implementation of the suggested dynamic information system, which is beyond the scope of this research, should consider the MDS as an intermediate layer of communication between sources and receiving agencies. This preserves the right of agencies to change the way they represent a data item, discontinue one, or change its definition, while still being able to share their data. However, data exchange with the intermediate MDS layer must comply with an agreed-upon data standard, dictionary and reporting protocol.

Investment in data standardisation for the effective sharing of health information is receiving international attention and funding through an EU-funded cross-agency collaboration. The 'Trillium Bridge' project involves 14 countries, 7 different health systems, healthcare providers, private companies and non-profit organisations, and aims at standardising health care information to improve cross-border health service delivery (Rasmussen, Chronaki, Erturkmen, & Lowe, 2020). The Integrated Data Infrastructure is another success story of standardisation that enables organisations to find and use reliable data collated from a range of public New Zealand organisations, thus facilitating evidence-based decision-making (Statistics New Zealand, 2018).

Information systems play a significant role in building situation awareness by providing decision-makers with reliable, up-to-date information (Currion et al., 2007). Usability considerations with regard to text colours and functionality are important for the uptake of information systems. The present research shows that usability aspects can discourage emergency managers from using emergency information systems in normal day-to-day activities. This lack of use results in unfamiliarity with the systems when the need arises. The design of emergency information systems should consider the different thinking preferences of decision-makers about their design, functionality, and data visualisation preferences. These principles should be derived from a profound understanding of human perception (Few, 2012).

Pilemalm, Lindgren, and Ramsell (2016) explored the implications of cross-agency and cross-sector collaborations on the development of information systems. The study concluded there was a need for end-user participation in the development of

information systems to avoid pre-defined technical solutions. This design approach bears a strong resemblance to the MDS where information requirements of emergency managers and health professionals are at the core of its development.

Finally, the development of national and international emergency information systems should account for differences in social and healthcare systems. In the United States, for example, the federal system of government decentralises authority down to a local level. There exists no single nationwide system of health insurance as the great majority of healthcare providers belong to the private sector (Ridic, Gleason, & Ridic, 2012). Obviously, political structures and operational modes dictate the way information flows within a system. These considerations certainly challenge the notion of creating a unified or national emergency management system.

7.3 Bridging the gap between disaster response agencies: Building a culture of understanding and trust

In New Zealand, despite communication failures and lack of preparedness in the management of previous disasters (Montgomery, 2018; "Next Generation Public Health," 2019; Sutton, 2012; Swatton, 2018), the country's outstanding response to COVID-19 was praised by governments and health agencies internationally ("World Health Organisation praises New Zealand," 2020). According to a global survey of the public relations industry (Provoke, 2020), the effectiveness of New Zealand's national response to COVID-19 is a result of powerful communication, evidence-based leadership, and careful use of terminology at the forefront of communication with the public (Cousins, 2020). These three factors resulted in the establishment of trust between emergency managers and health professionals, which was then transferred to the public, creating a successful triangle of collaboration. Hence, building a culture of trust and understanding across emergency managers and health professionals is pivotal for disaster healthcare.

7.3.1 Trust

Trust means that agencies believe in each other's abilities, resources and skills, and that they have the will to collaborate and complement each other (Salem & Jarrar, 2009). When sharing information, trust refers to believing that the recipient of the information will handle the information professionally (Lips et al., 2011). Vanneste

(2016) noted that interpersonal trust leads to institutional trust which, according to Zaheer, McEvily, and Perrone (1998), facilitates information exchange.

Outcomes from this work ratify the link between trust and smooth information sharing. Individuals who trust each other are naturally encouraged to share information and solve problems jointly. This research shows that the trust that stems from a history of good personal relations is the main factor that encourages a person to confidently share what they know without the need to refer to formal agreements. Furthermore, gaps in formal guidelines can be overcome through good relations. An interesting perspective on personal relationships attributes the effectiveness of emergency plans not to the plans per se but rather to the relationships created in the process of going through them. The opposite is also correct; when personal clashes exist, formal agreements and plans cannot enforce information sharing.

However, agencies that are fundamentally different in the way they are structured and the way they operate rarely communicate in normal circumstances. Potential causes of the miscommunication that exists between emergency managers and health professionals are the different structural and operational modalities that ultimately impact their level of communication. This suggests a need to focus on bridging the gap between the two sectors during peacetime with the aim of preparing them for smooth communication when a disaster occurs. An adequate understanding of operational modalities and the usability of information positively impacts information sharing and coordination across disaster response agencies (Bharosa et al., 2010).

Prior liaison between disaster response personnel plays a huge role in building the interpersonal trust necessary for reducing transaction costs and the need for formal contracting (Dyer & Chu, 2003). Prior liaison can be achieved both formally and informally. Activities such as sharing venues, joint social gatherings, or even acts as simple as passing by to greet each other can strengthen personal relationships. While informal activities focus on strengthening personal professional relationships, formal activities focus on strengthening institutional links (Braithwaite, 2015). The latter involves knowledge about the roles and responsibilities, equipment and tasks, and information requirements of other agencies (Granåsen, Olsén, & Oskarsson, 2018).

A DEH curriculum framework is provided by this research to assist disaster response agencies in understanding each other's priorities, structures, and operational modalities, and to equip them with the personal and technical skills needed for managing disasters.

7.3.2 Education and training: A multi-disciplinary approach to disaster preparedness

The debate that took place internationally on whether to relax lockdowns following the spread of COVID-19 worldwide is an example of the different priorities of governmental agencies involved in a collaborative effort. Despite their shared vision of supporting disaster survivors (Bissell, 2007), emergency managers and health professionals work according to different authority structures that challenge their ability to partner (Abbas et al., 2016). Moreover, health agencies are often criticised for being inward-looking (Helmreich, 2000; Kleinke, Christensen, Grossman, & Hwang, 2009) and for frequently failing to resort to ideas, theories or evidence from outside the sector (Braithwaite, 2015). These observations highlight the need to build a culture of understanding that helps reconcile the different operational perspectives that may arise between decision-makers in disasters.

While knowledge gaps can be sealed by practical experience, the cost of learning by experience can be too high in disaster situations. Disaster strategies and guidelines can assist with achieving outcomes. However, a deep understanding of the origins of these theories is critical for their practical implementation. Interprofessional education can achieve better communication and collaboration among learners through promoting the integration of research findings into routine use in an evidence-based manner. Accordingly, this research suggests a multi-disciplinary educational approach to strengthen institutional trust and improve cross-agency communication.

This research investigated the value, delivery mode and content of a disaster healthcare curriculum targeting combined groups of emergency managers and health professionals. The goal of the suggested curriculum is to bridge the gap between emergency managers and health professionals through joint education on each other's profession, priorities and capabilities. Furthermore, it advocates the utilisation of available ICTs to fill the digital solution gaps experienced within the disaster response

workforce. Educational courses are designed to increase participants' understanding of disaster situations (D. Alexander, 2003). The novelty of the suggested curriculum stems from its multidisciplinary nature. The literature addressing disaster medicine competencies has several intersections with the topics identified around disaster management education (see sections 2.7. and 2.8.2), including basic concepts of disaster management, communication skills, incident management systems, and psychological support. This supports the need for a multi-disciplinary approach to disaster education.

DEH (see section 2.9.2) refers to the application of information and e-health technologies in a disaster situation to restore the health of individuals to their pre-disaster levels and maintain health at those levels (Althwab & Norris, 2013; Russo, 2011; Sieben et al., 2013). Accordingly, the suggested disaster healthcare curriculum can be identified as a DEH curriculum.

The DEH curriculum: Value and delivery mode

Informed by the literature review, the Delphi study confirmed the value of the suggested DEH curriculum framework. The DEH curriculum, with its ability to bring emergency managers and health professionals to the table, can encourage knowledge sharing and mutual understanding, thus promoting interactive relationships. Braithwaite (2015) surveyed strategies for stimulating interactive relationships that encourage information exchange between teams and groups. Interestingly, DEH education can fulfil several of these strategies including promoting dialogue and shared meaning between groups (Jiggins, Van Slobbe, & Röling, 2007), supporting social diversity (Santos, Santos, & Pacheco, 2008), and building joint social capital by emphasising mutual goodwill across teams and groups (Willem & Scarbrough, 2006). A. Norris et al. (2018) have previously proposed a strategy for disaster e-health education and training that outlines a curriculum framework. The enthusiasm of disaster responders about the value of a DEH curriculum can be explained by the lack of short, in-service disaster medicine courses that can reach a wider group of health practitioners (A. Norris et al., 2018).

To deliver the DEH curriculum, this research suggests a blended approach that incorporates both face-to-face traditional place-based classroom methods and online

learning. Face-to-face teaching has the benefits of social engagement and the ability to discuss and collaborate alongside guidance from a facilitator (Cooke, 2020). However, Turoff et al. (2004) stated that emergency response personnel work an average of fourteen to eighteen hours a day. Given the limited time that response personnel have outside their work scope, distance learning offers an appealing alternative, especially with the advent of modern technologies that can provide adequate memory capacity and processing speeds (Kailas, Chong, & Watanabe, 2010). According to McCutcheon et al. (2015), online courses may be no less effective than traditional face-to-face delivery modes. This argument is expected to be verified in the near future as studies are currently evaluating the effectiveness of the e-learning necessitated by COVID-19 (Allo, 2020).

The suggested DEH curriculum is not meant to replace educational qualifications but rather to emphasise a multidisciplinary approach to cross-agency communication and its concomitant challenges. Therefore, the curriculum targets combined groups of emergency managers and health professionals.

Successful implementation of disaster education reduces the impact of disasters and results in resilient societies (Torani et al., 2019). D. Alexander (2003) noted that experienced emergency managers whose aim is to improve or update their knowledge require around 50 hours of education to build their skills. However, the length and assessment strategies of the DEH curriculum will be determined based on the final curriculum design.

The DEH curriculum framework

Disaster education curricula have been criticised for lack of efficacy and clarity (Erdur-Baker et al., 2015). For this reason, the approach followed for outlining a DEH curriculum was built upon identifying knowledge gaps experienced by disaster response personnel, in addition to the topics identified in the literature review. The results were subjected to a Delphi study seeking further refinement. This research identified 22 topics that were thematically grouped into: organisational knowledge, personal skills, technology and health. The rest of this section discusses the topics that challenged interview participants in responding to previous disasters, and were later

supported for inclusion in the DEH framework on the evidence provided by the Delphi study.

Topics in disaster management and disaster medicine education are reviewed in sections 2.7.1 and 2.8.2. Topics suggested by interview participants are found in section 6.2. The literature review and interview topics are combined in Table 6.2 and were subjected to the first round of the Delphi study. The results of the first Delphi round are listed Table 6.3. Another 13 topics were suggested by experts in the first round (see section 6.3). These additional topics were added to the results of round one and the combination of topics were subjected to the second Delphi round, yielding the final framework topics (see Figure 6.1).

Organisational knowledge

Organisational knowledge concerns: the basic concepts and terminology of emergency management and health response; the different organisational structures of the two sectors and their capabilities; the disaster terminology, roles and responsibilities in the main response agencies; incident management systems; national emergency warning systems; the lessons learnt from previous disasters; legal and ethical considerations surrounding information sharing; and the important issue of developing effective emergency plans.

Basic concepts cover types of disasters and their associated requirements, disaster lifecycle, and key concepts such as hazards, risks, vulnerability, and resilience (see section 2.4). The need for these basic concepts is well-grounded in the literature (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; A. Norris et al., 2018). Individuals participating in a collaborative context need to understand how other agencies operate, what their requirements, limitations and expectations are (Uhr, 2017), and how agencies coordinate incident responses of varying scale (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; Hawley & Matheson, 2010).

Terminology always adapts to shifts in thinking by adopting new terms or expanding old ones (Twigg, 2007). Although practical reference tools exist, such as the *Dictionary of Disaster Medicine and Humanitarian Relief* (Gunn, 2012), which covers over 3,000 definitions disaster medicine and humanitarian relief definitions, disaster responders still have different ways of perceiving disaster-related terms. In a 2016 attempt to

explain disaster terminology, member states of the United Nations requested a review of the various definitions relating to disaster risk reduction and suggested appropriate wording for ambiguous terms (United Nations [UN], 2016). The use of disaster terminology can impact the quantification of a disaster's magnitude, thus influencing the formulation of response legislation and policy (Yew, Delgado, Heslop, & González, 2019). Therefore, it is vital that educational efforts inform disaster responders of the existing, and sometimes contradictory, disaster terminology and highlight the differences that exist in definitions (Thywissen, 2006).

Organisational changes in management structures during disasters often causes confusion about roles and responsibilities. Giordano et al. (2017) attributed the lack of knowledge about roles and responsibilities to the limited comprehension of response agencies' interaction mechanisms. The different authority structures that exist for emergency managers and health professionals certainly reflect on their ability to promptly contact the right person/section in a different agency. Confusion about structures, roles, and responsibilities can be clarified through education (Flin, 1996; Paton & Jackson, 2002). Roles and responsibilities were frequently identified as central requirements of disaster education (D. Alexander, 2005; DisasterInfo, 2019; Grant, 2018; Walsh et al., 2012).

The term 'capabilities' refers to the available resources of an agency in terms of skilled personnel and the physical, institutional, social or economic means that can be used to reduce the level of risk or impact of a disaster (Thywissen, 2006). Outcomes from this work show that the duplication of tasks often happens due to a lack of knowledge about what other agencies can do or have done. Significant amounts of duplication and inefficient use of resources are linked to the silo management of disaster response (Chen, 2017). Hence, topics about capabilities were included in the proposed curriculum.

Emergency plans provide structures for mutual aid and complementary actions between responding agencies, including the designation of roles and responsibilities to individuals and organisations (D. E. Alexander, 2017). Despite their critical purpose, emergency plans are often ignored during disasters due to their cumbersome design. The design of emergency plans is heavily criticised as being too detailed and unclear

about roles and responsibilities. Current findings show that, at times of distress, plans that do not easily provide the required information are often ignored. The stress that characterises emergency situations and the complexity of procedures demands a design that enables emergency responders to easily and quickly find the required information (Canós, Alonso, & Jaén, 2004). A consequence-driven approach to the development of emergency plans, with sections pertaining to certain scenarios, was suggested by an interviewee to replace the often too-detailed risk-driven plans.

Emergency plans are not meant to be used as immutable guides to action but rather as informative tools that assist with taking the right course of action (Canós et al., 2004). They are used as tools to facilitate effective problem-solving among different disaster stakeholders (Fagel, Vendrell, & Watson, 2020). Hence, flexibility and adaptability to the changing circumstances of a disaster are core characteristics of an effective emergency plan (D. E. Alexander, 2017).

Legal and ethical considerations around information sharing have been outlined in the curriculum framework. In many countries, responding agencies are part of bigger institutions and hence are subject to each of these institutions' privacy and confidentiality act. In New Zealand, for instance, the ambulance sector does not have its own legislation that guides and regulates the provision of ambulance services. As part of the health sector organisations, ambulance services have responsibilities within the Health Act 1956 and New Zealand Public Health and Disability Act 2000. In the context of emergency management, the ambulance sector must comply with the Civil Defence Emergency Management Act 2002 and Epidemic Preparedness Act 2006. It is obliged to function under these pieces of legislation as well as other health and workplace legislation (New Zealand Ambulance, 2011).

Institutional restrictions often get relaxed in emergencies and disasters. In the United States, penalties on using private communications technologies that are noncompliant with the healthcare law were lifted to facilitate telehealth services in response to COVID-19 (Keesara, Jonas, & Schulman, 2020). Current findings show that response professionals often lack knowledge about legal interoperability. Legal interoperability covers laws, policies, procedures and cooperation agreements needed to allow the seamless exchange of information between different organisations, regions and countries (E-Health Governance Initiative, 2017). Moreover, in New Zealand, the

Privacy Act is often used as an excuse for not sharing information where actually the Act provides wide scope for information sharing (Auditor-General, 2018).

Topics around legal interoperability detailing when and how privacy regulations can be relaxed and how to recover from diminished conditions were included in the DEH framework to strengthen the sense of accountability across volunteers (individuals who shift from their normal roles into emergency management roles). Educating emergency managers and health professionals on policy and legislative settings will give them confidence to collect, share, and reuse disaster-related information.

Resilience relates to the ability of communities to withstand and recover from disasters, and to learn from previous disasters to strengthen future response and recovery efforts (Holdeman, 2014). Re-visiting previous disasters to reflect on what went right and what went wrong, to utilise useful processes, and to ensure previous mistakes are not repeated in the future, is crucial for creating resilient communities. Lessons learnt from previous disasters can improve future responses and avoid reinventing the wheel. They can also be applied in daily operations where appropriate. Information flow across disaster response agencies, information sharing with affected populations and the public, and the implications of declaring a state of emergency are some of the aspects that can be referenced when learning from previous events (Christchurch City Council, 2017).

Communication skills

In disaster situations, decision-makers often find themselves confronted with the dual need to act as leaders within their own agencies as well as collaborators in a heterogeneous response. In such contexts, team leaders need to have the ability to embrace a level of compromise for the sake of the whole effort while keeping themselves focused on their own agency's goals; this is a management paradox that requires leaders to be both participative and authoritative (Uhr, 2017). Without these leadership skills, personal clashes may happen and lead to failed collaborations.

The present research shows that inter-group bias and the feeling of superiority of some decision-makers can threaten the effectiveness of multi-agency response. Inter-group bias refers to the systematic tendency to evaluate one's own membership group or its members more favourably than others (Hewstone, Rubin, & Willis, 2002).

Present findings reveal that inter-group bias is a common attitude that makes some individuals feel excluded during multi-agency activities such as disaster drills. According to T. J. Allen and Sherman (2011), ego, one's idea or opinion of oneself, especially a feeling of importance and ability (Procter, 1995), is a major cause of inter-group bias. In her book *Ego vs. EQ*, Shirkani explains how emotional intelligence can balance an individual's ego when it becomes a root cause of excluding others (Shirkani, 2016). Emotional intelligence refers to the capacity to handle interpersonal relationships judiciously and empathetically (Leadem, 2018). Poor emotional intelligence and lack of good communication skills certainly reflect on the flow of cross-agency information exchange as communicators miss opportunities for learning from each other, exchanging ideas, and collaborating.

Emotionally intelligent leaders are more likely to lead effective teams and to be satisfied with working collectively (Gardner & Stough, 2002). The impact of emotional intelligence on leadership effectiveness (R. Kerr, Garvin, Heaton, & Boyle, 2006) makes it imperative for the effectiveness of disaster management (Fambrough & Kaye Hart, 2008). In healthcare, a 2018 study on the relationship between emotional intelligence and communication skills in healthcare staff concluded that emotional intelligence leads to better communication with patients and better health outcomes (Amini, Nabeiei, & Delavari, 2018). Fortunately, studies show that emotional intelligence can be taught and improved (Gilar-Corbi, Pozo-Rico, Sánchez, & Castejón, 2018; Lang, 2018; Sadri, 2011).

Research by Katz (2009) on leadership pointed out that basic skills which can be acquired by the majority of employees have more impact on leadership than personality traits. This, and the realisation that poor communication can negatively impair the effectiveness of disaster response, prompted the need to include communication skills as core competencies in both disaster management and disaster healthcare education and training (D. Alexander, 2003; Council on Linkages, 2014; Hawley & Matheson, 2010; Pfenninger et al., 2010; Subbarao et al., 2008).

Technology

The use of and reliance on ICTs is growing globally (Cascio & Montealegre, 2016). Nevertheless, the rate of digital innovation has frequently outpaced the adoption of

digital technologies in the field of public health emergency preparedness and response ("Next Generation Public Health," 2019). Traditional healthcare systems are structured upon in-person interactions between patients and their clinicians (Keesara et al., 2020). This mode of care is not only ineffective at times of disaster, it can be very risky in situations that require physical distancing such as during pandemics. Therefore, there exists an urgent need to leverage the potential benefits of digital technologies (Schulman & Richman, 2019).

Emergency response professionals need to be aware of emergency information systems, and technologies that support citizen-responder interactions such as social media. In addition, there exists a need to understand the behaviour of communication systems in harsh environments, the causes of weaknesses of communication systems, the effect of communication failure on the delivery of disaster healthcare, and how to select resilient technologies. The need for education on the use of technologies has been acknowledged by The Society for Disaster Medicine and Public Health (Homeland Security News Wire, 2018). The inclusion of technology education in the suggested DEH curriculum conforms to a comment by Keesara et al. (2020): “We have the technology to strengthen our healthcare system for our patients. It’s time we put these tools into practice” (p. e82(3)). More so, during disasters.

A lack of professionalism in managing disaster information reflects on the quality of information exchanged within and across response agencies. During response, capturing and entering disaster information is often left to the personal styles of individuals rather than following a systematic approach. The careful entry of information and ensuring correctness at the entry point prevents further complications which, according to Asimakopoulou and Bessis (2010), can result in serious implications. Accordingly, topics on national information systems are identified as crucial.

Health-related knowledge

Concepts in disaster medicine, epidemic control, pandemic response data collection, and psychosocial care were nominated for inclusion in the DEH curriculum framework by the Delphi experts, and are well-grounded in the literature (see section 2.8.2). Adequate disaster education and training on disaster medicine is crucial for disaster

medicine personnel (Ducharme, 2013; James et al., 2010). Nevertheless, plenty of health practitioners lack it (Walsh et al., 2012). Accordingly, the framework includes health-related knowledge useful both medical and non-medical personnel.

Health-related topics can be too basic for health specialists while too specialised for disaster management professionals. A possible approach for tackling the balance between relevance and the right level of detail may involve discussing how aspects of health deteriorates in the presence of various risk factors, for example, poverty, lack of shelter, overcrowding, and lack of water and sanitation. The method(s) followed in delivering these topics may benefit from a new approach used in Japan to teach disaster risk reduction at the higher education level. As mentioned in section 2.7.1, the method adopts a multi-disciplinary approach that radically shifts the focus of teaching towards nurturing creative problem-solving (Leleito, 2018). This is based upon the realisation that building key competencies through transferrable skills is essential to striving and prospering in dynamic contexts.

The consequences of disasters may extend beyond initial injuries and loss of life to serious psychological and mental health issues that may be experienced years after the occurrence of the disaster (Galea, 2007). Mental health issues are found to be twice or three times higher among disaster victims than the general population (Math et al., 2015). Psychosocial support was frequently highlighted in the semi-structured interviews and was later identified as a required competency for disaster response professionals. This finding is consistent with previous calls for including psychosocial training in disaster education (D. Alexander, 2005; Grant, 2018; Hawley & Matheson, 2010; A. Norris et al., 2018).

Disaster victims are often at high risk of suffering psychological problems such as anxiety and depression (Thoresen et al., 2019). A recent Australian study (Reifels et al., 2019) examined the lifetime prevalence and risk of psychiatric disorders associated with disasters. The results showed an association between disasters and an increased risk of post-traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), depression, panic disorder and alcohol abuse. Hence, addressing psychological resilience (the ability to bounce back and recover) is crucial for communities vulnerable to disasters (Kc et al., 2019). Unfortunately, the stigma associated with

mental patients in many parts of the world (Kc et al., 2019) prevents them from seeking help due to fear of societal rejection (Haddad & Haddad, 2015). Cultural factors related to shame, collectivism, and spiritual beliefs have negative implications on post-disaster psychosocial interventions (Hechanova & Waelde, 2017).

Mental illness can have far more life-changing impacts than physical illness, and the provision of adequate support at an early stage could minimise the impacts and support positive progress towards normality (Kc et al., 2019). The treatment of psychosocial issues, such as family separation, loss of property and continued poverty, requires the involvement of mental health professionals as well as psychosocial workers (Seto et al., 2019). This blended approach highlights the criticality of cross-agency cooperation and coordination between disaster response agencies to ensure the effectiveness of mental health interventions in disasters (F. H. Norris et al., 2002). Nevertheless, a 2017 study revealed that there exists a lack of mental health preparedness in the majority of countries, a situation that emphasises the importance of developing context-specific educational programmes (Roudini et al., 2017).

Psychological support in disasters should address the needs of disaster responders as well as victims. While training helps responders prepare themselves technically for what may be expected in a disaster scenario, psychological support following disaster response is equally important. In the United States, psychological first aid programmes have been developed and adopted by several disaster response organisations to lower the distress of traumatic incidents and to educate responders about immediate as well as long-term coping mechanisms (B. Allen et al., 2010). In New Zealand, some response agencies such as Fire and Emergency have pro-actively approached the wellbeing and emotional stability of their staff by creating a permanent welfare officer position.

An interesting result from the Delphi study pertains to the obvious interest of emergency managers in the clinical dataset and even in epidemic control, an area that obviously lies within the health sector’s speciality. Emergency management worldwide is concerned with ways to control and contain the spread of COVID-19 which escalated into a global pandemic. This confirms the interrelated and multidisciplinary nature of disaster response.

Finally, DEH is based upon the integration of e-health into the communication process between health professionals and emergency managers. In a broader sense, the focus of DEH is not only on technology, but also on building an integrative state-of-mind that encourages a collaborative attitude to improve disaster.

International humanitarian organisations have already started utilising e-health technologies such as mobile technologies to support and strengthen humanitarian work in the fields of global health and disaster response (United Nations Office for the Coordination of Humanitarian Affairs, 2011). Such initiatives have been especially valuable in developing countries where proper infrastructure and trained personnel are lacking. DEH has the potential to bring huge benefits to already existing initiatives and efforts to enhance cross-agency communication. Collaboration with governmental agencies and international humanitarian organisations in sponsoring knowledge sharing can benefit disaster stakeholders in many ways, including cost (IFRC, 2000). The growing awareness of the benefits of teamwork, interprofessional learning, and team competence, and the realisation that communication failures negatively impact healthcare provision, suggest that team training should be central to every practice (Long, Jowsey, Henderson, Merry, & Weller, 2020).

The following table (Table 7.1) summarises the points discussed in this section by presenting the topics included in the DEH framework and the rationale for inclusion.

Table 7.1 The DEH framework topics

Topic	Rationale for Inclusion
Basic concepts in disaster management and disaster medicine	Necessary for bridging the gap between the two sectors
Disaster terminology	Clarifies confusion about the various perceptions of disaster-related terms
Organisational structures of health and emergency management age	Facilities understanding of who is doing what and why
Roles and responsibilities of main response agencies	Enables responders to promptly contact the right person/section in a different agency
Incident management systems	Ensures disaster responders are informed of how disaster management is coordinated
Legal and ethical considerations around information sharing	Informs responders of privacy and confidentiality limitations and exceptions
The development of effective emergency plans	Facilitates adequate preparedness and ensures rapid information retrieval in disasters
Lessons learned from previous disasters	To avoid reinventing the wheel by learning from previous disasters
Epidemic control and critical appraisal of research evidence	Enables responders to make well-informed decisions during epidemics
Pandemic response data collection	To facilitate accurate and reliable data collection necessary for decision-making
Provision of psychosocial care	To prevent developing mental illness and ensure psychological symptoms do not go un-noticed
An overview of key e-health technologies	To facilitate the exploitation of ICTs
The potential role of DEH throughout the disaster lifecycle	To raise the profile of DEH and encourage its proper establishment and adoption
The national communication system, national database system, and national information management system	To familiarise responders with the telecommunication infrastructure and emergency information systems necessary for exchanging and enhancing the quality of disaster information
National emergency warning systems	Informs responders of medical and emergency management warning systems that reflect risks
Communication skills	Necessary for effective leadership, interpersonal trust and inter-agency information sharing
Management of teams under pressure	To avoid conflicts, and make the best of responders' capacities in disasters
Required skills for managing emergencies	Communication skills pertaining to leadership and the ability to collaborate, and avoid silos

7.4 Adoption of digital solutions: Small incremental changes

Despite the critical role of technology in relaying information across various disaster stakeholders (Kotabe et al., 2014), digital solutions were found to be hugely underutilised across both emergency management and health sectors.

In the health sector, responders bemoaned the lack of digital solutions that automate tasks such as resource management and patient tracking. A system that reports disaster health information in real time, although much needed, is still not widely in use. Moreover, the potential of social media platforms in disaster healthcare is still not fully recognised despite their powerful ability to engage and communicate with ordinary citizens (see section 7.2.3).

Emergency managers, on the other hand, showed their frustration with carrying out time-consuming tasks manually. Victim registration, the of documenting victims' details, is still being performed on paper and entered into a database later. Automating the process would enable responders to simply tick off names and details from existing databases. Emergency plans, despite their importance and the need to keep them safe, are usually kept in paper format. Transforming emergency plans into a responsive format is suggested to keep emergency responders engaged and updated. González, Canós, Norris, and Abbas (2018) noted that advances in software technology, such as process modelling and automation, have the potential to support a shift towards interactive systems that can significantly enhance the usability of disaster plans.

As decision-making becomes more reliant on data, the visualisation of large multi-dimensional data is becoming increasingly significant for decision-making (Wang, Guo, & Zhang, 2017). The unprecedented ability of technology to generate data at an overwhelming volume and velocity requires some layer of abstraction to enable humans to visualise and accordingly comprehend what is being generated (Berinato, 2016). The use of GIS to visualise and retrieve data can enhance SA and help disaster managers and health personnel with decision-making. GIS provides a powerful platform for SA. In New Zealand, for example, a cross-council collaboration for sharing geospatial data in Canterbury enables the public to search for properties, see the topography, and locate water services (Canterbury Regional Council, n.d.).

Despite the huge benefits of GIS, the capability is still underutilised, and many disaster responders are unfamiliar with its use. Moreover, the costs and complexities associated with its adoption and implementation prevent emergency managers and health professionals from harvesting the benefits.

These observations imply the need to change the digital approach to information management in disaster healthcare. This does not necessarily mean a reform that requires huge investments in digital solutions. While the research calls for the utilisation of revolutionary technologies such as AI and machine learning algorithms (see section 7.2.4), the above observations are linked to the utilisation of affordable technologies that are easily accessible by ordinary people, such as social media and mobile applications. Hence, the change aspired to is both incremental and transformational.

The utilisation of technology to enhance disaster healthcare does not necessarily require immediate investment in highly sophisticated technologies. The argument being put forward here is that small incremental changes made by adopting digital solutions for the visualisation and automation of simple but time-consuming tasks can significantly improve the quality of information exchange. This means investing in affordable technologies that can be easily set up and used by response personnel including people with disabilities. The choice of technology should be based on its efficiency in a given context rather than its future potential. This realisation is manifested in the Battle of Agincourt in 1415 where 6,000 British soldiers were able to defeat 15,000 French soldiers using the primitive English longbow. Despite its simple design, the English longbow was more efficient than the sophisticated French crossbows that required frequent rewinding (Loades, 2013). Similarly, despite their huge potential, the use of sophisticated telehealth technologies in developing countries may not be appropriate where electrical supplies and communication infrastructure are unreliable (Scott & Mars, 2015). This suggestion does not undermine the need to fully understand and utilise revolutionary technologies such as IoT or AI; rather, it is a call to think of incremental changes that ultimately bring transformational change. In the end, “the ultimate in sophistication is simplicity” (Thiessen, 1946, p. 17C).

In the context of disasters, connectivity itself is a form of aid as it relays life-saving information and assists with the delivery of critical resources to disaster responders and survivors (Garshnek & Burkle Jr, 1999). Failure of communication systems in critical circumstances can have catastrophic impacts (EL Khaled & Mcheick, 2019). Therefore, ensuring that emergency services are well-equipped and well-trained in the use of reliable and redundant communication tools should be central to disaster preparedness efforts (ADPC, 2011).

7.5 Auditing and accountability

A significant part of disaster preparedness relates to the development of emergency plans that help prepare individuals and communities for potential disaster events. The response phase, which often receives more attention than other disaster lifecycle phases, ideally starts by putting already established disaster preparedness plans into motion (Center for Disaster Philanthropy, n.d.). Therefore, the key element of successful disaster response is rooted in having well-designed disaster preparedness plans.

The present research shows that, in New Zealand, the complete absence of a mechanism to check the quality and, more seriously, the existence of emergency plans translates into lack of rigid civil defence auditing. Even when an emergency plan exists, non-compliance with the specified plan incurs no consequences for or liability on the agency. On the contrary, in the United States, the absence of an emergency action plan, the inadequacy of the plan or a failure to follow the plan raises liability issues (Binder, 2001). Despite the influence of the quality planning of local governments on the effectiveness of response, agencies often lack specific criteria for evaluating emergency plans (Henstra, 2010).

The lack of auditing and accountability extends to coordination frameworks. A mechanism to ensure that agencies are training their personnel in coordination frameworks is also lacking. Moreover, the absence of a consequence for a failure to follow these frameworks results in weak compliance that leads to poor coordination. In New Zealand, there exists no mechanism that ensures a response agency is trained in or will be using CIMS (see section 2.10.3) when required.

To ensure compliance and accountability, auditing mechanisms need to be in place for assessing emergency plans and ensuring that agencies comply with coordination frameworks. One can argue that these plans and frameworks are often used as general guidelines. While this is factually correct, the need for disaster planning and building up a capacity to manage unexpected events is undoubted (Enander, 2017).

7.6 The need to professionalise emergency management

Emergency response agencies often use 'business as usual' structures in disasters by utilising volunteers. Volunteers refer to staff with management roles who become part of the incident management structure. However, individuals who shift from their normal roles into emergency management roles are not as well-versed in manging disasters as emergency management professionals.

The lack of adequate emergency management training, especially on coordination frameworks and emergency information management, is a major factor behind suboptimal disaster response, the present research reveals. Consistently, a review of the performance of the New Zealand civil defence system reported that key roles in the system are often part-time, that training and professional development is very patchy, and that there are no required professional standards or accreditation (NEMA, 2018).

Appointing personnel who are not adequately trained in emergency management is a situation necessitated by the shortage of qualified emergency managers. In addition to ineffectiveness, understaffing can impact the efficiency of information exchange. When asked about SA, a senior emergency services manager bemoaned the shortage of staff which prevents them from co-locating information officers in EOCs.

Co-location significantly increases the efficiency of reporting by reducing the time required to receive and interpret information. In Sweden, professional response organisations and supportive actors are permanently co-located with the aim of strengthening societal resources in coping with emergency situations (Pilemalm et al., 2016).

In a dynamic and complex situation, informed decision-making requires awareness of the significance of sharing one's individual SA. Individual SA, i.e. one's share of

knowledge about the situation, contributes to the information that needs to be interpreted and built upon in the process of decision-making (Abbas & Norris, 2018). Figure 7.3 depicts the cycle of mismanaged information sharing.

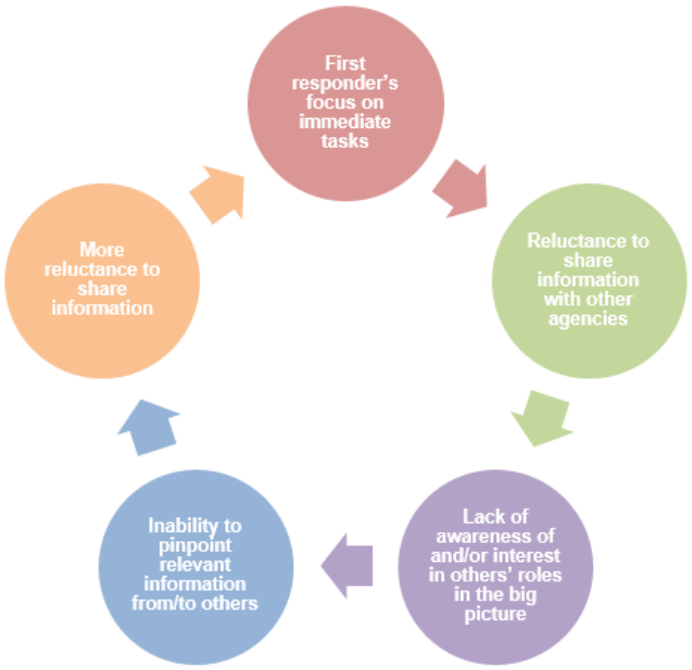


Figure 7.3 Lack of individual SA
(Bharosa et al., 2010)

The exclusive focus of individuals on their immediate tasks prevents them from being active contributors to shared SA. Co-locating disaster responders from different agencies in the same physical place creates a sense of collectivism and eventually builds interpersonal trust (Mojir & Pilemalm, 2014) which in turn facilitates information flow (Salem & Jarrar, 2009).

Understaffing is not confined to the emergency management sector. In health, a 2017 study predicted the global demand for qualified healthcare workers to double by 2030 resulting in a global shortage of 15 million health workers (J. X. Liu, Goryakin, Maeda, Bruckner, & Scheffler, 2016). The importance of tackling the shortage in emergency responders became evident with the COVID-19 outbreak where the risk of losing more health workers to the infection presented a serious dimension to the response effort.

In New Zealand, the scarcity of professional emergency managers results in many responders in any given EOC being non-emergency management professionals working within a structure that they may or may not be trained in. However, the proficiency of

emergency managers per se is questionable in the absence of processes and mechanisms to assess emergency managers. More serious still is the absence of professional standards or accreditation for becoming an emergency manager professional (NEMA, 2018).

The absence of minimal proficiency requirements in emergency management is strongly linked to the early establishment of the New Zealand Civil Defence and Emergency Management in 1959 to respond to natural disasters. Most responders recruited at the time were retired military personnel who were already on pension and hence were satisfied with a modest payment. The salaries of emergency managers continued to be low, resulting in it being difficult to attract talented and well-experienced personnel. The combination of low salaries and average skills reflected a negative image of emergency managers, often making them feel undervalued. A study demonstrated that emergency management personnel feel distanced from the health sector personnel who typically have higher social and academic ranking (Bissell et al., 2004). Besides, community members often lack adequate understanding of the skills and capabilities of emergency managers.

The following quote from one of the participants reflects a confusion among emergency managers themselves about what is expected of them:

> *I think the struggle for us is that we don't have a single voice guiding us on what does "Best Practice" mean in emergencies. What does it mean to call yourself an emergency management professional? Does that automatically trigger someone to know that you've done a university degree, or a series of courses or had an amount of experience? We don't have that yet!*

Clearly, there exists an urgent need to professionalise the field of emergency management. The professionalisation of education for emergency managers was called for by the National Science Foundation and the National Academies in the United States more than a decade ago (Waugh Jr & Sadiq, 2011). The professionalisation of emergency management aims at upskilling the competencies of emergency management personnel. Competencies are defined as the combination of skills and knowledge necessary to perform a certain task successfully (European Centre for Disease Prevention and Control, 2017). Competencies require contextual measurement and are usually achieved through designing an educational curriculum

that involves identifying learning objectives, content, and evaluation methods (Walsh et al., 2012). In 2017, generic standards for emergency and disaster management education in Australia were published (FitzGerald et al., 2017). The standards concern governance and policy frameworks, a theoretical and conceptual basis for practice, contemporary disaster management, leadership, communication and collaboration, professional practice and critical thinking.

Standards are critical for the accreditation process and for transforming the field of emergency management into the fully-fledged profession it vitally needs to become (Crews, 2001; Waugh Jr & Sadiq, 2011). In addition, standards facilitate the promotion of international learning, exchange, and comparability among emergency workers (D. Alexander, 2005).

7.7 Funding

Funding directly and indirectly impacts the scope, speed, effectiveness, and efficiency of disaster response (Wakolbinger, Toyasaki, Christopher, & Tatham, 2011). Disaster funding addresses disaster risk reduction, reconstruction and rehabilitation, and response (Watson et al., 2015). Although investing in preparedness efforts brings more value than investing in disaster response (Sen, 2019), the majority of disaster funding is poured into response (Aflaki & Pedraza-Martinez, 2016).

This research reveals that excessive funding of disaster response cannot address issues that stem from lack of preparedness. In fact, the combination of abundant resources and under-preparedness leads to inefficiencies and lack of coordination. This was evident in the response to the 2014 Ebola outbreak in West Africa where, despite extensive funding, the WHO's response was heavily criticised for its lack of preparedness (WHO, 2015b). Alas, funding preparedness and development programmes was found to be problematic due to reluctance to commit resources to low probability events (Lindell & Perry, 2003).

Coordination frameworks and emergency plans are critical for guiding the response to disasters. However, these guidelines can only be effective if disaster responders have the skills required to utilise them as instruments for effective collaboration. Training enhances employee and management behaviour through time (E. Cohen, 2017), and

highlights areas for improved inter-organisational cooperation (Graham & Stephens, 2018). A lack of training on plans and frameworks, which is often due to budget constraints, results in fragmented efforts and confusion about how individual agencies relate to the whole response effort, current results suggest.

Cross-agency training is an option for minimising training costs for individual agencies. Moreover, joint training enhances the quality of training, and establishes trust between training attendees (IFRC, 2000). Current results highlight a significant boost in the quality of response when individuals who have been trained together are jointly deployed. This could be attributed to the harmony created between team members during exercises in addition to the variety of skills usually present in diverse teams. Nevertheless, joint deployment also requires abundant human and financial resources in addition to flexible planning. These observations confirm the view that funding remains one of the biggest barriers to cross-agency collaboration due to an increasing disaster-induced drain on public finances (Clarke et al., 2017).

Funding not only influences the logistical aspects of disaster management; it also impacts information sharing. In the context of international humanitarian organisations, competitiveness for funding compromises transparency since ‘You look good when you have information that nobody else has!’ as one interview participant put it. In the military domain, competing for funding across service agencies is referred to as inter-service rivalry (Horwood, 2010).

Current results show that cross-agency collaborations concerning shared the utilisation of capabilities, GIS for instance, are often challenged with the question of who will be responsible for the cost. The allocation of a ‘cross-entity funding stream’ which sets aside funds for joint initiatives can support the establishment and continuation of cross-agency collaborations (Auditor-General, 2018). Certainly, the appropriateness of financing practices is subject to continuous policy debates and considerations (Jan Kellett & Caravani, 2013). Successful disaster finance strategies consider the evolving funding requirements related to each disaster lifecycle stage (Clarke et al., 2017).

Aflaki and Pedraza-Martinez (2016) analysed the trade-off between funding strategies and operational performance in humanitarian operations. They concluded that responses to severe disasters get over-funded due to extensive public attention and

the uncertainty associated with expected needs. Over time, funding provision declines and, interestingly, the resulting complacency results in a reluctance to fund preparedness programmes. Noting this, Furin and Brenner (2014) suggested that the best time to propose major changes for disaster preparedness, including funding, is immediately following large-scale widely-publicised disasters, even if they occur remotely. Indeed that was the case in the wake of COVID-19 where the New Zealand government allocated $47.8m for emergency service communication capabilities and $15.8m for the emergency ambulance service (Devlin, 2020). Finally, the relaxation of bureaucratic processes around budget approval and release is critical for managing the immediate requirements of disaster response (Macaskill & Guthrie, 2018).

7.8 A framework for improving cross-agency communication and information exchange in disaster healthcare

Disaster healthcare is the systematic process of using different skills and capacities – clinical, administrative, organisation and operational – to address the challenge of planning for, responding to, and recovering from the health consequences of disasters (Ardalan et al., 2009). It aims at reducing vulnerability and facilitating short-term emergency response and long-term recovery support (Perry, Lindell, & Tierney, 2001). Despite the rich literature on the topic of multi-agency communication and information exchange in disasters (Martin et al., 2016; Simon et al., 2015; Telfair LeBlanc et al., 2019), there exists no convergence on a multi-agency collaboration framework (Ward, Varda, Epstein, & Lane, 2018). This research diverted from following theoretical approaches to cross-agency communication with the expectation that these theories will benefit multi-agency partnership. Instead, the solutions discussed above are linked to conceptualise a communication framework built upon multidisciplinary partnership. Built upon solutions to real-life complexities, the framework provides guiding principles for improving disaster healthcare.

While incremental change concerns operating within the current rules repetitively to enhance efficiency and achieve best practice, transformational change experiments with new possibilities through working in fundamentally new ways (Waddell, 2019). As opposed to reform, these two change approaches do not strive for organisational restructuring. This research acknowledges the benefits of command and control (see section 7.3.1) and calls for enhancing SA across the main response agencies within the

vertical structure through the utilisation of a disaster healthcare MDS. Also, it addresses the need for a transformational change towards horizontal information exchange through the utilisation of cost-effective technologies such as social media, bottom-up planning through community engagement, and multi-disciplinary training and education (the DEH curriculum framework). Therefore, the framework provided advocates for a combination of incremental and transformational changes.

The solutions discussed touch on four dimensions:

- The refinement of disaster information exchange:
  - Vertically, via a disaster healthcare MDS, and horizontally, via social media platforms
  - Small incremental changes in the adoption of digital solutions (automation and visualisation)
- Bridging the gap between disaster response agencies by building a culture of understanding and trust through education and prior liaison
- Community engagement
- Strategic requirements:
  - Auditing and accountability
  - Professionalisation of the discipline of emergency management
  - Funding

Information exchange, which is certainly central to each of the above dimensions, is facilitated by technology. Technology can be viewed as providing services to emergency managers, health professionals and impacted communities based on identified processes. Four components emerge from this argument: people (disaster response professionals and the community), technology, and processes. These dimensions can be mapped into the ITIL4 service delivery framework.

Information Technology Infrastructure Library (ITIL) is a framework of best practices (see Figure 7.4, below) developed by the British Government's Central Computer and Telecommunications Agency (CCTA) for delivering IT services (White & Greiner, 2019). ITIL systematically helps businesses build a stable and scalable IT environment, strengthen customer relations, manage risks, and establish cost-effective practices. Initially, ITIL focused on people, processes, and technology prioritised in that order.

However, this view evolved to include partners and abandoned the prioritisation approach to adopt a multi-dimensional approach comprised of four synergetic dimensions: organisations and people, information and technology, partners and suppliers, value streams and processes (Magowan, 2020).

Figure 7.4 The four dimensions of service management
(BMC Solutions, 2019)

Disaster healthcare is built upon cross-agency collaboration and can be seen as a service-oriented emergency response. The concept of service-oriented emergency response realises that organisations (agencies), units and technical systems provide information and capabilities as services which enable response agencies to make use of existing resources and capabilities as needed (Pilemalm & Hallberg, 2008). Accordingly, the ITIL4 framework is used as a platform for conceptualising the communication model that similarly adopts a multi-dimensional approach to the enhancement of disaster healthcare, and to which emergency managers and health professionals, information technology, community (partners) and processes are central. Hence, this research offers a solution-driven communication model (see Figure 7.5, below) as a multi-disciplinary approach that could improve cross-agency communication and information exchange in disasters.

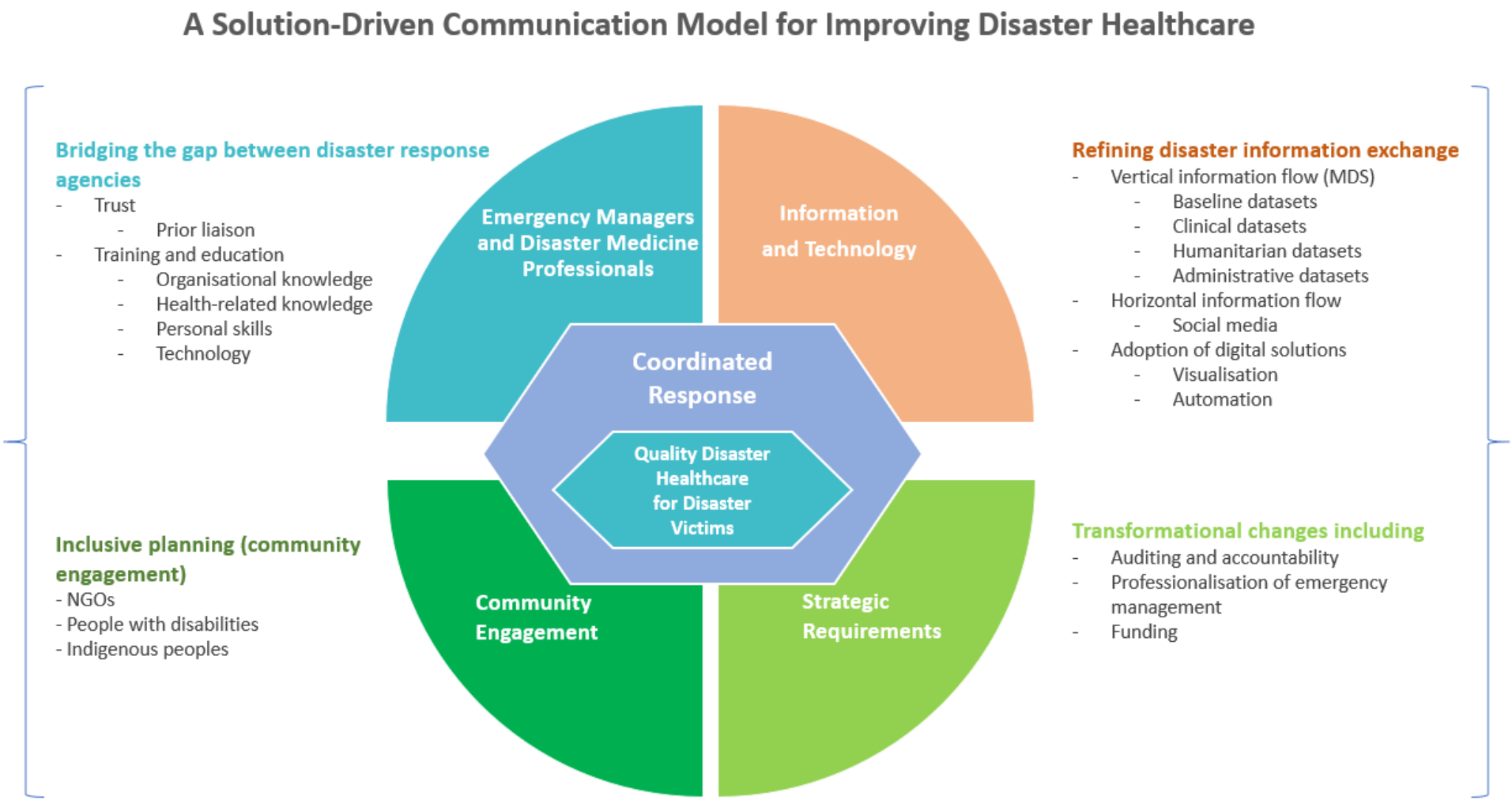


Figure 7.5 A solution-driven communication model for improving disaster healthcare

Disaster agencies are interdependent and, hence, should communicate and collaborate to achieve their common goal (Kapucu & Garayev, 2016). Considering that both emergency managers and health professionals aim at assisting disaster survivors, it is probably naive to expect the two sectors to respond to the same disaster independently without expecting increased costs, underutilisation of resources, or duplication of tasks, or all three.

The framework is built upon the realisation that a silo effort within a networked mode of interaction will compromise the potential and effectiveness of response (Fenwick, Seville, & Brunsdon, 2009). A silo effort within a networked mode of interaction will compromise its potential and effectiveness. Networked interactions have several benefits to its stakeholders, including shared resources, expertise, personnel, and information (Lazer & Friedman, 2007). A quality health response in a disaster relies on effective planning, adequate resources, and community-wide multi-disciplinary education and training (Green et al., 2003). The identified approaches were linked to provide a solution-driven communication framework that enhances disaster healthcare preparedness and response. While the framework guides activities that are mostly conducted during preparedness, their impacts are often seen in response.

The notion of resilience refers to the ability of societies to bounce back from disaster by predicting and preventing potential challenges, improvising and utilising resources in creative ways, collective conceptualisation of risks and joint problem-solving, and continuous maintenance of adequate situation awareness (Kendra & Wachtendorf, 2003). This study addresses these aspects and conceptualises them in a framework that offers solutions and recommendations for these inter-related aspects, thus contributing to disaster resilience on both the institutional and community levels.

A multidisciplinary approach to disaster healthcare necessitates a cross-agency collaboration which often requires adequate resources, flexible planning, and an extent of compromise around individual agencies' operational modes. However, the decision to participate in a collaborative endeavour often follows the notion that the sum is always greater than the total of the parts (Tatham & Houghton, 2011).

7.9 Chapter summary

This chapter has discussed the solutions suggested to address some of the challenges to cross-agency communication identified in Chapter 4. The solutions (MDS prototype and DEH curriculum framework) address the second and third research questions which were created after considering the first research question. A discussion of the rest of the issues identified in Chapter 4 followed.

The refinement of disaster-related information through the MDS approach and horizontal information exchange via social media platforms will aid evidence-based decision-making. The DEH curriculum has the potential to build trust across emergency managers and health professionals, and to enhance their skills through joint education and training. Community engagement is emphasised to ensure a comprehensive approach to needs assessments and effective planning and response. The utilisation of affordable technologies and digital solutions was found to make significant impacts on SA and resource utilisation. Lastly, these aspects require adequate funding, standardised practices, and rigorous processes that guarantee compliance with agreed-upon emergency guidelines and coordination frameworks. Implications for non-compliance with these guidelines and frameworks will emphasise accountability. The research pinpointed communication issues between emergency managers and health professionals and provided practical solutions for addressing them. The elements of the discussion were linked to offer a communication framework for improving disaster healthcare.

Chapter 8 Conclusion, Recommendations, Limitations, and Future Work

8.1 Conclusion

The present research explored the communication challenges that exist between emergency management and health agencies in disasters. The aim of the research was to propose solutions and recommendations for improving communication between disaster response agencies, thus improving healthcare provision to the victims of disasters.

Communication certainly underpins all stages of the disaster lifecycle. Factors that impact effective communication between emergency response agencies were identified via interviewing emergency managers and health professionals affiliated with the key agencies responsible for disaster response. Information about participants and questionnaire details are found in section 3.5.2. The main issues were thematically grouped into trust, authority and leadership, situation awareness, technology and legislation (Chapter 4). Accordingly, two approaches were suggested: the disaster healthcare MDS (see section 5.3.2), and the DEH curriculum framework (see section 2.9.2).

The MDS is a technical approach that aims at enhancing SA. Identifying critical datasets that are meaningful to both emergency management and health agencies enables emergency response professionals to determine what is critical for their work, rather than receiving situation reports that contain too much or irrelevant information. Considering the stressful context of disasters, and the limited time required to make critical decisions, enhancing SA can literally translate into better disaster healthcare outcomes. Moreover, the MDS provides raw data that can be interpreted into relevant information by individual agencies based on their functions. This standardised reporting feature of the MDS ultimately refines information quality by imposing rigour and accuracy on the data exchanged and alleviating ambiguity, thus facilitating interoperability.

The disaster healthcare MDS has been identified by choosing datasets deemed critical by both emergency managers and health professionals. However, data analysis

revealed that excluded data items may be 'absolutely essential' for one group of experts but not the other. Excluded datasets can be utilised in designing sector-specific MDSs that aim at enhancing SA within the sector. Moreover, the Delphi approach followed in identifying the MDS prototype may be used to design scenario-specific MDSs addressing the information requirements of specific disaster types such as pandemics or floods. Expanding the MDS to include as many data points as possible about different event types may leave more room for theory building and hypothesis generation.

The MDS is a technical solution to the inefficient exchange of disaster information. Nevertheless, as noted by Davenport, Eccles, and Prusak (1998) "*no technology has yet convinced an unwilling manager to share information*" (p. 56). The outcomes of this work emphasise the need to establish interpersonal and institutional trust across disaster response agencies through prior liaison and joint education and training.

Prior liaison encourages agencies to become accustomed to collaboration to mitigate the impacts of disasters and prepare disaster response plans, as well as coordinate their actions during and after a crisis. By contrast, joint education and training seals the knowledge and skills gaps experienced by emergency managers and health professionals in disasters. This interdisciplinary approach to disaster management creates a culture of understanding and trust that facilitates smooth information flow and joint problem-solving in disasters. Moreover, understanding the structural and operational aspects of various agencies promotes flexibility when the need to take joint actions arise. Prior liaison can play an important role in establishing trust through building relationships that facilitate knowledge sharing.

Education is another way of knowledge sharing that follows an evidence-based approach to learning and identifies specific areas of knowledge that require special attention. This research identified a framework for a disaster healthcare curriculum targeting combined groups of emergency managers and health professionals. The interdisciplinary curriculum framework aims at educating emergency managers about each other's agencies and equipping them with necessary technical and non-technical communication skills. The DEH framework (see section 6.4) was evaluated and refined by consulting experts in emergency management and health. Many of the issues raised

during semi-structured interviews relate to a lack of organisational knowledge, communication skills, technological skills, or health education. Hence, the DEH topics were picked based on these knowledge gaps.

The MDS prototype and the DEH curriculum framework were integrated with the communication solutions discussed in sections 7.2 and 7.4–7.7 to offer a framework for improving cross-agency communication and information exchange in disasters (see Figure 7.5). This solution-driven communication framework offers human and technical approaches to the enhancement of disaster healthcare. In addition, the communication framework identifies strategic requirements in sections 7.5–7.7 that have the potential to improve not only cross-agency collaboration but also the performance of individual agencies.

8.2 Recommendations

In light of the outcomes of this research, the implementation of the following ten recommendations is suggested:

8.2.1 Practical implementation of the DEH: Formation of virtual interdisciplinary teams of emergency managers and emergency medical professionals

In this work, the need to consider disaster preparedness and response from a multi-disciplinary perspective was discussed. The DEH curriculum targets combined groups of emergency managers and health professionals (see section 7.3.2). This educational approach aims at bridging the gap between the two sectors and building a culture of understanding and trust. The recommendations take this further into forming interdisciplinary teams of emergency managers and emergency medical professionals with the aim of establishing prior liaison and virtual knowledge networks.

This recommendation is inspired by two practices in health and emergency management; The WHO Emergency Medical Teams (EMTs) and the Fly-In Teams of emergency managers in New Zealand.

The WHO EMTs initiative assists organisations and member states to build capacity and strengthen health systems by coordinating the deployment of quality assured medical teams in emergencies. By contrast, the Fly-In Teams have people with the appropriate skills and experience able to go wherever required, without delay, to work alongside

and support the local team to ensure a comprehensive and immediate response is underway.

The formation of joint teams of medical and emergency management personnel, including communication officers who would be trained to jointly deploy nationally in disasters, is highly recommended. These teams should have representatives from each locality, and should virtually communicate on a regular basis, and physically meet when possible. Even though joint deployment may be challenging, forming joint interdisciplinary teams which communicate regularly has the potential to build rapport and trust, facilitate smooth information flow, and encourage knowledge sharing and joint problem-solving in disasters.

8.2.2 Raising the profile of DEH

The DEH curriculum holds a potential for the enhanced provision of disaster healthcare. It is recommended that this potential is communicated to a wide audience of people who have expertise in disaster management, disaster medicine, and e-health. This includes the possibility of establishing collaborations between governments and international humanitarian organisations which would potentially benefit from DEH. Scientific papers are recommended to be published more widely, along with a consideration of the possibility of a conference dedicated to the establishment of the DEH discipline. Workshops and cross-university collaborations would accelerate the development of DEH and set the domain on a path to becoming a vital and sustainable component of mainstream disaster healthcare.

8.2.3 Establishing communication protocols with community representatives

Communication with decision-makers to discuss pressing needs and share SA is crucial throughout the disaster lifecycle, and especially during response. This should not be left to the availability of emergency personnel who are usually fully occupied during response. Identifying community representatives and preparing their contact information beforehand, specifying suitable communication channels including local media and social media platforms, and connecting with them regularly during peacetime should be core to preparedness efforts.

8.2.4 Developing a legal framework to support the inclusion of persons with disabilities

People with disabilities have the right to be active citizens within their communities. Previous experiences illustrate that this important sector is often excluded from disaster mitigation and planning efforts. This not only compromises the quality of response, it also resembles a level of resource underutilisation. The inclusion of people with disabilities in disaster preparedness and response should not be discretionary. It is recommended that a legal framework is put in place to support the inclusion of people with disabilities in all activities and stages of disaster management to which they can contribute.

8.2.5 Taking steps towards the professionalising of emergency management

Emergency management key roles, according to the findings of this research, are found to be part-time, and the lack of training on coordination frameworks and emergency information management was found to be a major factor that compromises the quality of response. Moreover, there exists no minimum requirements for accrediting emergency management. Accordingly, setting standards for the education and training of emergency managers through shared knowledge is a crucial step towards the transforming emergency management into a fully-fledged profession.

8.2.6 Effective development and presentation of emergency plans

The often-cumbersome design of emergency plans prevents emergency responders from using them in disasters. It is recommended that the design of emergency plans is simplified to ensure crucial information is included and laid out in a simple, readable format that facilitates efficiency. This can be achieved through technological solutions, such as mobile apps, that present plans in a responsive, attractive form. Advances in software technology, such as process modelling, whereby a process may be analysed, improved and automated, have the potential to make a shift towards interactive systems that significantly enhance the usability of disaster plans. Responsive emergency plans can keep emergency responders engaged and up to date with planning changes, and hence are recommended.

8.2.7 Auditing and accountability

Coordination frameworks and emergency plans are critical for guiding disaster response and improving its efficiency. The absence of a consequence for failure to follow these guiding structures allows the evasion of compliance. Based on the findings of this research, it is recommended to ensure that emergency response personnel in key agencies are trained on coordination frameworks (incident management frameworks), and are adequately informed on their emergency plans. Moreover, it is recommended that a mechanism for assessing the effectiveness of emergency plans is identified.

8.2.8 The integration of social media into disaster management strategies

Social media has demonstrated its usefulness in various disaster stages. Information exchanged over social media platforms has the potential to play a significant role in raising SA and guiding decision-making. The emergence of social media as the leading method of unofficial content sharing in many parts of the world, and its ability to reach a wide range of people, suggests giving these technologies a higher profile in disaster communication. Hence, it is recommended that social media platforms are integrated into the development of disaster response strategies alongside measures for verifying its reliability and accuracy.

8.2.9 Funding GIS capabilities

GIS is a powerful tool that has a huge potential to support communication and decision-making. It can integrate and produce a variety of information layers that can be shown using the same set of data. In addition, GIS saves valuable time that is much needed during response through the exchange of data with relevant stakeholders. Allocating enough resources for adopting GIS systems within EOCs is recommended.

8.2.10 Funding joint-training programmes

Joint training is one way to share the cost of training and improve trust and relations between response organisations. In addition, joint training identifies strengths and weaknesses in the response system and builds the communication and personal links required to facilitate collaboration and coordination in disasters. Therefore, allocating adequate funds for joint training is recommended.

8.3 Limitations

The present research was limited by a number of constraints.

For budget implications, challenges to effective cross-agency communication in disasters were identified by interviewing disaster response personnel, many of whom work in New Zealand although their experiences may not be limited to New Zealand only. Additional insights may have been gained had the data been collected from diverse political/social settings. Moreover, this research addresses common issues and information requirements associated with multi-agency interaction in a disaster setting regardless of its type. Although every disaster has its own unexpected twists that require tailored solutions, disaster impacts share commonalities regardless of their type or region of occurrence. What may be experienced in a certain region may benefit other countries that share similar circumstances. Therefore, outcomes from this work can be generalised to draw attention to areas that require further improvement, and to policies and practices required to avoid similar challenges.

Despite empirical evidence that the size of the Delphi panel is adequate for achieving reliable judgment (see section 3.5.3), increasing the number of experts may have slightly increased the level of confidence with regards to the decision to exclude marginal datasets. In Delphi, each round requires a questionnaire to be designed based on the analysed feedback of the preceding round. Although electronic surveys are efficient in both collection and analysis, limiting the size of the Delphi to the minimum reliable number was thought to be the best approach to managing the research timeline.

8.4 Future work

The current piece of work identified the important agencies involved in disaster healthcare and attempted to populate an MDS with data relevant to their operation. The potential value of the MDS was identified and design suggestions were made. A further step beyond identifying the disaster healthcare MDS would be to consider its implementation.

Future work can be conducted to use the MDS in the design of a national emergency information system (see section 7.2.4) that supports real-time sharing of a

comprehensive disaster healthcare MDS across response agencies. Among other requirements, the implementation of the MDS will certainly require the creation of an associated data dictionary that provides specific definitions and formats to enable interoperability. Future work can be conducted to design an interactive emergency information system that connects the public with each other and with disaster response agencies.

In disasters, members of the public often have the most up-to-date knowledge of the current state of the emergency and its likely progress. They connect with others to inform and help one another and may extend links to form groups of digital volunteers. A system that facilitates information flow between these community elements and officials in national and international agencies tasked with disaster response could produce a ‘collective intelligence’ that could inform and greatly improve the quality and effectiveness of the targeted response. The messages exchanged could be ad hoc, but many would be pre-determined by the disaster healthcare MDS. The description of the suggested system relates to social computing, which is the use of computer systems to support the generation, representation, processing, use, and dissemination of information that is distributed interactively across social collectives such as teams or organisations. The composition of these social collectives may change over time, and the information exchange may involve all or some of the group members at any given time.

A suggested design for the suggested system would involve the following aspects. Considering the disaster healthcare MDS, each participating agency indicates what data it can provide, that is, what data it ‘owns'. The combined data from all agencies are stored in a database (an intermediate layer) and an MDS is defined by an agency as the minimum set of those items in the database collection that it needs to discharge its role in a disaster. Some of these items will be provided by the agency itself but others will be provided by other collaborating agencies and each agency is responsible for updating data items that it owns. Occasionally, an agency will need a data item not part of its usual MDS and it will issue a request for that item, which will be routed automatically to the source of the item.

Manual processes that require automation, such as resource allocation, can be viewed as separate modules that link to the database and extract the relevant data needed to accomplish defined tasks. This allows task modules to be developed and added to preparedness plans in order to be primed with data by issuing simple SQL requests during response.

Effective disaster response relies on collecting, combining, analysing and distributing information in a useful format. Obtaining real-time data as an incident unfolds can assist response agencies in determining the location of affected individuals, assessing required needs, and informing first responders and the public of changing conditions and new risks. A dynamic structured information system based on the MDS would facilitate the collection of fragmented data from response agencies and its preparation for use by all of the agencies, hence building a holistic picture of the incident.

Lastly, future work may consider expanding the DEH framework into a fully-fledged interdisciplinary curriculum. A challenging aspect of the design of a multidisciplinary curriculum relates to striking a balance between relevance and specialisation. For example, topics related to one discipline may be considered basic by participants from that discipline while others may find them too specialised. A suggested approach involves making a radical shift towards nurturing creative problem-solving skills. It is based upon the realisation that building key competencies through transferable skills is essential to striving and prospering in dynamic contexts. Hence, a problem relating to disaster management is presented to people with diverse backgrounds to solve it, and the solutions are examined, evaluated and possibly integrated to solve the issue at hand. The DEH curriculum targets disaster response professionals who need to upskill their abilities. A blended approach of face-to-face and online courses is thought to be best. These courses need to be sponsored, possibly by governmental agencies and/or international humanitarian organisations who may benefit from the DEH curriculum.

8.5 Chapter summary

The chapter has reflected on the outcomes of the present research and accordingly suggested ten recommendations to be implemented. Research limitations have been mentioned and future work suggested for tackling some of the limitations identified.

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Appendices

Appendix A Ethics Approval - Interviews

AUTEC Secretariat

Auckland University of Technology
D-88, WU406 Level 4 WU Building City Campus
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

27 March 2017

Dave Parry
Faculty of Design and Creative Technologies

Dear Dave

Re Ethics Application: **17/69 Cross-agency communication and information exchange in disaster healthcare**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 27 March 2020.

As part of the ethics approval process, you are required to submit the following to AUTEC:

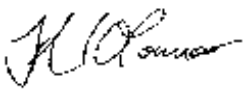
- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 27 March 2020;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 27 March 2020 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

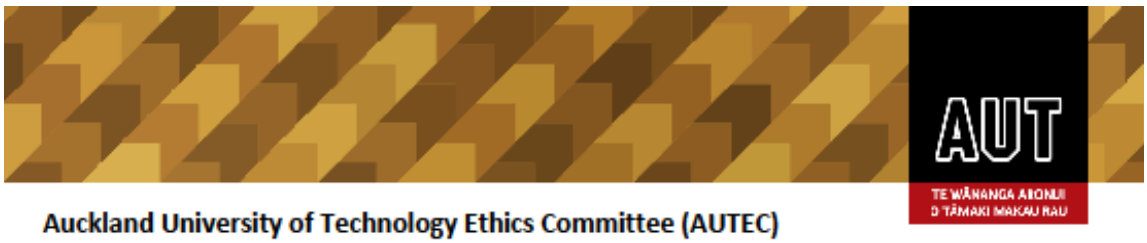
All the very best with your research,



Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: rsa247@hotmail.com

Appendix B Ethics Approval - Delphi Study



Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
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T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

27 February 2019

Dave Parry
Faculty of Design and Creative Technologies

Dear Dave

Re Ethics Application: **19/41 Cross-agency communication and information exchange in disaster healthcare: Stage 2**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 27 February 2022.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/research/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/research/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/research/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation, then you are responsible for obtaining it. If the research is undertaken outside New Zealand, you need to meet all locality legal and ethical obligations and requirements. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: reem.abbas@aut.ac.nz

Appendix C Information Sheet – Interviews

Participant Information Sheet

Date Information Sheet Produced:
14 September 2017

Project Title
Cross-Agency Communication and Information Exchange in Disaster Healthcare

An Invitation
My name is Reem Abbas. I am a PhD student at Auckland University of Technology (AUT). Would you be willing to participate in my PhD research that looks into the quality of communication and information exchange between emergency managers and health personnel in disasters? The findings of this research may lead to improving the quality of healthcare delivered to disaster victims. Given your formidable and unique experience into humanitarian response, your participation will be invaluable to my research. If you wish to participate, please find attached an information sheet with the full details.

What is the purpose of this research?

I am carrying out this research in pursuit of a PhD in Health Informatics. The objective of the research is to investigate the factors that may affect communication between the main agencies providing healthcare services in disasters; disaster management and disaster medicine. In doing so, I will be conducting interviews with professionals in the field of disaster medicine, disaster management, and information and communication technologies to increase my understanding of the aspects of inter-agency communication and information exchange. I am trying to find out the factors that may impact effective communication between clinical and emergency personnel during disasters, the essential information that these practitioners need to communicate in emergency situations, and how can communication between these two sectors be improved. Research findings, papers, and publications may contribute to the establishment of a new discipline namely Disaster e- Health (DEH) that combines disaster management, disaster medicine, and eHealth.

How was I identified and why am I being invited to participate in this research?

I got your contact information from Mr Nizar Abdelsalam Salih and you kindly agreed to communicate with me. In your capacity as a United Nations representative and your formidable expertise in disaster response, you are in an ideal position to give me valuable first-hand information from your own perspective.

How do I agree to participate in this research?
If you agree to participate in this research, you will be given a consent form to sign and return.

What will happen in this research?

If you wish to participate in the research, I will be conducting an interview with you at a convenient place and time of your choice. The interview will be taped and is expected to last between 60- 90

minutes. The interview will be held at a convenient premises of your choice. It could be held at your office, AUT city campus, AUT south campus or another place that you find convenient. In the interview I will try to capture your thoughts and perspectives on the quality of communication and information exchange between disaster management and health personnel in disaster events. I will also ask about how you think this quality could be enhanced. Your views on cross-agency communication during disasters will be collected and analysed, with the aim of laying the foundations for a healthcare communication strategy in crisis. The information collected from you will only be used for the purpose of this research and will not be used for any other. Transcripts of your interview will be sent to you for checking, amendment, and removal of items that you would like to omit.

What are the benefits?

I am conducting this research in pursuit of a PhD in Health Informatics. You may benefit from the findings as it involves your area of expertise. The findings may contribute to enhancing the quality of healthcare delivered in disasters thus helping the wider community.

How will my privacy be protected?

Your participation in this research is completely voluntary. Your contact details will be kept confidential and will only be used to contact you for the purpose of this study. Other than being acknowledged in the findings, your name will not be mentioned in this research if you do not wish to have it mentioned. However, given that the community of experts in disaster response may be relatively small, the information you provide, the name of the organisation you work for, or your job title may enable someone to identify you. If you do not wish to be identified, please indicate so in the consent form. Transcripts of the interview will be sent to you for checking, amendment, and removal of items that you would like to omit. However, once the findings have been produced, removal of your data may not be possible.

What are the costs of participating in this research?

The interview lasts between 60 m- 90 minutes.

What opportunity do I have to consider this invitation?

I appreciate it if you could respond to this invitation within 2 weeks. If you wish to participate please let me know a suitable date and time for the interview.

Will I receive feedback on the results of this research?

A copy of the findings will be sent to you. Interview transcripts will also be sent to you for further consideration and possible amendments.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Dave Parry, dave.parry @aut.ac.nz, +6499219999 ext. 8918.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, ethics@aut.ac.nz , 921 9999 ext. 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:
Reem Abbas

E-mail:
raa247@hotmail.com
Mobile: +64223509160
Project Supervisor Contact Details:

Associate Professor Dave
Parry E-mail:
dave.parry@aut.ac.nz Tel:
+6499219999 ext. 8918
Approved by the Auckland University of Technology Ethics Committee on *------27/03/2017---------*
AUTEC Reference number *---17/69----------*.

Appendix D Consent Form – Interviews

Consent Form

Project title: Cross-Agency Communication and Information Exchange in Disaster Healthcare
Project Supervisor: Associate Professor Dave Parry
Researcher: Reem Abbas

- O I have read and understood the information provided about this research project in the Information Sheet dated 14 September 2017.
- O I have had an opportunity to ask questions and to have them answered.
- O I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- O I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- O I understand that my name will not be mentioned in the study, but I might be identifiable from the information I provide, the name of the organisation I work for, or my job title (please tick one): YesO NoO
- O I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- O I agree to take part in this research.
- O I wish to receive a summary of the research findings (please tick one): YesO NoO

Participant's signature: .....

Participant's name: .....

Participant's Contact Details:

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on ---27/03/2017---------
AUTEC Reference number ---17/69 ----------

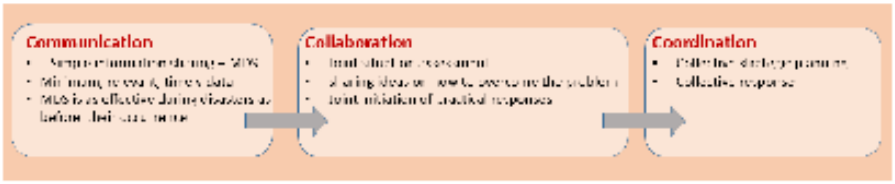
Appendix E Semi-Structured Interviews Questionnaire

Disaster Healthcare: The 3Cs Model and Minimum Data Sets

When a disaster event such as an earthquake, armed conflict, or epidemic strikes, emergency medicine and emergency management personnel usually play the biggest roles in providing relief. However, although emergency medicine and emergency share the same vision of providing public health services to disaster victims, post-disaster analysis reveals poor communication between the two sectors often resulting in substandard and sometimes unavailable healthcare.

Improving cross-agency communication, that leads to better collaboration and hence coordination of actions is therefore critical to increasing the efficiency and effectiveness of the overall disaster response.

Our research proposes a three-stage (3Cs) model for better effectiveness of response (see figure).



A key component of this model is the concept of Minimum Data Sets (MDS). An MDS is a basic set of data developed and maintained by an agency for its own purposes that can be supplemented on an 'as-needs' basis at each model stage by accessing relevant data from MDS 'owned' by other agencies.

To date, we have perceived the need for four distinct but interconnected MDS as follows.

Baseline MDS

Contains a priori data about the geography, infrastructure, and demographics of the region affected by the disaster as well as relevant health and epidemiological data. These data may be comparatively static in non-disaster situations but can be changeable and dynamic when a disaster strikes. The baseline MDS are key elements of resilience planning.

Healthcare MDS

Healthcare MDS focus specifically on the health situation. Embraces numbers of casualties, types of injury, triage statistics, resource availability and requirements, etc.

Situation Awareness MDS

This MDS comprises dynamic data on the general, current status of the disaster, its severity, impact (casualties, damage etc.), prognosis, risks, and general priorities.

Humanitarian MDS

These data describe fundamental needs such as shelter, food, water, evacuation priorities etc., that although clearly related to health needs also apply when healthcare is not the major consideration.

Sample MDS are shown at the end of this document. We now need your expert opinion on the usability of the 3Cs model, its strengths and weaknesses, and the concept and composition of the suggested MDS.

Your responses to the questions on the next page will help us to improve our model and realise its potential benefits. However, please do raise any issues that you feel are not covered by the questions.

Questionnaire

1. Is the 3Cs model a valid approach to understanding inter-agency communication, collaboration, and coordinated action necessary for the assessment and delivery of disaster healthcare? What are its strength and weaknesses?

2. Are the proposed MDS the best groupings? Please review the compositions of any of the suggested MDS that fit within your areas of expertise. We are especially interested in whether a data item is perceived as essential or just desirable, what, if anything is missing, other "essential" data are important to be included in these sets, can these data be easily maintained (accessed and updated), what other agencies would benefit from them and of course, any other features that influence the MDS utility.

3. How important is trust when deciding what data you or your agency would be willing to enter and maintain in an MDS?

4. What other factors would make you unwilling to share information with other agencies in a collaborative disaster response? Why are these factors a deterrent to sharing?

5. Do you think that a course on disaster healthcare involving both disaster managers and clinicians would lead to better understanding between the disciplines that would translate into more effective care? What topics, including those from you own area of expertise, would you see as essential course elements?

Healthcare MDS

1. Patient's District Health Board
2. Patient's (NHI number)
3. Patient's date of birth
4. Triage category: The degrees of urgency to wounds or illnesses
5. Responding agency (St. John, Salvation Army, Red Cross, Civil Defence, etc.)
6. Responder's profession (Physiotherapist, social worker, public health nutritionist)
7. Service location (emergency department, home, community location, etc.)
8. Medical specialty (mental health, antenatal, respiratory, emergency medicine, etc.)
9. Referrer (self, GP, specialist, nurse, midwife, etc.)
10. Employee identifier: (pertaining to the health care provider providing the service)
11. Health service activity commencement
12. Health service activity completion
13. Patient discharge date
14. Encounter outcome (discharged, ongoing care, referred to another profession, palliative care)
15. Encounter outcome reason (service complete, service not delivered, patient deceased)
16. Destination (Other health specialty, shelter, palliative care services, GP, overseas, hospital)
17. Urgent required resources

Situation Awareness MDS:

1. # of casualties
2. # of deaths
3. Disaster severity (state of emergency , evacuation)
4. Horizontal information exchange channels (e.g. Hashtags, websites, Facebook pages, etc...)
5. Access data (security level, collapsed bridges, blocked roads)
6. Compromised infrastructure (hospitals, schools, community centres)
7. Location of mobile clinics and transport services
8. Availability of transport services

Humanitarian MDS:

1. Location of healthcare facilities (hospitals, primary healthcare centres, PHU, etc.)
2. Accessibility requirements (visas, prevention of access by authorities, etc.)
3. Premises/site to which access is compromised or denied
4. Number of required isolation spaces (in mass casualties)
5. Requirements for patient transfer and discharge
6. Location of welfare services
7. Relocation data: availability of suitable space and/or accommodation, staffing availability and capacity, equipment, services and supplies
8. Excreta and waste management requirements
9. Shortage in reliable food
10. Nutritional status
11. Location of designated area for viewing/identifying bodies
12. Facilities for the public to enquire about missing/deceased persons

Baseline MDS:

1. Demographics (e.g. housing, transportation, age, gender, disability, migrant status)
2. Pre-existing health status
3. Community resources (e.g. shelters, location of healthcare facilities, counsellors for mental support, etc.)

Appendix F Information Sheet – Delphi Study

Participant Information Sheet

Date Information Sheet Produced:
4 February 2019

Project Title
Cross-Agency Communication and Information Exchange in Disaster Healthcare

An Invitation
I am a PhD student at Auckland University of Technology (AUT). Would you be willing to participate in a Delphi study of two or three rounds to identify the critical and most useful datasets that emergency managers and health professionals need to exchange in disasters? The study also seeks your opinion on the value, content and delivery mode of a suggested framework for a disaster healthcare curriculum. Findings of this research will lead to improving the quality of healthcare delivered to disaster victims. Given your knowledge and expertise in emergencies, your participation will be invaluable to my research. If you wish to participate, please find attached an information sheet with the full details.

What is the purpose of the Delphi study?

This Delphi study is part of my research in pursuit of a PhD in Health Informatics. The objective of the research is to investigate the factors that may affect communication between the main agencies providing healthcare services in disasters; disaster management and disaster medicine. In doing so, I have conducted interviews with professionals in the field of disaster medicine and disaster management to increase my understanding of the aspects of inter-agency communication and information exchange. I am now conducting this Delphi study to get experts' opinions on the critical and most useful datasets that disaster responders need to communicate in emergencies, as well as their feedback regarding a suggested framework for a disaster healthcare curriculum targeting combined groups of disaster mangers and health professionals. Research findings, papers, and publications may contribute to the establishment of a new discipline namely Disaster e- Health (DEH) that combines disaster management, disaster medicine, and eHealth.

How was I identified and why am I being invited to participate in this study?

Your contact details are available on a public website. Given your expertise in disaster management, your insights will be invaluable to my PhD study.

How do I agree to participate in this study?
If you agree to participate in this study, you will be given a consent form to sign and return.

What will happen in this Delphi study?

This is a two to three round Delphi study consisting of two parts. In the first part you are asked to evaluate (and add) datasets that you think are critical for disaster response - from a professional point of view. Part two, seeks your opinion regarding a disaster e-healthcare curriculum framework

targeting combined groups of clinical and non-clinical disaster response personnel. Your feedback will be analysed and in light of the findings, a second iteration will be conducted to refine the results.

What are the benefits?

I am conducting this research in pursuit of a PhD in Health Informatics. You may benefit from the findings as it involves your area of expertise. The findings may contribute to enhancing the quality of healthcare delivered in disasters thus helping the wider community.

How will my privacy be protected?

Your participation in this research is completely voluntary. Your contact details will be kept confidential and will only be used to contact you for the purpose of this study. Other than being acknowledged in the findings, your name will not be mentioned in this research. However, given the small pool of participants in this study, the information you provide may enable someone to identify you. If you do not wish to be acknowledged in the research findings, please indicate so in the Consent Form. If you do not wish to be identified, please indicate so in the consent form. You can refuse to participate in this study now or at any point during the duration of the study without needing to give reasons. However, once the findings have been produced, removal of your data may not be possible.

What are the costs of participating in this study?

Each Delphi questionnaire takes about an hour to complete. The maximum total cost of the Delphi study is about 3 hours.

What opportunity do I have to consider this invitation?

I appreciate it if you could respond to this invitation within 10 days. I would be very appreciative if you could send me your feedback within 2 weeks' time.

Will I receive feedback on the results of this study?

If you wish to receive feedback on the results of this study, please indicate so in the Consent Form.

What do I do if I have concerns about this study?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Dave Parry, dave.parry@aut.ac.nz , +6499219999 ext. 8918.

Concerns regarding the conduct of the researcher should be notified to the Executive Secretary of AUTEC, Kate O'Connor, ethics@aut.ac.nz , 921 9999 ext. 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:
Reem Abbas

E-mail:
reem.abbas@aut.ac.nz
Mobile: +64223509160

Project Supervisor Contact Details:

Associate Professor Dave
Parry E-mail:
dave.parry@aut.ac.nz

Tel: +6499219999 ext. 8918

Approved by the Auckland University of Technology Ethics Committee on *-----27 February 2019--------*
AUTEC Reference number *---19/41------*.

Appendix G Consent Form – Delphi Study

Consent Form

Project title: ***Cross-Agency Communication and Information Exchange in Disaster Healthcare***

Project Supervisor: ***Associate Professor Dave Parry, Professor Tony Norris***

Researcher: ***Reem Abbas***

☐ I have read and understood the information provided about this Delphi study in the Information Sheet dated 4 February 2019.

☐ I have had an opportunity to ask questions and to have them answered.

☐ I understand that the Delphi study will have a second round.

☐ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.

☐ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.

☐ I agree to take part in this Delphi study.

☐ I wish to receive a summary of the research findings

☐ I agree to being named as a contributor to the final published results without any of my contributions or votes being identified

Participant's signature: .....

Participant's name: .....

Participant's Contact Details:

.....

.....

Date: .....

Approved by the Auckland University of Technology Ethics Committee on ----27 February 2019------

AUTEC Reference number ---19/41 ----------

Appendix H Delphi Round One Questionnaire

Cross-Agency Communication and Information Exchange in Disaster Healthcare

Participant Information

Name: _____ Gender: _____

Country of Residence: _____

Area(s) of Expertise: _____

Number of Years in Emergency Management and/or Health Emergency Management: _____

Organisation/Current Position: _____

Reason for participating in this study: _____

Total time taken to complete the questionnaire: _____

Overall Project

When a disaster strikes, response agencies exchange information to understand the full picture of what is happening around them and make decisions accordingly. However, post-disaster analysis reveals that cross-agency information exchange is inefficient. Disaster responders say that they often receive too much information some of which can be irrelevant, inaccurate, out-dated or incomplete. This present project is designed to address, and hopefully overcome, these issues as they relate to the improvement of healthcare provision and outcomes in disasters, and we are requesting your expertise in assisting us to achieve these goals.

Part One: Evaluation of the Suggested Primary Datasets

This part aims at identifying the critical datasets that disaster responders need to share to achieve a coordinated response. **Please feel free to add data items that you consider critical for your work in the case of a disaster event, change definition that you feel might improve the importance of an item, and/or rename it if you wish.** In the next round, you will be asked to vote on the changed definitions and any new items suggested by participants.

Importance

(How critical this data item is to your own work?)

1. Not Important at all
2. Little importance
3. Some importance
4. Degree of importance is unknown
5. Some significant importance
6. Very Important
7. Absolutely essential

1. **Baseline Data**

   Contains a priori data about the demographics of the region affected by the disaster as well as relevant health and epidemiological data. These datasets may be comparatively static in non-disaster situations but can be changeable and dynamic when a disaster strikes. The baseline dataset is key for resilience planning.

Data Item	Importance	Comments (Rationale behind evaluation/rename/re-define)
Individuals Total number of individuals recorded as living in a given geographical area		
Households Total number of households recorded as living in a given geographical area		
Age distribution Age groups recorded as living in a given geographical area (0 – 14, 15 -24, 25 – 44, 45 – 64, 65+)		
Males Total number of males recorded as living in the a given geographical area		
Females Total number of females recorded as living in a given geographical area		
Others Total number of individuals that are neither males nor females recorded as living in a given geographical area		
Contacts A comprehensive contacts list of positions, email addresses and phone numbers of key contacts in government agencies, NGOs and community groups		
Accreditation Agency-specific lists of emergency responders qualified to cross-deploy, showing training completed, assessments, previous roles, and number of previous responses		
Life Expectancy Life expectancy at birth, by gender in a given geographical area		
Disabled Total number of disabled people recorded as living in a given geographical area and their contact information. Disability is defined as any self-perceived limitation in activity resulting from a long-term condition or health problem lasting or expected to last 6 months or more and not completely eliminated by an assistive device.		

Major causes of death Ranked by age-standardised mortality rates and by gender, in a given geographical area		
Cardiovascular disease Total cardiovascular disease mortality by gender and total cardiovascular disease hospitalisation in a given geographical area		
Cancer Total cancer registrations, and total cancer mortality in a given geographical area		
Respiratory disease Total number of asthma hospitalisation and total number of diagnosed asthma cases in a given geographical area		
Diabetes Total number of diagnosed Diabetes prevalence, Diabetes complications – renal failure with concurrent diabetes, and Diabetes complications – lower limb amputation with concurrent diabetes in a given geographical area		
Malnutrition Total number of malnutrition cases in a given geographical area. Malnutrition is the lack of proper nutrition, caused by not having enough to eat, not eating enough of the right things, or being unable to use the food that one does eat		
Infectious diseases Meningococcal and Tuberculosis notification rates, acute rheumatic fever initial hospitalisation rates		
Immunisation Childhood immunisation coverage information; number of un-immunised children in a given geographical area		
Suicide Suicide rates, by age group and gender in a given geographical area		
Interpersonal violence Intentional self-harm hospitalisation by age group and gender in a given geographical area		
Mental health High or very high probability of anxiety or depressive disorder, by		

Major causes of death Ranked by age-standardised mortality rates and by gender, in a given geographical area		
Cardiovascular disease Total cardiovascular disease mortality by gender and total cardiovascular disease hospitalisation in a given geographical area		
Cancer Total cancer registrations, and total cancer mortality in a given geographical area		
Respiratory disease Total number of asthma hospitalisation and total number of diagnosed asthma cases in a given geographical area		
Diabetes Total number of diagnosed Diabetes prevalence, Diabetes complications – renal failure with concurrent diabetes, and Diabetes complications – lower limb amputation with concurrent diabetes in a given geographical area		
Malnutrition Total number of malnutrition cases in a given geographical area. Malnutrition is the lack of proper nutrition, caused by not having enough to eat, not eating enough of the right things, or being unable to use the food that one does eat		
Infectious diseases Meningococcal and Tuberculosis notification rates, acute rheumatic fever initial hospitalisation rates		
Immunisation Childhood immunisation coverage information; number of un-immunised children in a given geographical area		
Suicide Suicide rates, by age group and gender in a given geographical area		
Interpersonal violence Intentional self-harm hospitalisation by age group and gender in a given geographical area		
Mental health High or very high probability of anxiety or depressive disorder, by		

gender in a given geographical area		
Infant health Low birthweight rate, infant mortality rate, sudden unexpected death in infancy (SUDI) rate and sudden infant death syndrome rates in a given geographical area		
Data Item	**Importance**	

2. **Clinical Data**

The clinical dataset focus specifically on the health situation of disaster victims.

Data Item	Importance	Comments (Rationale behind evaluation/rename/re-define)
Triage The assessment of a patient to decide how urgent their injury or illness is and how soon treatment is required		
Identifier A number given to a disaster victim for identification		
Age Approximate age of victim in years at time of treatment		
Gender Male or Female or Other		
Location Where the victim has been found		
Details The date, time and duration of victim's treatment		
Presentation type Injury, illness, environmental or mental health		
Presentation details Details of each type of presentation. For example: Injury: fracture, burn, concussion, etc. Illness: cardiac arrest, respiratory, Gastrointestinal etc. Environmental: heat related, drug related, etc. Mental health: anxiety, psychiatric disorder		
Outcome Referred to further health treatment, discharged home, refused treatment or deceased		
Data Item	**Importance**	**Comment** Please indicate if the item is: Completely new, a major rework of an existing item, a set of items put together or a few items splitting up an existing item.

3. Humanitarian Data

Comprises dynamic data on the general, current status of the disaster, its severity, impact (casualties, damage etc.), risks, and general priorities. These data describe fundamental needs such as shelter, evacuation priorities etc., that although clearly related to health needs also apply when healthcare is not the major consideration.

Data Item	Importance	Comments (Rationale behind evaluation/rename/re-define)
Fatalities Total number of deaths as a result of the disaster event		
Injured Total number of individuals injured in the disaster event		
Missing Total number of individuals missing since the start of the disaster event		
Evacuees Total number of individuals evacuated		
Shelters Number of shelters in a given geographical area		
Vulnerable persons Total number of vulnerable persons in need of care (elderly, homeless, etc.)		
Unaccompanied Total number of unaccompanied children		
Total number of available hospital beds This indicator provides a measure of the resources available for delivering services to inpatients in hospitals in terms of number of beds that are maintained, staffed and immediately available for use. This includes regular beds, ICU beds, HDU beds, PICU beds.		
Compromised medical facilities Total number of impacted medical infrastructures		
Risks Long and short term expected issues		
Priorities General priorities of response agencies		
Coordination A dataset containing the name of each response agency, summary of planned activities, and location(s) of activities		
Accessibility Buildings and areas that are unsafe to access		
Blocked roads Compromised streets and roads		
Traffic zones		

Heavy traffic streets or roads		
Security Total number of critical security incidents in a given geographical area (to indicate the level of security)		
Data Item	**Importance**	**Comment** Please indicate if the item is: Completely new, a major rework of an existing item, a set of items put together or a few items splitting up an existing item.

Part Two: The Disaster eHealth Curriculum

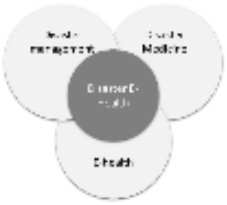
"Emergency management and the health sector are natural allies that have, seemingly, only recently begun to recognize each other [1]". A comprehensive approach that unifies medical principles with a sound understanding of disaster management procedures will yield a well-rounded and better-prepared disaster responder [2]. For this reason, a Disaster eHealth (DEH)* curriculum targeting both disaster mangers and health professionals is suggested as a viable approach to educating the two sectors about each other and to help them utilise information and communication technologies in disasters. In Part 2, we are looking for your opinion about the value, topics and delivery mode of the suggested curriculum.

Disaster Management (DMAN) is the discipline concerned with responding to and mitigating the terrible effects of disasters.

Disaster Medicine (DMED) is the specialised field that has evolved to provide care for human casualties who need rapid treatment and mental health support in disasters.

EHealth Technologies, such as the electronic health record (EHR), telehealth, decision support systems, data analytics, RFID, Internet of Things, cloud computing, and social media, are the technologies that are revolutionising the planning and delivery of mainstream healthcare. These technologies have the ability to ensure health information and health-related services are available anytime and anywhere, to automate workflows, and to provide seamless care for immediate intervention as well as longer-term treatment. They also 'democratise' healthcare by encouraging the active participation of the consumer in the care process, an important asset in a situation where professional care may be in short supply.

Disaster eHealth (DEH) refers to the application of eHealth technologies to assist the prognosis and treatment of the sick and injured in a disaster, and to support appropriate care in the post-disaster situation. Disaster eHealth (DEH) can be thought of as a domain at the intersection of three constituent fields: disaster management, disaster medicine, and eHealth.



1. Gowan, M. E., Sloan, J. A., & Kirk, R. C. (2015). Prepared for what? Addressing the disaster readiness gap beyond preparedness for survival. *BMC public health*, *15*(1), 1139.
2. Clottone, G. R., Biddinger, P. D., Darling, R. G., Fares, S., Kelm, M. E., Molloy, M. S., & Suner, S. (Eds.). (2015). Clottone's disaster medicine. Elsevier Health Sciences.

Question 1

The following list of suggested topics is not intended to be comprehensive but to present a coherent picture of DEH and its potential, and to highlight aspects that can facilitate disaster healthcare provision.

Please tick the topics that you think should be included in a DEH Curriculum and feel free to suggest other topic(s)

- ☐ **Basic concepts and terminology in Disaster Management**
- ☐ **Basic principles and terminology in Disaster Medicine**
- ☐ **Roles and responsibilities of main response agencies in normal and emergency situations, and how agencies complement each other - with emphasis on differences of approach and responsibility that distinguish disaster situations from normal circumstances**
- ☐ **Capabilities of health, civil defence, non-governmental organisations, and other response agencies (services provided)**
- ☐ **Expected disease symptoms and health risks education**
- ☐ **First aid and emergency response**
- ☐ **Epidemic control**
- ☐ **Topics in health promotion and prevention**
- ☐ **Addressing stigma**
- ☐ **Provision of psychosocial care**
- ☐ **Enabling community empowerment**
- ☐ **Creating opportunities: How can agencies relate in normal and emergency settings**
- ☐ **Lessons learned from previous disasters**
- ☐ **Organisational structures of health emergency management and civil defence**
- ☐ **Incident management systems (Coordination frameworks)**
- ☐ **Aspects of developing effective emergency plans**
- ☐ **Legal and ethical considerations around intra and inter-agency information sharing**
- ☐ **An overview of key eHealth technologies such as the electronic health record (EHR), telehealth, and decision support systems, the RFID technology, data analytics, mobile technologies, cloud computing, social media etc., their applications in emergencies, and their limitations.**

  (For example, the use of big data in epidemiology or the role of remote sensing in disaster management)
- ☐ **The potential role of DEH throughout the disaster cycle demonstrating contributions that DEH could make in disaster reduction, readiness, response and recovery.**

  (A good example of the value of DEH in the recovery phase is the use of telehealth to assist patients suffering from long-term mental stress incurred by their disaster experiences. Unobtrusive measuring devices are available to monitor these patients in their own homes where they are most comfortable and to alert carers to the need for intervention).
- ☐ **Use cases where collaboration between DMEDs and DMANs may be established and where eHealth technologies may be utilised - a problem solving approach.**

☐ Scenario evaluations upon which students can recommend improvements or redesign of existing applications to improve the efficacy and efficiency of care

Are there additional topics you think are important to be included in the DEH curriculum?

_____
_____
_____
_____

Question 2

Preferable delivery mode: ☐ Face-to-face traditional place-based classroom methods

☐ Online course

☐ Both

Comments:

_____
_____
_____
_____

Question 3

There is a need for meaningful communication between non-clinical disaster managers and health specialists. Do you see value in developing a DEH curriculum for this purpose? ☐ Yes ☐ No

Comments:

_____
_____
_____
_____

THANK YOU

Appendix I Delphi Round Two Questionnaire

Cross-Agency Communication and Information Exchange in Disaster Healthcare

Round 2

Start of Block: Default Question Block

Q7

This Delphi study aims at enhancing cross-agency information exchange during disasters by limiting information exchange to critical datasets. This second and final round seeks your opinion in additional datasets and topics suggested by survey responders in the first round.

Estimated response time: 20 minutes
All parts of a question must be answered before you can proceed

Name:

_____

Q1 The following datasets have been voted for as 'very important' or 'absolutely essential' by the **majority** of responders in Round One. Please tick the items that you agree with as being **very important** or **absolutely essential** to **your own work**.

- [ ] **Contacts** A comprehensive contacts list of positions, email addresses and phone numbers of key contacts in government agencies, NGOs and community groups

- [ ] **Triage** The assessment of a patient to decide how urgent their injury or illness is and how soon treatment is required

- [ ] **Presentation type** Injury, illness, environmental or mental health

- [ ] **Presentation details** Details of each type of presentation. For example: Injury: fracture, burn, concussion, etc. Illness: cardiac arrest, respiratory, Gastrointestinal etc. Environmental: heat related, drug related, etc. Mental health: anxiety, psychiatric disorder

- [ ] **Details** The date, time and duration of patient's treatment

- [ ] **Outcome** For example: Referred to further health treatment, discharged home, refused treatment or deceased

- [ ] **Fatalities** Total number of deaths as a result of the disaster event

- [ ] **Injured** Total number of individuals injured in the disaster event

- [ ] **Shelters** Number of shelters in a given geographical area

- [ ] **Vulnerable persons** Total number of vulnerable persons in need of care (elderly, homeless, etc.)

- [ ] **Unaccompanied children** Total number of unaccompanied children

- [ ] **Total number of available hospital beds** This indicator provides a measure of the resources available for delivering services to inpatients in hospitals in terms of number of

beds that are maintained, staffed and immediately available for use. This includes regular beds, ICU beds, HDU beds, PICU beds.

- [ ] **Compromised medical facilities** Total number of impacted medical infrastructures
- [ ] **Risks** Long and short term expected issues
- [ ] **Priorities** General priorities of response agencies
- [ ] **Coordination** A dataset containing the name of each response agency, summary of planned activities, and location(s) of activities
- [ ] **Accessibility** Buildings and areas that are unsafe to access
- [ ] **Blocked Roads** Compromised streets and roads
- [ ] **Security** Total number of critical security incidents in a given disaster-affected area
- [ ] **Comments** _____

Q2 Do you find individual patient data such as Triage, Presentation Type, Presentation Details, Details, and Outcome 'very important' or 'absolutely essential' to YOUR decision-making in a disaster situation? Please explain.

_____

_____

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Q3 Please indicate the level of **importance** of the following datasets to **your** own work in a disaster response setting

	Importance: The extent to which you may utilise this dataset in your own work

	Not important at all	Little import-ance	Some import-ance	I don't know	Some significant importance	Very import-ant	Absolutely essential

Spoken languages in the impacted area (English, French, Arabic, etc.)	○	○	○	○	○	○	○
List (and GPS coordinates) of health service delivery points in impacted areas	○	○	○	○	○	○	○
Resources/capacity at health service delivery points	○	○	○	○	○	○	○
Number of attacks on health care facilities (static and mobile)	○	○	○	○	○	○	○
Number of attacks on health workers	○	○	○	○	○	○	○
Number of people with disabilities among disaster-affected populations	○	○	○	○	○	○	○
Locations of people with disabilities in disaster-affected areas	○	○	○	○	○	○	○
Types of disabilities among disaster-affected populations	○	○	○	○	○	○	○
Number of disaster-related mental health cases	○	○	○	○	○	○	○

Proportion of non-breast-fed children under 1 year of age (by gender)	○	○	○	○	○	○	○
Exclusive breastfeeding rates among infant 0 – 6 months	○	○	○	○	○	○	○
Maternal mortality rates	○	○	○	○	○	○	○
Contraceptive prevalence	○	○	○	○	○	○	○
Fertility rates	○	○	○	○	○	○	○

Q4 Please choose topics that you think should be included in educational programs targeting combined groups of disaster managers and health professionals

	Yes	No

Proportion of non-breast-fed children under 1 year of age (by gender)	○	○	○	○	○	○	○
Exclusive breastfeeding rates among infant 0 – 6 months	○	○	○	○	○	○	○
Maternal mortality rates	○	○	○	○	○	○	○
Contraceptive prevalence	○	○	○	○	○	○	○
Fertility rates	○	○	○	○	○	○	○

Q4 Please choose topics that you think should be included in educational programs targeting combined groups of disaster managers and health professionals

	Yes	No

How health is affected by disasters/emergencies: Topics highlighting how different aspects of health deteriorate in the presence of different risk factors (e.g. poor shelter, overcrowding, lack of water and sanitation, etc.)	○	○
How to manage people in a tense or conflict environment	○	○
How to communicate effectively to a range of audiences and in a wide range of settings	○	○
Budget management in resource-constrained settings to optimise gain	○	○
Mandatory emergency management qualifications	○	○
National emergency warning systems	○	○
Epidemiology, including ability to critically appraise research evidence	○	○
Pandemic response data collection and analysis	○	○
Multi-text process for data collection	○	○
Crowd sourcing	○	○
National communication system	○	○
National information management system	○	○
National database system, if available	○	○

End of Block: Default Question Block

Appendix J Journals Consulted in the Literature Review

Appendix A: Journals Consulted in the Literature Review

Journal of the American Medical Association (JAMA)

Academic Medicine

ACM Transactions on Information Systems (TOIS)

Administration & Society

American Journal of Disaster Medicine

American Journal of Public Health

Annals of Emergency Medicine

Annals of Operations Research

Annual Review of Nursing Research

Annual Review of Psychology

Asia Pacific Disability Rehabilitation Journal

Australasian Journal of Disaster and Trauma Studies

Australian And New Zealand Journal of Public Health

Australian Journal of Emergency Management

BJPsych Open

BMC Medical Informatics and Decision Making

BMC Psychiatry

Policy Studies Journal

Public Management Review

The British Medical Journal (BMJ)

Communications of the Association for Information Systems (CAIS)

Cambridge Quarterly of Healthcare Ethics

Computers in Human Behavior

Decision Support Systems

Digital Journalism

Disability and Health Journal

Disaster Medicine and Public Health Preparedness

Disaster Prevention and Management

Disasters

Epidemiology and Psychiatric Sciences

Ergonomics

Frontiers in Public Health

Geological Disaster Monitoring Based on Sensor Networks

Global Journal of Management and Business Research

Health Informatics New Zealand

Health Psychology Open

Humanitarian Exchange

Imperial Journal of Interdisciplinary Research (IJIR)

Implementation Science

Indian Journal of Psychological Medicine

Information Systems Frontiers

Information Technology and Management

International Journal for Quality in Health Care

International Journal of Computer Science and Information Technology Research

International Journal of Critical Infrastructures

International Journal of Disaster Risk Reduction

International Journal of Emergency Medicine

International Journal of Environmental Research and Public Health

International Journal of Health System and Disaster Management

International Journal of Information Quality

International Journal of Lifelong Education

International Journal of Medical Informatics

International Journal of Production Economics

International Journal of Public Administration

International Journal of Qualitative Methods

International Journal of Research–Granthaalayah

Iranian Red Crescent Medical Journal

Journal of Advanced Nursing

Journal of Ambient Intelligence and Humanized Computing

Journal of Applied Systems Analysis

Journal of Big Data

Journal of Communication

Journal of Contingencies and Crisis Management

Journal of Disaster Research

Journal of Economic Perspectives

Journal of Education and Health Promotion

Journal of Global Health

Journal of Human Sciences

Journal of Information and Knowledge Management

Journal of Information Science

Journal of Information Technology Theory and Application (JITTA)

Journal of Medical Internet Research

Journal of Occupational and Organizational Psychology

Journal of Personality and Social Psychology

Journal of Primary Health Care

Journal of Public Administration Research and Theory

Journal of Public Affairs Education

Journal of Selected Areas in Health Informatics (JSHI)

Journal of Systems and Software

Journal of the American Medical Informatics Association

Journal of the International Society for Telemedicine and eHealth

Journal of Trust Research

Leadership & Organization Development Journal

Natural Hazards

Organization Science

Plos Currents

Prehospital and Disaster Medicine

Procedia Engineering

Public Administration Review

Public Health Reports

Regional Development Dialogue

Risk Management

Smart Homecare Technology and Telehealth

Social Science & Medicine

The American Review of Public Administration

The International Journal of Aviation Psychology

The Lancet

The Reserve Bank of New Zealand Bulletin

Turkish Journal of Emergency Medicine