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Knowledge-based framework for water security in crisis scenarios

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Knowledge-Based Framework for Water Security in Crisis Scenarios

A. C. Richards

**A thesis submitted in partial fulfilment of the University's requirements for
the Degree of Doctor of Philosophy**

January 2016



DECLARATION

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ABSTRACT

This research addresses the need for efficient and effective management of water during any part of a crisis lifecycle, which is paramount if the negative impact on human health and quality of life is to be minimised.

The unique contribution to knowledge is expressed through the creation of a framework for application of four key elements: Crisis Management, Knowledge Management, Public Health and Human Security within the realms of water resource utilisation during humanitarian crises.

Through secondary data collection, the four key elements were identified. Primary data was subsequently gathered from subject experts in the form of semi-structure interviews that utilised a questionnaire to guide participants through the identified problem domain. This resulted in the creation of a draft framework that was critiqued by domain experts through both questionnaire and interview. A final framework was then constructed that took into consideration the needs expressed by all participants.

The final framework was then tested against the historic crisis of Hurricane Katrina, for which a plethora of data and information was readily available, to ascertain its validity and applicability. Further work was identified as being the creation of an interactive toolbox of resources, which could be utilised in times of crisis based on need and applicability.

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PART ONE

1 INTRODUCTION

The use of Knowledge-based frameworks to facilitate disaster management is widespread amongst governments and aid organisations. However, none of the frameworks currently in operation takes into consideration the following four essential elements considered in this research: Knowledge Management, Crisis Management, Public Health and Human Security; within the realm of water and waste water provision.

This chapter aims to contextualise the area of research into Knowledge-based frameworks and their relevance for Crisis Management given the aforementioned research elements. The chapter then goes on to detail the associated problem domain in order to set the scene for the remainder of this research.

1.1 Research Roadmap

This research concentrates on the field of Crisis Management within scenario-specific solutions, based on an iterative Knowledge-base, which allows for updates based on new knowledge and historic information analysis.

A crisis framework helps structure the planning of, and response to, crisis situations that may contain disaster within each occurrence.

The term *framework* is widely used in many contexts, from architecture within the field of Civil Engineering, to software development for Computing applications. In this instance, the term is intended to indicate a logical structure upon which planning and response activities may be placed in an orderly manner (Oxford Dictionaries 2015), allowing multiple actors to interact with the framework whilst having an appreciation of everyone else's place within the structure.

Whilst there are many instances of both crisis and disaster frameworks, few take into account the human factors when considering relief operations, preferring to concentrate on reactive activities considered to be of primary importance. Thus several areas are often left unexplored. For example:

- The inclusion of local actors within any relief or improvement operations. Without the engagement of local actors, the long-term benefits of aid/relief are often stilted, with local communities failing to understand the implications of new infrastructure or improved social interventions such as education.
- An understanding of the impact of aid on social coherence and sense of community. When combined, a lack of understanding and buy-in from the community can result in the perpetuation of crisis.
- Lack of an exit strategy in order to mitigate the current trend towards perpetual aid. Due to the nature of crisis often being enacted upon *developing countries* and products/services being delivered by private contractors, the imperative to provide viable exits often goes unrealised: the profit motive taking precedence.
- Problems related to a myriad of aid organisations involved; all following their own agendas and often competing with one another. By their very nature, different organisations display differing missions and visions. These often clash, reducing efficiency and effectiveness of crisis response and delivery of aid/relief.

The thesis introduces a framework for the management of crises by taking into account four key research elements with which all types of crisis response should be concerned:

- **Knowledge Management** to facilitate collection, collation, and dissemination of information in a timely manner, thus allowing stakeholders to garner Knowledge and respond in a way which may be both efficient and effective;
- **Crisis Management**, intended to cover all possible crisis needs which are context-specific and capable of delivering multiple solutions based on actor-type and desired outcomes;
- **Public Health** to ensure that the overall health and wellbeing of victims, actors and stakeholders within and without the crisis domain maintain standards of health which do not further compound the crisis at hand;
- **Human Security** in order that the framework takes into consideration the needs of all actors within the field so as to prevent/mitigate secondary crises which often extend the disrupted state.

By combining the four elements, Crisis Management can be instigated in a manner more beneficial to all concerned; empowering aid agencies, government, and local actors in a structured and coherent effort capable of moving through any given crisis occurrence as quickly and effectively as possible. The final outcome is then based upon what is best for the community itself, rather than the interests of external entities.

The resultant framework provides the intended holistic approach to Crisis Management through a modular structure, which facilitates enactment of individual components on an ad-hoc basis, thus reducing the need to apply elements that do not fulfil the overall aims of those concerned.

Said framework makes future provision for a series of *toolboxes*, each allowing a set of bespoke activities to be employed in order to facilitate identified actors access to specific actions which, when combined with other actors and toolboxes, allow for a holistic solution to any given crisis.

This chapter provides an introduction to the research topic of Crisis Management with regards to water supply and reclamation. The role of Crisis Management is explained in detail along with structure and purpose as regards the largest contributor to this sector; namely, the United Nations (UN). The UN exemplifies current practice concerning planning and application of crisis solutions in its capacity as the de-facto organisation within this field. The environment to which this research applies is detailed and examples explored to provide a rich picture illustrating the current methods of operation and structure that aids in identification of the resultant research problem domain.

Research justification is detailed to take account of the unique contribution to Knowledge and its contextualisation within the predefined problem domain. Summary of methodology employed and reasoning for its application is also given in order that understanding is derived early in the text as to the research type chosen and execution techniques employed.

1.2 Research Context

Crisis Management constitutes a growing area of concern for nation states, governments and aid organisations (Rosenthal, and Kouzmin 1997:277). During the first part of the twenty-first century numerous large-scale natural disasters have claimed many lives whilst incurring unprecedented costs for those both directly and indirectly affected. As the global population continues to increase and natural resources become ever more depleted, conflicts amongst interested parties are also set to rise. Selby (2005:204) postulates that the main causes for these projected conflicts will be centred on oil production and clean water processing, both of which are becoming focal points for world leaders in the twenty-first century (Gleick 1993:79).

One major crisis that took place in 2005 and has yet to be completely solved is that of Hurricane Katrina, which struck mainland USA, causing over one thousand deaths and billions of dollars in damage. Much has been written about Katrina, which provides a rich environment in which to test the framework. Therefore, the penultimate chapter employs this crisis as a test-bed for the final framework.

1.2.1 Historical Context

There are many organisations tasked with planning for, and reacting to, crises and disasters: these range from multinational primary actors such as the *United Nations*, *World Health Organisation* (WHO), and *World Bank* (WB); medium-sized enterprises such as *Medicine Sans Frontiers* (MSF) and finally, small-scale, single-issue organisations including those constituted to serve only one crisis situation such as *Haiti Relief*, etc.

The first humanitarian relief effort took place in Biafra in 1968 during the Nigerian civil war (Chandler 2001:681) and consisted of an airlift, the largest since Berlin in 1948-49 (Miller 2000:3). Since this time, five large humanitarian undertakings have marked the 20th and 21st centuries: namely, Ethiopian famine, Somalia, Rwanda, Kosovo, and Afghanistan, alongside numerous smaller instances (Solana 2005). Therefore, the requirement for coherent strategies is vital in the planning and provision of aid to those in need. However, it appears that such strategies rarely look outside of organisational boundaries or to those affected by crises (Stephenson 2005:337); rather, the delivery of products and services remains the focus for most relief agencies with a distinct inability to formulate strategies or tactics which facilitate inclusion of an exit strategy (Western 2002:114).

Thus, it is the intention of this research to provide a holistic framework for Crisis Management, which provides for inclusivity of actors from all aspects of the Crisis Management environment. This includes *victims*, those in need of assistance within the crisis domain, in order to provide timely assistance with empowerment to all concerned, intended to mitigate the all-to-common permanent presence of such organisations within sovereign boundaries.

1.2.2 Key Research Dimensions

Crisis comes in many forms and for a multitude of reasons, some natural and others human-made. When crisis strikes, it is often perceived to have done so without apparent forewarning. However, most crises are predicable, if only those concerned could, or would, identify the precursor events that signal imminent movement from the norm (Harff and Gurr 1998:569). Once predications are made then some action prior to the event could be undertaken to help remove or, at least, mitigate the overall effect, thus reducing the chances of extended crisis timelines.

1.2.2.1 Crisis Prediction

Due to the way in which media reports crises, the general populous often feel that nothing could have been done to prevent its occurrence and that the event itself appeared as a complete surprise to all concerned (Franks 2006:281). This is mostly a misnomer as almost all human-made and naturally occurring crises have both weak and strong signals regarding their impending arrival: those that are human-made often display very strong signals pointing directly towards impending crisis (Sheaffer, Richardson, and Rosenblatt 2002:1). Therefore, predication and prevention/mitigation are possible if those in a position to act do so in a timely manner.

This is often not the case due to many influencing factors: the need for large-scale organisations to react quickly is often impeded by their physical size and structure which requires long lead-times in order for them to reach a consensus of opinion whilst obeying their internal business processes (Balcik, Beamon, Krejci et al. 2010:23). Such processes are designed to ensure that the correct decision is reached in all instances (Pettit and Beresford 2005:313) but may actually be the reason why any decision is inept due to the lack of timeliness on the part of the organisation and its contribution to the overall *value chain* as concerns the entire crisis situation (Russell 2005).

1.2.2.2 Crisis Planning

Many nation states and aid organisations plan for several contingencies as regards crises but many more do not, preferring to wait for crisis to occur before acting (Gandy 2006:371). This is often due to lack of political will and/or economic encumbrance rather than imperfect knowledge with regard to the most prevalent crisis modes within their geographic/demographic spheres (Hofmann and Hudson 2009:1). In the instance of *Hurricane Katrina* in the USA during 2005, knowledge of the decomposing state of the levees due to lack of federal investment was well known, with analysts predicting imminent breach under even minor storm conditions (Briaud et al. 2008:134). Therefore, the delay in declaring a state of emergency through *executive order* by President George W. Bush cannot be attributed to a lack of understanding as to the severity of the disaster without taking into consideration the inability of those in senior positions to comprehend individual scenarios without the aid of subject experts (Eikenberry, Arroyave and Cooper 2007:160). Contrary to popular opinion, crises cover many differing formats and may take generations to occur the impending water crisis due to overpopulation and poor governance of our limited supply serves as a case in point (Gleick 1998:571).

1.2.2.3 Imperfect Knowledge

The examples given above along with many others detailed in the rest of this work, helped define a multidisciplinary approach (Pearson and Clair 1998:59) using the four dimensions for this research. Upon further investigation, shortcomings of the four dimensions appeared to be based around *imperfect Knowledge* and its causal effect as regards both primary and secondary crises, compounded in some instances, by a lack of Knowledge Management regarding known facts (King 2005). *Imperfect Knowledge* may be considered the state in which almost all knowledge resides, rarely is the picture a complete one. Gaps are filled by assumptions and observer bias (Cornelis, De Cock and Kerre 2003:260).

Humanitarian Crisis, by its very definition causes a negative impact on Public Health, as does anything that degrades the host environment thus generating unwanted consequences for human beings (Macrae and Harmer 2004:10). Such occurrences usually manifest themselves as crises, either short or long-term. All of the aforementioned impacts Human Security through the degradation of societal norms and the denial of basic human needs. This results in partial or total societal breakdown, with the consequential effect of a reduction in Human Security and Public Health as laid-down within the necessities identified by *Maslow's Hierarchy of Needs* (Duffield 1994:39). The imperfect Knowledge which surrounds this area has a negative impact on crisis relief as the humanitarian needs of victims often takes priority over long-term Public Health issues. This results in the perpetuation of crisis previously mentioned.

1.2.2.4 Impact of Crisis

As with most aspects of life, those either without wealth or living in a country whose social coherence lacks provision of clean water, sanitation, shelter, and basic requirements of community, often live within an environment that, by its very nature may be hazardous to health. Crisis may be a perpetual state-of-being in which individuals and/or communities exist due to environmental conditions which cannot be avoided by the individual (Ayoob 2004:99). Such conditions are often exacerbated by lack of education regarding the needs for sanitation in order to maintain or improve Public Health (Smith, Garbharran, Edwardset al. 2004:62). For example, in ad-hoc refugee camps the situation of latrines too close to sources of drinking water can result in cross-contamination of the supply due to ground leaching (MacDonald, Ahmed, Islamet, et al 1999:7).

Therefore, some crises may well be averted or remedied by simply educating the relief agency and/or local population as to the need for and, implementation of, good practice. Such programmes are provided by Non-Governmental Organisations like the United Nations who educate communities under their *Water, Sanitation and Hygiene* (WaSH) banner, empowering local communities in the field of potable water management and sanitation (UNICEF 2008).

The lack of proper reclamation of contaminated water may well be of larger concern than provision of clean water, which may be available and of a standard acceptable in the short-term (Leaning, Briggs, and Chen 1999). Thus focus is required when identifying possible primary activities by contextualising response mechanisms for temporary infrastructure creation as opposed to permanent infrastructure reinstatement (Johnson, Lizarralde, and Davidson 2005).

The onset of disease due to unsanitary conditions provides a completely different lens with which to focus regarding Public Health as it constitutes secondary crisis due to the primary dynamic (Connolly et al. 2004:1974). Such contributing factors need to be taken into consideration when formulating any proactive or reactive response plan to ensure that the intervention by external actors does not escalate the crisis or cause secondary crises to ensue. It is not uncommon for such secondary crises to occur through the direct actions of those attempting to mitigate the original crisis and takes a myriad of forms, from those that appear obvious to obscure events employing the law of *unintended consequences* (Leaning, Briggs, and Chen 1999). For example, after the invasion of Afghanistan in 2001, the internal Police Forces were disbanded due to their connection with undesirable political and religious *terrorist* groups. Whilst, on the face of it, this appeared to be a positive move designed to reduce the influence of such groups, the result was a break-down in law-and-order due to the vacuum created when domestic law enforcement are replacement by the occupying forces of several foreign powers. Hence, reinstatement of a Police Force proved extremely complicated as political affiliations were difficult to establish, which resulted in many members of the original forces being absorbed into the new regime but bringing with them old practices which were the reason why they were disbanded in the first place (Hamann 2009).

The idea of crisis covers many different areas, some posed by diseases and viruses directly related to unclean water and ineffective reclamation. Such debilitating and life threatening instances include Polio, Hepatitis, Typhoid, Cholera, Cryptosporidiosis, Ascariasis, and Schistosomiasis. When all forms of infection are taken into consideration, they constitute one-third of the total number of deaths in developing countries (Demena et al. 2003). When we consider the fact that over one billion people do not have access to clean water (Ridoutt and Pfister 2010:113) it reinforces the idea that crisis is, for some, a perpetual state of being. This further strengthens the argument that whilst crises can appear without forewarning that is foreseen by all, it does proffer the argument for increased focus on the prevention of crisis as a primary factor rather than something that can be done if time and resources are made available.

Availability of clean water is usually based upon infrastructure and the need for governments to recognise the importance of this basic human right above many competing factors which consume limited economic resources whilst doing little to improve the lives of people in such a way as to provide a springboard for further societal improvements such as Human Security and education (Madrigal, and Alpizar 2011). Access to clean water and effective reclamation resources helps create community and encourage citizens to spend time on improving activities rather than the collection of water and disposal of waste.

1.2.2.5 Crisis Management

The main concern during crisis is delivery of primary care to those affected. This ranges from clinical assistance (Chu, Stokes, Trelleset al. 2011) and the provision of shelter, to personal security and reinstatement of pre-crisis infrastructure. A key part of this support is the provision of clean drinking (potable) water which allows individuals to not only remain hydrated, but undertake basic sanitary tasks and thus mitigate secondary crises born about by bacteriological ailments (Lantagne, and Clasen 2012:30). Coupled with the delivery of potable water is the need to reclaim contaminated (or brown) water that may again compound the introduction of disease driven secondary crises if left unchecked.

If the crisis is one with a definite trigger event such as natural disaster, then refugees are usually a resultant factor; the needs of these individuals are met by camps or emergency shelter within existing structures that need to have facilities for the supply of water and its resultant reclamation (Biran, Schmidt, Zelekeet al. 2012). Introduction of such facilities are often expensive and difficult to manage, especially if the effective population is not used to using such amenities within the normal societal frameworks. Thus, education of those considered refugees is important in order to establish and maintain basic operating standards within the provided facilities in order to prevent secondary crises from accruing (Mahamud, Ahmed, Nyokaet al. 2011:234).

The management of any crisis is important if desirable outcomes are to be achieved through the co-ordinated efforts of all stakeholders. Crisis Management needs to take a structured form that makes provision for all actors, regardless of their role or perceived hierarchical relevance to the situation.

1.3 Purpose of Research

On the basis of the context outlined in this section, the key concepts driving the nature of this research are defined as:

Research problem: Crisis Management suffers from a lack of efficiency and effectiveness in many areas of its strategy, planning, and operation. This is due to many factors and may occur at any time during either proactive or reactive activities. Such limitations often affect key actors for which the delivery of resources is paramount to the success of their operation. This need is further exacerbated by temporal and spatial considerations that are essential to good deployment strategies in times of crisis. There is a need for solutions to Crisis Management to be generated in a more efficient and effective manner. Introduction of a framework would allow for structured implementation of a management strategy that could support key actors in the management of strategy, planning, and operation of solutions to specific crises.

Research question: How can Water Resource, Knowledge Management, Public Health and Human Security be related to a Crisis Management domain in such a way that a more efficient and effective structure for proactive and reactive solution be generated?

Aim: The provision of a framework which encapsulates Water Resource, Crisis Management, Public Health and Human Security with respect to Crisis Management utilisation as a mechanism for the amalgamation of temporal, spatial, and stakeholder-centric pressures to deliver efficient and effective crisis solution platforms.

Objectives: In order to achieve the aim, the following research objectives were constructed to provide additional focus regarding particular key features:

- Evaluate and analyse four main research elements: Water Resources, Public Health, Human Security and Knowledge Management;
- Evaluate the importance of water resource application within the Crisis Management arena.
- Evaluate existing frameworks with regards to efficiency and effectiveness;
- Formulate and design a framework to provide efficient and effective Crisis Management;
- Validate framework against a pertinent historic crisis.

Unique Contribution to Knowledge: a unique contribution to the body of knowledge in Crisis Management is achieved through unification of the four research elements focused within the context of water resources in order to provide a framework capable of being tailored to individual crisis scenarios. Such a framework provides structure, through which, individual or group entities may achieve unity of purpose whilst avoiding duplication of effort, thereby increasing the efficiency and effectiveness of strategic planning, tactical alignment, and operational activities.

Framework: the framework proposed by this research comprises topics gleaned from both primary and secondary sources; the former providing core elements capable of presenting a detailed overview of strategic, tactical, and operational factors supported through secondary research. The framework is intended to provide rigorous structure through which both proactive and reactive responses may be delivered in times of crisis. Proactive elements are identified within said structure and take the form of resilience planning as regards the problem domains. It is important to reinforce the fact that supply of potable water to vulnerable demographics cannot hope to be affective if little or no consideration is given to waste collection and removal in order to provide a holistic sanitary environment on which crisis relief may be based.

Validation: identification of the four primary topics for water resources within scenario-specific crises comprised a Venn diagram, delivering: Knowledge Management, Crisis Management, Public Health, and Human Security. These areas were explored in detail using both primary and secondary sources which facilitated creation of a draft framework subsequently sent for validation to experts within any two (or more) of the Venn fields. This allowed for each key feature to be analysed through a cross-disciplined lens, thus increasing the chances of providing detailed feedback capable of influencing the final framework.

Scope and Boundaries: the research was undertaken utilising both primary and secondary data. Primary data was collected from two participant groups, the first via an umbrella organisation known as the Finish Water Forum. This organisation was chosen due to its expertise in water and crisis management. Therefore, experts within a myriad of fields to do with both topics could be easily located and interviewed within the time constraints of this work.

The second group was chosen by means of their expertise as practitioners of the four key elements of Crisis Management, Knowledge Management, Public Health and Human Security, alongside expertise within the water industry with regards to strategic Crisis Management.

Due to the timescales available and the need to travel to Finland to conduct face-to-face interviews, a semi-structured questionnaire was constructed and utilised in order to provide focus whilst allowing participants to elaborate upon their answers to specific questions.

It was decided that such data collection would provide a richer picture of the problem domain than providing closed questioned questionnaires to a larger population of participants who may not have the level of expertise of those chosen. Rather, a focussed approach was adopted to garner opinion from those for whom the four key elements and water was an integral part of their research and/or practice.

The four Venn spheres were chosen based on secondary data collection that, it emerged could be categorised into one of each of the elements. Other elements could have been created by it the research objective would have become too complex to be clearly quantifiable within the resultant framework.

Limitations: Whilst the framework is intended to be universal in application to all types of crisis, it is outside the scope of this work to explicitly test and refine each crisis type and exemplar instance. Therefore, Hurricane Katrina was chosen as a test subject due to its recent occurrence, plethora of research available as secondary data, and the fact that it occurred outside of the usual group of countries for which we ascribe the term *crisis*.

The further work required to create individual crisis models would incorporate test data from historic events in order to refine the framework on an iterative basis. This will be a long and complex job and thus, falls outside of what is possible within the time allowed for this research.

Primary data was collected from participants in the form of *mind maps* so as to allow for non-linear fact linking as each individual answered open-ended questions and commented on pertinent information as, and when, it arise. Audio or video was not collected so participants were free to express their opinions without recording equipment tempering their response. This meant that verbatim note taking was impossible and therefore limited the ability to collect all information. Rather, key points were collected and collated as part of the analysis.

1.4 Thesis Structure

Figure 1.1 details the thesis structure, illustrating each phase of the research and inherent narrative. The following give a brief explanation of each chapter:

Chapter one comprises an *Introduction* which details overarching reasons for the chosen area of research, setting-the-scene through topic exploration alongside contextualisation brought about through a brief appraisal of key considerations currently being utilised and identification of the shortcomings regarding current process. The aim and objectives of this research along with a brief statement as to the unique contribution to knowledge achieved through this work is also detailed.

Chapter two consists of a *Literature Review*, covering the four main problem domains which are dealt with individually and then combined with research undertaken to provide conjoined information covering more than one problem domain. Each domain was researched using the *pearl-growing technique* in order to filter past-research into previous work most pertinent to the criteria derived in the Research Methodology chapter.

Chapter three details the *Research Methodology* and provides justification for the way in which research was undertaken, giving comprehensive rationalization for the underlying reasoning behind both the methodology employed and methods undertaken.

Chapter four is an in-depth appraisal of the *Finnish Water Forum*, its method and mode of operation. Both their headquarters in Helsinki, and worldwide presence within the arena of water focused Crisis Management are explained alongside each individual entity concerned with water and disaster and its connection to the umbrella organisation.

Chapter five delivers analysis and resultant *Draft Framework* which constitutes a comprehensive appraisal of each and every element needed in order for an interested party to fully analyse any given crisis scenario for the purposes of preventative planning and/or proactive operational management. The resultant output is a draft framework diagram detailing the aspects and their interrelationships that may be used to ascertain pertinent factors needed for consideration based on the aforementioned criteria of planning or operations.

Chapter six describes *Validation* from independent experts based on the draft sub-frameworks created from the original research areas. Feedback collected was utilised to create the final framework given in chapter seven, combining all previous information into an offering capable of being employed within any given crisis scenario.

Chapter Seven explains the *Final Framework* that takes into account all comments made by individual validators. The final framework is one that is intended for all actors; be they, primary, secondary, or tertiary, and as such, considers many different facets of the crisis context, all of which may not be applicable to every actor.

Chapter eight provides *Validation Case Study* through the analysis of a historical crisis; namely, Hurricane Katrina. Katrina was chosen for its recent historical context (2005) and the fact that it occurred within the confines of the world's richest country but still constituted a crisis. In addition, the myriad of information available on the crisis allowed the framework to be applied in a most comprehensive manner, incorporating as many of the framework segments as possible into each of the crisis stages and problem domains.

Chapter nine provides the *Conclusion* drawn from this research, its limitations, and the further work that will be undertaken as post-doctoral activity. The recommended further work alludes to a *toolbox* of activities that will be undertaken by different actor groups as part of a unified response plan. This allows for multiple organisations and local actors to interact without duplication of effort or lack of purpose.

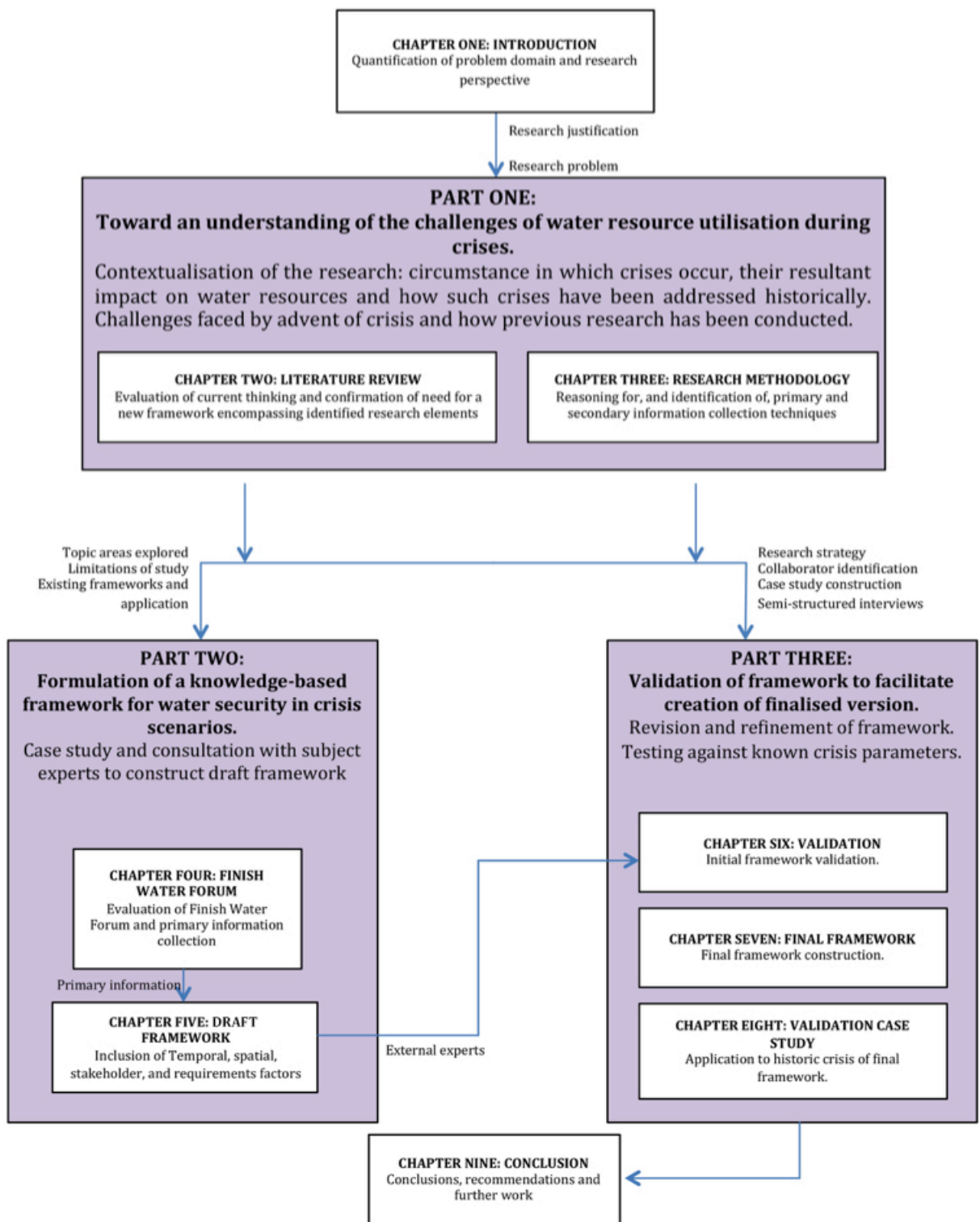


Figure 1-1: Thesis Structure

1.5 Conclusion

The four research elements of Crisis Management, Knowledge Management, Public Health and Human Security were identified and underlying factors explored. Aim and objectives were identified alongside the purpose of research. The desired output of a framework was outlined. Finally, the thesis structure was defined.

2 LITERATURE REVIEW

The literature review chapter is intended to provide an overview of the four key research elements of Crisis Management, Knowledge Management, Public Health and Human Security in order that the problem domain be better understood. Existing Crisis Management frameworks are then considered to provide an overview of current thinking and thus further justify the need for an all-encompassing version covering the aforementioned four elements.

Each of the topics considered provides a lens through which crises may be viewed; the resultant output of which is often different dependant on the topic being considered. Hence, the need for a holistic model is justified so as to fulfil the overall aim of the research.

2.1 Crisis Management

The words *crisis* and *disaster* are sometimes used interchangeably to mean a undesirable event or situation which disrupts the status quo (Shaluf et al. 2003:24). Whilst the UN has a definition for *disaster*, it does not quantify the word *crisis*. UN definition:

“A disaster is a sudden, calamitous event that causes serious disruption of the functioning of a community or a society causing widespread human, material, economic and/or environmental losses which exceed the ability of the affected community or society to cope using its own level of resources” (UN/ISDR 2005:1).

With this in mind, a definition for the word *crisis* was sought so as to provide coverage for spatial and temporal factors that, whilst including the disaster period, were not confined to its lifecycle. The International Federation of Red Cross and Red Crescent Societies (2006) describe *complex* emergencies (crises) as being characterised by:

- “extensive violence and loss of life;
- displacements of populations;
- widespread damage to societies and economies;
- the need for large-scale, multi-faceted humanitarian assistance;
- the hindrance or prevention of humanitarian assistance by political and military constraints;
- significant security risks for humanitarian relief workers in some areas .”

Such consideration was incorporated so as to make provision for the delivery of aid and assistance to those in need regardless of their disaster status. Hence, the term *crisis* has been defined as being any situation that is undesirable with regards to the welfare of human beings within the confines of water and related to the four key research elements of Knowledge Management, Crisis Management, Public Health and Human Security.

2.2 Problem Domain Identification

Such is the nature of crisis that it is often used a synonym for *disaster* or *emergency* and can sometimes lose its potency due to such association. Therefore, it was considered essential that *crisis* be used throughout the work to define a quantifiable unit of concern based on basic human needs and wants as laid-down by Maslow through his Hierarchy of Needs (1943). The synergy between Maslow and the research Venn diagram are shown in figure 2-1.

In addition, figure 2-1 identifies the four problem domains associated with crisis management within the context of water resource management. These domains were chosen because of the quantifiable nature of the attributes as regards crisis management. Secondary research revealed information that could be categorised into one of the problem domains. This provided a manageable architecture through which the research question could be readily explored and a draft framework created. In addition, the use of these elements provided structure to both the participant questionnaire and resultant draft framework. Through application of these elements, a continuous narrative was applied to the entire thesis that allowed for consistent structure and resultant framework, which could be applied to crises identified as part of the secondary data validation process.

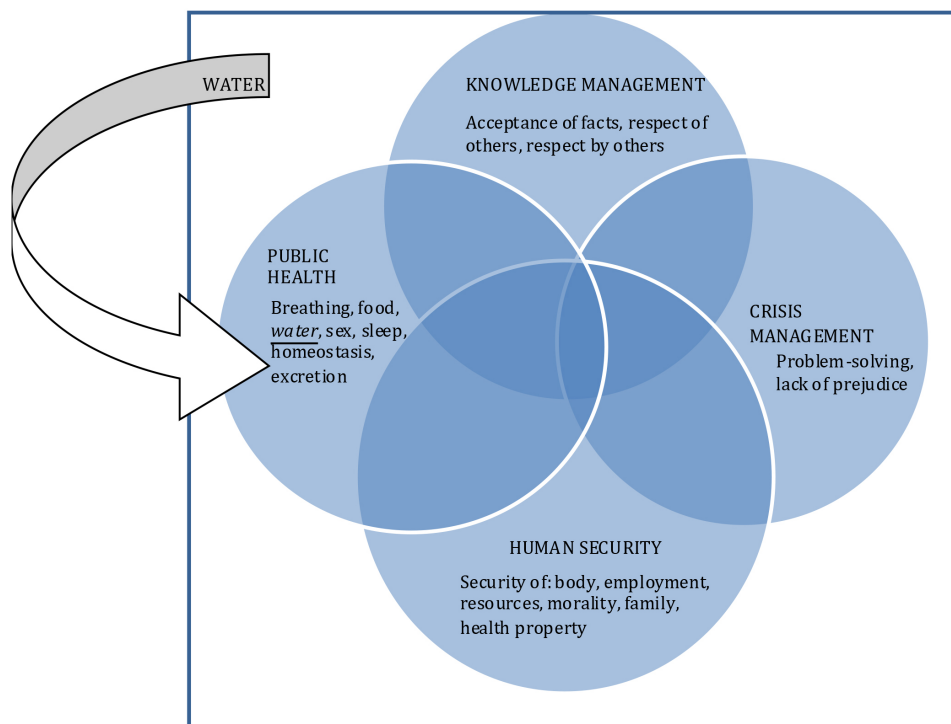


Figure 2-1: Maslow Research Venn Diagram

2.3 Existing Crisis Frameworks

Frameworks are simplified versions of reality necessary to convey understanding where the real world is too complex to analyse in its entirety (Fincher and Petra 2004). However, where models explore particular instances or occurrences of a scenario, frameworks aid in the facilitation of structure around which individual strategies, plans, and tasks may be constructed in order to provide robust answers to complex questions. A framework is described by Oxford Dictionaries (2015) as “a basic structure underlying a system, concept or text”. As such, the frameworks considered in the next section operate on this premise; as does the final framework offered for consideration as the output of this research.

The utilisation of any framework is intended to provide a structure around which resilience plans, response strategies, deployment tactics, and operational tasks may be constructed so as to constitute a coherent solution to any given crisis (European Parliament 2011)

Five frameworks currently in use were studied in conjunction with the aforementioned material in order to garner a comprehensive picture of the work done to date and its application within a real-world environment. The following frameworks were selected due to their national and/or international importance and influence within a global context through international deployment or direct relevance to the research questions posed:

- **UNISDR Hyogo Framework for Action:** a plan to explain, describe and detail the work that is required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk - governments, international agencies, disaster experts and many others - bringing them into a common system of coordination. The HFA outlines five priorities for action, and offers guiding principles and practical means for achieving disaster resilience. Its goal is to substantially reduce disaster losses by 2015 by building the resilience of nations and communities to disasters. This means reducing loss of lives and social, economic, and environmental assets when hazards strike (UNISDR 2005).
- **Federal Emergency Management Agency National Disaster Recovery Framework:** a guide that enables effective recovery support to disaster-impacted States, Tribes, Territorial and local jurisdictions. It provides a flexible structure that enables disaster recovery managers to operate in a unified and collaborative manner. It also focuses on how best to restore, redevelop and revitalize the health, social, economic, natural and environmental fabric of the community and build a more resilient Nation (FEMA 2011).
- **Disasters Framework:** based on current approaches to disaster response and disaster risk reduction and drawing on our experience in South Asia, the Pacific region and Africa, the framework sets out WaterAid's potential contribution to disaster mitigation, preparedness, response and recovery, as a development actor and within their mission (WaterAid 2013).

- **The Red Cross, Red Crescent and Hyogo Framework for Action:** based on lessons learned and good practice from past experiences and using the HFA as a systematic guide, the International Federation of Red Cross and Red Crescent Societies (the International Federation), together with the National Societies, has been fine-tuning its strategies and programmes with respect to disaster risk reduction. This has resulted in the Framework for community safety and resilience, which provides the foundation for all Red Cross and Red Crescent interventions in the area of disaster risk reduction and all actions that contribute to the building of safer and more resilient communities (International Federation of Red Cross and Red Crescent Societies 2008).
- **National Disaster Management Framework (South Africa):** the national disaster management framework comprises four Key Performance Areas (KPA) and three supportive enablers required to achieve the objectives set out in the KPAs. The KPAs and enablers are informed by specified objectives and, as required by the Act, Key Performance Indicators (KPIs) to guide and monitor progress. In addition, each KPA and enabler concludes with a list of guidelines that will be disseminated by the NDMC to support the implementation of the framework in all three spheres of government (South African Government 2005).

There are many disaster management models other than those detailed from which to create a response strategy and implementation plan: some are concerned mostly with relief immediately after the inception of a disaster, whilst others concern themselves with a holistic end-to-end methodology, both linear and non-linear (Altay and Green 2006:475).

As crisis scenarios are notoriously complex and difficult to predict with any great certainty, models must be created in order to reduce the incident to a form that is comprehensible by humans (Fiedrich and Burghardt 2004). Such models usually incorporate some type of tiered approach to assessment, management, response, and recovery as a way of delineating between the distinct disaster phases. However, disasters occur in an unpredictable, non-linear way and such models are difficult to apply to numerous sub-crises requiring different actors to operate based on differing tiers of the model simultaneously.

Fiedrich, Gehbauer, and Rickers (2000:41) discuss the ability to distinguish critical elements concerned with each phase of disaster response that can be applied through identifying previous incidents of a similar nature alongside theoretical assumptions about their causes and effects. The output of which is utilised to establish a common understanding in order to define a response plan to most effectively action relief efforts. A viable output from such understanding comprises frameworks and/or scenario models that utilise this secondary data in order to provide future capabilities.

2.4 Phases of Crisis

Stability: this is considered by the World Health Organisation (2000) as the period of calm between crisis events in which societal norms are followed and the need for any type of disaster response is not required. It is during this period that those governments and organisations with the resources to provide proactive strategies, plans, and tactics employ proactive measures to mitigate future incidents. The idea of stability is subjective: countries such the UK would consider much smaller incidents to constitute a crisis when compared to countries for which civil unrest or poor government is a part of everyday life.

Weak Signals: it is during this period that the first signs of impending crisis are present (Bennett 2012). However, it is possible for such crises to be averted if measures are brought into play with mitigate the signals or remove them altogether. An example may be given from the field of crowd control where *overflow* areas or security cordons are brought into play when masses of people are present within a confined area in order to prevent surging, crushing, and resultant injury.

Strong Signals: may become present with or without the preceding *weak signals* in the instance of both natural and human-made crises (Bennett 2012). It is at this point that the ability to avoid the crisis becomes impossible and plans created during the phase of *stability* are utilised if such scenarios have been considered. With or without preventative measures, the likelihood that reactive measures will have to be undertaken increases greatly within a tightly considered timeframe.

Crisis: it is unlikely that this stage will have been reached without transcending at least one of the two preceding *signal* stages (Rezaelan and Gruen 2011:77). At this point-in-time the crisis is full-blown and all relief efforts are being undertaken to shorten the temporal element within which loss-of-life occurs. This stage can be further reduced into a *blue-light* phase, during which the emergency elements of any crisis occur and a *post blue-light* phase where the crisis is still in existence but a steady-state has been achieved (Levy and Gopalakrishnan 2014). Such subdivision is apparent in poorer countries where famine is a regular occurrence but malnutrition is ever-present.

Post Crisis/ Crisis Prevention: once the ensuing crisis has been dealt with a state of readiness may be maintained so as to prevent secondary crises from coming into effect or to mitigate the chances of resultant crises occurring (Simola 2005:341). For instance, increased presence of Police Officers after an earthquake in order to prevent looting and other criminal activity through the visual presence of *law and order*. The sooner control of the situation is regained then the sooner the following phase can be actioned so as to bring the chance of further crises to a close.

Reconstruction: Once a steady-state has been achieved and the chances of secondary crises mitigated, the need for reconstruction on a permanent basis becomes of paramount importance. By the reinstatement of physical and social infrastructure, the responsible powers are able to achieve a state of *stability* and thus close the circle (Singh and Wilkinson 2008). After the Typhoon that struck Haiti in 2010 the reconstruction of an iron marketplace was considered so important as to be backed by Bill Clinton's charity. The marketplace provided a safe-haven for both vendors and customers whilst simultaneously reinvigorating the local economy through encouraging trade.

2.5 Crisis Management

Crisis Management is the process by which government bodies and organisations deal with events outside of the norm (NATO 2015). As part of a crisis a disaster may occur but this does not necessarily need to be the case: crisis situations may occur without a preceding disaster. Crises are often considered to be unforeseen but this is not the case as both weak and strong signals will often pre-empt its occurrence (Dely 2005).

Organisations themselves may induce a crisis that has ramifications that spread far and wide due to the global nature of modern business and its direct effect on local, national, and international economies. Therefore, the need for crisis preparedness has become an important part of the planning process for both governments and the organisations which operation under their jurisdiction (Pearson and Mitroff 1993:48).

The management of crisis situations is paramount to timeline reduction of the emergency (blue-light) phase, immediately before, during, and directly after a crisis has ensued. Crises may continue long after initial crisis indicators have subsided, resulting in additional Human Security issues that were not derived within the original crisis scenario (Ritchie 2004:669).

In the paper *Architecture of a Natural Crisis Management Framework and its Application to Risk Assessment*, Viqueira et al. (2005) argue that effective emergency decision-making is only possible if data is made available as information in the correct format and resolution. This is often implausible as data collection is undertaken by numerous organisations and is therefore difficult to assemble with any given level of clarity (Thompson et al. 2003:250).

Deployment does not cover the four elements which are the focus of this research: rather, the locus of interest is formed around crisis response/relief or emergency planning without taking into consideration Public Health or a shared knowledge-base (Thompson et al. 2006:23).

Decision-Support Systems may be used to great effect if populated with pertinent data and programmed with sufficiently accurate algorithms. However, this is extremely difficult to achieve for the reasons previously mentioned, and may be further compounded by slow computer responses to data, making such devices a planning tool for proactive enhancements rather than reactive emergency decision-makers (Borkulo et al. 2005). The idea postulated by Viqueira, et al. (2005) is that crisis considerations consist of multiple spatial and non-spatial attributes that often conflict, further re-enforces this position.

The Open Geospatial Consortium (OGC) framework is used by Viqueira et al. (2005) to define a logical architecture that makes provision for the logical operation of a system comprising a group of principles and technical concept. This works well when used within the realm for which it was conceived. However, in recent years, grid computing has become more popular due to its de-centralised control which allows developers more freedom to construct test-bed systems (Joint Information Systems Committee 2006).

Whilst Viqueira et al. (2005) concentrate on the logical architecture for their framework; they fail to explore the underlying reasoning as to why the data must be collected and how this is to be done. This leaves the paper without any knowledge-base criteria on which to construct architecture.

2.5.1 Local Actors

Most modern Crisis Management methodologies concentrate on the utilisation of professional bodies. These are capable of delivering aid and relief to those affected with little consideration of the positive role that may be conducted by those very individuals for whom the situation is most prevalent (Hori and Shaw 2012). It is usually in the reconstruction phase of a disaster or the development phase of crisis that the local population are considered as being stakeholders in the process (Ernst 2011:123). This is facilitated by a need to communicate with those affected in order to provide training programs and recruit human capital for work in construction of physical assets (Christoplis, Mitchell, and Liljelund 2002).

The reasons for not employing local actors are many and varied. These include a misunderstanding of their level of education and therefore worth to an evermore complex, information systems driven process requiring detailed understanding of information technologies and the synergies with operational command and control. Locals are often considered to be partisan which biases the positive effect of any work undertaken to those of their own community, tribe, religion, or social predicates (Kogut and Ritov 2005:157). However, the lack of local actor inclusion in all aspects in the planning and execution of Crisis Management undertakings is to miss a wealth of knowledge which may well be unknown to those constructing such models (Zetter and Deikun 2010).

Stakeholder buy-in is also of great importance to any Crisis Management action as it galvanises the community into actioning plans that may have otherwise disenfranchised them due to the fact that actions were being imposed upon them rather than consulted as to the wants and needs of the local population. Hence, the use of local actors is a major consideration in the measurement of success when undertaking any such action (Wells et al. 2013:1172).

Whilst a framework needs to be grounded in accepted theories and practices, it is also required to engage with local actors so as to prevent the actions undertaken being seen as oppressive to the community due to lack of communication or understanding as the processes being performed or goals sought. Often, a lack of strategic vision neglects explanation as regards the desired outcomes of each Crisis Management action and is justification within the community at large (Pelling 2011:383).

2.5.2 Crisis Modes

The different types of crises most prevalent in the world today may be found in table 2-1, which clearly shows that flooding occurs more often than any other crisis.

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Table 2-1: Occurrence of Disaster Types (UNOCHA 2015)

A breakdown of each crisis mode is provided below as detailed by the World Health Organisation's Natural Disaster Hazard Sheets, which give an overview of each event mode and associated predictable consequences. There are no de facto frameworks for each of the crisis modes as several institutions offer their own interpretations. The five major frameworks in operation to deal with these crises have already been detailed in section 2.3.

Flood: classified amongst sudden onset phenomena, although different types may occur, such as flash floods, river floods, coastal floods, associated with tropical cyclones, tsunami, storm surges (WHO 2015a).

Location of settlements on floodplains, vulnerable buildings lack of warning system and awareness of flooding hazard and land with little capacity of absorbing rain all contribute to the escalation of crisis intensity (WHO 2015a).

Threat to human life may be through direct impact of floodwater, but drowning is the leading cause of death in case of flash floods and coastal floods. Fatal injuries during evacuation or during cleanup activities can occur.

Earthquake: defined as the shaking of earth caused by waves moving on and below the earth's surface and causing: surface faulting, tremors vibration, liquefaction, landslides, aftershocks and/or tsunamis. Aggravating factors are the time of the event and the number and intensity of aftershocks (WHO 2015b).

Location of settlements in seismic areas, inadequate building practices and regulations and dense concentration of building with high occupancy are decisive factors. This is further compounded by an absence of warning systems and lack of public awareness on earthquake risks (WHO 2015b).

Direct impact remains the major cause of fatality through trauma, asphyxia, dust inhalation (acute respiratory distress), or exposure to the environment (i.e. hypothermia) (WHO 2015b).

Surgical needs are important the first weeks. The broad pattern of injury is likely to be a mass of injured with minor cuts and bruises, a smaller group suffering from simple fractures, and a minority with serious multiple fractures or internal injuries and crush syndrome requiring surgery and other intensive treatment. (WHO 2015b).

Storm: impact from such phenomenon extends over a wide area, with strong winds and heavy rains. However, the greatest damage to life and property is not from the wind, but from secondary events such as storm surges, flooding, landslides and tornadoes (WHO 2015c).

The main causes of loss of life center on settlements located in low-lying coastal areas (direct impact), which may be further increased through poor building design, or construction. Insufficient lead-time for warning and evacuation, alongside non-compliance with evacuation procedures add to the chances of death. Direct Impact is also the number one killer and, like Earthquakes secondary hazards occur from injuries sustained, trauma, and asphyxiation due to entrapment. Electrocution or drowning constitutes another danger while securing property such as television antennas or boats (WHO 2015c).

Drought: a prolonged dry period within natural climate cycle. It is a slow-onset phenomenon caused by rainfall deficit combined with other predisposing factors. Drought often results in mass displacements of population. Drought leads to water and food shortages and is likely to have a long-term environmental, economic and health impact on the population (WHO 2015d). Droughts are often predictable periods of unusual dryness.

This means that often advance warning is possible. Factors influencing the impact of drought include demographic pressure on the environment, food insecurity, and economic systems strictly dependent on agriculture. Poor infrastructure e.g. irrigation and water supply and sanitation systems, poor health status of the population before the disaster, time of the year and absence of warning systems are of particular interest to those who wish to mitigate potential crisis (WHO 2015).

Main causes of death include reduced food intake and lack of varied diet leading to protein-energy malnutrition, micronutrient deficiency: Vitamin A deficiency increases the risk of death from measles; severe iron-deficiency anaemia increases the risk of child and maternal mortality. Outbreaks of scurvy due to vitamin C deficiency, of beriberi due to thiamine deficiency, or of pellagra due to niacin deficiency can also occur (WHO 2015d).

2.6 Knowledge Management

The definitions of Knowledge Management (KM) are manyfold. Mostly defining the *know-how, know-who, know-why* originally described by Santosus and Surmacz (2005). However, it is with the following definition that the researcher has chosen to explore the field:

“Knowledge Management embodies organizational [sic] processes that seek a synergistic combination of data and information processing capacity of information technologies, and the creative and innovative capacity of human beings.” (Bali and Gibbons 2008:112).

This definition highlights the need for both data and information processing, explicitly detailing the two as distinct in their own right. Other definitions tend to deal with data and information as a single entity, ignoring the need to differentiation between data and appended metadata so as to provide contextualised information (Ludtke et al. 2012).

For the purposes of this research, the final element of Knowledge Management brings together Crisis Management, Public Health, and Human Security in order to create a framework for water resource management in crisis situations. The collection and collation of information is not enough to ensure an effective response to any given crisis scenario: rather, the application of a knowledge-base drawn from data acquired and information accrued may help provide a pertinent response to any such scenario (Haigh and Amaratunga 2010).

However, KM has been kept as a separate entity within the aforementioned Venn diagram in order to make provision for its discrete application rather than an all-encompassing umbrella. This is because, whilst Knowledge Management is of such importance, it is required to operate as a part of the holistic approach being proposed, rather than leading the other interfacing elements.

Molhotra (2003) details several shortcomings of some Knowledge Management Systems (KMS) that centre on a lack of human intervention once the data has been harvested. Thus the Knowledge Management System outputs are taken on face value, resulting in an output-driven environment rather than one in which strategic leadership takes precedence. However, Bali and Gibbons (2010:31) propose that Knowledge Management must utilise the “creative and innovative capacity of Human Beings”. It is this fundamental difference between the theory of Knowledge Management and its application in a Knowledge Management System that result in an inability for prescriptive solutions even when detailed information is made available in a time-critical event such as that brought-on by crisis or crises.

In 2010, the UN published a report entitled ‘Disaster Relief 2.0’ which concerned itself with filling the information gap by providing a geospatial appraisal of any given disaster incident through the utilization of twenty-first century technologies. The report centred on a case study of Haiti.

The need for Knowledge Management is central to any proactive or reactive co-ordinated crisis response (Yates and Paquette 2011). However, the data gathered is often of a standard incompatible with that required for tasks that involve risk to human life. Therefore, the creation of a decision-based Knowledge Management System is often undertaken in order to provide information pertinent to the crisis scenario. Peng, Zhang, Tang, et al (2011:320) present a framework which utilises data integration in order to remedy the problem; the intension is to provide timely information from multiple sources to key stakeholders. The use of a decision support system is recommended and detailed as being at the core of such a solution, allowing for multiple data streams to merge in order to present a coherent picture of the current and/or future landscape as regards the crisis environment (Alonzo et al. 2012).

2.7 Human Security

Various neologisms have arisen incorporating the word *security* as a cursive purposely falling outside of the realm of national defence (Paris 2001). Human Security is taken as the “freedom from fear and want” (United Nations 1948:37), now forming a large part of foreign policy for many governments (King and Murry 2001).

2.7.1 Water

Adam Smith identified access to clean water as a basic human need in ‘The Wealth of Nations’ (1776:12) that illustrates the length of time that such essential requirements have been identified and yet remain unresolved. The text goes further than simply detailing the need for access to water; highlighting the requirement for such access as a fundamental right, giving rise to human dignity.

Access to clean water is a basic human need that, if left unresolved, quickly escalates into dehydration, malnutrition, disease, and ultimately death. A report commissioned by the United Nations (UNDP 2006) analyses Human Security issues surrounding water distribution and its link to poverty. Once a crisis situation is underway it is usually those most vulnerable who receive less organised aid in the first instance than that of their wealthier counterparts. Those most able to flee the crisis do so immediately, often leaving local infrastructures in disarray.

Water sanitation has a direct influence on health levels enjoyed by citizens of a particular geo-economic status - “ill health associated with deficits in water and sanitation undermines productivity and economic growth, reinforcing the deep inequalities that characterize current patterns of globalization and trapping vulnerable households in cycles of poverty.” (Watkins 2006:5).

There are many causal elements as regards sanitation, such as the gender inequalities experienced by girls and women for whom the collection and preparation of potable water *fit* for human consumption denies them the opportunity of education whilst increasing the possibility of sexual abuse and rape at the hands of predatory males (International Network on Women and Gender Equality 2008).

2.7.2 Violence

The threat of violence once a crisis has ensued is always of concern to actors deployed into the field of operation. The UN often combines peacekeeping troops with civilian workers providing aid and relief. However, smaller organisations are not offered this protection in every instance and sometimes rely upon the services of private security contractors, equipped to provide minimal support if the threat of violence becomes apparent (Fast 2010).

Many humanitarian organisations have to be mindful of violence enacted upon them, with some having to cease operation if the threat level escalates to a level considered unacceptable by those in command of the aid operation: this may be interior or exterior to the actor concerned and is regularly under the remit of the UN if it is operating during the crisis (Kurtenbach and Wulf 2012).

Any attempt to provide a solution to the dangers faced by local actors and aid workers alike is therefore expected to address the challenges of violence in a crisis scenario.

2.7.3 Military Factors

Each epoch of military history has been ascribed a particular model as the prevalent mode of engagement. The twentieth century model for military involvement in crisis situations centred upon *Interventionism*; the use of military resources to further one government's interests within the sovereign territory of the other (Massingham 2009). In cases such as civil disturbance or international intervention for the prevention of crimes against humanity, interventionism has proven to be inept due to a multitude of factors: such as an inability to respond to emergency situations in a timely manner, lack of funds and resources, unachievable goals, and lack of exit strategy (Hofmann and Hudson 2009).

The model is based around the principle of liberal interventionism where the forces at the disposal of one nation are used to influence another's directly. As can be seen by recent interventions by NATO countries with or without the backing of the UN, the nation-state having the will of another imposed upon it is rarely happy with military forces of a foreign power being on their soil. This can be felt at either or both national and local levels (Moore 2012).

Military organisations suffer from the fact that their primary function is not that of international aid' with troops being trained for theatres of war and peace keeping activities rather than relief efforts. NATO and the UN ascribe to the coherent application of military solutions but are often left wanting due to a lack of co-operation between those supplying the military resources and those commanding them in the field. In addition, the political interests of individual nation-states or cabals between them has the knock-on effect of stalling, and sometimes derailing, relief efforts with large pledges of aid rarely matching that which is eventually deployed (Barry and Jefferys 2002).

During the second-half of the twentieth-century, the United States of America (USA) has been the most prevalent power concerned with the delivery of international aid to stricken countries, which has allowed their administration to dominate world-politics through access or denial to its military industrial complex. However, with recent events in the Middle-East and in particular Libya during 2011 taking precedence, the USA had to reduce its commitment to instigating a no-fly zone over the country in order to prevent unnecessary losses to human life caused in response to actions by rebel forces engaged in a conflict against the Gaddafi regime (Cooper 2011). Such intervention in crises by military forces can often lead to a psychological state known as victimhood being displayed by those who seek protection (Enns 2007). This can be induced by the belief that a community that appears to be coping to an acceptable standard by the relief effort will be abandoned in favour of those with greater needs.

2.8 Public Health

Public Health deals with the general wellbeing of a population at large and includes all chronic and acute ailments. However, there has recently been a move to include human rights in this equation, proffering that health goes beyond the physical and mental to include environmental aspects (Rothstein 2007). Public Health is a key component of Crisis Management as it is concerned with the victims of crisis; be this as part of a disaster or purely due to a crisis situation in itself.

Galea and Vlahov define urban health as “the study of [*how*] characteristics of the urban environment may affect population health” (2004:341). The urbanisation of populations has both positively and negatively impacted on the ability of governments to cope effectively under crises. Some positive impacts include centralised emergency response teams (Fire, Police, Ambulance, etc.), and the ability to supply aid to a significant number of people within a concentrated area. However, population density greatly affects the spread of disease and the likelihood of crime after a breakdown in law and order. Sparsely populated areas often display the opposite characteristics and therefore constitute a different scenario for emergency planners (Oden 1995).

Urban health is an integral part of Human Security, having been the focus of the United Nations Development Programme’s (UNDP) annual report of 2006 (Watkins): this examined the current inequalities as regards water sanitation and its availability to those most vulnerable. The report also focussed on the impacts that clean water has on the level of health experienced by both urban and rural populations (table 2-2).

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Table 2-2: Access to Clean Water (UNICEF 2004)

Public Health becomes of paramount importance if not only the issues of Human Security but also the aforementioned military factors are to be included as global actors engaged in large-scale operations undertaken to counteract the militaristic paradigm shift. These facets are not fully explored by the UNDP report, with funding for such humanitarian undertakings made by in conjunction with nation states under an umbrella of the UN. Criticism of UN policy is widespread as the trend towards *post-institutionalism* defines those all-encompassing approaches to such universal needs as that of water supply as being fraught with problems when dealt with in a *non-local* manner (Mosse 1997). Twenty percent of the poorest people in Peru either purchase their water from private vendors or collect it from unsecured sources, thus greatly increasing their risk of contracting water-borne diseases (Watkins 2006) in no way informs the reader as to the underlying reason for such a statistic.

2.8.1 Water

Water is the most important resource in relation to life; without regular intake of fluid, most humans will die within seven to fourteen days. Considering the negative impact of crisis situations and associated time to reinstatement of essential services, the supply of potable drinking water is of paramount importance once a crisis has occurred.

The UN places such credence on the need for water and sanitation that it has commissioned several reports over the last decade, some of which are explored in this section (UNICEF 2013).

Water is essential for many aspects of human society, including:

- drinking water;
- sanitation (including sewage);
- health;
- food security;
- energy generation;
- religious practices (ablutions);
- agriculture (irrigation);
- livestock;
- industry;
- transport.

It is often considered to be available in abundance due to the Earth's surface being four-fifths covered by water. However, as table 2-3 and figure 2-2 illustrate, the percentage of water fit for human consumption is miniscule (Global Water Resources Gleick 1996). Therefore, the chances of obtaining water from alternative sources deemed sustainable may be very small.

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Table 2-3: Global Water Resources (Gleick 1996)

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Figure 2-2: Earth's Water Distribution (USCG 1996)

2.8.1.1 Water Inequalities

According to the UN some 2.6 billion people do not have access to improved sanitation (figure 2-3) on a daily basis; the majority of these being in developing countries concentrated around sub-Saharan Africa and Southern/Eastern Asia. In addition, 884 million people do not have access to improved sources of drinking water (figure 2-3) that is centred on the same regions as sanitation. Even within countries heavily affected by such factors there are huge disparities between rural and urban populations, with seven out of every ten people without access to improved sanitation living in rural areas (WHO/UNICEF 2010). The inequality being further compounded when a crisis situation arises through contamination of water by pollution of rivers, streams, and ground water sources. Additional problems of access to rural areas under such circumstances exacerbates the scenario, bring another set of problems that need to be considered in the relief operation.

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Figure 2-3: Sanitation of Drinking Water Definitions (WHO/UNICEF 2010)

2.8.1.2 Gender Inequalities

In countries where water has to be collected from remote sources, i.e. water collection that takes greater than thirty minutes per trip, are most likely to be collected by women or girls (figure 2-4). This introduces an entirely new facet to water and its place in society because many water sources are remote and mostly attended by females, there has been a tendency for predatory males to exploit this opportunity for sexual gratification. Sexual assault and rape is much more likely to occur to girls and women as they make the long and often isolated trip to and from a water source (Fisher 2006).

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Figure 2-4: Distribution of Drinking Water Collection by Person Type (WHO/UNICEF 2010)

Figure 2-4 also illustrates the disparity between boys and girls who are tasked with water collection. This activity is often undertaken throughout the day and may impact negatively on the children's opportunity to obtain a suitable education with double the number of girls undertaking water collection than boys.

2.8.1.3 Economic Inequalities

There are many contiguous factors affecting the availability of potable water and sewage removal but as always the social-cultural elements are not the only areas for concern; with political will, bolstered by economic power playing a key role in the provision of such essential needs for human health and social development (Meier, et al. 2013).

Although crises are capable of striking any country regardless of global status as can be proven by the 2011 earthquakes in New Zealand and Japan, it is the developing countries that are usually worst affected by such incidents (Keefer, Neumayer, and Plumper 2011). This compounds what is often already a precarious existence for the respective indigenous population. Therefore the blue-light phase may well have to deal with citizens who are not used to government intervention into their daily lives which can introduce additional unknown facets to an already desperate situation (O'Sullivan, et al. 2013).

Developing countries, in particular Africa, are most often lacking fundamental features such as an integrated healthcare system, as well as readily available sources of power, heating, and water (Foster and Iriceno-Garmendia 2009). Whilst the infrastructures of developed countries may be damaged, they can often be brought back on-line with the intervention of skilled actors. However, the same cannot be said if the infrastructure does not exist in the first place.

Where open latrines are in common usage and drinking water suppliers are located near-by, there is an increased risk of cross-contamination most notably through direct contact with contaminated substances. In addition, the risk of ground penetration of pathogens (leaching) is often a cause for concern of which the local population are usually ignorant. Therefore, the water that is available is often contaminated after cleansing or insufficiently cleansed in the first instance (Graham and Polizzotto 2013).

The human cost is further exacerbated by the introduction of additional contamination brought about by the crisis situation. These may be many and varied and consist:

- dead humans and animals in watercourses;
- sewage entering watercourses, homes, and locations where population is situated;
- chemical contamination of water courses and foodstuff.

Once again, these contaminants are better dealt with by those with the economic wherewithal to commit sufficient resources (Swarzenbach et al. 2010).

2.8.2 Water security

Water resource management is a key component of a structured and effective society. The understanding and management of such water resources is defined as water security and covers one's ability to fulfil their daily water consumption needs (Birkett and Mala-Jetmarova 2014). Due to several reasons, water crisis has already been felt by some countries and is projected to affect many more as the impact of these incidents increase. The reasons concerned include:

- climate change;
- agricultural pollution (Nitrogen, Phosphor, Potassium – NPK);
- industrial pollution;
- man-made structures to redirect the flow of watercourses which may have disastrous consequences when communities of even countries are denied access to previously abundant supplies of water;
- shifting eco-zones;
- changes in bio-diversity;
- population increase driving-up demand;
- desalination introducing corrosive brine into eco system;
- non-renewable underground and surface aquifers;
- water wastage through overuse for unnecessary activities such as aesthetic gardens.

The UNDP Millennium Development Goals are all derived from a necessity to remove as many people as possible from extreme poverty.

“We will spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty, to which more than a billion of them are currently subjected. We are committed to making the right to development a reality for everyone and to freeing the entire human race from want.

(UN Millennium Declaration, UN A/Res/55/2, 2000:5)”

From this declaration, the UN hopes to increase the perceived value of water amongst both the poorest and richest communities by encouraging water resource conservation as a measure installed to arrest the current irreversible damage being done to the world’s water supply.

One method by which the needs of consumers could be met is by the use of Integrated Water Resources Management (IWRM) through the use of a water resource management model that predicts demand using geospatial data and distributes water accordingly (Engle et al. 2011). For this to be effective, water grids would have to be built covering large geographical areas, and with the potential for one grid to be connected to another to give intra-continental cover (Choo, Yoon and Maeng 2014). This may be further upscaled to cover inter-continental water demands in the future.

For such a systematic approach to work, global governance would need to be addressed to bring stakeholders together for the formation of an integrated water consumption strategy providing both the logical and physical nexus to construct and maintain such a huge undertaking as an international water grid. However, much may be learnt from previous such endeavours that have seen trans-continental gas and petroleum pipelines bring energy resources from source to point of consumption (Water21 2012).

With any such international undertaking, diplomacy will have to adapt to cover such national interests of nation states without unnecessary detriment to its partners and fellow stakeholders. These political imperatives are not to be ignored if countries are to avoid the predicted water wars of the future.

The aforementioned Millennium Development Goals are as follows and may be left unfulfilled if water is not central to their successful completion (United Nations 2006):

- eradicate extreme poverty and hunger;
- achieve universal primary education;
- promote gender equality and empower women;
- reduce child mortality;
- improve maternal health;
- combat HIV/AIDS, Malaria, and other diseases;
- ensure environmental sustainability;
- develop global partnership for development.

If an understanding of everyday consumption requires for present and future populations are left unexplored, it is almost impossible to predict the requirements of a community under threat of crisis or disaster. Therefore, a detailed understanding of the usual water and sanitation consumption may help produce a model for delivery of water relief that best addresses the need of those affected (Flint 2004).

In addition to the above is a need to provide water that is fit for purpose; there is no perceivable gain in cleansing water to a standard in excess of that required. Potable water will always require cleansing to the highest standards in order to prevent ill-effects to consumers but for the purposes of irrigation, removal of waster (lavatories, etc), the method of cleansing does not need to be so fastidious. Failure to provide potable water is a crisis in itself. Rather than over-treat such water, resources would be better focussed on providing demand at a level and to a quality set-out by an overall delivery strategy (Whittington et al. 2012).

Industry may also wish to reduce its consumption by introducing continuous loop systems where water is treated and reintroduced into supply through on-site facilities rather than reintroducing polluted elements into watercourses which cause problems downstream of the contamination point. Closed-loop systems, (those with feedback that alters resultant inputs based on output variances) may then be utilized in times of crisis to facilitate emergency water supplies in addition to the added benefit of independent operation which may survive natural disasters or be repairable with minimal interaction with national power and water grids.

2.9 Conclusion

Crisis Management is a complex problem with no one solution offering a panacea. The topics explored in this review have given four different focus points that aid in the construction of a framework to answer the core research question.

There is a view that attempts to understand individual facets of Crisis Management by making large generalisations and sweeping statements in order to justify their positions. This is done for the purposes of simplification but, in doing so, compounds the level of uncertainty experienced by those working in crisis situations.

As previously identified, there may be many and varied first responders in operation within the crisis area who do not ascribe to the same model of operation. Therefore, it seems reasonable to create a model capable of being scaled according to the situation at hand and all actors involved. This is very difficult to create as the very nature of disaster response requires international aid from countries whose first languages differ and for whom differing priorities may be in place due to cultural, religious, or even past event drivers. Model availability and common agreements for operation must be in place to assure successful operation of any such undertaking.

The overarching problem as regards the research is the consolidation of previous examinations into a knowledge-base capable of propelling original outputs. Most data and information collected has been done in a way relevant to independent researchers or those working for large Non-Governmental Organisations such as the United Nations. This has served to reduce the transparency of research across the board and thus impede the level of clarity obtainable from secondary data.

The draft framework has to combine this information in a way that helps to demystify the current situation. Whilst this is the overall aim of the research, it is also recognised that this solution will constitute the evolution of current thinking. The fact that a framework needs to be produced indicates that the problem domain is too complex to be mapped in its entirety. The unknown factors that may occur under the guise of *non-linear dynamics* serve to create a situation in which it is impossible to formulate a response to each and every permutation.

3 RESEARCH METHODOLOGY

Water resource management encapsulates a myriad of fields, from the anthropological, to the technological. This chapter covers the research philosophy, methodology, individual methods employed to secure the four elements of Knowledge Management, Crisis Management, Public Health, and Human Security. Furthermore, each element's influence upon the research design is explored in order to fulfil the research aim. The research contained primary data collection and analysis alongside secondary data collection and analysis in order to provide a *rich picture* of the current landscape regarding Crisis Management. The methods employed also include multiple validations so as to add gravitas to the resultant framework.

3.1 Background

In order that the attributes regarding research methodology be properly explored, the principles suggested by Denzin and Lincoln (2000) have been taken into consideration; namely, that research methods in themselves are of secondary importance when compared to the paradigm which governs the overarching methodology of any research question. Therefore, this chapter identifies and focuses on the research paradigm, questions and resultant methodology in order to provide a holistic approach to each and every element previously outlined.

The *Research Onion* was developed by Saunders, Lewis, and Thornhill (2006) (figure 3-1) to illustrate the composition of research and the relationship between each design element.

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Figure 3-1: Research Onion (Saunders, Lewis and Thornhill 2006)

3.2 Research Philosophy

The research philosophy forms the first layer of the *Research Onion* and thus underpins the design, providing a theoretical explanation for methods used to gather and analyse data. Epistemology is the branch of philosophy that deals with knowledge and its acceptability within differing spheres of research. The arena within which research is to be completed directly impacts the type of research undertaken and the research methodologies employed (McNiff 2002). The research was conducted from the viewpoint both of a *resources* researcher and a *feelings* researcher in order to gather as much information as possible. The resources element consists of qualitative information from secondary sources, free from influence by the researcher; whilst the feelings element was undertaken within the context of an interview, allowing the interviewee to express opinions and observations which formed part of a semi-structured discussion (Bryman 2008).

Such factors combine to form a *positivist* approach, being provided by a highly structured methodology facilitating replication of crisis scenarios in the creation of a framework/model. Thus, the approach taken contained elements of *positivism* in so far as creating a framework that was testable against a historical crisis event.

However, the concept of positivism is not without its detractors; the main criticisms being that the actors under scrutiny are not fully appreciated and their actions not placed into context (Gibbert, Rulgrok and Wicki 2008). On the other hand, *interpretivism* may be used to allow the researcher to distinguish between individual humans in their role as social actors. This is particularly important when the role of those engaged in humanitarian interventions may have their designation and position in the chain of command changed by events such as the engagement of other agents which may bring more personnel and economic wealth to a crisis situation, thus rearranging the organisational structure by both direct and indirect methods (McCourt 2013). On balance, positivism was utilised as the overall methodology as the resultant output could be tested against an historic crisis and thus validated.

The theory of ontology deals with those social phenomena that may be entered into a knowledge framework to represent social entities. Hence, in the case of this research, ontology is utilised so as to make provision for the social aspects of crisis as they appear within the context of water. As far as ontology impacts the research design, the impact of objective and subjective components may greatly affect the outcomes of any information gathering exercise.

It may be presumed that management, as an entity in itself is objective due to the fact that the structure that underpins an organisation has been created to best support the activities for which such an organisation exists. However, the individuals who fill the roles denoted by organisational structure are, in themselves incapable of existing on a purely subjective preposition. Rather, each actor brings with them a set of predefined perceptions gathered through either direct or indirect experiences both related and unrelated to any given situation. When each social actor is approached it is important to understand that the answers given will always be subject to the opinions and bias originating from each and every aspect of their life (Saunders, Lewis and Thornhill 2007).

3.2.1 Research Paradigms

A paradigm is defined as being a way of examining social phenomena from which insight into real-life issues and problems may be gained. Such paradigms are assigned to the four-box model given in figure 3-2 and may be attributed to individual organisations in different ways. The four dimensions are placed around the outside of the model, corresponding to different perspectives on change and its application to an organisational issue. In the realm of Crisis Management, the approach most appropriate is that of the *regulatory perspective* where the analysis has more akin with continuous incremental improvement than with radical change. This was chosen to better represent the Crisis Management environment as much research has been done in this arena even though the multifaceted dimensions set down in the original Venn diagram have not be explored before (Krauss 2005).

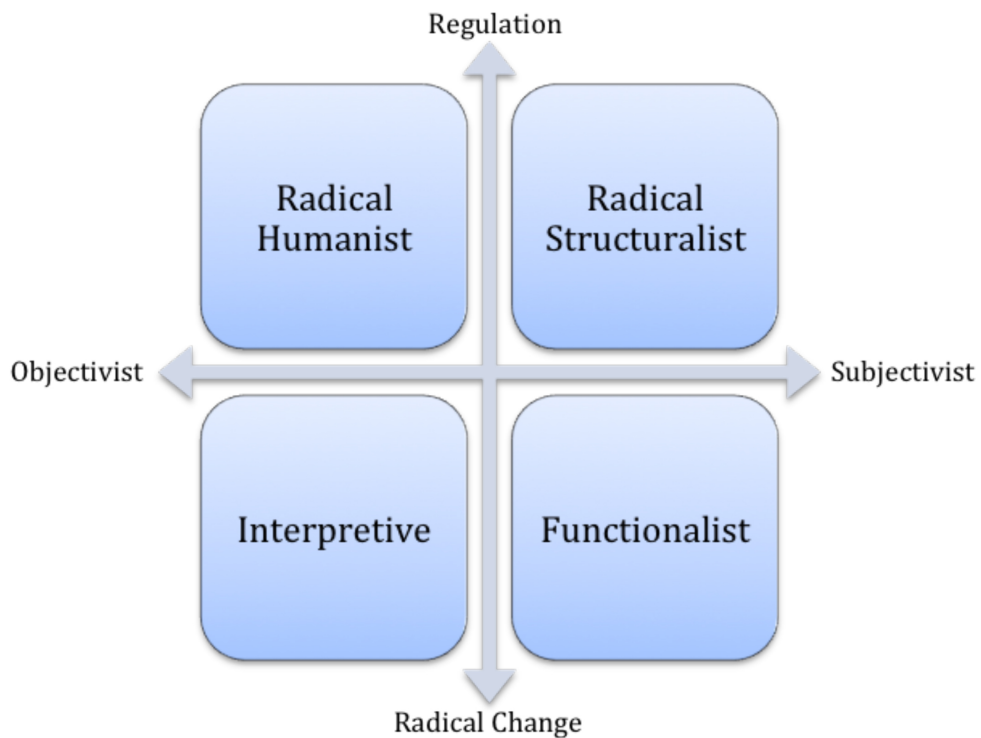


Figure 3-2: Research Paradigms

The research is based in the *interpretive paradigm* that allowed for the identification of irrationalities within organisational structures of those involved in Crisis Management as well as the transient nature of operational structures during times of crisis. This paradigm allowed for the interpretation of information in order to construct a new framework for the application of water resource within the realm of Crisis Management.

3.3 Research Approach

The second layer of the *Research Onion* is concerned with the interpretive nature of this research. An *inductive* approach was considered most appropriate as it allows for the collection of data in order to develop a theory, therefore ignoring previous theory so that a framework or model may best be constructed from base data rather than merely reinterpreting what had gone before. Direct interaction with a subject group such as those provided by Finish Water Forum allowed for such primary data gathering in an inductive manner, thus allowing for a subjective interview combined with an objective questionnaire (Saunders, Lewis and Thornhill 2007).

3.4 Research Design

Research Design consists of three main parts; strategies, choices, and time horizons, which combine to form an understanding of the process regarding research design. Together, these provided a general plan as to how the research question was to be answered.

The design followed all three possible tracks, i.e. exploratory, descriptive, and explanatory; using each style to exploit different aspects of the research criteria. However, the main route of enquiry was that of an *exploratory study* which allowed for a literature review, and interview of social actors. This allowed for an initially broad scope of enquiry that became progressively narrower as time went on and the domain knowledge of the researcher increased (Yin 2009).

The *descriptive studies* allowed for the portrayal of actors and events based on individual case studies to reinforce the primary information collected from FWF and provide a contextualised understanding of crises and their place inside a given scenario (Yin 2009).

The combination of exploratory and descriptive studies provided the foundations for the third part of the research design; namely, *explanatory studies* which enabled the researcher to identify causal elements which connected the four research domains within the context of water (Knowledge Management, Disaster Management, Public Health, and Human Security). By gathering information on previous crisis situations and applying it to the aforementioned domains, explanatory dimensions of the research were explored before a definitive framework or model was constructed.

3.4.1 Research Strategies

The research tasks employed were chosen as they reflected a mixed approach to the gathering of data and information. These provided the best picture of the current environment surrounding Crisis Management and to glean the maximum amount of information within the given timeframe. The primary aim of this research was the development of a framework capable of delivering high-quality assistance to those engaged in strategic, tactical, and operational undertakings as part of either proactive or reactive Crisis Management water resource allocation. A research strategy had to be chosen which enabled the researcher to gain a deep understanding of the current environment for such undertakings. The research tasks performed were as follows:

- Survey in the form of a questionnaire;
- Case study;
- Archival research.

The remainder of this section provides justification for each of the tasks performed and why their combination provides a robust picture of current practice within the research domain. The use of three research tasks helped strengthen the information gathered by providing triangulation on both the sources through which said information was gleaned and the methods by which it was garnered.

3.4.1.1 Survey

As previously mentioned, it was the intention of the researcher to provide an inductive approach to the research but this could not be achieved in its entirety due to the need to provide some form of *inductive* data gathering. This took the form of a survey in the guise of a questionnaire delivered as part of a semi-structured interview and thus contributes to the descriptive and explanatory aspects of the design (Foddy 2001). The questionnaire allowed for the collection of *qualitative data* from the interview to provide a rich picture regarding the understanding of crises by those social actors employed by FWF.

3.4.1.2 Case Study

The use of a case study allowed for exploration of crises in a given scenario that gave an insight into the individual aspects of each incident whilst simultaneously combining to form an overview of crises in general. This was once again, undertaken with FWF but was further enriched by the inclusion of *archival research* that is explored in full in the next section.

The case study allows for a rich understanding of the context of each crisis and what it meant to the social actors involved. The question of ‘why?’ is best answered through this type of investigation as it allows for the interviewees to express their own opinions through the use of open-ended questions and general discussion.

However, the risk in questioning such actors is that their responses were affected by individual beliefs due to experience and imperfect knowledge. Therefore it was imperative to validate the draft framework with another group of experts so as to mitigate imperfect knowledge. However, this can prove difficult to negate altogether. Qualitative information raises the issue as respondents may have formed opinions based on external influences beyond their control or even their understanding.

The use of multiple cases was considered appropriate as it allowed for several independent scenarios to be considered, thus providing an opportunity to apply the lessons learnt from each into the framework or model to provide a more robust output. Hence, FWF as an umbrella organisation provided the ideal solution, providing a comprehensive understanding of Crisis Management from several key perspectives. When combined with independent experts, the final framework could be tested against Hurricane Katrina with confidence as to its theoretical validity.

3.4.2 Qualitative Research

Qualitative data collection was used throughout this research as only non-numerical data needed to be collected in order to provide the information required to conform to the previous ascribed research philosophy.

The qualitative information was gathered through the use of both questionnaires, as part of a semi-structured interview with each participant, and the use of a case study of the natural disaster instance known as Hurricane. Qualitative information was also collected through desk-based research as secondary data, previously produced by numerous organisations within the ascribed fields.

3.5 Time Horizon

The chosen time horizon for this research was that of a *cross-sectional* study, providing a *snap-shot* of the Crisis Management arena based around one case study combined with historical evidence gained through the exploration of previous incidents. This type of study is further explored through the use of interviews and questionnaires, allowing for a moment in time to be collected and analysed alongside interviews supplemented by other historical events.

Such a time horizon is preferable to *longitudinal* study as it allows for the formulation of a framework within the allotted timeframe. In addition, further justification is given by the fact that the use of a snap-shot may provide information whose quality is sufficient for the purposes of framework creation without the need for long-term study within the chosen organisation which would be difficult to arrange and execute.

3.6 Research Ethics

Blumberg et al (2005:92) define ethics as the “moral principles, norms or standards of behaviour that guide moral choices about our behaviour and our relationships with others”. Therefore, it was important that not only did the conclusion reached need to be academically sound but that the way in which all data and information was collected, collated, and disseminated be ethical.

Within the field of ethics there are two major viewpoints, those of *deontological* and *teleological* that polarise the landscape. Deontology defines the ends of any research as having to justify the ethical standpoint whilst teleology states that the ends justify the means that may be unethical. For this research a deontological position has been taken as the infringement of an individual’s ethical rights are not in question due to the nature of the research and the social actors being questioned. In addition, a code of ethics laid-down by Coventry University was instigated and adhered to throughout the research.

The centre-point to an ethical research strategy was non-maleficence, avoiding any harm to Informants as consent was sought prior to interview or questionnaire and the social actor involved maintained the right to refuse any answer which may have made them feel uncomfortable along with the ability to remove themselves from the research at any time prior to the submission of a completed thesis. Informants were also given the option of participating in the study with or without their name and position being revealed; this right to anonymity helps protect those involved and encouraged an open and honest dialogue with the researcher. In addition, the responses given by one social actor was not revealed or eluded to in subsequent sessions so as to not allow for transference of information that had been previously declared confidential.

Due to the nature of interaction between the researcher and collaborator it was impossible to perform any *covert* data gathering as explicit permission was required and attendance of the researcher could only happen in an *overt* manner. Even if covert techniques had have been possible, they would have been considered unethical due to the deontological nature of the study. Therefore, the idea of *habituation* came into force where a professional organisation such as FWF was deemed as being capable of accepting the researcher without this having any discernable impact on the data and information being sought.

Each individual was given the opportunity of stopping the interview at anytime if they felt uncomfortable; in addition, each question was answered on a purely voluntary basis.

Negative deception was not considered to be an issue as the research would be mutually beneficial; helping to provide fresh insight into the problem domain whilst presenting FWF to a wider audience outside of Finland. Positive deception was mitigated through the use of multiple Informants, interviewed separately but using the same method and question-set.

3.6.1 Data Processing and Storage

Data capture, processing, and storage are highly regulated within the European Union (EU) and are covered by several pieces of legislation. The UK also has sovereign laws governing the same that combine to provide a highly developed framework regarding an individual's rights to information collection, processing, storage, and retrieval.

Directive 95/46/EC is defined as the Data Protection Directive and covers every aspect of data usage within the EU since 1980: the main elements of which are:

- Notice—data subjects should be given notice when their data is being collected;
- Purpose—data should only be used for the purpose stated and not for any other purposes;
- Consent—data should not be disclosed without the data subject's consent;
- Security—collected data should be kept secure from any potential abuses;
- Disclosure—data subjects should be informed as to who is collecting their data;
- Access—data subjects should be allowed to access their data and make corrections to any inaccurate data; and
- Accountability—data subjects should have a method available to them to hold data collectors accountable for following the above principles.

These provide a stringent set of guidelines to which any researcher operating within the EU must adhere.

The UK provides additional legislation through the Data Protection Act 1998 and the Freedom of Information Act 2000. These provide even greater levels of protection alongside additional rights regarding to personal information held about any given individual and their rights of access. Such legislation directly affected the research approach in that data must be stored securely and not be made available to others without direct written agreement with those participating. This did not negatively affect the study as no sensitive data was gathered. Therefore, information gathered was done so with explicit understanding that it would be used for the purposes of research in the first instance but that any subsequent audience would be free to use the resultant information in whatever way they saw fit.

3.7 Sampling Technique

The ultimate sample is that of a *census* where every member of a given population participates in the survey. For all but the largest of surveys or the smallest of populations, such a technique is impractical; therefore a sample of the population needs to be chosen which is of significant size in that it fulfils the research objectives without incurring to great an impact on the data gathering time horizon. As previously mentioned, both a questionnaire and semi-structured interview were used to gain the opinions of those social actors chosen for the study; these were chosen using the tools and techniques now described. There are two techniques for sampling, namely; *probability* and *non-probability* that allow for two different approaches to the sampling strategy. Non-probability sampling was the one chosen as it allows for the total population to remain unknown, both in the sense of number of employees within FWF and its external actors, and in the nature of their work as defined by the number of crises dealt with in any given period: this still allowed the researcher to generalise aspects of the population without needing a statistical justification; rather, one based on subjective judgement. This allowed the researcher to select the case under scrutiny and associated actors involved from an available pool, checking for level of detail and relevance to thesis objectives.

Through the use of such judgemental sampling (purposive) the outcomes were not intended to be a statistical representation of the entire operation regarding FWF or disaster management in general. Therefore, it has to be accepted that the case used may not be applicable in every instance; rather, an example of a single occurrence relevant to the research objectives and achievable within the defined time horizon. It may be argued that a *critical case* would have carried greater weight as regards the overall research aim but this is to overestimate the relevance of any single case as being definitive, from which generalisations may be drawn without fear of contradiction. This cannot possible be the case due to the nature of this type of research and the outputs derived therein.

3.8 Secondary Data

The previous chapter was written as a literature review analysing different sources of secondary data in order to provide a picture of the current theoretical landscape as regards the research topic for the purpose of developing a framework that is informed by the latest theory and practice. In addition to the literature review were many other data sources that could be considered as secondary data i.e. data that had been previously collected for another purpose but could now be analysed to fulfil the aim of this research. Up until this point chapter three has been concerned with primary sources of data that was collected from FWF as part of the collaboration process. This has been heavily supplemented by secondary data gathered from FWF and large-scale NGO's such as the UN and WHO who release huge amounts of data each year for just such purposes. This data was of great importance as it formed the backbone of this research due to the fact that data collection on such a grand scale would be impossible for the independent researcher given the multitude of variables involved; geographical region, language, data collection, and information dissemination.

The secondary data studied fell into all three of the accepted areas; those of *documentary*, *multiple source*, and *survey* as defined by Saunders, Lewis, and Thornhill (2007:249).

The researcher encountered a myriad of secondary data that was considered far too large and detailed to be studied in its entirety. Therefore, the available material was filtered using the citation method to provide a subset of data which contained the materials of greatest importance as defined by the number of times said text had been cited in other articles within the academic sphere. This provided quality information that was utilised in addition to the primary data collected so as to construct and test the framework.

3.9 Primary Data

Primary data is defined as being “data collected specifically for the research project being undertaken” (Saunders, Lewis, and Thornhill 2007) and concerns everything that was composed either through the use of semi-structured interviews or questionnaires.

The aim and objects of the research had been previously defined and both the questionnaires and semi-structured interview created. However, as the interviews progressed, the researcher was able to better understand the operation of the organisation and its role in Crisis Management: this helped with a greater level of granularity as regards the aim and objectives, allowing for a clearer understanding of the mode and methods of operation within such scenarios. The FWF has many organisations under their umbrella that afforded an opportunity to interview several different actors within the organisation. This allowed for larger spread of ideas and opinions helping garner a greater level of understanding regarding the problem domain.

3.9.1 Semi-Structured Interviews

The interview formed an intrinsic part of the research, allowing social actors to interact with the researcher in a manner that was simultaneously structured and professional, whilst remaining semi-formal thus allowing Informants to speak without fear of judgement or retribution from anyone within or without the organisation to which they were affiliated.

The typology chosen was one of a semi-structured interview; this falls between that of the structured and unstructured interview and offers a qualitative approach to the technique, serving as a platform for selected themes through the use of open questions based on the answers given to previous questions metered to the subject. This interview approach allowed to researcher to glean information which may not have been forthcoming had the questions posed been of a rigid nature, forcing the participant into succinct answers. In addition, the fact that English was a second language to most of those interviewed was better served by an ability to rephrase questions in order to attain the level of clarity judged sufficient by the researcher.

Evidence shows that managers and those employees with greater levels of autonomy prefer the interview method to one of a questionnaire as it may be perceived as being in-line with their current method of engagement within the pre-existing organisation; providing another facet to their work which is not considered as being outside of their permitted scope or locus of control (Babin, Griffin, Zikmund, et al 2012).

The interviews were conducted in Finland at both the site of Kuopio Innovation (KI) in Kuopio and FWF in Helsinki over a three-day visit. The visit also included tours of FWF and KI facilities, alongside talks and provision of additional printed material. The case study chapter provides detailed information as to the individuals interviewed and their position within the respective organisations.

The use of a semi-structured interview style allowed for an opportunity of gathering data in a manner conducive to that of a case study that remained at the centre of the research. This engaged with the Informants in a way that permitted the answering of not only *what* and *how* questions but *why* the answers given were the answers perceived as true; thus providing inference in the manner of exploratory research which aided in the design of the resultant framework or model. This method also allows for reflection on the questions being asked and their internalisation of both implicit and explicit knowledge that must then be externalised in order to convey their thoughts and feelings.

The use of semi-structured interviews is not without its drawbacks; namely, the question of reliability. The information being conveyed may merely be hearsay rather than factual. This can be conveyed unintentionally as the subject's perception of events may not be a true reflection of what actually happened. However, perception of the event can be as important as the factual evidence, therefore, corroboration through the interviewing of several subjects regarding the same event is important (Saunders, Lewis, and Thornhill 2007). Hence, all information gathered was brought together to form a consensus of opinion as regards each aspect of the frameworks constituent parts.

The information collected was recorded by hand using short notes and *mind maps* that were written-up immediately after the interview to facilitate maximum memory recall. Audio and video recording were both considered but dismissed as it was felt that such verbatim methods could have impeded the ability to collect candid responses to questioning and thus endanger the validity of the study in its entirety (Saunders, Lewis and Thornhill 2007).

Due to the time-consuming nature of semi-structured interviews, only a small sample size was undertaken as part of the study. This was not considered a major drawback when other data sources were taken into consideration and used to supplement information gathered from Informants.

3.9.2 Questionnaire

A questionnaire was employed as part of the semi-structured interview in order to facilitate a starting point for topical discussion regarding the problem domain. The questions formulated were categorised as per the identified research elements and presented to the Informants as such. Paper copies were printed and the interviews conducted without audio recording equipment so as to allow for free and frank discussion. The questionnaire can be found in appendix C.

3.10 Analysis

The data analysis was analysed qualitatively, in-line with the data collection. It does not necessarily follow that the method of analysis be defined by the data collected but in most cases it is true to say that qualitative data will be analysed qualitatively.

3.10.1 Qualitative Analysis

Qualitative data analysis concerns itself with data that has been collected through such means as open-ended questions within the context of a semi-structured interview. Therefore, it was of interest regarding this research because the associated inductive and deductive modes were employed as a mainstay.

Whilst it is often considered easier to construct a question from quantitative data, the use of qualitative data cannot be underestimated. This research concerned itself with data collection using qualitative research that was able to provide the most significant results due to its immediacy to those providing the information and those who form the user demographic intended by the resultant framework or model.

The analysis of qualitative data proved challenging due to the non-standard nature of open-ended questioning, allowing the respondent to take the conversation in numerous directions in order to fully convey their response.

The analysis was therefore undertaken using the qualitative method advocated by Miles, Huberman and Saldana (2014) and shown in figure 3-3. Utilising this method allowed for the collection of qualitative data which was reduced into themes and connected statements, displayed as mind maps for the purposes of consolidation and simplification. Conclusions were then drawn from the mind maps (shown in appendix C) and a draft framework constructed. The same method was then employed for validation, further refining the framework through questionnaires and interviews with domain experts (appendix E). Thus, the final framework was constructed, ready for validation against an historic event.

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Figure 3-3: Qualitative Data Analysis (Adapted from Miles, Huberman and Saldana 2014)

3.10.2 Mind Mapping

The use of such a tool allowed the researcher to interact with each subject in a manner more conducive to semi-structured interview with notes being taken in the illustrative mind map form. Due to the nature of such interview technique, common themes and key points could be attributed to the map in a non-linear fashion and thus, gather information from general discussion which often exposes important points which were appropriate to themes that lay outside of the question in hand. Consolidation tables were created so as to refine the mind map information into common themes for presentation.

3.11 Triangulation

Each key theme identified through primary and secondary data collection was combined with existing knowledge held by the researcher and justified through corroborating citations. Validation was undertaken using industry experts and the resultant framework tested against a case study. Thus, triangulation of information was achieved which aided in attributing validity to each of the elements entered into both draft and final frameworks.

3.11.1 Constant Comparison Kaleidoscope

As part of the triangulation procedure, the kaleidoscope metaphor was employed to visualise information categorisation and representation (Dye et al. 2000). This metaphor lends itself to the graphical representation employed by mind maps and, as such, is an ideal way of explaining the creation of framework elements. Figure 3-4 shows how the kaleidoscope is employed and its relationship to mind mapping and resultant consolidation through refinement.

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Figure 3-4: Kaleidoscope Metaphor (Dye et al. 2000)

3.12 Draft Framework

Having analysed the data, a draft framework (figures 5-2 to 5-5) was constructed based on thematic responses as shown in appendix C. This took the form of four diagrams based on the four research elements. Each diagram consisted box models that were connected via interrelated themes. Once the initial draft framework was created it was validated by cross-domain experts who were able to deconstruct the themes and thus validate or contradict the key themes and associated operations identified.

3.13 Validation

Validation subjects were chosen once a draft framework had been constructed in order to provide feedback outside of the original study Informants. This allowed for an entirely subjective appraisal of the draft output in order that corrections and refinements could be made before a finalised framework was produced. Identification of, and justification for, the individuals chosen to validate the work is presented in the final framework chapter. The questions posed are listed in appendix E along with the accompanying mind maps.

3.14 Credibility

3.14.1 Reliability

Before the research strategies are finalised and again once the data has been collected, it is important to analyse the predicated levels of reliability obtained through any data gathering exercise. As previously mentioned, the bias of anyone questioned or interviewed will almost always be brought to bear on anything collected but there are other considerations that must be understood (Easterby-Smith et al., 2002:53):

- Will the measures yield the same results on other occasions?
- Will other observers reach similar observations?
- Is their transparency in how sense was made from the raw data?

There are four main threats to reliability; namely, *participant error*, *participant bias*, *observer error*, and *observer bias*. Participant error may occur due to the levels of motivation experienced by those taking part in the study. This cannot be completely controlled; however, by delivering the questionnaire and interview in a professional manner, the researcher endeavoured to provide as neutral as possible an environment (Saunders, Lewis and Thornhill 2007).

Participant bias was easier to control through interviewing each social actor on a one-to-one basis and in confidence, thus eliminating either direct or indirect pressures placed on them from the management team. This may be especially prevalent in FWF which is run in a militaristic style with each person obtaining rank within the organisation.

Observer error was less of a problem as all of the interviews and questionnaires were delivered by the researcher without outside interference from members of the supervisory team. This allowed for a single interpretation of the material that helped reduce error through misunderstanding on behalf of the researcher.

Observer bias was not so easy to eliminate, as the predilections carried by the researcher cannot easily be put aside. The way this was combated was to ensure that the researcher was fully aware of the background to each question being asked and that there were several ways of understanding both the original question and the answer given. However, it is almost impossible to remove bias as it is integral to us as human beings.

3.14.2 Validity

There are numerous threats to validity that can render any identifiable *causal relationship* useless: *history, testing, instrumentation, mortality, maturation, and ambiguity about causal direction*. These can occur in isolation or combination to invalidate any primary research (Saunders, Lewis and Thornhill 2007).

Questioning members of FWF about a recent crisis may have had an element of history that was painful to recall due to the humanitarian nature of their work. However, it was highly unlikely that this was communicated to the researcher as it may well have been seen to lack professionalism.

Ambiguity about causal direction was a major concern for the researcher as understanding the cause and effect in any given scenario is always open to misinterpretation, this was diminished by ensuring that supporting questions were asked within the interview to ensure that the answer being given was contextualised and fully explained in order to provide correct causal direction for the analysis part of the study and, ultimately, the conclusion.

The other threats to validity were unlikely to occur due to the cross-sectional nature of the study and the time horizon employed. This removed difficulties in staff moving position within the organisation or an individual attaining new Knowledge which affected their previously held opinions and beliefs. In addition, the idea of organisational learning did not negatively impact the study for the same reason.

3.15 Conclusion

As detailed in the previous sections, the data collection process was complex and time consuming for all involved. The need to have an understanding of the expected results was important as it helped the researcher in understanding the process from start to finish, thus helping identify and rectify possible problems before transmission into the population undergoing study.

PART TWO

4 CASE STUDY: FINNISH WATER FORUM

This chapter provides justification for the use of a case study in order to elicit primary information from domain experts in the fields of Water Management, Crisis Management, Knowledge Management, Public Health, Human Security. The chapter goes on to offer an overview of the chosen research collaborator, the Finnish Water Forum (FWF); providing background to the organisation and its role in crisis and disaster management. The structure of the organisation and reason for its existence are detailed along with relevant members who provided information pertinent to the research. The primary information collection method is then detailed, with information collated and discussed in order to form a draft framework ready for expert evaluation in the next chapter.

4.1 Case Study

The requirement for primary information in order to triangulate secondary information detailed within the Literature Review drove the need for a case study to be conducted. By utilising an organisation with many years' experience in Crisis Management, the researcher was able to synthesise a framework that reflected the current theory and practice without compromising the need to produce a unique piece of work. The case study offered the best overall solution to the problem of information collection from a small population ordered by a single organisation. Such empirical study helps alleviate the problems concerned with theoretical research; namely, an inability to gather information outside of the original research questions through serendipitous conversation with those actors consulted (Yin 1994).

The social sciences tend to utilise the *case study* method when exploring a single entity in detail and usually for the collection of qualitative data or information. The justification for such an undertaking is given when the number of cases explored is small, Informants few which therefore limits the positive impact of data collection methods where a large group is required (Gomm, Hammersley and Foster 2000).

The case study approach covers interaction with a particular instance or organisation without exerting influence or control over informants. Rather, the focus concerns in-depth understanding of the organisation or contextualised research question. Such a case study can help develop a theory or test a question in order to create new and relevant Knowledge (Yin 1994).

Grounded theory was employed through the case study to allow for a framework to emerge based on both primary and secondary information collection (Bryant and Charmaz 2007). This allowed for a theory to emerge that created the draft framework and provided proof of concept ready for validation and final framework construction.

Furthermore, the epistemological standpoint of positivism advocates working with an observable social reality and thus centres itself around the need for a detailed methodology capable of delivering concrete generalisations which can be tested and validated through third-party interactions (Saunders, Lewis and Thornhill 2007). Therefore, a case study not only provides structure whilst simultaneously allowing theory to develop, but also makes provision for generalised outputs that may be readily tested through law-like generalisability.

Due to the plethora of conflicting information available from the Crisis Management sector, obtaining definitive *truths* as to the correct method and content for a framework. Other means of collecting information were considered inappropriate such as the use of only secondary information without triangulation with current thinking and practice within the community.

The case study method provides the researcher with a neutral standpoint from which to view the situation and hence collect impartial information without undue influence on Informants. However, it must be remembered that all witnessed observation may have an impact on what is said and how it is interpreted.

Such micro-level information gathering was further embellished by the use of previously and subsequently collected secondary sources detailed in the Literature Review chapter. This provided both meso- and macro-level information capable of contextualising the primary sources within a larger environment. As detailed in the Research Methodology chapter, informants outside of the original group validated the resultant framework.

The conclusions drawn from the case study approach are often generalised and hence, afford the researcher the opportunity of creating outputs capable of being applied to numerous instances of a particular problem domain (Scapens 1990). Thus, the case study method was considered an ideal approach to this research as it best lent itself to the problem of collecting generalised information as regards water and Crisis Management in order to create a systematic framework capable of delivering structured strategic, tactical, and operation elements within any given crisis scenario without the need for major redesign.

Such a method is not without its problems: the very fact that a generalised output is obtained can result in weakly formed arguments leading to fuzzy analysis and incorrect conclusions. In order to mitigate this aspect, the initial framework created was validated by another set of actors outside of the Finnish Water Forum and for whom the priority was application of outputs rather than formulation. In addition, the validators were chosen for their expertise across at least two of the originally identified problem domains expressed in figure **2-1**.

4.2 Finnish Water Forum (FWF)

The FWF (2011) describe by themselves as being “... a joint network of the Finnish private and public water sectors. It serves as a platform through which commercial enterprises, government and non-government organizations, scientific institutions and water-related associations can consolidate their water Knowledge to find solutions for global water challenges.

Finnish Water Forum (FWF) serves as a contact point for any enquiries related to the Finnish water industry, technology, science and management. The expertise and high standards of its members make FWF an excellent entry point to the Finnish water sector and its services. FWF members have a long experience in the world market, offering efficient engineering and consulting services. Through FWF this competence is supplemented with high quality expertise in institutional and administrative matters and in education and research.”

4.3 Unit of Study - Finnish Water Forum

The *unit of study* is defined by the boundary of primary research and therefore consists of the Finnish Water Forum’s constituent members (Remenyi 2012). Such a unit of study was chosen in order to provide a definitive boundary to the research and hence contain the information being gathered within the field of water-based activities concerned with crises and their scenario-specific constituent parts. Such an approach is considered normal within the social research and thus relevant to this study (Yin 1994).

Umbrella organisations such as FWF provide governments, academic institutions, and private companies an opportunity to collaborate on a myriad of projects that, in turn, receive an increased chance of success due to the cross-pollination of Knowledge, skills, and ideas. In addition, the recent global economic downturn has encouraged organisations to seek collaboration as part of their respective cost-reduction strategies.

With the added involvement of government and NGOs any such organisation can provide advice and support whilst aiding in the creation of national and international standards, modes of operation, and best practice. In addition, governance is often part of their remit thus closing the loop and allowing for incremental improvements to be made over time to any policy as knowledge is gained and errors corrected.

Such organisations also provide a ready-made infrastructure into which interested parties may imbed themselves as a permanent fixture or for a limited time in order to solve a problem or achieve an objective which requires specialist knowledge and skills which are on-tap within such a collection of actors.

The FWF is particularly pertinent as its remit concerns the multi-faceted arena of water and reclamation that is of global concern and of paramount importance in times of normality or crisis. FWF has many collaborators whose individual expertise, when combined, provides a comprehensive combination of strategic thinking, tactical planning, and operation activity.

Finland has a highly-development Crisis Management industry, providing research, education, and consultation services to an international market. FWF has links with the UN as well as other NGOs and governmental organisations in addition to universities, associations and private companies. This is somewhat understood when one takes into account the fact that Finland has over one-hundred and ninety thousand lakes along with six-hundred and fifty rivers, not to mention the prevalence of ground water sources. Many of these resources are shared across international boundaries and, as such, require shared governance in order to protect the water-based assets as they cross borders and are influenced by deferring styles of government.

The expertise gained from such resource management made the FWF an ideal candidate for collaboration as their sophisticated infrastructure provided the opportunity for contacting and subsequently interviewing several different organisations under the FWF umbrella; thus allowing for a much wider scope of opinions and viewpoints whilst retaining unity of purpose.

As the set from which actors could be drawn was small, the research was bounded by a micro-level case study with seven initial actors and a further five validators. However, considering the size of FWF, the number of contributors employed represented a large percentage of the organisations' personnel directly engaged in activities relating to the research area.

FWF (2011a) is based in Helsinki and provides a network for collaboration in all things water related. The forum (figure 4-1) consists of several Ministries, along with numerous research institutes, universities, schools, and private enterprises; in addition to links with other associations.

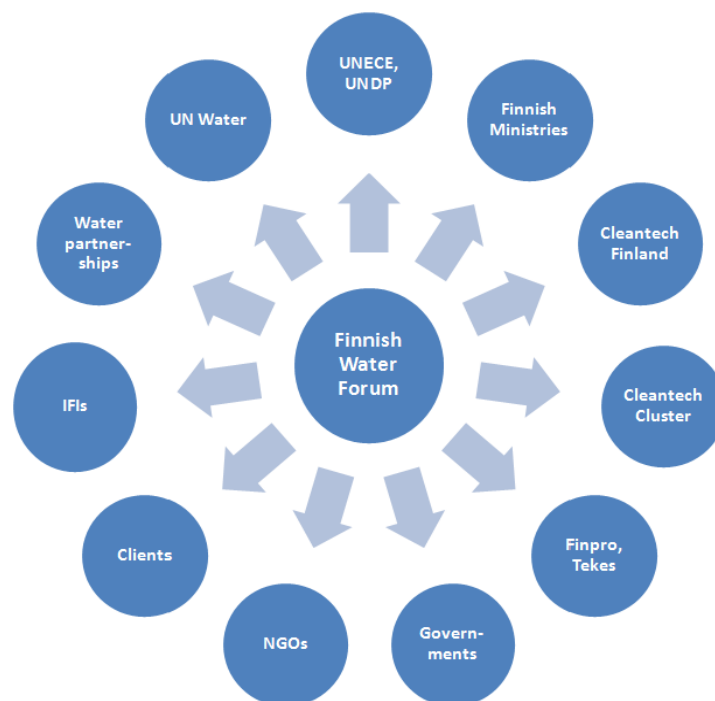


Figure 4-1: Finish Water Forum Members

4.4 FWF Organisational Structure

“Finnish Water Forum was an association consisting of institutional members representing a wide field of actors both from public and private sectors. The highest authority of FWF is the General Assembly meeting at least once a year. The General Assembly elects the Chair and other members for the Executive Board.” (Finnish Water Forum 2011b).

The forum was managed at the time of this research by two personnel:

- Managing Director: Ms. Katri Mehtonen;
- Project Manager: Ms. Saija Vuola.

This provided a streamlined structure that allowed members to exchange ideas and methods of operation in addition to collaborating on numerous projects. Whilst the management structure is small, its ability to garner influence was substantial due to the fact that the Executive Board was Chaired by Under-Secretary of State for Finland: Anne Sipiläinen, who provided guidance on public policy issues and aided in international collaboration opportunities.

4.5 FWF Reason for Being

FWF (2011b) quantified its reason for existence as being:

“Mission - Finnish Water Forum’s mission is to promote Finnish water knowhow and to develop sustainable business and cooperation opportunities for a wide spectrum of Finnish water sector actors internationally.

Vision 2015 - We are in a strategic position for promoting export opportunities within the water sector. We are a focal point in exploring and assessing potential water related projects and their potential funding.

Definition - By export business development FWF we mean a broad spectrum of water-related expertise: good governance, expertise on water legislation, capacity building, research, education, consultancy, technology, technological products, chemicals and combinations of all of these.

Values – Transparency; Flexibility; Partnership; and Responsibility”.

FWF (2011b) states that “The objective of the Finnish Water Forum is to promote collaboration between private and public water sector in Finland and strengthen its capabilities and competitiveness. Moreover, FWF supports the implementation of water related strategic objectives in development co-operation and other international activities. Meeting these objectives, FWF will:

- create and support joint thematic networks between public institutes, universities, private enterprises and NGOs;
- assemble and transfer water related information between international water-related organizations and Finnish water sector;
- promote the visibility of the Finnish water expertise at international forums;
- facilitate planning and implementation of water related projects.”

4.6 FWF Imperatives

FWF provides a central point for all actors within the field of water based research, design and technological applications. As such, it’s imperative is to introduce said actors to one another and facilitate co-operation through joint projects, sequential projects, and knowledge sharing. Hence FWF have several layers of operation, from that of a strategic concern, through tactical considerations, and on to the operational tasks required to realise the strategic intentions.

4.6.1 Strategic Objectives

FWF has the strategic goal of facilitating Knowledge sharing and inter-organisational co-operation through the administration of a common forum, affording all actors and stakeholders equal status in order to facilitate effectiveness management to achieve common targets. This allows many disparate organisations to work together so as to reduce the need for duplication of effort whilst gaining maximum leverage for individual organisational core competences. This has the overall effect of providing ‘best in field’ solutions to companies and governments worldwide.

4.6.2 Tactical Requirements

FWF make provision for real and virtual spaces in which organisations and institutions may *blue sky* particular problem loci and therefore decrease the time lag between problem identification and solution building. Allow conversation to occur between actors without the pressure of tangible outputs; rather, a free forum in which ideas may be expressed which aids in the formulation of new and innovative solutions.

4.6.3 Operational Concerns

Provision of marketing materials and conference events to encourage potential Informants to join the discussions whilst maintaining cross-institutional support from those already invested with FWF. A directory of potential partner institutions for any given project within associated fields which allows those looking for potential collaborators to make quick and effective contact-oriented searches.

4.7 FWF Key Informant - Kuopio Innovation

Kuopio Innovation was used as part of the FWF Informants as it liaises with business and academia on the theme of water resource utilisation. It is based at *Kuopio Science Park* in Kuopio, Finland. Its remit concerns water research in all its forms: from water surveying and treatment to quality monitoring and hygiene. One of its main contributors is *Savonia University of Applied Sciences* who focus upon water supplies, development methods for monitoring of water quality, and restoration of waterways and related process development.

The university has a test facility within Koupio Science Park capable of providing a pilot-scale water system to simulate real-world demands such as supply and pollution. The individuals who work on this system have gained Knowledge in the field of water treatment with disaster situations relevant to water and waste water contamination. This plant and associated processes are operated in conjunction with University of Eastern Finland who specialise in watercourse management and environmental microbiology. Hence, the combination of core competencies held by this organisation proved ideal in providing essential elements relevant to the framework construction.

Environmental informatics is also a key part of the University of Eastern Finland's remit within the science park that provided expert Knowledge as to the control and monitoring of water assets and infrastructure.

Finally, Kuopio Innovation also deals with the *Human Security Grid* that deals with aspects of Human Security specifically centred on water-driven capabilities and concerns. The purpose of the grid is to bring together stakeholders within the areas of business, education and research in order to provide a collaborative forum for those concerned with water-based Human Security issues.

4.8 Approach to Data Collection and Analysis

4.8.1 Primary Information Collection

The research centred on the aforementioned primary actors who provided expertise in each of the areas previously identified. A trip was organised through FWF and Koupio Innovations in 2011 to visit both Helsinki and Kuopio and thus each of the organisation's headquarters. This allowed for face-to-face meetings with each of the primary actors within their own facilities and comprised a tour of each domain, semi-structured interviews and a questionnaire so as to provide consistent information gathering across the spectrum of Informants.

The use of each participant's native environment was intentional so as to provide the most comfortable setting in which to conduct the interviews and hence avoid any unnecessary discomfort that may have influenced the level of interaction or granularity of information provided. In addition, it afforded the researcher an opportunity to experience first-hand the organisation and its method of operation which yielded greater information in the form of leaflets, pamphlets, and magazines as well as prompting further conversation as part of the tour.

The primary actors were chosen to represent each key element identified in the original Venn diagram detailed in figure 2-1. These centred on the application of each element within the confines of water supply and reclamation. Each participant was asked the same set of questions as part of a semi-structured interview that ensured consistency whilst allowing for impromptu conversation pertinent to the problem domain being explored. Figure 4-2 illustrates to chronological flow of each visit.



Figure 4-2: Primary Data Collection Flow

4.8.2 Interview

An interview consists of a meaningful discussion between two or more people where the context of the discussion may be highly structured to achieve consistent answers that may be readily compared (Saunders, Lewis and Thornhill 2007). However, the interview may also be semi-structured to allow for a free-flowing discussion capable of delivering detailed answers to open questions which may take many different forms and provide much more information than originally envisaged.

The interviews took place between 12th and 16th November 2011 in Finland in Helsinki and Kuopio. Both FWF and Kuopio Innovation aided in the bringing together of those actors chosen which aided in providing an atmosphere of collaboration. The interviews lasted approximately two hours but were further extended through the addition of guided tours around each of the collaborators' installations within the innovation site and their independent facilities. Thus, on average, the contact time with each participant was in excess of six hours and covered more than the initial questionnaire which provided a great detail of contextualisation and supplementary information as to the work undertaken and reasoning for its use.

The focus on the interview was not to gain their opinion of Crisis Management; rather, it was designed to investigate each participant's individual organisation and respective method of operation. This resulted in primary data that described the current modes of operation and organisational structures under which each existed in order to provide an understanding as to the current state of Crisis Management. When combined with the secondary data analysed in the Literature Review, a draft framework could be created which addressed some of the problems identified with regard to the identified research question and problem domain.

4.8.3 Questionnaire

A questionnaire is often used to garner information where the population surveyed is large or where consistency of response is desirable. Such primary information collection methods are common within case study research and as such formed the core information gathering technique for this research. As previously mentioned the use of such a method as part of a semi-structured interview provided a mixed approach that provided structure whilst making provision for informal conversation concerned with the research and associated topics.

One questionnaire was used for all FWF Informants so as to provide a unified approach to data collection; a copy of which may be found in appendix C. Subsequent framework validation was undertaken using another set of Informants, utilising a different questionnaire pertinent to the problem being addressed; namely, that of analysing the draft framework so as to provide feedback and creation of the final outcome framework.

The questionnaires submitted to FWF consisted fifteen questions which were split into the standard triumvirate for Knowledge Management; namely, *people*, *process*, and *technology*, with the adjunct of *sense-making* to provide an additional lens with which to evaluate the information being gathered.

People: the questions contained within this section were designed to explore the Knowledge base of the individual participant and their organisational schema.

Process: this covered the operation of each organisation and its respective command and control structure.

Technology: where and how technological aspects within the problem domain were utilised with respect to activities undertaken.

4.9 Conclusion

The need to gather primary information with regards to the imperatives of water within any crisis required input from those informants concerned with key aspects of water resource management based on supply and reclamation. The secondary information as to previous research and existing frameworks provided information that could be incorporated into any proposed solution. Once combined, the gaps in Knowledge and application of Crisis Management principles were identified and a framework constructed to plug these.

The result of such a case study was to prepare a draft framework capable of being tested by external cross-domain experts who would critique the output so as to make provision for the final framework. The draft framework identified key themes and principles that were carried forward into the final framework and associated conditions under which it was tested via a historical crisis incident.

Analysis of the information collected and creation of the resultant draft framework are detailed in the next chapter.

5 DRAFT FRAMEWORK

The need for a coherent and holistic Knowledge-based framework for water resource allocation is apparent when the use of current frameworks does not yield desirable results. This chapter provides analysis of information gained via primary data collection in order to identify key issues concerned with alleviating the aforementioned problem. Secondary information is combined through the different themes identified. The combined information is related to each of the proposed research elements and discussed in detail so as to provide a rich picture as to the constituent elements concerned with such a structure. A set of draft sub-frameworks is finally created ready for validation in the coming chapters.

5.1 Framework Overview

The initial framework was constructed through a combination of primary and secondary information. Thus, the resultant draft framework considers each of the originally identified elements of Knowledge Management, Crisis Management, Public Health and Human Security through the lens of water resource. The four individual thematic diagrams are built using each key operation associated with the interviews and questionnaires. Commonalities are expressed through connections between each theme and relevant operation.

The relationships between the different concepts was then made explicit in sub-frameworks that represent different 'dimensions' of Crisis Management, with a view to combining them at a later stage in the research.

5.2 Results

As detailed in chapter four, the Finish Water Forum was utilised as the umbrella organisation under which individual stakeholders were used to provide Knowledge and information with regards to particular aspects of the delivery of water resources during times of crisis. This was achieved through the application of several lenses, all of which have been covered previously.

The results of the analysis of information gathered took the form of *mind-maps*, that is, information organised in the form of diagrams with focus on concepts and relationships, constructed during the interviews and consisting of both the immediate answers to the questionnaire, along with additional information presented as part of the semi-structured discussion that was interwoven into the interviews.

Once the mind-maps had been collated by theme, the table in appendix D was created in order to compartmentalise the information in the first instance. The detailed discussion concluded with the construction of a series of charts detailing each of the four elements originally identified as part of the secondary information collection and analysis. Outlines of the interviews may be found in Appendix C.

Once the table was created, key themes were identified and used to formulate the headings given in the following discussion. Finally, a series of draft sub-frameworks were constructed based upon the identified themes, interlinking the aforementioned headings into a coherent set of tables, each focussed on an individual element as laid-down in the original Venn diagram.

5.3 Analysis and Discussion

Given the results from the semi-structured interviews conducted at Finish Water Forum (chapter four), the elements in the following subheadings were identified (appendix D). Each of the areas is categorised by primary data topic and discussed in detail. This provides background as to the content and inherent aspects in order that a draft framework could be created for further validation by a group of chosen experts.

5.3.1 Water

As the allocation of water forms the crux of this work, it was be considered before all other elements so as to be at the forefront of all other discussion around this topic.

As has already been covered in other chapters, it is without dispute that provision of potable water and reclamation of brown water is of paramount importance in any given crisis scenario (Chang and Shinozuka 2004). Therefore, confirmation of this fact was left unchallenged by any of the Informants; all of who agreed with the core concept of water delivery and return.

Table 5-1 details each key fact given by a respondent and the number of corroborating responses. Based on the fact that informants were questioned, each issue raised could be confirmed or denied by other informants. These are discussed in the following sections and constitute the draft framework content. Each fact was derived from the primary data mind maps in appendix C were at least two participants out of seven agreed (29%). This number was chosen due to the knowledge domain of each informant occurring at least twice. Therefore, if both informants agreed on the same point confidence was considered to be at an acceptable level due to corroboration by two individuals. However, due to the multidisciplinary nature of each informants work, agreement from any two was considered sufficient for the fact to be considered bona fide at the draft framework stage.

WATER		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	• Clean water provision and dirty water removal at the center of water provision.	100% (7/7)
	• Adequate road infrastructure required for bowser/tanker transportation to be effective.	43% (3/7)
I2: CM/KM	• Potable water provision to ensure health of populace.	100% (7/7)
	• The need for supply and reclamation infrastructure integrity: agreed level-of-service to ensure compliance with demand and quality.	86% (6/7)
I3: CM/HS	• Clean water as a health issue: health quickly deteriorates without access.	100% (7/7)
	• Ability to provide clean water to those in need essential to management of situation.	100% (7/7)
	• Crisis management of treatment plants as part of resilience planning.	29% (2/7)

	<ul style="list-style-type: none"> • Assessment of crisis situation with regards to supply and reclamation: how improvements can be made during crisis. 	71% (5/7)
I4: PH/Water	<ul style="list-style-type: none"> • Provision of brown water (excrement) reclamation to reduce chance of secondary contamination, infection or disease. 	100% (7/7)
I5: Water	<ul style="list-style-type: none"> • Water standards and current supply quality used as a baseline for crisis quality expectations. • Sanitation as prevention of secondary issues: displaced persons affected by lack of hygiene. • Introduction of temporary treatment plant to alleviate 	29% (2/7) 29% (2/7)
I6: PH/Water	<ul style="list-style-type: none"> • Drinking water for all: bottle, bowser, or mains supply imperative to stave-off secondary crises. • Washing to maintain hygiene important for health and mental wellbeing. 	100% (7/7) 86% (6/7)
I7: CM/HS	<ul style="list-style-type: none"> • Getting water to those in need in a timely manner • Equipment reinstatement after crisis has occurred. 	100% (7/7) 71% (5/7)

Table 5-1: Primary Data Consolidation - Water

All Informants agreed that the main problems associated with water were mostly centred-on that of delivery and quality, with the need for a water supply that did not introduce secondary crises into the environment through infection. As all Informants stated, consumption of non-potable water already provided a cause for concern as most areas affected by large-scale crises are usually to be found in developing countries whose quality and availability of water may well fall below that of the developed world.

Temporary water infrastructure was considered high on the agenda within any crisis situation where medium to large populations were at risk. As stated in section 2.7: where only small populations were affected, water could be provided using bowsers (large portable water storage vessels) and on-site water sanitation equipment.

Based on the need for infrastructure, the pre-crisis level-of-service would need to be assessed along with crisis severity so as to establish the amount of work required for reinstatement or replacement of any such tangible and intangible assets. Therefore, the Informants were most concerned that assessment of the current situation be taken into consideration when formulating a relief effort so as to allow for maximisation of effectiveness with regards to the overall provision of potable water (Chang, Svekla and Shinozuka 2002).

Once potable water had been re-introduced, the focus should then shift on to that of reclamation and sanitation in order to, once again, prevent secondary crises through infection. This is often more complex than the provision of potable water as the removal and treatment process is difficult to instigate and maintain through either biological or chemical treatment plants (Thames Water 2011). Therefore, it may be necessary to introduce temporary treatment plant to cover the need or mass-tankering of waste away for the populated area for disposal or treatment at a later date. However, as three Informants stated, such a solution is fraught with difficulty due to the need for serviceable roads and a large fleet of vehicles and accompanying operational personnel.

The need for water to be used for washing of humans, clothing, living space, and cooking ancillaries will also need to be taken into consideration for the same reasons as previously detailed; namely, that of sanitation. Once this has been addressed, then a tolerable living standard has been reached, after which, reinstatement or creation of new infrastructure can take place without concern for secondary disaster due to poor sanitation.

All of the above is purely concerned with the provision of potable water and removal of waste. In addition to this imperative, Crisis Management activities were identified which were seriously impacted upon by the necessity for water and sanitation.

5.3.2 Crisis Management

As the first of four key elements identified through relevant literature, Crisis Management provides an important lens through which to view the provision and reclamation of water. As has been explicitly detailed in the previous section, management of each scenario in order to provide tailored solutions is imperative, therefore, the use of Crisis Management tools and techniques impact greatly on the ability to make such provision (table 5-2).

KEY ELEMENT #1: CRISIS MANAGEMENT		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Command and control of crisis scenario required to facilitate efficient and effective solution in shortest possible timeframe. • Availability of financial resources for workers and goods procurement. • Introduction of skilled personnel into crisis arena. • Inclusion of Knowledge Management strategy to allow for command of scenario. • Entry/Exit strategy: knowing the identified metrics for insertion and withdrawal. • Resilience planning in preparation for common/major crisis modes. • Education of locals to provide crisis relief and reinstatement of assets; e.g. Reservists. 	<p style="text-align: center;">100% (7/7)</p> <p style="text-align: center;">86% (6/7)</p> <p style="text-align: center;">100% (7/7)</p> <p style="text-align: center;">43% (3/7)</p> <p style="text-align: center;">43% (3/7)</p> <p style="text-align: center;">100% (7/7)</p> <p style="text-align: center;">57% (4/7)</p>

	<ul style="list-style-type: none"> • Removal of media <i>hotspots</i> to ensure aid gets to those most in need. 	29% (2/7)
I2: CM/KM	<ul style="list-style-type: none"> • Defined reporting lines for aid/relief organisations. • Security of expensive resources to prevent theft. • Resource utilization to manage crisis. • Availability of skilled personnel as responders. • Cash availability as payment for people and services/goods and equipment. • Data collection and analysis to provided effectiveness and efficiency improvements for future instances. • Refugee reduction through a safe environment from which nobody need leave. • Integration of software for monitoring and information sharing within the crisis. • Knowledge-bases capable of providing key information and learning for those effected by crisis before, during and after the event. 	<p>71% (5/7)</p> <p>29% (2/7)</p> <p>71% (5/7)</p> <p>71% (5/7)</p> <p>100% (7/7)</p> <p>43% (3/7)</p> <p>43% (3/7)</p> <p>43% (3/7)</p> <p>57% (4/7)</p>
I3: CM/HS	<ul style="list-style-type: none"> • Secure resource compounds to protect valuable assets. 	71% (5/7)

	<ul style="list-style-type: none"> • Skills and knowledge within crisis arena needs consolidating for application of solutions. • Paying for actors in a timely manner. • Utilisation of information technology to co-ordinate efforts. • Use of mobile phone technology beyond that of phone calls: data gathering, internet, etc. 	<p>57% (4/7)</p> <p>86% (6/7)</p> <p>86% (6/7)</p> <p>71% (5/7)</p>
I4: PH/Water	<ul style="list-style-type: none"> • Interorganisational co-operation to facilitate coordinated response strategy and operational activities. • Supply integrity of water as an integral part of CM • Telemetry and automation of assets through mobile technologies. 	<p>71% (5/7)</p> <p>100% (7/7)</p> <p>57% 4/7)</p>
I5: Water	<ul style="list-style-type: none"> • Identification of who has what skill set and how can it be utilized in an efficient and effective manner? • Sustainability of supply and reclamation within the crisis scenario. • Level-of-service as regards availability and quality of crisis relief efforts. • Money and how to allocate. • Secondary crisis – sewage pollution. 	<p>71% (5/7)</p> <p>100% (7/7)</p> <p>71% (5/7)</p> <p>86% (6/7)</p> <p>100% (7/7)</p>

	<ul style="list-style-type: none"> • Use of mobile phone technologies for near real-time reporting of crisis escalation. 	86% (6/7)
I6: PH/Water	<ul style="list-style-type: none"> • Scenario ownership by both locals and professionals. • Law-and-order through both military and policing. • Application of stakeholder management and its implications for social cohesion as a force for good within any given crisis. • Cash required for reinstatement and running costs (sustainability). • Fossil-fuel pollution due to localized electricity generation. • Risk management to facilitate speedy crisis reduction. • Scenario planning based on previous crisis occurrences. 	<p>100% (7/7)</p> <p>100% (7/7)</p> <p>100% (7/7)</p> <p>86% (6/7)</p> <p>86% (6/7)</p> <p>43% (3/7)</p> <p>100% (7/7)</p>
I7: CM/KM	<ul style="list-style-type: none"> • Situation appraisal utilising reporting lines through which information is transferred. • Resource management to facilitate efficiency and effectiveness. • Financial management to <i>sweat</i> resources. • Risk management to prevent crisis escalation. • Use of locals to reduce professional aid agency presence. 	<p>43% (3/7)</p> <p>86% (6/7)</p> <p>71% (5/7)</p> <p>71% (5/7)</p> <p>86% (6/7)</p>

	<ul style="list-style-type: none"> • Leverage from existing technology available to general public, such as mobile phones, computers and social media. • Ownership remaining with locals to encourage involvement in solution planning and execution: prevention of water trading. • Exploitation of BYOD to coordinate efforts at every stage. 	<p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">86% (6/7)</p> <p style="text-align: right;">43% (3/7)</p>
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Table 5-2: Primary Data Consolidation - Crisis Management

All of the informants held similar opinions with regards to Crisis Management and its influence over crisis scenarios. The need to take control of any given scenario within the shortest possible timeframe so as to assess the situation before allocating resources greatly influences the effectiveness of operations as the resources required often compose of skilled personnel and expensive equipment which are both difficult to obtain and time-consuming to bring into force.

Two Informants spoke of the need for security being a Crisis Management concern as introduction of expensive tools and equipment into a socially unstable arena may result in anything from petty pilfering to major theft that further exacerbates the situation. Thus, the reinstatement of law-and-order will directly impact on the effectiveness of any intervention.

Effective Crisis Management can also inspire stakeholders to more efficient and effective interactions with their surroundings and other actors to effect change within the chosen environment. This can be utilised to provide inter-organisational co-operation through shared initiatives and mixed workgroups, providing specialised skills and Knowledge to solve particular issues without resorting to duplication of effort due to redundant problem-solving activities.

Therefore, Crisis Management is an essential component when applied to any given scenario as it provides opportunity for holistic management of the situation alongside efficient utilisation of resources in order to provide effective relief to those in need.

5.3.2.1 Sustainability

The two informants for whom water was their domain of expertise explicitly stated sustainability of water supply and reclamation and the management of resources and equipment is required in order to provide a reliable level-of-service commensurable with the standards of hygiene set-down by the primary operator within the crisis scenario. This may be provided through the use of high-quality personnel and equipment capable of being operated and maintained to a standard that provides adequate supply of potable water and treatment of reclaimed waste. This can be difficult to maintain within a crisis as the availability of people and technology may be limited.

The need for a free flow of money from the state and/or aid agencies directly to the local actors involved in activities surrounding the aforementioned operation and maintenance of plant and equipment is important if the trust of locals is to be achieved. It is often the case that foreign companies involved in Crisis Management operate as a modern business; invoicing for work done and making provision for employees through well-established salary schemes and bank transfers. However, this is not always common practice if local actors are used to *cash-in-hand* and does not therefore conform to their normal method of operation. Thus, if a sustainable workforce is to be employed, some of whom may be left in place after the crisis subsided, a cash economy is often required to sustain local interested and build a sound local economy.

In addition to the economic factors concerned with sustainability are the environmental issues that impact upon the crisis relief effort and local ecology. The introduction of chemical treatment can lead to poisoning of the surrounding environment in addition to the already present pollution caused by sewage and unsanitary conditions (Werner, Altenburger, and Schüürmann 2015). Therefore, consideration must be made for the impact of both crisis-based factors and those introduced by the relief effort. Hence, the use of alternative energy as a power source may be important as the introduction of a multitude of diesel-powered equipment can introduce many different pollutants into an already vulnerable environment (Nebhay 2012).

5.3.2.2 Risk Management

By its very nature, risk is an integral part of any activity undertaken by an individual or group of actors. This is further compounded by the activity being set within a crisis scenario and thus requires focused attention. When crises occur, many national and international aid organisations offer help and support in the form of individuals sent to the crisis theatre; this can hinder those already involved in the relief operation as the skills and capabilities of said organisation may be inadequate for the problem at hand.

Therefore, two of the Informants explicitly identified the need to manage risk in as far as allocation of correctly skilled individuals. This is of great importance whilst simultaneously being a drain on the resources for those in command of the situation. The need to manage additional risks concerned with the aforementioned secondary crises is also of concern as resources engaged in solving one problem can quickly escalate another due to mismanagement or unforeseen events. Thus, risk management strategies need to be in existence that allow for the free-flow of information so as to empower those operating in, or affected by, the crisis scenario. Hence, the four facets of risk management were introduced into the framework to facilitate risk-reduction policies. The four facets are:

- Risk removal;
- Risk mitigation;
- Risk transfer;
- Risk acceptance.

Each of the above identifies a particular way in which risk may be tackled. However, within the arena of business in general, risk is often seen as a limiting factor. The shift of focus from maximising opportunities to minimising risk can reduce the effectiveness of company performance (Drucker 2007). With this in mind, the need to maximise opportunity can be said to be even greater when applied to a crisis scenario as timeliness of action may have far-reaching consequences. The need to reduce risk whilst maintaining momentum is one which needs to be applied to any Crisis Management strategy in order to produce results which are relevant given, not only the severity of incorrect action, but of no action at all.

5.3.2.3 *Entry/Exit Strategies*

As can be seen from many modern conflicts and humanitarian interventions, a coherent exit strategy is either not apparent or non-existent; from the United Nations peacekeeping activities in Bosnia to its humanitarian undertakings in Ethiopia. Any given crisis intervention requires both a planning interjection into the situation, a well-planned engagement strategy, and corresponding exit component which can deliver both timely and accurately placed assistance couple with well-understood timeline initiatives which respond to humanitarian needs whilst allowing for the effected population to envisage a time when a steady-state will return to their area (Mutimer 2015).

Many previous interventions have failed to incorporate this that has led to *victimhood* on the part of those affected along with the creation of an economy reliant on perpetuation of the crisis state imposed (Schnabel, Halabi and Noor 2013). Therefore, it is essential that both entry and exit strategies be formulated as part of the proactive planning and/or reactive operations dependant on the crisis scenario at hand.

Such strategies may cover the replacement of military style relief efforts with a civilian-oriented reconstruction phase alongside the transition from external actors to those within the boundaries of a given sovereign state and local geographic. Hence, all informants talked about the need to identify and implement milestones capable of instigating such step-changes being crucial if a post-crisis stage is to be successfully enacted.

The initiatives that cover these activities is often marred by those whose interest lies with retaining the current status for the purpose of profit or political influence, both of which can perpetuate the state of crisis. Thus, those in control must be made aware of the temporal nature of their presence and the desire to remove them as soon as practicable. As stated through secondary information, the United Nations has suffered from a reluctance to leave crisis situations as the consolidated efforts of those involved has not resulted I the desired outcome; often due to a lack of foresight as to the feasibility of their aspirations, coupled with a predisposition to self-perpetuation.

The reluctance to leave can also be influenced by that of the local authorities as the exiting of such large-scale organisations as the UN can create a vacuum with regards to financial support, often signalling an end to financial support from the international community. This, combined with the removal of military elements that not only provided logistical infrastructure, but provided the often-needed security of those engaged in the relief efforts, further compounds those negative influences brought to bear on those attempting to provide post-crisis support.

The removal of such entities can also result in a mass exodus of refugees from the affected area as the removal of security forces and international-based infrastructure implementers is often connected with a determination in the status of existence for those whom the crisis has impacted. Furthermore, such cause-and-effect may well have the resultant impact of producing a new crisis, secondary to the one for which the external actors were originally assigned.

5.3.2.4 Resilience Planning

The very nature of proactive Crisis Management demands that resilience planning be taken into consideration so as to mitigate risk to certain scenarios considered to be of significant importance. Community resilience is at the centre of many locally based initiatives whilst the need for countrywide strategic, tactical and operational initiatives is often overlooked. Therefore, a consolidated effort is often required to encourage those in power to see the value in scenario planning to increase resilience as an integral part of the Crisis Management process.

The primary factor with such planning is cohesion between disparate factions within government, their associated agencies, and the international relief organisations who may intercede when resilience plans fail. It is not uncommon for the conflicting priorities of these organisations to become the focus of effort that would be otherwise allocated to reducing and removing the crisis situation.

Such planning is designed to aid in the formulation of co-ordinated approaches to particular crisis situations in order to prevent such infighting from becoming a problem. Primary information confirmed that this could range from the formulation of single command and control structure to integration of communication systems in order to facilitate Knowledge sharing.

Community resilience focuses on the need of a local population to be self-reliant when certain crisis modes ensue so as to make provision for water resource functionality whilst preventing breakdown in social cohesion and hence mitigate the risk of secondary crises coming into existence. Such need is further impressed upon by the social capacity within the local community for education and vocational skills learning in order to present solutions to problems as and when they become apparent (Holzer and Warren 2014).

Community education schemes often take the form of practical introductions to the functionality of plant and equipment used within the crisis sphere but are often limited to superficial operational tasks and hence lack the underlying theory required in order to empower those affected with the knowledge to maximise utilisation of said equipment in the mitigation of crisis across multiple platforms and failure modes. This lack of training further compounds the ineffectiveness and inefficiency of often-expensive tools and equipment being under-utilised during times of need and therefore presents a new failure mode of its own.

In addition to such initiatives, there is also the need for localised planning; be this in the form of land planning of flood plains and run-off areas, or the need to provide volunteer groups capable of delivering essential skills and services in times of crisis. As described during the general discussion with Informants, three thought that the above should be coupled to such endeavours as the application of *Bring Your Own Technology* (BYOT) which is currently utilised to great effect within the business sector in order to gain leverage from the technology currently in possession of employees in order to provide business benefit without the need for capital or operational expenditure beyond that of creating integration and convergence of existing technologies.

Inclusion of such equipment by government agencies and external organisations is an important element in any resilience plan, allowing for the use of technology already in place and without requirement for initial training or periodic refresher courses.

Undertaking risk assessments and learning from previous iterations of similar crises allows for the community-at-large to benefit from proactive resilience planning which draws upon lessons-learnt in the formulation of crisis response to a myriad of potential hazards.

5.3.2.5 Weak and Strong Signal Identification

By undertaking risks assessments, those in a position to do so may impart skills and knowledge accrued during prior undertakings with regards to crisis mitigation and operation undertakings without the need to resort to naive strategies devoid of historical knowledge. In addition, the collection and collation of data and information pertinent to particular crisis modes can provide stakeholders with relevant information which can influence the actions required to bring said crisis to a timely closure whilst allowing for the regrouping of primary actors in order to help prevent secondary crises from occurring. Such signal identification can take several forms, from that of knowledge sharing of historical information and associated lessons-learnt, to the creation of new strategies based on previously unmined information influenced by prior failure modes. Hence, the inherent value of signal identification is found in its influence on Crisis Management and its influence on mitigation of particular crisis scenarios.

Signal identification may take the literal form of sensor-networks capable of providing early warning of imminent danger to local and national communities. Such systems have been in existence for many decades but were traditionally the preserve of national agencies or university-based research entities. However, all Informants mentioned that with the advent of personalised mobile computing though the use of smart-phones and associated *apps*, the democratisation of data gathering and dissemination has seen a shift to citizen-based information gathering and utilisation.

For example, the use of smart-phone accelerometers in the detection of seismic events has been used in recent years as a cheap alternative to dedicated networks. Problems with data inaccuracy being mitigated through the use of software which averages data collected from a very large number of devices within the local (Minson et al. 2015).

Such data collection techniques are readily transferable through simple applications capable of providing data and information in ready-to-use formats that require little, if any, training but provide near real-time input in to crisis scenarios.

Alongside such data availability is the rise of *lite* applications which are easy to write and often given away by their authors free of charge and without intellectual property rights. These applications allow users to interact with data streams which were previously unavailable to them and thus allows for the creation of new networks which may be impromptu and transient without the need for large capital investment and long delivery timeframes (Li et al. 2013). Applications that prove useful are utilised across the affected community whilst those that serve little purpose are abandoned at little or no cost to the user.

It is of great importance that such technological advances are included in Crisis Management as it provides local actors with the ability to interact within international aid organisations and thus make provision for an integrated response strategy to be enacted without disenfranchising those for whom the crisis is a reality affecting their community.

5.3.2.6 Escalation Prevention

Escalation prevention deals with mitigating the chances of an increase in magnitude of the crisis currently underway or the prevention of secondary crises being brought into effect and thus compounding the current undesirable situation. One of the prime areas for concern deals with law-and-order within the crisis scenario; historical crises have often seen escalation in the situation due to criminal acts undertaken due to a breakdown in social cohesion and societal norms. It is therefore necessary to design plans capable of implementing law enforcement strategies in order to both contain the crisis and prevent further escalation that may be difficult to mitigate once underway (Terry 2002).

Criminal acts are not limited to those perpetrated by opportunists who see a reduction in law enforcement activity as a signal for reduced risk of being caught. There are those for whom a state of unrest is desirable, where long-term gains may be sought through recruitment of locals into gangs, seizing of property as fortification, and looting of weapons and ammunition for organised and targeted criminal undertakings due the future; perhaps even in the post-crisis phase (Terry 2002). Thus, the need for comprehensive law-and-order activities is important not only for short-term stability but for long-term security.

As mentioned in previous sections, the need to reduce the change of secondary crises coming into effect is important for several reasons; namely, resource allocation may have to be split between the original need and developing need due to limited availability of trained staff, plant, and tools and equipment. Thus containment may actually reduce the primary crisis timeline if resource and materials can be properly allocated.

All Informants iterated that the requirement for containment of current situation as regards water allocation and supervision of supplies at hand, were integral to escalation prevention. This was due to both being open to *black-market* transactions when those most in need have little or no supply. By ensuring such essentials are readily available, the organisations involved in the relief operation may help prevent escalation through water trading.

Violent crime is also a major factor in the crisis scenario as it affects all those directly and indirectly involved. Those who are a victim of violent crime often go on to develop psychological trauma at a later date and affect those closely connected with them. Community members indirectly affected often change their patterns of behaviour in order to avoid the places and times at which the violence is most likely to occur; thus impacting relief operations through a reluctance to interact with staff, officials, and local organisers at allocated times and venues (WHO 2014). With natural disasters, there are usually secondary occurrences such as tremors and aftershocks. Therefore, it is important to assess the situation as quickly as possible in order to instigate the most appropriate relief effort and therefore reduce the chance of escalation as much as is reasonably practicable.

5.3.2.7 Infrastructure

The requirement for a concise infrastructure is essential in the delivery of water and subsequent removal of waste (figure 5-1), the infrastructure for which is known as *supply and sewerage*. Once a crisis has occurred, assessing the level to which infrastructure has diminished is of high importance as, once again, correct allocation of resources can be achieved through a comprehensive appraisal of currently capabilities.

By its very nature, infrastructure is a difficult thing to replace once damaged because of its complex nature and requirement for highly skilled workers with specialist tools and equipment. Therefore, the short-term solution is often to provide temporary equivalents to the fixed plant and equipment in order to make similar provision for water and waste without the need for extensive civil engineering. As previously mentioned, the possibility of such secondary escalations as *aftershocks* may also impact the priority to which permanent reinstatement of fixed assets is sought. Thus temporary, easily repaired installations may be preferable until a steady state may be accomplished within the crisis domain.

The introduction of temporary supply and reclamation plant is a difficult one to address given the inherent complexity of such installations. Therefore, repair and maintain should be the first thought whenever attempting reinstatement of such tangible assets. Therefore, it is important that any Crisis Management solution make provision for the training and allocation of personnel capable of reintroducing such crucial infrastructure requirements (Brown et al. 2012).

Informants agreed that whilst urban areas are often at the forefront of humanitarian efforts once a crisis is underway, rural populations should not be forgotten as their water and waste connectivity is often much simpler than that of larger conurbations. The reinstatement of such infrastructure may be achieved with much less effort and due to the level of complexity; local actors may be more readily employed in its repair and maintenance. Therefore, there is a real need for community education with regards to such aspects of self-determination that should not be overlooked by the Crisis Management agencies when constructing resilience plans.

Infrastructure once again relates to law-and-order, along with civic organisations and other stakeholders whose input into the pre-crisis topography was a daily occurrence. Without societal infrastructure it is difficult to introduce new actors and resources into the area due to a lack of co-ordination with regards to crisis mitigation.

5.3.3 Knowledge Management

As one of four key elements identified through secondary research, Knowledge Management should form an integral part of any crisis control strategy. A recurring theme through this research has been that of information identification and collection coupled with knowledge creation and sharing in order to provide all stakeholders with the information and Knowledge required to shorten as much as possible the crisis timeline and thus return the locale to a steady-state as quickly as is reasonable (table 5-3).

KEY ELEMENT #2: KNOWLEDGE MANAGEMENT		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Information confidence and its application to dissemination (information democracy). • Leverage must be gained from people, process and technology to fully utilize environment. • Process-orientation rather than results-driven diminishes the effect of good Knowledge Management. • Exploitation of social media is on the rise and should be embraced before, during and after, crisis. • Success-driven rewards for aid workers based upon good information gathering. 	<p style="text-align: right;">29% (2/7)</p> <p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">29% (2/7)</p> <p style="text-align: right;">43% (3/7)</p>
I2: CM/KM	<ul style="list-style-type: none"> • Lack of confidence in information available from unconfirmed sources or those without any professional standing. 	43% (3/7)

	<ul style="list-style-type: none"> • Use of people, process and technology to define the crisis scenario and arena thereof. • Avoid process focus and embraced goal setting as the best way to utilize Knowledge Management. 	43% (3/7)
		43% (3/7)
I3: CM/HS	<ul style="list-style-type: none"> • <i>Stakeholders</i> versus <i>actors</i> within the crisis domain: who is given what responsibility? • Use of <i>victims</i> as <i>actors</i> so as to maintain Human Security and social cohesion. • Use of technology in possession of such <i>victims</i> in order to provide an information grid to facilitate coordinated crisis response. 	29% (2/7)
		29% (2/7)
		57% (4/7)
I4: PH/Water	<ul style="list-style-type: none"> • Knowledge Management is the means, not an end in itself. • Use of local population as part of solution in order to enfranchise community. 	29% (2/7)
		57% (4/7)
I5: Water	<ul style="list-style-type: none"> • Water supply and reclamation exists within a complex environment which is reliant on key stakeholders/actors for it success. • Good processes are required for good practice to be employed and tested through metrics. 	43% (3/7)
		71% (5/7)

I6: PH/Water	<ul style="list-style-type: none"> • Use of short, medium and long-term HRM aids in the effective use of water for Public Health. 	29% (2/7)
I7: CM/KM	<ul style="list-style-type: none"> • People, process and technology are key to any Knowledge Management solution as they cover each and every aspect. • Governmental/NGO intervention and guidance as to data collection, collation and dissemination inside and outside of the crisis environment required to formulate efficient and effective response plans. 	<p>43% (3/7)</p> <p>100% (7/7)</p>

Table 5-3: Primary Data Consolidation - Knowledge Management

Knowledge Management plays a key role in all such activities as the possession of knowledge allows actors to make informed decisions based on factual evidence rather than *gut instinct*. With the advent of smart phones and localised technology, it is now possible to collect, collate, and disseminate information in near real-time to anyone with an interest. This has allowed aid organisations to make their data readily available and thus garner maximum leverage from its application.

However, this is far from a panacea, as the information relayed to those in the field does not constitute the entire picture. Two Informants talked about the many different factors affecting information confidence, from an individual's application of reason to the need for politicking, the information made available may be influenced and/or utilised in a multitude of ways. Therefore, there is a definite need for not only the information itself to be presented to those with an interest in events, but to provided decision support tools capable of advising them as to the best course of action for any given scenario.

The three Knowledge Management informants reiterated the triad of people, process, and technology, as it has become a paradigm for Knowledge Management. Therefore, the following sections will consider each of the Knowledge Management concerns raised in the interviews using this lens.

5.3.3.1 People

Those who are involved in the crisis at any stage, along with any person affected by said crisis are known as *stakeholders* because of their stake within the given setting. These individuals vary in both number and designation; from employees of organisations and the victims upon which they express influence within society-at-large, to government and other organisational groups as entities in themselves who influence both macro and micro-environmental factors (Mullins 2007).

The interviews conducted provided insight into the need for excellent people management skills to ensure maximisation of available human resources through the use of collaborative strategies and initiatives capable of delivering coherent operational undertakings supported by tactical planning.

The need for focussed human resource management presents itself in one of three ways:

- Short-term Immediate relief for those in-need;
- Medium-term initiatives intended to provided reinstatement of services;
- Long-term engagement with communities through localised application of state-influenced strategic intentions.

By applying a human resource lens to each of the above, planning and application of local, national, and international resources may be organised for maximum impact. Tis will facilitate not only structural rebuilding and integrity but societal reconstruction through value-added activities capable of sustain local communities and individuals.

The need to include victims is integral to any resource plan as it allows for individuals and communities to gain value and self-worth through game-full employment as part of both the relief and reconciliation processes.

It should not be forgotten that a provider allocates finance for anything within the remit of crisis prevention, crisis mitigation, or post-crisis rebuilding. Namely, an individual or group of individuals and should therefore be considered within the same sphere as actors on-the-ground. Often, financial resources are allocated based not only on need, but also on a set of desirable outcomes formulated by those in positions of influence (table 5-1). Thus, the people empowered to allocate such resource should be taken into consideration when planning and enacting any Crisis Management undertaking.

Government has a major role to play in the planning and enacting of any risk management strategy. Effective implementation of any plan helps to reassure affected communities of the capability and commitment of its leaders in bring about a successful resolution to any given instance of crisis. As an adjunct to this, the reinstatement of law-and-order has already been detailed but is directly influenced by strong government, capable of delivering workable solutions, available to all and timely in delivery.

The Literature Review explored large-scale organisations and groups such as the United Nations alongside those outside of that considered governmental. Both carry great influence over the potential success of resilience planning, crisis response, and post-crisis reconstruction. Hence, the need to identify with the wants and concerns of individuals responsible with allocating aid and assistance is crucial if the ability to gain maximum leverage from available resources is to be achieved. Therefore, all potential groups and organisations should be identified in the planning stage so as to offer the largest possible catchment area for potential stakeholders for any given crisis occurrence.

5.3.3.2 Process

All informants also raised the process by which Knowledge Management is employed as a cause for concern, with three citing a dislike of rigid processes that may prevent the correct action from being carried-out. However, it is important to state that the need for process is integral to any Knowledge Management programme for, without one, coherent strategies and operational tasks cannot be performed.

One of the problems with process-oriented paradigms is the need to distance the information being enacted upon from the person or persons affected by its action. This can serve to disenfranchise both the personnel performing the process and the individuals on whom the process is operated. Such a move away from the personal aspects of Knowledge Management can be seen in the application of customer services within the retail sector in the 1990s where those engaging with companies from whom help was being sought felt that their expectations were not being met due to a lack of personal interaction with staff. Rather, the informants felt that they had been reduced to a number and therefore were considered to be of little value to the organisation with which communication was being sought (Johnson 2012).

Customer Relationship Management (CRM) emerged in the early 2000s as a way of dealing with such disparity between customer and business. This management techniques focused on gaining leverage from the use of technology whilst employing human interaction whenever possible in order to validate the customers' experience with any given company (Johnson 2012).

One informant stated that aid organisations need to move away from the idea of *victims* within the crisis scenario by rebranding them as *actors*, in order to best leverage their skills and knowledge. It is reasonable to assume that the use of such CRM methodologies could prove useful during interactions employed through traditional means and those posed by the introduction of new technologies within the crisis arena.

If such changes in communication are to occur, then the requirement for processes capable of delivering customer-centric interactions in a real-time environment are essential. In addition, such interactions may well serve to encourage the reduction in secondary crises occurring whilst mitigating crisis escalation. When combined, these can help to bind communities together and help stabilise an already fractured demographic.

As can be seen from virtually any aid organisation, dealing with recurring crises within the same locale and demographic is almost inevitable. Therefore, the instigation of such customer-focused processes could also help in the creation of knowledge within the community affected and thus aid in the reduction in impact of future crises based on historical knowledge gained by those affected (Buttle and Maklan 2015).

5.3.3.3 Technology

The use of current technology and potential to employ any future technologies has been mentioned in many of the other headings within this chapter. However, it is important to deal with the topic as a separate entity as the utilisation of any technology suitable to the field can have huge ramifications with regards to efficiency and effective of all stakeholders.

As never before, technology capable of serving almost every form of Knowledge Management is available to anyone in possession of a smart phone and linked to a network. Thus, the potential for exploitation of this existing community of users is almost without bounds.

There is a real need to employ as many people as can be managed within any given crisis scenario. The greater the number of personnel able to operate in a coherent and co-ordinated manner, the greater the chance of any crisis being brought to a successful conclusion within the shortest possible timeframe. However, the limiting factor for utilising such large numbers of people from disparate backgrounds is the inability to assess individual knowledge and skills, and the allocation of these to particular tasks and activities.

The technology currently available in everyday life may also be brought to bear for collection and dissemination of information to others of interest. This has been seen by the use of social media in raising large sums of money that is allocated directly to aid workers who are sent to the crisis area based only on this initiative. This has both good and bad aspects but illustrates the immediacy of technology in garnering and allocating resources within a short period of time, directly to those for whom the resources were raised (Gao and Barbier 2011).

With the convergence of mobile phone technologies, society has seen the creation of small applications capable of being built quickly and distributed for minimal cost to all those who have interest in the situation. Such advances in computing provide a real opportunity for the creation and dissemination of programmes which deliver tangible benefits to those involved in the crisis scenario as well as making provision for historical data and information which may be made available to researchers and policy-makers in the future.

In addition to the mobile phone-based technologies there are such simple to use and inexpensive to purchase computers such as the *Raspberry Pi* which is currently being utilised by a spectrum of users, from school children to large corporations and state agencies. Such computers retail for a very small amount but have the capacity to produce generalised computing undertakings as well as bespoke, single-use activities; some of which may result in destruction of the device – again of little concern due to price (Raspberry Pi 2015).

The reduction in financial outlay for such computing technologies may be combined with a general reduction in ancillary peripherals in order to produce complex tools and equipment at minimal cost but with which much may be gained. Therefore, it is important to encourage developers in their creation of tools and equipment that may be used within any given crisis.

5.3.3.4 Knowledge Sharing

With the increase in both computing power and availability comes the ability to collect data and information in order to facilitate the creation and dissemination of new knowledge. Thus, there is an increased need for knowledge sharing to be made an integral part of the Crisis Management arena, especially between organisations (figure 5-1).

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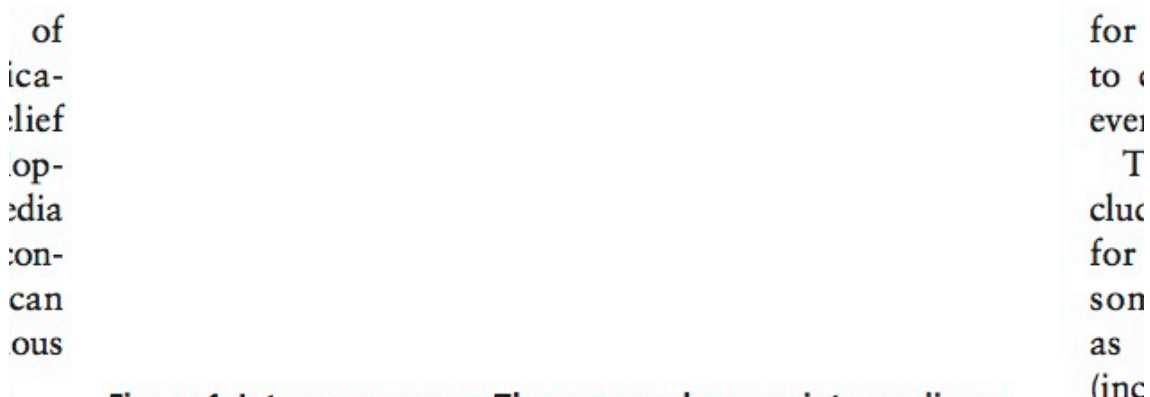


Figure 5-1: Interagency Knowledge Sharing (Gao and Barbier 2011)

All of the informants engaged in this research were, by the very nature of the interview, participating in knowledge sharing. With this in mind, it is not difficult to appreciate the need for discussion around the subject. The problem arises through the fact that most discussions taking place are rarely made available to a larger audience other than those directly engaged in the activity. This presents several problems due to a lack of multicast opportunity and the inherent limitations of such closed discussion.

The recording of meetings and presentations is integral to a knowledge sharing strategy which encompasses this information capture technique alongside the use of knowledge-bases, allowing all stakeholders access to correct and timely information through a common portal. Such interfaces are common in large businesses but rare within the field of Crisis Management where the stakeholders may be transient as well as numerous.

The use of technology is of primary importance when considering the conveyance of information to those stakeholders who can gain leverage from its delivery; provide too little and the actor may make poor decisions based on incomplete information; too much and the actor may well stop interacting due to information overload. Both of these are undesirable as they reduce the efficacy under which the Knowledge-sharing paradigm is based.

The key to circumventing such failure modes is through the allowance of autonomy to those engaged in operations whilst making provision for the integration of knowledge sharing activities within the daily routines of those involved. This helps to formulate an interactive culture without forcing users to engage with the knowledge platform or technology used for its delivery.

By encouraging freedom of use, both professional personnel and local actors may be encouraged to use the knowledge base as an adjunct to their current portfolio without impeding *best practice*. Coupled with this concern is the limitation of resources in times of crisis which directly relate to the number of operational activities enacted compared to those surrounding the tactical and strategic elements: the fewer the resources, the greater the likelihood that reactive undertakings will be the priority.

Two informants highlighted the focus upon prioritisation of reactive tasks as being seen as the only way to deal with any given situation. They further identified this as a misnomer; the need for planning and resource allocation becomes even more important when they are restricted in availability and nature. Therefore, strategic and tactical needs should be encouraged whenever possible as they can reduce duplication of effort and redundant solutions.

5.3.3.5 *Success-Driven*

The correct allocation of resources can quickly lead to more successful outcomes to those activities made a priority regardless of the crisis scenario. This can help instil a success-driven culture for the duration of the crisis that aids in the provision of timely solutions delivered in the most efficient and effective manner possible.

The idea of success-driven culture is a well-established one, being utilised in nearly all forms of business to improve performance whilst gaining the maximum focused input from those involved (Drucker 2011). Outside of the private sector however, there seems to be a lack of success-driven initiatives. It has been proposed that this is due to the absence of competition within the public sector. For example, the United Nations is not used to *benchmarking* itself against other NGOs within the aid and relief sector. The absence of self-appraisal may lead to a lack of self-awareness with regards to effectiveness of operations and thus harbour inefficient and bloated methods of operation.

Whilst bonus schemes and performance-related-pay may not be the answer for aid organisations, there remains the necessity for *lean* operations in order to make best use of money and human resources that are usually in scant supply for any given operation. Thus, there remains an obligation on the part of strategic policy makers and managers for the introduction of results-based guidelines within aid organisations so that the tangible and intangible benefits of such bodies may be maximised.

5.3.4 **Public Health**

As the third of four key elements identified from the literature, Public Health has a major part to play in the provision of Crisis Management strategies (table 5-4). Public Health is the mainstay of any democratic government as it is the bedrock on which Society is built (Public Health England 2013). Without a healthy population, productivity cannot be maximised and resource allocated according to the greatest net benefit. Rather, means at a country's disposal are directed at cure instead of prevention and thus inefficiently allocated.

KEY ELEMENT #3: PUBLIC HEALTH		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	• Introduction of normal routine into the crisis scenario so as to provide emotional anchor point reminiscent of pre-crisis behavior.	86% (6/7)
	• Public Health should form a part of the Crisis Management plan so as to provide holistic solutions.	100% (7/7)
I2: CM/KM	• Knowledge as to pre-crisis health of population so as to ascertain tolerance level and survival rates.	43% (3/7)
	• Focus on potential secondary crises and risk management thereof.	43% (3/7)
	• Speed of response is important for reducing the overall impact of crisis and the shortening of timelines.	86% (6/7)
I3: CM/HS	• Good sanitation is key to reducing the crisis timeline and impact.	71% (5/7)

	<ul style="list-style-type: none"> • Infrastructure reinstatement so as to provide victims with amenities. • Provision of consumables to aid in victim recovery. • Use of community leaders to rally victims and aid in coordinated response to, and management of, crisis. 	<p>43% (3/7)</p> <p>43% (3/7)</p> <p>86% (6/7)</p>
I4: PH/Water	<ul style="list-style-type: none"> • Water is integral to general Public Health and crisis prevention. • Prevention of secondary crisis occurrence through access to clean water and sanitation. • Personal hygiene for self-respect and the respect of others. 	<p>100% (7/7)</p> <p>86% (6/7)</p> <p>86% (6/7)</p>
I5: Water	<ul style="list-style-type: none"> • Water is essential to health and wellbeing. • Emergency provision for short-term relief whilst making medium/long-term plans for renewal and/or reinstatement. • Use of local community in providing short-term solutions to water and sanitation problems; collecting and purifying water whilst dealing with localized waste. 	<p>100% (7/7)</p> <p>43% (3/7)</p> <p>57% (4/7)</p>
I6: PH/Water	<ul style="list-style-type: none"> • The mitigation of crisis through water applications cannot be underestimated as it informs all aspects of our lives. • Utilisation of community leaders is organizational buy-in from community at large. 	<p>86% (6/7)</p> <p>57% (4/7)</p>

I7: CM/KM	<ul style="list-style-type: none"> •Infrastructure integrity crucial to supply and reclamation. •Mental health of social cohesion and family/community structures. 	<p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">43% (3/7)</p>
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Table 5-4: Primary Data Consolidation - Public Health

Three informants stated that Crisis Management as part of an integrated Public Health strategy does not only aid in the mitigation of any ensuing crisis but can, by its very nature, prevent one from occurring in the first instance. In addition, a healthy populace is not only less prone to crisis but better equipped should one occur. Therefore, the instigation of Public Health initiative should not be seen as a cost centre but as a way of decreasing future risk.

As can be seen from many of the large crisis effecting any given society at any given moment; those most likely to survive and return to a steady state are those for whom the initial starting point was one of equilibrium where the affected society was fully-functioning and supported by robust infrastructure (Middleton and O'Keefe 1998). Therefore, any loss of infrastructure should be dealt with as soon as possible as an aid in the return to a pre-crisis state.

As part of a crisis scenario, the need to prevent escalation and/or the inclusion of secondary crises has been explored. Often, such secondary crises take the form of health-related matters due to the lack of water availability and sanitary conditions. Therefore, the essential provisions should be dealt with as a matter of priority in order to allow those affected to gain some sense of stability and hence prevent escalation of their situation.

By ensuring that infrastructure reinstatement is at the nexus of relief operations, the victims of crisis may be reassured and encouraged into taking action commensurate with the reduction in severity of their plight and speedy return to a more comfortable existence with the crisis environment.

5.3.4.1 Sanitation

Sanitation is the zenith with regards to Crisis Management. Without good sanitation, those affected by the initial crisis will quickly be subjected to secondary crises usually of much greater severity than the original occurrence.

As explored in chapter two, good sanitation is of paramount importance in every aspect affecting the lives of those within the crisis domain; from the health worker administering aid and the surgeon performing an operation to families preparing food and attending to personal hygiene.

The importance of sanitation goes far beyond the physical; it also impacts greatly on the emotional wellbeing of those encumbered by the crisis. The ritual of washing as a form of ablution or for personal hygiene is integral to what it means to be a member of society. Those who are homeless, for instance, are often shunned by more secure individuals due to the stigma attached to poor personal hygiene and the perceived risk to the health of those nearby. Therefore, the necessity to present those affected by the crisis with the opportunity to cleanse themselves and their essential belongings may have far-reaching consequences as to their physical and mental welfare.

As explored in chapter two, part of relief operations must concern itself with an appraisal of the topographic area in order to create a delivery plan for the equipment installation and operation. In the first instance it may be necessary to tanker the waste and provide potable water though via bowsers. However, this needs to be considered as a short-term solution. The provision of sanitation via these methods is costly in personnel allocation and operational requirements such as frequent replenishment and removal of water and waste respectively.

In the medium-term it is necessary to make use of whatever infrastructure remains in order to create semi-permanent stations for the aforementioned amenities. These can be expanded to provide showering and domestic washing facilities as well as provision for medical stations that can be directly connected to the temporary installations.

As can be inferred by the previous statements, the installation of such physical amenities along with the personnel required to facilitate operation, help create a centre around which some semblance of normal life may be present. This can be used as the catalyst for additional work and thus enable the formulation of other community-based activities which may, in turn, present a micro-infrastructure capable of sustaining the population.

The introduction of a Public Health initiative inside any Crisis Management plan will aid in the return to normal everyday activity by aiding in the creation of structure and by providing an activity-based environment in which locals can be engaged in order to initially assist aid workers on the ground and (in certain circumstances) provide replacement for them once they withdraw from the area. The focus on sanitation as the core of Public Health should not be underestimated, without such allocation, the following headings in the sub-section would be heavily penalised. Once sanitation has been tackled, those concerned in the relief operation may then focus their attention on to the secondary concerns detailed in the following sections. However, as described above, such undertakings with regards to sanitation and infrastructure may have already alleviated to some extent the following concerns insomuch as providing the kernel around which society can begin to rebuild.

5.3.4.2 Assistance

When in discussion with all informants, the subject of assistance in any guise was repeatedly mentioned as being of great importance to any crisis programme offered. Therefore, the area was given its own space within the initial framework to allow for further exploration with regards to the importance of its appearance and inherent functionality.

When crisis occurs, thoughts turn to the *blue-light* emergency services that provide immediate relief to the area through provision of medical attention, rescue, fire control, and the enforcement of law and order. If these tasks can be managed to an acceptable degree within the initial disaster then victims receive better services and feel as if their plight is being dealt with in an effective manner.

With this in mind, the need to make such provision for emergency response should not hamper those whose role and responsibilities extend to the protection and reinstatement of infrastructure to provide essential products and services. These go beyond that of water and waste, allowing for the introduction of logistical operations that allow for transport of goods and services into and out of the locale. This can consist of medical supplies to that of blankets and food. Thus, *assistance* consists of many different considerations and as such requires full integration into the Crisis Management planning and response.

Inside of any society is an organisational infrastructure that may be intangible to the outsider; consisting of such influencing factors as the provision of religious facilities and services to the need for family members to congregate at meals times and to sleep in the same location. Leverage may be gained from such formal and informal network in order to provide coherent assistance to those who may not be able to act for themselves.

These local groups can often be brought to bear through the inclusion of their community leaders in Crisis Management planning and execution. As such, the groups can play an important role as regards the internal and external community. This has been experienced through the mobilisation of religious groups in providing relief through distribution of food and water to merely being present in someone's life during such a traumatic time.

The use of additional assistance from professional emergency and aid organisation can be supplemented through engagement with local community and pre-established informal organisations. In doing so, the local population can feel a part of the solution rather than merely the problem itself.

5.3.4.3 Secondary Crises

The inclusion of a dedicated aspect to the framework entitled *secondary crises* is based upon the assumption that poor management of the scenario can in itself lead to further crisis through escalation or new instances of previously unrealised events. The prevention of secondary crises may have many positive benefits as exclusion of such events helps prevent further degradation of the scenario currently underway.

By planning for, and responding quickly to, any crisis situation, the powers-that-be may reduce the overall impact by interjecting before secondary crises are made apparent. However, this is not a given, stakeholders must be vigilant to the possible of secondary crises occurring at any moment and plan for response as appropriate.

Informants stated that secondary crises are invoked when infrastructure requirements are not met due to a lack in consistency of response or any inability to allocate the correct human-resource type and associated materials within a given timeframe to the affected demographic and geographic locations.

The reason for secondary crisis being attributed to this part of the framework is due to the fact that they most often affect the health of those victimised by the ensuing crisis and thus compound the already undesirable state in which those affected find themselves. If those in positions of power and influence can act in a coherent and consistent manner during operations designed to achieve their primary objectives, then secondary crises may be averted or at the very least mitigated; in doing so, the original crisis can be brought to a satisfactory conclusion without the need for additional people and materials having to be brought to bear.

5.3.4.4 *Social Cohesion*

The basis of society is cohesion; it influences the actions of its members in such a manner that their undertakings complement one another, acting in concert so as to provide a safe and productive environment. Such social cohesion is impossible without a desire to be part of a collective of individuals performing as a whole that is why it often fails once the tangible elements are placed in peril by crisis (Manyena 2014). This can take the form of structural damage during earthquake, hurricane, etc. or when certain members of society chose not to act for the good of others such as in times of civil unrest when the populous may well attack its own infrastructure due to unrelated concerns with its government.

The social theories as to why this happens lay outside the scope of this research but remains tied to it by the fact that one impacts upon the other. By including as much of the local population in the decision-making process for crisis resilience and through engagement with said populous during operations undertaken as part of the crisis response, those in position of influence may be used to sway others and thus reduce the possibility of self-inflicted secondary crises from taking place. Such social cohesion can often be reinstated by the aforementioned techniques and accompanying actions; when combined with informal structures such as religious communities and non-religious clubs etc. the result can said to be gaining leverage through the employment of *human capital*. Human capital is the inherent characteristics of a community, formed through mutual trust, social obligations, and mutual expectations in order to facilitate a society of which the majority can feel a part (McDermott 2012).

Human capital is a method through which a community can be used as an interconnected network in order to provide support to the professional engaged removal of the crisis: then, as the crisis subsides, local actors may be in a position to take control through support of the professionals which would ultimately disengage once an acceptable level of autonomy had been reached.

All informants mentioned that in addition to the immediate effects of crisis, both medium and long-term aspects should be considered in so far as making provision for both the reinstatement of tangible and intangible assets as well as the facility for improvement of the social situation. In doing so, the local community may be inspired to create a better environment to that which came before the crisis. The measures that could be considered are many and varied but could take the form of such social enterprises as *credit unions*, formed to provide a safe and secure way of providing savings and loans without the premiums demanded by *for-profit* organisations (Smith et al. 1981).

By engaging with the local community in order to make improvements rather than merely returning the locale to a pre-crisis state, one can garner support from those for whom the future is preferable to the past.

5.3.5 Human Security

As the final of the four key elements identified through secondary research, Human Security brings into play the need to make provision for those victimised by crisis in such a manner as to facilitate both the mental and physical security of each person along with the community as a whole (table 5-5).

It is during times of crisis that the fabric of society is vulnerable to attack by those whose interests are political in nature. The protection of what is already a vulnerable set of people is not only important if secondary crises are to be averted but also imperative to the reinstatement of a pre-crisis scenario from which the victims came.

In times of extreme danger, it is often military aspects of government or international organisation that are seen delivering aid and enforcing law-and-order (Weiss 2012). Whilst such authoritarian organisations provide excellent services as part of a first response strategy, they are often ill equipped once a more collaborative phase of the relief effort is made operational (Gentry 2000). Therefore, it is important that the actors used for each stage of a crisis response operation are those who have the most to offer given the needs of those made victim by its enactment.

KEY ELEMENT #4: HUMAN SECURITY		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Resilience planning caters for Human Security through established protocols and scenario-specific responses. • Leaders must be included in Human Security process in order to ensure political will is applied to departments and operatives within governmental structures. • Good media relations are important if the required aid is to be maximized and <i>clustering</i> avoided. • Utilisation of <i>media relations</i> personnel can aid in the process of directing media to those in most need. 	<p>57% (4/7)</p> <p>43% (3/7)</p> <p>43% (3/7)</p> <p>43% (3/7)</p>
I2: CM/KM	<ul style="list-style-type: none"> • Retaining law-and-order reduces criminality and makes victims feel safe. • Inclusion of Business community in all areas helps to leverage skills and knowledge. 	<p>100% (7/7)</p> <p>29% (2/7)</p>

	<ul style="list-style-type: none"> • Business can be part of the solution where <i>Public</i> resources may be limited. 	71% (5/7)
I3: CM/HS	<ul style="list-style-type: none"> • Criminality and the threat to citizens that can cause secondary crises. • Crisis response needs to be specific to place and time to ensure Human Security is maximized. 	71% (5/7) 100% (7/7)
I4: PH/Water	<ul style="list-style-type: none"> • Structure required to implement pre-designed plans in an effective manner. • Water resources need to be applied in an effective manner, as they may be limited. • Water standards will vary due to geographical location and availability of resources. • Use locals to provide solutions; their knowledge is invaluable. 	71% (5/7) 57% (4/7) 100% (7/7) 86% (6/7)
I5: Water	<ul style="list-style-type: none"> • Safety and security of water supply to ensure drinking water reaches those in need and cannot be diverted by criminal elements. 	71% (5/7)
I6: PH/Water	<ul style="list-style-type: none"> • Which parties have what designation; are <i>victims</i> transient or permanent. Can they be brought to bear as crisis responders? 	57% (4/7)

	<ul style="list-style-type: none"> • Social media could be used to direct actions and identify problem areas, helping to produce a knowledge map of the crisis domain. 	57% (4/7)
I7: CM/KM	<ul style="list-style-type: none"> • Military personnel do not provide Policing to the level of dedicated specialists and thus should only be used when essential. • Validation is important if any plans or frameworks are to be considered sound. 	<p>100% (7/7)</p> <p>100% (7/7)</p>

Table 5-5: Primary Data Consolidation - Human Security

5.3.5.1 Infrastructure

Once again, infrastructure has been mentioned throughout the chapter as it affects many different aspects of reliance and crisis planning as well as response initiatives and operational personnel allocated within theatre. Infrastructure with regards to potable water supply and waste reclamation is well understood as most countries within Europe and North America have well-established and reliable networks. This is not the case in much of the developing world and, as such, its integrity cannot be taken for granted during times of resilience planning (Briscoe 1999).

One informant described infrastructure within its geopolitical context as allowing those responsible for relief operations to tailor the response based on crisis mode and place of occurrence. This brings into sharp focus the need for planning and hence, a framework which makes provision for structured strategic concerns with regards to application of resources within fixed loci of control.

Infrastructure considerations are vast when it comes to the business-as-usual aspects of a society and may be in sharp contrast to those of a crisis-ridden one. The use of strategic planning in order to quantify and compartmentalise those infrastructure elements essential to each part of a successful crisis response operation allows for allocation of resources to each with maximum efficiency and effectiveness. This is not necessarily the case when reactive operations are instigated, as the response order may not be immediately apparent as the crisis unfolds.

The infrastructure considerations for water resources is a complex one as the level to which potable water needs to be cleansed is debatable and usually based upon state-set metrics or those recommended by the World Health Organisation (Arnold and Colford 2007). In addition to these measures is the paramount requirement for supply of potable water; thus, standards that are adhered during steady state are may not always applicable during times of crisis.

In conjunction with clean water standards are those of reclamation. During normal operation, waste may well be treated and the resultant water returned to a watercourse. However, in times of emergency, it may be sufficient merely to move the waste away from populated areas for treatment and/or disposal at a later date. This tactic does have its limitations and may not be a viable option if the crisis continues for an extended period of time (Veenema and Goodwin 2003).

As part of any resilience plan it is recommended that upper and lower standards of acceptable for both potable and wastewater be established. In this way, the delivery of services can be maintained within acceptable guidelines commensurate with those of the available infrastructure and community expectations. By defining expectations, the design of temporary infrastructure may be defined along with that of reinstatement/improvement in the post-crisis phase of operations.

5.3.5.2 Government

As with any aspect of control with regards to human habitation, governmental input is a critical success factor, those who get it right create a safe and prosperous environment where people can triumph based on merit; for governments who do not, the picture is a poor one, often rife with corruption and nepotism (Bayley 1966).

The purpose of government is to govern its people by undertaking social activities intended to improve the lives of individuals and society as a whole. Government initiatives include healthcare programs for the prevention and cure of illness so as to present a productive and healthy population capable of performing value-added activities designed to create and maintain a buoyant economy. In addition, the very fabric of society is engineered through social endeavours whose ultimate aim is for the betterment of the country at large; not to mention, its status within the international community.

Governments are often at the epicentre of change within their respective national and international communities, providing guidance and support to state and private enterprises whose function is to create wealth, either directly or indirectly (Etzkowitz and Leydesdorff 1995). As a part of this, it is often seen as a necessity to provide crisis resilience plans which mitigate as far as is reasonably practicable, the impact of any negative incident liable to hinder economic activity (Davoudi et al. 2012).

Such organisations as the UN, WHO, World Bank and International Monetary Fund (IMF) operate as non-governmental organisations only through the grace of contributing governments who pay for their operation whilst providing personnel capable of performing value-added activities. These organisations have a direct impact on sovereign states' ability to deal with crisis as well as making provision to support those for whom relief and aid need to come from outside its boundaries (Held 1991).

As part of any framework, NGOs and the governments who fund them need to be dealt with as a matter of priority, allowing for the self-interest of all parties to be taken into consideration alongside those of the community at large. Whilst this is often difficult to comprehend it is, none the less, a factor that requires consideration. Without the support of those with financial power, very little can be achieved within any given crisis scenario (Held 1991). This is no less the case with water as the cleansing, provision, and reclamation are both time-consuming and expensive; without the required financing little, if anything, may be achieved.

After the framework has been produced, it needs to be validated by individuals with experience as regards interaction with water companies, NGOs, and governmental bodies. Therefore, the final framework presented has been validated in such a manner as to provide input from individuals with experience in these areas.

5.3.5.3 Affected Demographic

The idea of employing those able to add value to the local community from within its ranks has been presented throughout the text as a simple way to provide multiple positive benefits to all concerned whilst presenting few negative drawbacks. It is with this in mind that the affected demographic may be split into its constituent parts:

- i. Victims – those for whom the crisis has created an environment within which they are unlikely to be able to add value; be this because of age, infirmity or illness/incapacity (Roberts 2005).
- ii. Non-Actors – the subset for which crisis has denied them the opportunity of adding value due to a lack of knowledge and/or skills (Hagmann and Caveltly 2012).
- iii. Local Actors – elements within the affect demographic whose knowledge and skills can be brought to bear for the good of both the local community and, either directly or indirectly, the population at large (Centre for Security Studies 2011).

By splitting those affected into sub-groups, aid workers and governmental officials may be able to utilise community members in both the relief and reconstruction within the crisis domain and thus reduce the impact on external workers whilst simultaneously making provision for the community in beginning the healing process through direct action and productive activity (Cannon 2008).

Of the three sub-groups identified, it is the potential *actors* on which the remainder of this section is focussed, as it is this set of individuals who can provide the most support to themselves and the other, more vulnerable, groups identified.

The proposed framework contains an element concerned with the collection and collation of people's knowledge, skills and attributes within and around the crisis zone. In doing so, these attributes may be utilised for the good of all.

Such use of the local population is often seen as undesirable due to a lack of professional training and the idea that their integration into the relief effort will present more problems than solutions (Long 2003). However, all informants stated that, rather than diminish the relief efforts of professional agencies, the utilisation of local resources often adds benefit through local knowledge as regards culture, community and geography; not to mention, the ability of local actors in preventing aid workers making mistakes due to the uniqueness of either locale or scenario.

5.3.5.4 Media

The media is defined as those for whom the gathering and dissemination of news is the premier aim of their business. Such media organisations not only deliver factual information but, in recent times, have also moved towards comment and opinion by both professional news gatherers, other actors involved in the story and members of the public. Such an approach to any given situation can have positive and negative effects upon the case in hand (Brosius and Engel 1996).

Rather than merely reporting factual information pertinent to the situation, *rolling* news has demanded that modern news organisations deliver continuous content that therefore requires a less focussed approach, relying on information gleaned from a wider array of entities from within the story. This can serve to present the situation differently to that given by government agencies and other operatives on the ground.

Due to such *colouring* of crisis situations, many relief and aid organisations employ liaison officers who filter information for presentation in such a manner that maximises the objectives of the organisation itself. In order to present news organisations with information in this manner, the amount of time and effort employed can be considerable. Therefore, the framework must contain elements that allow for information and knowledge sharing that fulfils both parties' needs.

Media clustering is often the result of on-the-ground newsgathering with is transmitted via audio-visual means. The media cluster into areas where the news stories are most likely to attract the maximum number of consumers. This often has the effect of delivering a picture of any given crisis that is not a true reflection of the facts (Miller and Goidel 2009). With the use of multi-media information channels that are accessible directly by the public, those for whom the gathering of funds, materials and other resources may better interact with the public, as they are often the source of much with regards to funding through donations of money and tangible items. In addition, the pressure brought to bear on governments and agencies of public opinion is powerful; this can be used to encourage those in positions of power to act more quickly and pertinently with regards to the crisis in question (Yin et al. 2012).

5.4 Draft Framework

Primary data was collected through FWF and analysed, the draft framework was created in modular format. Each sub-framework is given in illustration in figures 5-2, 5-3, 5-4 and 5-5. Each of the modules covered one research dimension, existing as independent sub-frameworks but capable of being orchestrated as a single entity. The different dimensions explore key themes identified by both primary and secondary research. These were combined into individual illustrations so cross-discipline industry experts could review the two or three sub-frameworks pertinent to their fields without confusion. In addition, the creation of such sub-frameworks allowed for a more elegant aesthetic that could engage with validators without the need for over-complication of ideas or delivery.

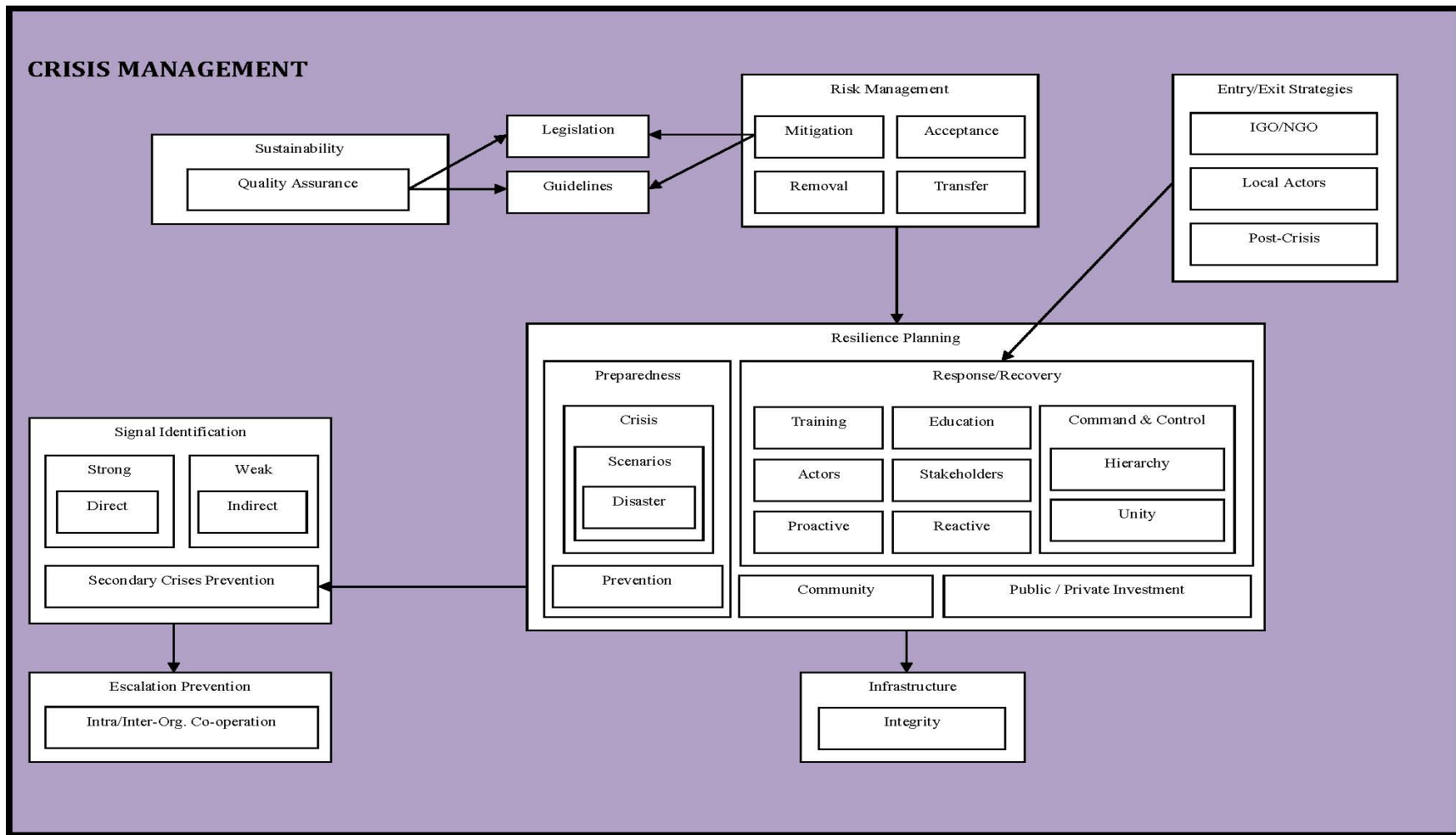


Figure 5-2: Draft Sub-Framework - Crisis Management

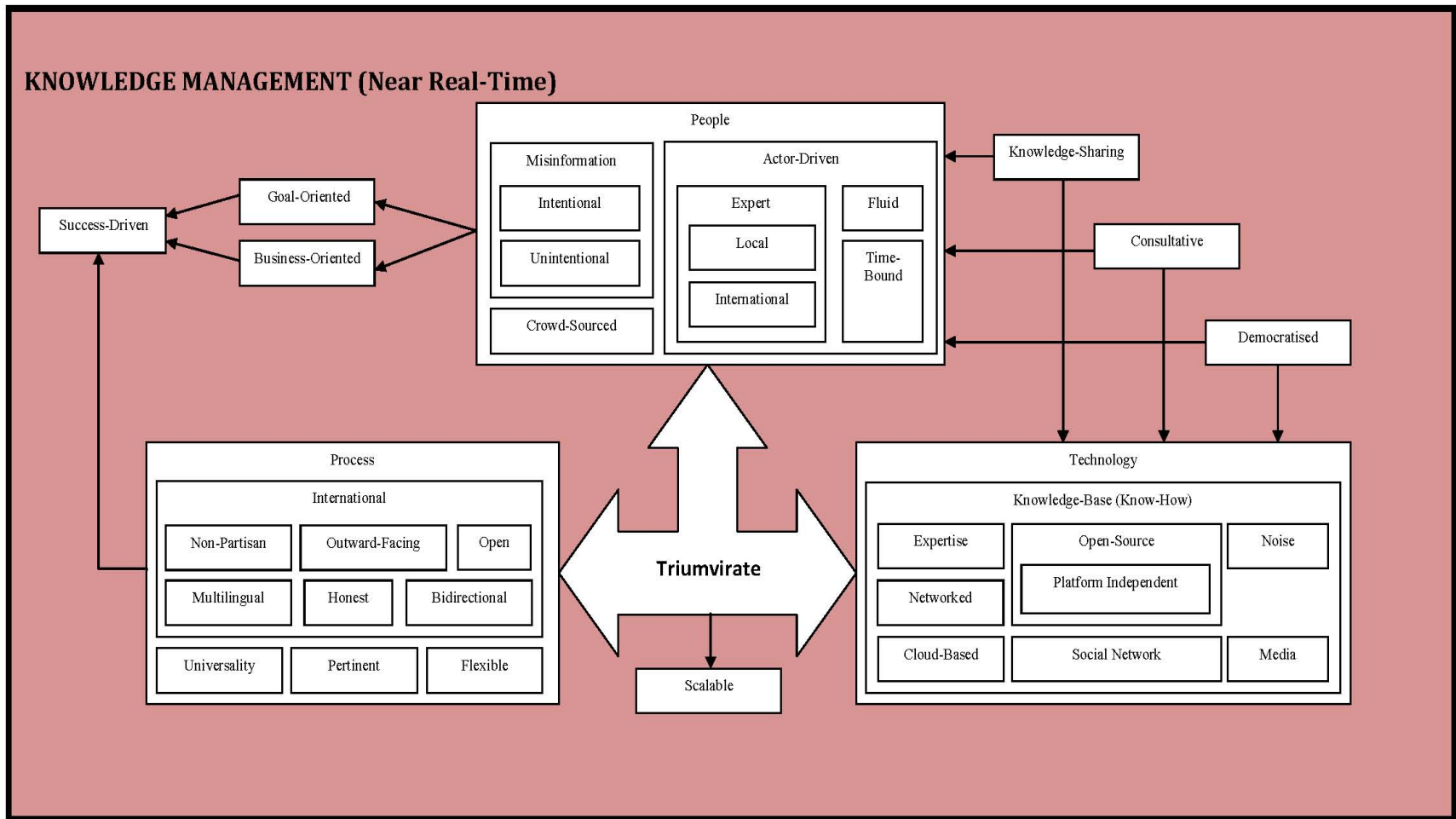


Figure 5-3: Draft Sub-Framework - Knowledge Management

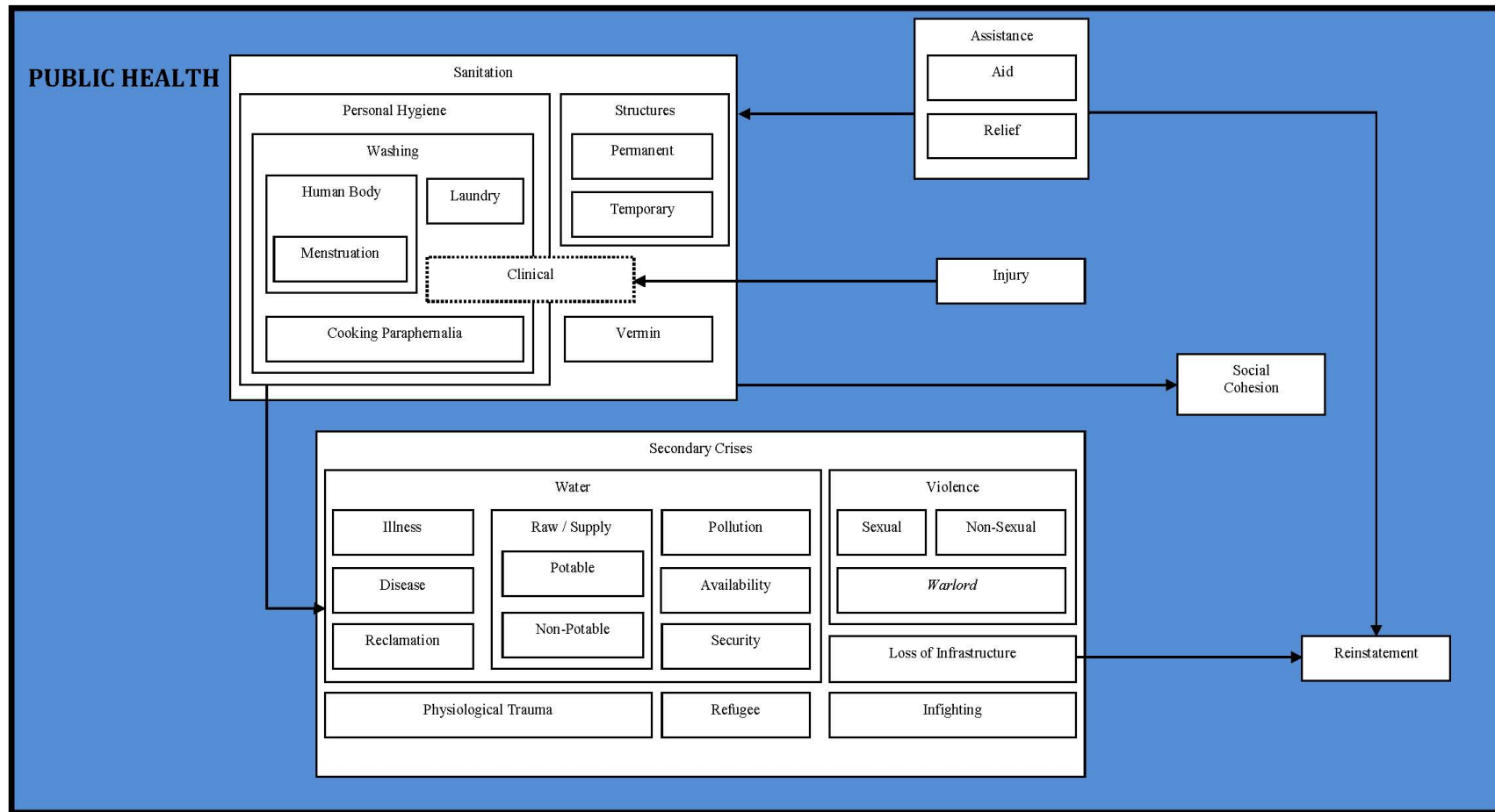


Figure 5-4: Draft Sub-Framework - Public Health

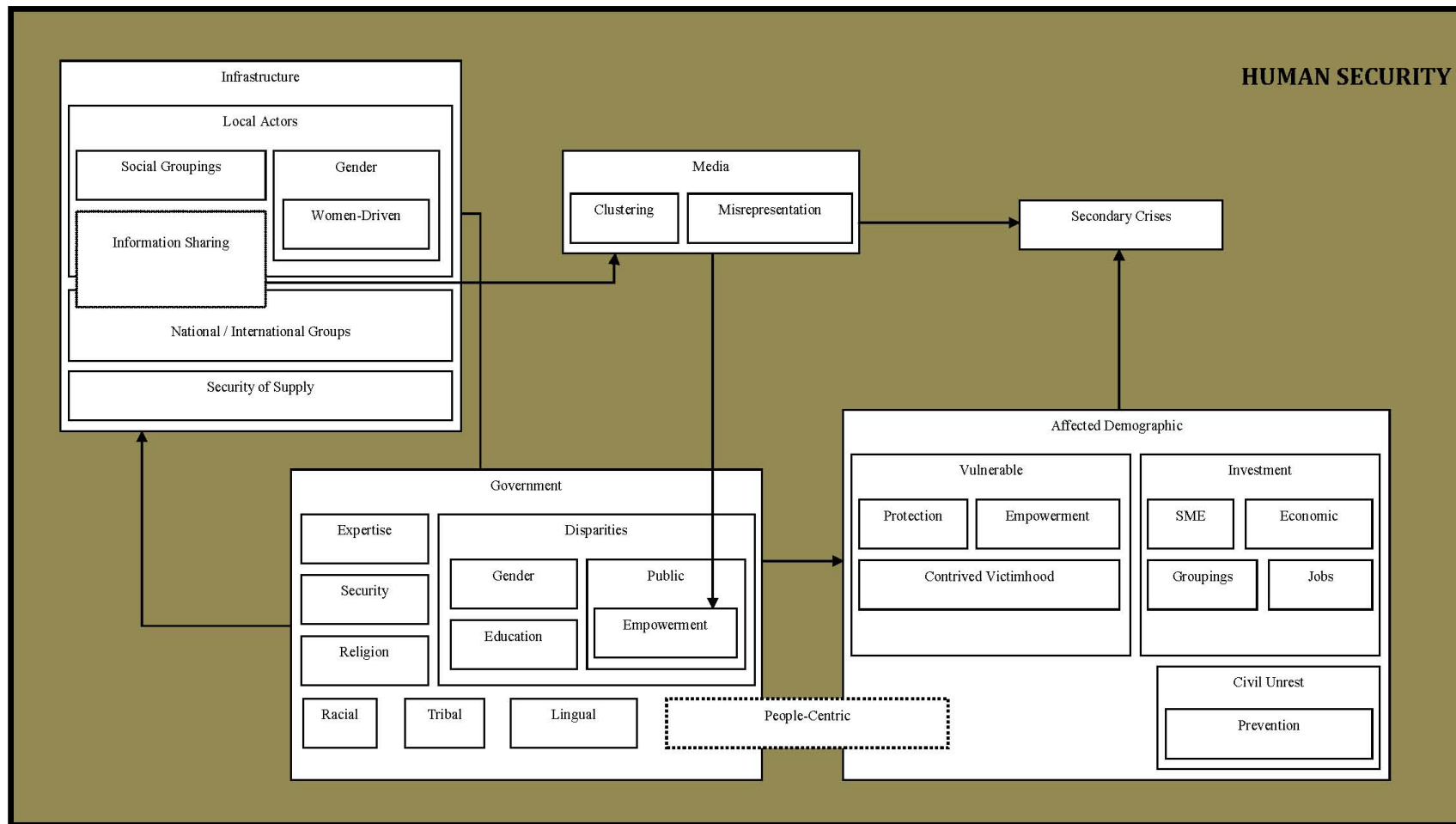


Figure 5-5: Draft Sub-Framework - Human Security

5.5 Conclusion

Given the modular nature of the draft framework and the inherent fragmentation that this brings, it was conceived that post-validation by industry experts, the framework would be brought together into a single illustration. The single framework would maintain its segmented nature by virtue of its form whilst providing holistic solutions.

Only after the validation had occurred however, was this idea fully formed and capable of producing the final framework shown in chapter seven. Thus chapters six and seven should be considered as a conjoined route to the final framework.

PART THREE

6 VALIDATION

With the creation of a draft framework came the need for validation by experts within the four key research elements. The ultimate aim of validation at this stage was making the necessary improvements to the framework to ensure it was both relevant and rigorous. This chapter describes the process followed for validation of the draft version and introduces the final framework, produced on the basis of the feedback received. The final framework construction and interpretation is explained in detail alongside its applicability in the assembly of an associated *toolbox* capable of providing action-led instruction sets for all major stakeholders.

6.1 Domain Experts

Having created the draft framework detailed in the previous chapter, domain experts within several organisations were contacted in order to evaluate and validate the individual elements and their interoperability. The individuals chosen were experts in at least two of the original research domains; namely, Knowledge Management, Crisis Management, Public Health and Human Security. Thus, their knowledge was multidimensional and, as such, more likely to highlight shortfalls in the draft frameworks design and intended operation.

As was the intention of the draft framework, the initial artefact is in the form of four box diagrams, allowing for identification of each element and their basic relationship to one another within the context of the original research domains. This was intended to stimulate conversation between each validator and the researcher without too great an emphasis being put on the graphical dimensions of the final framework.

6.2 Approach

The validators were asked to comment on both individual elements and the cohesiveness of the overall framework; this allowed for impartiality with regards to the applicability of each facet and the interoperability thereof. Validators were selected from industry and charity as it is the interconnection of both entity types that is usual within any given crisis scenario. Validators were further chosen so as to cover all permutations for any two research elements. Therefore, validators were selected based on the following criteria of experience within specific pairings of the research domains:

- Knowledge Management;
- Crisis Management;
- Public Health;
- Human Security.

Phase one consisted of each validator being sent an initial copy of the draft framework by e-mail along with a questionnaire (appendix E). They were each asked to complete the questionnaire within one month and return for phase one of the validation. Phase two consisted of interviews with each validator which comprised feedback regarding their questionnaire and further discussion as to the framework both, as a whole, and based on each element.

Phase two was followed by analysis of all the data in order to produce a revised framework that took into consideration all Informants and secondary data.

6.3 Validator Selection

As previously mentioned, validators were selected for their multidisciplinary Knowledge, skills and experience. The particular individuals chosen were selected from industry and charity based on the network connections established by the researcher both prior to, and inclusive of, the research timeline. This facilitated a much more critical discussion as the validators were already known to the researcher and, as such, felt more able to voice their opinions.

The number of Informants was based on facets of the identified research domains. The figure 6-1 illustrates Informants and associated expert domains.

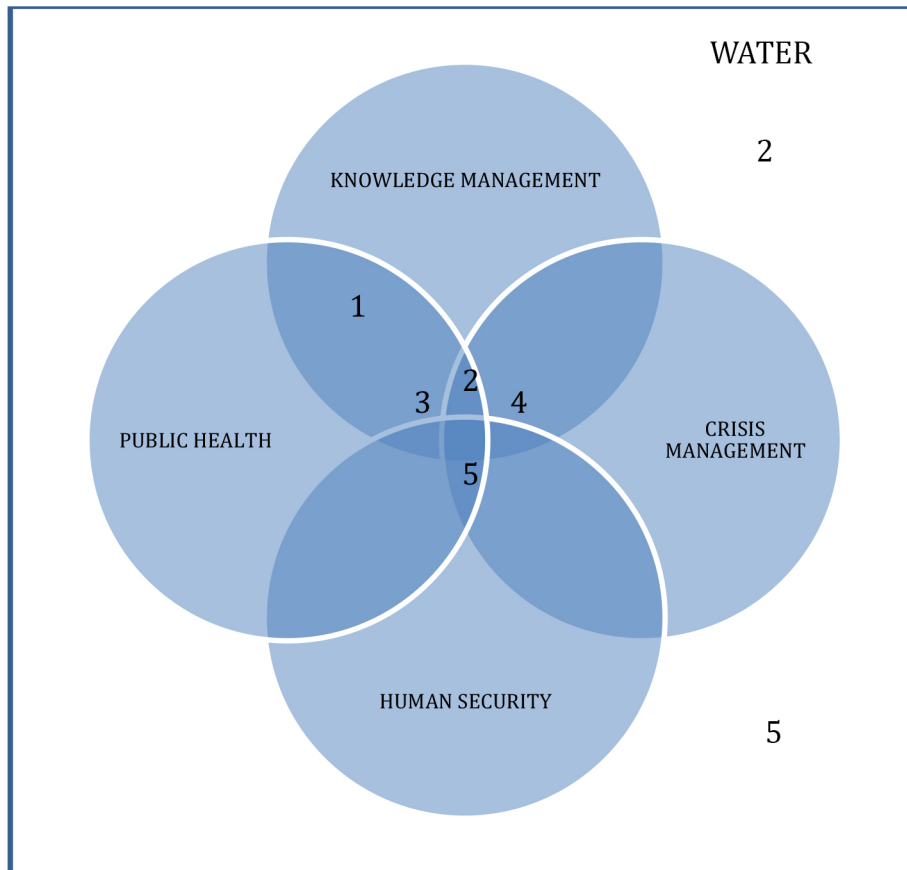


Figure 6-1: Validation Venn Diagram

The numbers indicated in the above Venn diagram are ascribed to the following Informants:

1. Academic.
2. Industry practitioner.
3. Academic/ industry practitioner.
4. Industry practitioner.
5. Academic.
6. Industry practitioner.

6.4 Phase One of Validation

Each validator was sent a copy of the questionnaire via e-mail. The responses were collated into key themes and similar comments in the form of a mind map as such a method lends itself to the idea of a non-linear, non-hierarchical presentation of information. The representation of information in this manner was chosen because of form factor, which produces diagrams that do not express preferences, either explicitly or implicitly.

The mind maps were filtered based on corroboration and contradiction. Corroborations required no action and contradictions were consolidated in figures 6-2 to 6-11 along with proposed solutions.

The questions were accompanied by a copy of the draft sub-frameworks, broken-down into the four research domains so as to allow each validator to concentrate on their respective field of expertise but affording them the opportunity of commenting on the other domains without fear of contradicting their respective elements.

The validators' questions and response mind maps are given in appendix E.

6.5 Phase Two of Validation

Once information had been collated from phase one, the validators were invited to individual interviews to discuss their initial responses and comment on any proposed changes. UK-based validators were met in-person with the USA informants being interviewed via telephone.

This time-lapse between questionnaire and interview allowed the researcher time to adjust framework elements prior to meeting.

Each interview was scheduled for one hour to discuss the framework and its implications for implementation with the given context of Crisis Management. The discussion was once again captured using the previous mind maps to remove any hierarchical influences and thus provide an unbiased recording of each session. Such was the level of expertise that the framework changed into a much more coherent representation of the original research question. The comments from each validator were added to the mind maps in appendix E and comments for improvement were added to figures 6-2 to 6-11 in ***bold type italics*** to provide a holistic validation based upon independent thought and interactive discussion.

6.6 Results

Tables 6-1 to 6-10 show that the primary outcome from validation process was a reduction in the complexity of the draft framework, merging certain elements whilst removing others altogether. In addition to these changes was the creation of a crisis wheel that attributed each of the draft framework elements to particular timeframes within the crisis lifecycle. A breakdown of the changes made in response to the validators' comments is provided in this section.

Validation interviews confirmed the framework validity and helped identify the further work as detailed in chapter nine.

VALIDATION Q&A/ INFORMANT	VQ1. What is your overall impression of the framework and its usability?				
	I1	I2	I3	I4	I5
Answer	Confusing, complex layout. Lack of connectivity	Process accessibility. Actor utilisation essential to operation	No indication as to hierarchy of importance	No elemental hierarchy of importance	Confusing, overlapping, lacks segmentation, no temporal factors
SOLUTION	Creation of single illustration for entire framework. Connections had been removed to avoid confusion. Connectivity dependant on stakeholder and interactions	These factors are at the centre of the framework's intended operation.	The framework is not designed to be hierarchical. However, a crisis wheel was imbedded at its centre to allow for temporal factors to be taken into consideration.	Each of the four research elements does not take preference. Rather, the lens through which the framework is viewed extracts the importance factors.	Introduction of a crisis wheel facilitates segmentation based upon temporal aspects and the four research elements.

Table 6-1: Validation Answer One

VALIDATION Q&A/ INFORMANT	VQ2. What impact can such a framework have on the mitigation of crises?				
	I1	I2	I3	I4	I5
Answer	Requires testing against a real crisis	Where is the resource allocation? Unfocussed deployment. Crisis dependant	Reduce uncertainty through application of each element	Lacks specificity as to crisis phase applicable	Secondary crisis mitigation through political imperative. Post-crisis identification required
SOLUTION	Validation chapter tests the final framework against Hurricane Katrina	Resource allocation is scenario specific. This is tested in the validation chapter. Intentionally crisis dependant to provide holistic solution to any instance	Framework may be applied to any given crisis and is intended to operate as part of a knowledge creation model: given in further work chapter and figure 9-1	Introduction of crisis wheel allows for identification of each phase and its application to the research elements	Secondary crises included within crisis wheel. Post-crisis phase also included within crisis wheel

Table 6-2: Validation Answer Two

VALIDATION Q&A/ INFORMANT	VQ3. Are there any parts of the framework that appear disjointed or lack cohesion?				
	I1	I2	I3	I4	I5
Answer	Lack of micro-level information	No identifiable starting point. Loci overlap between diagrams. Scalability unclear. <i>Modularity complicated</i>	No elemental hierarchy of importance	Disjointed framework with no regard to water	Greater detail required. ID minimum standards. <i>Colour-coding required of connected activities</i>
SOLUTION	It is not the intention of the framework. Rather the creation of a <i>toolbox</i> as recommended in the final chapter is advocated	Creation of a circular illustration indicates starting point to be anywhere stakeholder wishes, dependant on need. Loci overlap removed through use single illustration <i>Removed previously so no action taken</i>	This is intentional, as the quantification of need is considered paramount rather than arbitrary hierarchies.	Framework consolidated into single illustration. All elements are applicable to water; some directly, others indirectly. It is the intention that the framework be used for entire crisis cycle	Framework colour-coded and greater detail intended as part of further work. Validation chapter provides detail as to application. Minimum standards are crisis and geographically dependant <i>Colour-coding already in place</i>

Table 6-3: Validation Answer Three

VALIDATION Q&A/ INFORMANT	VQ4. Which elements would you add to fulfil core competencies within your knowledge domain?				
	I1	I2	I3	I4	I5
Answer	Confusing domain names	Local factors, topological, demographical. <i>Little media management.</i>	Cultural management of local actors, expectations, supply/demand, <i>wants versus needs</i>	Greater interrelationship clarity required	Who provides what? Lack of <i>people-focus</i> . <i>Gender elements ignored</i>
SOLUTION	Detailed explanations are to be supplied as part of framework deployment.	Local factors will be employed through scenario-dependant applications whilst constituting a dynamic knowledge base. <i>Media managed through relations element</i>	Local actor relationships dependent on crisis mode and location. Local actors are integral to the framework	Interrelationships removed, as clarity was subjective. Concentric rings removed need for connectivity whilst allowing for greater unity of purpose	Stakeholder/actor delivery scenario dependant. <i>Gender elements form an important part of the framework through both Public Health and Human Security elements</i>

Table 6-4: Validation Answer Four

VALIDATION Q&A/ INFORMANT	VQ5. Which elements would you remove or alter and why?				
	I1	I2	I3	I4	I5
Answer	Change <i>Human Security</i> . Remove overlaps	Remove multiple diagrams	Integrate diagrams. Add explanations	Framework elements lack explanation	Provide operational guidance
SOLUTION	Human Security is essential in delivering an holistic solution and therefore remains	Illustrations amalgamated into a single visual entity	Illustrations amalgamated into a single visual entity Explanations will form part of toolbox as described in further work chapter	Explanations provided in chapters five, six and seven. Detailed explanations will be deployed with framework as part of <i>toolbox</i> given in further work chapter	This will be done through <i>toolbox</i> deployment

Table 6-5: Validation Answer Five

VALIDATION Q&A/ INFORMANT	VQ6. How would you describe the complexity of the framework within a knowledge-based environment?				
	I1	I2	I3	I4	I5
Answer	Simplistic; requires macro- framework	Arrows & boxes unclear	Correct complexity level but confusing number of diagrams	Does it provide solutions to <u>any</u> conceivable crisis?	Dependant on support documentation. Matrix required, identifying key elements
SOLUTION	Provision of macro-framework falls outside of thesis domain	Removed as framework consolidated	Consolidated into single diagram	The framework is intended to be all- encompassing; allowing for deployment in any situation	Key elements are dependant on particular crisis mode and occurrence. Toolbox intended to provide supporting documentation

Table 6-6: Validation Answer Six

VALIDATION Q&A/ INFORMANT	VQ7. How would you describe the validity of the framework within a knowledge-based environment?				
	I1	I2	I3	I4	I5
Answer	Apply to a crisis for confirmation as to validity.	Readily understandable without boxes or arrows	Test validity of framework <i>How is framework refined?</i>	Unclear interrelationships	Map against sphere clusters for Venn Diagram
SOLUTION	Validation chapter applies framework to Hurricane Katrina	Removed as part of consolidation process	Framework tested with Hurricane Katrina <i>Further work chapter details process in figure 9-1</i>	Removed as part of move to a single framework illustration	Each sub-framework is based upon the four elements and consolidated as concentric rings for the final framework

Table 6-7: Validation Answer Seven

VALIDATION Q&A/ INFORMANT	VQ8. How would you rate the modular aspects of the framework based on the four Venn spheres?				
	I1	I2	I3	I4	I5
Answer	Remove modularity for sake of clarity and simplification	Differing importance of Venn sphere. Crisis non-specific	Confusing to non-experts	Unclear as to the validity of original research spheres	Having to utilise four frameworks is complex
SOLUTION	Removed as part of single framework	All spheres are considered equal dependant on lens through which crisis is viewed. Intentionally non-specific as framework is universal	It is intended that deployment include a <i>toolbox</i> for application so stakeholders and actors can apply any element considered pertinent to their needs	Validity of original research spheres given throughout chapters two and three.	Framework changed to single entity

Table 6-8: Validation Answer Eight

VALIDATION Q&A/ INFORMANT	VQ9. What do you consider the key facets of Crisis Management when related to your knowledge domain?				
	I1	I2	I3	I4	I5
Answer	Response time, on-going crises mitigation, prevention & control of full-blown crises	Peoples' skills, knowledge & ability. Cohesion	Reduction in magnitude of crisis	Secondary & tertiary prevention activities	Removal of corruption
SOLUTION	Framework is intended to provide a coherent response to crises in a timely manner	Framework takes into consideration the skill-set of all; from victims as potential actors, to the use of professions	Through application of framework, crises may be avoided or at least addressed quickly in order to reduce impact	Prevention activities are integrated into the framework and can be applied preventatively as shown in validation chapter	Corruption is dealt with as part of the framework as it was identified as a key factor in risk reduction

Table 6-9: Validation Answer Nine

VALIDATION Q&A/ INFORMANT	VQ10. What is the primary importance of water supply and reclamation when applied to your field of expertise?				
	I1	I2	I3	I4	I5
Answer	Water education, training & awareness for all	Economics of Industry & Agriculture, public health	Preservation of life	Community health & development. Violations of property rights	Saving lives, Malsow's hierarchy of needs
SOLUTION	Education forms part of the framework and has been explored throughout this research. It is tested as part of the case study validation chapter	These form part of the framework strategy as provision of food and employment are paramount if both primary and secondary crises are to be prevented/mitigated	The framework is based on the prevention of loss-of-life	The inclusion of community and local actors throughout the framework aids in developing sustainable relationships for all concerned. This includes personal rights and the right to return to their pre-crisis status as property owners/dwellers.	Maslow's hierarchy of needs forms part of the original Venn diagram justification and is therefore integrated into the entire framework

Table 6-10: Validation Answer Ten

6.6.1 Crisis Wheel

Based on the feedback surrounding legibility and detail given by validators, a crisis wheel was constructed in order to allow for each research element to be ascribed to a particular phase of the identified crisis lifecycle. A circular format for the final framework and crisis wheel was chosen as it solved several issues:

- The introduction of a crisis wheel at the center of the framework allowed for the starting point to be anywhere in the continuum of crisis. The nature of crises is that they are cyclic: therefore, a shape that could complete an infinite number of iterations was preferable;
- Concentric rings containing each of the research elements allowed for individuality to be retained whilst providing a unity of purpose for the entire endeavor;
- The circular format also facilitated integration of all research elements dependent on the crisis wheel phase under consideration. This allowed elements under scrutiny to be active whilst others were rendered inactive in order to simplify the stage under consideration.

The crisis wheel allowed the whole framework to be displayed in diagrammatic form based upon a particular phase of the crisis lifecycle. These phases are explored in detail later in this chapter.

6.6.2 Domain-Specific Segmentation

Each segmented entity may be switched on or off depending on the crisis phase under consideration. This allows the framework to exist in numerous different forms depending on the user-role and crisis lifecycle stage. Therefore, the framework can be split into modules that allow users to concentrate on their part of the solution without having to understand the entire process or appreciate the role of every stakeholder.

6.7 Conclusion

The construction of a draft framework served to consolidate primary information into a format commensurate with the four research element of Crisis Management, Knowledge Management, Public Health and Human Security. The resultant framework served as a platform for validation by industry experts.

7 FINAL FRAMEWORK

The draft framework was taken into consideration along with feedback from the aforementioned experts in order to create the final version. The final framework consists of all the inputs included in the draft framework in conjunction with the expert validation to create a simplified illustration that may be displayed as one diagram. The need for consolidation is to provide a practical solution which is more easily understood and therefore, likely to be incorporated into any Crisis Management strategy.

7.1 Final Framework Construction

The appearance of the framework shown in figure 7-1 is that of a central *crisis wheel* encapsulated within four concentric circles, each a representation of the originally identified research elements. This construction allows for each stakeholder to extract corresponding words and phrases through the use of colour-coded segments, linking each of the *crisis wheel's* internal components to those of the outer rings. In doing so, the resultant outputs are tailored for specific actors and stakeholders based, not only on the action-set required but, the temporal nature of each set of activities as defined by a particular crisis phase within the inner wheel.

Once the relevant sub-set of information has been extracted, a toolbox is presented which allows stakeholders and actors to perform activities commensurate with achieving shared goals within the crisis instance. These activities are object-oriented and thus capable of being utilised both as *classes* in their own rights and *instances* relevant to particular crisis modes and geographical locations. However, this is merely an inference within the thesis as it is to this end that the *further work* for consideration as part of the post-doctoral research will be presented.

The concentric circles which form the outer rings of the crisis wheel are intended to provide bi-directional data and information flows which may be mined at a later date in order to provide an iterative aspect to the framework which makes provision for continuous incremental improvement as particular scenarios are tested during its lifetime.

7.2 Stakeholder Types

Those involved either directly or indirectly within the crisis domain are considered to be stakeholders and therefore inherent to the success or failure of any subsequent relief and/or aid operations undertaken. The Federal Emergency Management Agency defines stakeholders as those individuals coming from the following organisation types (FEMA 2013):

- Local, state and federal government agencies;
- Citizens (those previously described in this thesis as *actors*);
- Media;
- Business and Corporations;
- University and research institutions;
- Non-profit organisations and emergent community organisations;
- Contractors;
- Associations and collaborative partnerships.

By utilising as many of the above stakeholder types in a coherent and consistent manner, it may be possible to mitigate the initial crisis and prevent secondary instances from occurring. Historically, this has been difficult to manage due to the disparate nature of stakeholders. It is desirable that the adoption of this framework would assist in the consolidation of effort and resources through common objectives and the capacity for knowledge sharing between stakeholders.

7.3 Actor Types

As previously detailed throughout this work, the actors consist of anyone from any demographic whose input is either explicitly sought or through direct/indirect action, adds value to the crisis scenario. Therefore, the framework is designed to be fluid and open-to-all so as to maximise the interaction of those engaged in activities pertaining to any stage; be this strategic, tactical or operational in nature.

7.4 Crisis Phases

Each of the identified phases within the crisis wheel shown in figure 7-2 is detailed in this section, covering all aspects of the crisis cycle, from the non-crisis intermissions through to the consideration present at its peak.

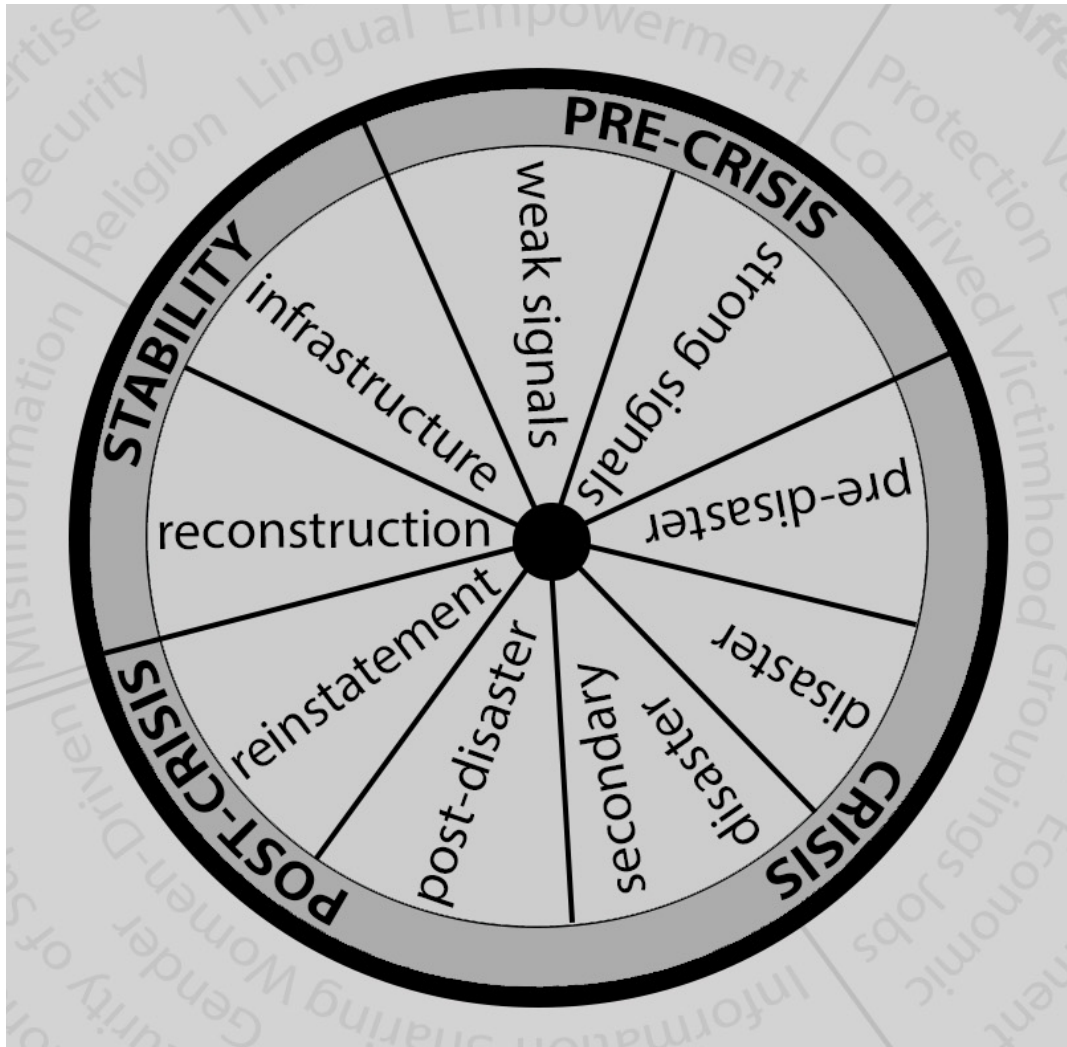


Figure 7-2: Crisis Wheel

7.4.1 Stability

The stability phase concerns itself with the period of time between crises where no perceptible indicators are present. This is a key phase within the framework as it allows for reliance planning with all its associated activities. It is during this period that work may be undertaken which may be considered preventative or, at least, proactive rather than reactive; allowing those in positions of power to utilise resources to create a stable a resilient community better capable of resisting crisis whilst simultaneously mitigating unavoidable elements of any given scenario.

In order for such undertakings, existing agencies must be given the correct human resources, infrastructure and funding so that resilience may be interwoven into the fabric of the community. This is most often not the case for anything that may be considered a rare event, such as intermittent natural disasters. Authorities have concerns over the allocation of public funds to schemes whose benefit may not be realised within a single political lifecycle. Therefore, it is imperative that not only are governments encouraged to engaged in such programmes but that these undertakings be presented to the public in such a manner as to garner their approval and, ultimately, support for future investment.

Stability is not taken for granted, as some countries do not have the luxury of periods of stability. Rather, they exist in a state of continuous threat, be that through political unrest or financial impediment. Therefore, resilience planning has been considered as a separate entity, which, whilst ideally dealt with during a stable state, is often created and implemented inside of crisis. Such mutual exclusivity is therefore desired but not essential to the implementation based upon the crisis wheel.

7.4.2 Pre-Crisis

The pre-crisis phase is denoted by *weak signals* that may be almost imperceptible or initially thought irrelevant. Such weak signals are difficult to distinguish amongst all of the ambient noise created within a macro-environment; they may consist of elements and, as such, make detection and interpretation difficult or impossible until their presence moves into the realm of strong signals.

Weak signals may occur quickly and transition to strong signals within a short period of time. For example, earthquakes are usually preceded by tremors, which may occur weeks, days, or only moments before the main shock. Thus, the need to react quickly is a core concept within resilience planning and should be considered as part of the crisis wheel's application. There are no standard time periods between phases; rather, contextualisation is needed and requires many differing data points across a myriad of fields.

Strong signals relate directly to the impending crisis, be these in the form of political instability or through other macro-environmental indicators. Both weak and strong signals are presented in greater detail in the following sub-sections.

Through early identification of weak or strong signals, agencies are able to structure their response based on predetermined plans; the early identification occurs, the more time key actors have in structuring their response. Hence, the integration of those people, processes and technologies whose role is to monitor the environment for weak/strong signals need to be integrated into the entire Crisis Management infrastructure as their core competencies are at the centre of a well-considered response to the pre-constructed strategy. It is important to be aware that strong signals may be the first to reach Crisis Management bodies as the preceding weak signals were simply too weak to comprehend; therefore, the crisis wheel takes account for the omission of this step without collapsing. If a weak signal can be detected well in advance of any impending crisis then the time available to implement the viable response is increased which may lead to a much higher quality response with less risk to both human life and infrastructure elements.

7.4.2.1 Resilience Planning

Resilience planning is now common practice in developed countries but somehow still fails to produce the desired outcomes as regards crisis mitigation. This is often due to disparities between actors and agencies involved in the resilience process. Internal rivalries and lack of knowledge sharing are often to blame as government entities compete for finance and resources. It is therefore necessary that any resilience plan see all those who participate as equal practitioners within the crisis environment, regardless of role or responsibility. Poor planning will lead to poor implementation if the research and monitoring staff are not given the same level of kudos as those for whom operational crisis response forms the core of their role.

With the above in mind, a collegiate team, comprising representatives of all major agencies and actors needs to participate in the construction of a resilience plan. This however, brings its own problems in that too many representatives on any one steering group could potentially cause paralysis with regards to the effectiveness of any given outcomes'. Therefore, sub-groups would have to be convened so that particular aspects of each crisis could be analysed and subsequent interlocking planning elements be created based on the knowledge and skills of key actors from each field.

If the above was to become a reality, then the framework would provide a structure around which the groups could be formed into a coherent entity and thus create a holistic solution to any given disaster scenario which has historical context or may be new to all concerned.

An additional benefit to the inclusion of the crisis wheel would revolve around the ability of external organisations' to understand the desired outputs from any such programme of resilience planning. Thus making provision for grants, aid and any other form of assistance in the form of expert knowledge or infrastructure to be overlaid on to the programme whilst allowing other, less developed governments to copy the planning without having to resort to first principles.

When recruiting individuals or sister organisations for the purposes of resilience planning, the framework would not only aid in actor identification but in locating voids within current provision within or without the country concerned; this would allow concerned parties to create agencies or authorities which would fill the gap and strengthen any offering.

7.4.2.2 Weak Signal Identification

The identification of immature or fragmented data/information constitutes weak signals as they form incomplete information, which is unrecognisable or difficult to enact upon. Due to the often, temporal nature of such indicators, the ability to collect, collate, and disseminate could remove or, at least, reduce the crisis risk long before the actual crisis state comes into being.

The identification of weak signals can be an extremely difficult and costly endeavour, requiring a multitude of resources and sophisticated analysis software. By the very nature of such signals, identification can often result in false positives or negatives which drive each phase of the crisis wheel in unrewarding directions, wasting time, money and opportunity; in addition, to the loss of confidence in system validity.

Such weak signals are often masked by noise that makes identification even more difficult. In recent times, the advent of big data concepts have lead to an increase in the success rates of weak signal capture due to the commercial significance with regards to Customer Relationship Management (CRM), its ability to generate income and therefore create or sustain competitive advantage within the chosen marketplace.

Therefore, weak signals can now be detected with greater confidence and are thus included within the crisis wheel to encourage those engaged in the process to incorporate such technology into the planning and execution of crisis activities. This may be employed through the utilisation of social media such as Facebook in the collection, collation and dissemination of data/information.

Such crowdsourcing of activities has proved popular within the fields of Astronomy and Cosmology, Citizen Journalism, and Policing; not to mention the recent inclusion of such activities in acute presentation within the medicine. For example, crowdsourcing has recently been employed in the identification of Glaucoma through the use of software that allows anyone with a computer and internet connection to assess images of eyes for the disease. If one could employ such techniques into weak signal identification, then resilience planning and crisis execution could be enacted with a much greater level of accuracy at reduced resource costs.

7.4.2.3 Strong Signal Identification

The concept of strong signal identification is much easier to quantify, with indicators pointing either directly or indirectly (but easily mapped) to a foreseen crisis state. Therefore, the inclusion of strong signals is an obvious one as, through their identification, resilience plans may be enacted in a timely manner to mitigate any given scenario. Such signals are not necessarily the best ones on which to act; they often present themselves at a moment in time where the impending crisis may be unstoppable or where the threat to human life has risen beyond that which is acceptable given the crisis type.

Strong signal identification must be used in conjunction with weak signals to build a causal database upon which decisions may be made before the strong signals is made manifest within future crisis instances. Through the creation of such a resource, stakeholders would be able to create confidence ratings for resilience plans due to the identification of weak signal combinations preceding any strong signal occurrence.

7.4.3 Water

It is throughout the entire process that water is taken into consideration for the formulation and operation of resilience plans and crisis responses. With this in mind, the inclusion in water is implicit throughout the entire framework and, as such, does not form a exclusive part of the structure but rather, is integral to the entire framework.

The framework and inclusive crisis wheel are dependant on each other and on the lensing of any undertaking in the context of water allocation based upon crisis types and modes. Thus, the model is constructed entirely from a water-based imperative but does not include water terminology so as to engage with those for whom the knowledge of water and reclamation does not extend beyond that of the consumer. This allows for non-specialists to be employed as actors within the framework without the need for complex domain-specific nomenclature. It is intended that such an approach result in greater fluidity of knowledge and information between stakeholders without the usual alienation of those who are not party to complex and jargonistic language associated with the industry.

7.4.4 Crisis

As detailed across previous chapters, crisis can occur with or without associated disaster. Therefore, Crisis Management takes precedent over disaster management during the strategic undertakings but may well be superseded by any disaster occurrence as the impact of the latter is usually of a more temporal importance. When crisis occurs without an impending disaster, resilience plans may be brought into play often without the need for emergency response; rather a more considered application of any resilience planning may be enacted to mitigate or remove the identified threat. With this in mind, the crisis wheel is capable of highlighting the interlocking ring segments that are of greatest importance in order to provide guidance for any and all agencies involved in planned activities. This allows for the full integration of actors so as to provide both efficient and effective response measures, which can resolve the crisis in a timely manner and with the least impact on community in general.

For any given crisis the wheel can be set to deliver the applicable elements deemed most effective, as the crisis develops, the wheel may be reset to construct a different combination of deliverables which are, once again, tailored to the specific temporal needs.

As the centre of the crisis wheel depicts the phases of crisis, it is important that correct identification of the phase in question be directly linked to the elements detailed in the concentric rings. These are based on the four key factors identified early-on in the research; namely, Crisis Management, Knowledge Management, Public Health and Human Security. From this the four concentric rings are segmented to cover each of the main attributes for consideration during each phase of the crisis wheels inner-section. Whilst the previous sub-sections have dealt with steady state or pre-crisis conditions, it is the following sub-sections that are concerned with actual crisis and any given disaster contained therein.

7.4.4.1 Pre-Disaster

The draft framework pre-disaster phase may sometimes be considered synonymous with that of the crisis phase as the latter may well encompass the former. However, for the sake of clarity, pre-disaster is explicitly declared within the crisis wheel so as to make provision for instances where it may occur independently of the crisis. Pre-disaster is in place to allow for the operational deployment of assets within the incurring crisis but before the disaster has occurred. Based on the principle that crises can occur without accompany disaster, it is plausible to extrapolate that pre-disaster action would mitigate or completely remove the impending disaster. The deployment of clean water and sanitation equipment prior to an predicted disaster could aid in reducing its impact without the need for a crisis scenario to be in place as disasters may occur without the aforementioned crisis being made apparent to those affected.

7.4.4.2 Disaster

As mentioned in the previous section, a disaster may exist within any given crisis context but is not mutually inclusive. Therefore, the disaster phase may be omitted if no such emergency (*blue light*) element is brought into play. However, disaster still needs to be considered as an independent factor as the weak/strong signals may not have been detected or dealt with prior to the disaster occurring. When a state of disaster is invoked, the crisis wheel enacts a mostly operational function so as to contend with the emergency requirements as and when they are considered paramount. However, this is not the sole purpose of the wheel when dealing with disaster; both tactical and strategic concerns still need to be considered in order to ensure, as far as is reasonable practicable, that the operational activities being undertaken fulfil the four strategic elements.

The inclusion of the crisis wheel in any disaster environment has to be controlled by the governing agency to ensure that each objective is dealt with in an efficient and effective manner so as to distribute resources to best effect. Disaster is therefore considered integral to the wheel even if it is not always included within a given crisis scenario.

7.4.4.3 Secondary Disaster

Given the fact that crisis and disaster is not a mutually inclusive event, the inclusion of a secondary-disaster phase will only come into existence if a primary disaster has already occurred. It is important to note that where a primary disaster has occurred, secondary disaster may be numerous in nature. However, in the case of no primary disaster, what would have been considered a secondary occurrence is now taken to be the primary event. The only requirement for the classification 'secondary disaster' is that a primary one is in effect; it does not in anyway indicate the type of disaster at hand.

Secondary disasters are present because of causal factors concerned with the primary disaster; such as, outbreaks of disease after earthquake due to a lack of sanitation infrastructure. It is vital to ensure that the crisis wheel does not recognise any secondary disasters where there is no primary disaster, as this would prevent the segments from operating correctly.

It is often the case that secondary disaster outstrips the impact of primary disasters in that they often have more severe outcomes and last for a longer period of time. Most naturally occurring disasters cause loss of life within a small period of time but the resultant secondary effects may well last for much longer; they may also continue into the crisis phase and be of a more acute nature.

7.4.4.4 Post-Disaster

Once the primary, and perhaps, secondary disaster phase has ended, the wheel moves into a post-disaster period which is denoted by a lack of immediate danger to humans and the community at large. However, the crisis period has not concluded but is considered to be free of any disaster elements. Hence, post-disaster may deal with some infrastructure reconstruction intended to make provision for a tolerable existence for those concerned. For example, refugee camps in various safe havens close to conflict zones in the Middle East or Africa. It is by utilising a post-disaster element that agencies may begin to improve the environment concerned without consideration for the long-term strategies for resilience or reconstruction of permanent infrastructure. This allows said agencies to provide relief based on need rather than long-term goals set-down in the next section of the wheel.

Many developing countries become entrapped by post-disaster crisis, unable to move on to the post-crisis phase. The reasons for this may be many fold but are most often concerned with a lack of political will or the financial wherewithal required to fund resilience projects capable of preventing long-term crises. The perpetual state of crisis reduces the effectiveness of almost all proactive projects due to the need to focus reactive aid and relief efforts in combating crisis effects on communities with within the given locus.

7.4.5 Post-Crisis

Once the post-disaster phase has subsided through successful fulfilment of coherent infrastructure reinstatement projects that allow communities to function to a standard deemed suitable, the post-crisis phase come into operation. It is at this stage that major construction and infrastructure projects are introduced so as to strengthen the affected area through increased effectiveness of available resources.

Developed countries usually have on going projects designed to deliver improvements to the economic prosperity and social needs of their electorate. This can be seen in large European Funded undertakings, which are under continuous implementation within member states. It is imperative that such long-term planning be introduced to those countries for which this is not common practice. The World Bank makes provision for such endeavours but this transfer of wealth is not nearly enough, with much being wasted due to a lack of vision and coherence of activities, further exacerbated by systemic corruption (Nielson and Tierney 2003).

7.4.5.1 Reconstruction

As can be seen from such projects as the Iron-built market in Haiti, destruction of such edifices can render local economies impotent, preventing local people from earning a living through the transfer of goods and services (Smith 2011). The market was reconstructed in order to provide, not only, hope to the local people but as a reinstatement of the local economy's ability to function in the fields of B2B and B2C trade; thus kick-starting the flow of money between the local populous and further afield (Smith 2011).

It is through the investment of fiscal aid that the economic dis-benefits of disaster may be overcome as it encourages communities to reengage with one another thus allowing for the trade of goods and services to stimulate further infrastructure improvements which are not only planned by government but also demanded by those affected.

7.4.5.2 Infrastructure Improvements

As mentioned in the previous sub-section, reconstruction and infrastructure improvements can be delivered as part of a holistic solution. It is often observed that once a disaster or crisis has come to an end, local communities proceed to rebuild using exactly the same materials and construction techniques without utilising the opportunity to understand lesson learnt and integrating them into future solutions. This ultimately results in the same risk factors and weak points being in place for a repeat crisis anytime in the future (Alexander 2004).

It is the intention of the crisis wheel to ensure that the post-crisis lessons are not only learnt but that resultant planning and construction is carried-out in a manner cognisant to risk mitigation or removal in the event of a similar crisis occurring in the future.

7.4.5.3 Resilience Planning

Whilst resilience planning has been covered earlier in this chapter, it is important to close the circle so as to complete the crisis wheel. Therefore, whilst resilience planning sits within a state of stability on the crisis wheel, the imperative for undertaking such activity may be considered at anytime during the post-crisis phase. This may not necessarily be possible but should always be desirable when undertaking any of the aforementioned construction and infrastructure improvements. Resilience plans may be implemented as part of these activities or even at the planning stage for infrastructure improvements. This allows for resilience to be built into the very fabric of any undertaking, making provision for crisis relief inside the community and environment itself.

7.5 Crisis Instances

The crisis wheel is embedded within a dynamic framework that may be reconfigured to given crisis types in order to make provision for the best possible solution for the given criteria selected. At the centre of the crisis wheel are the aforementioned elements. The phases presented are used to define particular modes concerned with the crisis lifecycle and, as such, allow users to interact with the framework based upon their particular interest.

The concentric rings provide each of the elements presented in the draft framework presented in the previous chapter. These are dynamic and can be configured to represent particular crisis modes or occurrences, thus allowing users to operate the wheel based on whatever phase and criteria is their current concern.

As the central phases of the crisis wheel denote temporal elements through which crisis patterns transit, it is somewhat difficult to rank recommended activities in order of importance. Therefore, the user is expected to have prior knowledge of crises pertinent to their particular interaction with the environment. However, guidelines have been set in the previous chapter, detailing the intention of each segment of the concentric rings and offering examples relevant to each.

Given the above criteria, the crisis wheel is best used by a group of actors, whose interaction may be guided and controlled through the allocation of responsibilities and accountabilities based upon their particular knowledge and skills, combined with the locus of control defined by the group at large. If this is implemented into any phase of the crisis, the outcomes may be structured around each element so as to bring about a collegiate approach to *problem solving* and enactment of subsequent strategies, tactics and operational activities. The need to involve local actors in each phase needs to be taken into consideration as making provision for non-experts as part of such steering groups may be difficult, especially if literacy and educational deficiencies are present due to geographical location or demographic factors. Thus, the wheel needs to be employed in the simplest manner possible when utilising such Informants so as to take advantage of their knowledge and skills outside of a professional or academic context.

This is often not the case as top-down approaches are the norm within strategic decision-making and subsequent planning. The wheel has been adopted as an antidote to such thinking, placing each of the elements within concentric rings, thus removing hierarchical preconceptions as to what is decided, at which level and by whom; equality being the key to collegiate involvement and thinking.

As experts within the identified fields are often, by their very nature, specialists, the wheel also encourages interaction through the incorporation of fluidity as to the utilisation of individual segments. As with many frameworks, the problem comes in performing each and every segment. This is not the case with this tool; rather, individual segments may be moved to align with others and may also be completely omitted if considered appropriate by Informants. However, this is not without problems as some elements obviously rely upon the outputs from others. Rather than stating these explicitly within the framework, it is considered that the users are best placed to make decisions surround implementation or omission of certain activities. The framework is very much dependent on a combination of people, process and technology: each coming together as a triumvirate that delivers practical solutions whilst achieving the maximum positive effect. During validation, the draft framework was deconstructed and analysed by each domain expert; this resulted in a framework that was capable of being enacted either partially or as a coherent whole. Therefore, the individual segments are colour-coded to indicate interdependences but these may be tailored to individual crisis modes, driven by experts involved in its application.

7.6 Existing Frameworks Comparison

Focussing on the five identified frameworks detailed in section 2.3 of the literature review with the intention of providing comparison between their *modus operandi* and that of the final framework, the following discussion compares and contrasts the content and objectives of each.

The five frameworks initially investigated provided individual aspects relevant to the research domain but fell short of providing the solution intended by this research. The final framework has been created to formulate a holistic crisis management solution that can best deal with the different modes of proactive and reactive intervention.

The introduction of social media and other democratised methods of community organisation means that the final framework endeavours to create a platform that is organised and operated by actors for whom input has not been previously sought or readily accepted.

UNISDR Hyogo Framework for Action: this plan deals mostly with professional-level stakeholders, those for whom disaster and crisis form part of their work remit. It does not deal with the local actors, for whom the impending crisis is a personalised experience, impacting themselves, family and community. The final framework proposed by this research attempts to address this shortcoming by providing much in the way of local actor interaction and actor-driven engagement with the crisis domain and eventually return to steady-state. The Hyogo framework also differs in its immediacy with regards to crisis instances centring, as it does, on the part of government and professional agencies to put into place preventative measures along with response plans that require professional equipment and services.

The final framework focuses much more on empowering all stakeholders to interact at every stage of the crisis wheel in order to gain buy-in, whilst creating community cohesion in times devoid of crisis. This is intended to increase responsiveness, agility and flexibility so no matter the crisis mode, communities are best placed to respond.

Federal Emergency Management Agency National Disaster Recovery Framework: deals with the interaction of disaster management teams who operate within an organisationally federalised environment across the crisis and post crises phases. This differs somewhat from the final framework in that little provision is made for the cyclic nature of crisis and subsequent occurrence of secondary crisis.

The final framework on the other hand, is scalable to any impending crisis and may be centralised, federalised or decentralised in nature depending on crisis mode and size. Size may be determinable as either geographical spread and/or population density.

Disasters Framework: *WaterAid* deal solely with the water implications of disaster. The use of their framework as part of secondary data collection was important due to the focus of this research. However, the framework itself is bounded by this fact whereas, the final framework was designed as a holistic solution that does not require other crisis management frameworks to run in parallel. Rather, the final framework is a stand-alone solution designed to integrate all stakeholders across the crisis landscape.

The Red Cross, Red Crescent and Hyogo Framework for Action: disaster risk reduction was the focus of this framework and is concerned with the core organisations interventions in crisis scenarios. Once again, this differs from that of the final framework in such as it does not make provision for the integration all actor-types with the crisis domain so as to create a knowledge-driven solution.

The final framework concerns itself with interaction and integration of stakeholders, regardless of organisational affiliation. Rather, it focuses on the interoperability of all who require assistance and/or can add value based on demographic, personal and temporal information.

National Disaster Management Framework (South Africa): a government-centred framework that concerns itself with crises within South Africa. This was of particular use as it is concerned with the allocation of resources to those most in need whilst making provision for bi-directional information flow that may be used for tailoring the response activities. The focus being on crises within South Africa itself means that it mostly deals with crisis modes for which the country is most familiar, this falls short of the objectives of this research, which was to create a framework capable of being deployed to any situation in any location. The final framework is designed for universal deployment, one of the drivers for which, was the intentions detailed within the further work section of this document. Namely, creation of a knowledge-base which transmogrifies the framework into specific models based on locale and crisis mode based upon analysis of historical data.

7.7 Conclusion

The final framework constructed as part of this chapter comprised primary information collected from informants at the FWF and validation from industry experts. When combined, the draft framework was simplified into a single illustration comprising, four concentric rings commensurate with the original research elements. At the centre of the illustration a crisis wheel was constructed to allow for segmentation of the crisis lifecycle and thus, the entire framework. The final framework constructed allows for a multi-faceted, multi-disciplinary approach to crisis regardless of the phase or scenario under consideration.

8 VALIDATION CASE STUDY

The knowledge-based framework that forms the nexus of this thesis has been created, validated and refined in previous chapters. This chapter details its application to a historically important crisis and disaster; namely, Hurricane Katrina. Each framework element is applied to the event filtered by sequential phases of the crisis wheel based within the framework. Thus, validation of the final artefact is achieved through appraisal a real-world crisis lifecycle scenario that illustrates the role of the framework within strategic planning, tactical resource allocation, and operational execution.

8.1 Validation Approach

Validation of the proposed framework is intended to answer the original research question detailed in chapter one whilst complying with the request of validators for testing of the framework.

Chapter two dealt with modes and instances of specific crisis types. Table 2-1 showed that flooding was the number one natural disaster, with storm being the third most prevalent. Therefore, it was considered pertinent to utilise Hurricane Katrina as it constituted a large storm, which contributed to large-scale flooding of the affected area.

Through application of the framework to Hurricane Katrina, it can be seen that each element can be successfully implemented based on both temporal and spatial imperatives.

In order to effectively apply the framework to Hurricane Katrina, key aspects of the disaster were identified and their impact upon victims and property assessed. The following details each phase of the crisis wheel applied to the available information, with the subsequent framework segments extracted and employed to the scenario with the intent of removing obfuscation through disambiguation of individual crisis elements.

Only segments of each of the crisis rings will be utilised that applies to the scenario at hand. The segments identified in the draft framework and appended to the crisis wheel may occur under several of the domains originally identified:

therefore, where these do not apply, the segment will be ignored. This illustrates the module, dynamic way in which the framework may be utilised.

8.2 Validation Object: Hurricane Katrina

Hurricane Katrina was a natural disaster that struck the mainland of the United States of America between 23rd & 31st August 2005. The initial phase of the disaster took place when a Hurricane developed over the Bahamas on 23rd August due to tropical weather patterns common to the region; beginning as a standard cyclone, then developing into a hurricane shortly before striking land at Hallandale Beach, Florida. However, the storm continued along the Gulf of Mexico before, once again, making landfall on 29th August in southeast Louisiana where it was to cause the greatest amount of damage (Hartman and Squires 2006).

However, it was not the wind itself that was the major factor, rather, the levee system used to protect the region from flooding had been neglected by successive governments, which led to their breaching on 29th August. This catastrophic failure allowed floodwaters into the city of New Orleans, covering over 80% of the available area within the city and neighbouring parishes (US House of Representatives 2006).

The flooding remained for weeks, and infrastructure became fragmented, thus compounding the already overstretched emergency response teams in the area. Much has been written about the underlying factors causal to the disaster. From the lack of leadership at executive level, through to uncoordinated emergency response from competing organisations within the federal system unwilling to work alongside one another, to the widespread looting undertaken by victims for whom no other option was made available.

The disaster has been studied in the intervening years by a many and varied population of scholars, journalists, and members of the public who were victims or who simply gained interest in the subject. This provides a rich picture of the event from numerous perspectives and from a diverse group of stakeholders. Therefore, the framework has been set against this disaster as a test of its operational validity.

8.3 Background

The United States of America (USA) enjoys the status of being the world's richest country with a GDP of nearly seventeen trillion dollars in 2013. (World Bank 2015) With such wealth and opportunity for provision of resources, the USA should have been in a position where such crisis could have been mitigated without disaster occurring or avoided altogether. However, this was not the case; during the state of stability illustrated on the crisis wheel the country failed to put in place sound resilience measures (US House of Representatives 2006). The stable-state was overseen by successive governments which underinvested in the flood defences and emergency response infrastructure needed in the event of hurricane. Levees had been constructed by the United States Army Corps of Engineers (USACE) in response to the Flood Control Act of 1965 (US Congress 1965). The system of breaks had been poorly constructed and maintained (US House of Representatives 2006).

In addition to the shortcomings of the USACE, the Federal Emergency Management Agency (FEMA) did not put into action its emergency response plan, nor did it review any of the preventative measures for which it was responsible (The White House 2005). All of these mistakes should have been prevented by rigorous processes created during the stability period but were not due to a lack of funding and political will. Within the context of stability, the following sections will utilise the concentric rings of the framework with respect to each of the detailed elements.

8.4 Framework Application

This section evidences key elements of the rings based upon identified phases of the crisis wheel. Each applicable element is explained in the context of the crisis phase in question and respective historic outcome experienced under the conditions of Hurricane Katrina.

The sub-sections begin with a stripped-down framework that identifies the crisis wheel segment and associated ring in effect. Each entry is then examined with respect to the historic context under scrutiny. The elements chosen for validation of the framework were based on the following criteria so as to maximise the rigour employed during testing. Further, randomised tests may be found in appendix G. These were employed to less impactful elements of the conditions surrounding the event but provide additional validation of the framework as a whole.

8.5 Validation Criteria

The events leading to and emanating from Hurricane Katrina consisted of many factors. In order to validate the framework, some key elements were identified and applied to the framework. Each segment and ring was tested once so as to give an example of the application of each and was based on the following criteria:

- Quantity of secondary information readily available so that most elements within each ring were applied;
- Information available in each research element so every ring could be applied once;
- Temporal information available so that each segment of the crisis wheel could be applied once.

8.6 Validation Process

Justification for each of the entries within both the crisis wheel and concentric rings of the framework are presented across the previous chapters. Therefore, the validation case study concerns itself with the failings concerning Hurricane Katrina and resultant impact of each entry. It is not the intention of this chapter to further elucidate explanation of each component. Rather, the focus is that of application and how the absence of such considerations negatively impacted upon the chosen crisis.

Sustainability: in the case of Louisiana's levee system, the measures which should have been undertaken through the employment of a rigorous approach to design, construction, and maintenance of the structures was left wanting due to the financial cost (US House of Representatives 2006).

Quality Assurance: the levees were supposed to be inspected at regular intervals as per the Flood Control Act of 1965 under which they were constructed. However, in recent years, management of the maintenance routines had been inadequate with many jobs either being completed to an unsatisfactory standard or not undertaken at all (US House of Representatives 2006). Had a stringent maintenance plan been in place that facilitated audit, this lack of compliance could have been avoided (Day et al. 2006).

Legislation: as previously mentioned, the Flood Control Act 1965 had been used to effect the construction and administration of such edifices but, over time, had become unworkable. The initial provision had been for a series of works that protected the entire area. However, a caveat was placed on the act, insisting that projects were not to exceed \$10m; if this number were insufficient, then local authorities would have to shoulder some of the cost (US Congress 1965).

The legislation was fundamentally flawed due to the centralisation of activities through the USACE but for whom the local community had to burden some of the cost. The Levee Boards that had existed prior to the acts inception retained responsibility for the programme once completed but as of 2005 the project was only 60-90% with a further ten years constructed expected (US House of Representatives 2006).

Risk Management: as can be seen from the above, risk management was a problem for the stakeholders as the need for a flood control system was universally agreed; the timeframe for construction was hampered by the cost of such an endeavour. Thus, risk management could have been better employed in the project management plans for construction. However, the complexity of the undertaking was not understood at the time of the acts creation; therefore, risk management was difficult as many of the problems encountered were unforeseen or, in the case of weak signals, unrecognised.

Scenario planning could have been utilised for all know possible permutations, which would have employed the four risk methods within the framework, allowing for categorisation and ranking of the projected projects.

Entry/Exit Strategies: during the stable phase it is uncommon for an international presence to be required. In the case of the USA, it is highly unlikely that outside assistance would ever be sought due to its position as the leading global economic power. Therefore, the entry/exit aspects were applied to the federalised nature of US agencies and states. Due to the nature of decentralised control through a federalised government administration many conflicts of interest occur which hampers the efforts of individual organisations having to exist within a structure where jurisdiction is blurred and ultimate accountability difficult to attribute (Schneider 2005). Thus, entry/exist strategies are difficult to apply and administer.

The need for centralised command and control was understood in the aftermath of Hurricane Betsy which struck the same region in September 1965 and resulted in \$139m damage to the area with five attributed deaths: this provided a catalyst for introduction of the aforementioned act. The fact that from 1965 until 2005 the work done still only constituted 60-90% of that needed showed the level of importance attributed to the operation. No firm completion dates were set, nor exit strategy for handover from USACE to the respective Levee Boards (Mittal 2005).

Resilience Planning: this formed the backbone of the entire legislation; making provision for an infrastructure capable of dealing with any tropically-induced cyclone/hurricane. Some thirty projects were authorised under the act, which constituted a series of interlinked measures. However, the modelling tool used by USACE was criticised by those in the meteorological agency as underestimating the impact of future disasters. Therefore, the resultant resilience plans were based on incorrect information which rendered the scheme vulnerable to extraordinary weather conditions; the exact event for which they were supposedly planned (US House of Representatives 2006).

Preparedness: The preparedness of any crisis family is based upon the accuracy of the resilience plan created for protection of the vulnerable within a given scenario. The level of preparedness was not faulty at every level: for instance, the US Coastguard had in-place a response plan which was more than capable of dealing with minor breeches in the defence structures. However, it did not have the resources at its command for a catastrophic failure. Therefore, reservists were worked into the plan to provide a second tier of support for full-time responders (Davis et al. 2007).

The resilience plan did not take into account the difference between a crisis and disaster with the former being planned for but the latter going without sufficient resource allocation or scenario-specific planning. Hence, when disaster struck, the time taken to respond and degree of to which response was enacted proved insufficient (Schneider 2005).

Response/Recovery: One of the major factors upon which crisis/disaster mitigation relies is the timeliness of response. With this in mind FEMA were tasked with creating response plans for a myriad of scenarios within the US. However, this relied upon a single point of failure. Namely, the President's ability to issue the executive order required to set any such plan in motion. As was widely reported at the time, the President did not issue this order until three days after the event (US House of Representatives 2006).

Actors: the actors within any resilience plan are usually many and varied, which can cause problems in itself through a lack of common nomenclature and the different operational cultures within each respective organisation. However, as is the case with separate organisations responsible for their own procurement, the equipment and materials are often strikingly different and often with the inability to integrate with other agencies equipment and materials.

Stakeholders: actors are a subset of stakeholders who are manifest through their interaction in the creation of a resilience plan or the impact of a plan enacted upon them. As such, involving stakeholders in the planning process is important not only as an awareness exercise but in creating buy-in from commentators who may have to provide indirect financial support for the project. As was the case in Louisiana, projects exceeding \$10m had to be partially funded by local government via the consent of taxpayers. However, the intermittent nature of natural disasters in the area proved a force for intransigent attitudes amongst the population, stubbornly against taxation for the scheme (Schleifstein 2015).

Training: this forms the heart of actor-management within a resilience plan as it allows for local actors to gain Knowledge and skills useful in the event of a crisis. This combines with the feeling of self-worth gained by those involved in the training, as they feel empowered and valued by the local community and national authority. In the case of the levees, this was not the case as the creation of such plans was done under the remit of USACE and was constructed using army labour (Labor Tribune 2013).

Education: in order to mitigate the backlash against such a huge financial expense, the education of stakeholders is an important consideration. Public consultation is an important factor when attempting to garner support for large-scale public sector projects. In the case of Katrina, education could have included that of school children; forming a part of their compulsory education so as to provide a better informed adult population in the future (Inland Revenue Service 2015).

Proactive: the proactive element of education with regards to response and recovery planning is mentioned above but the inclusion of information and Knowledge transfer can go further through public initiatives and their inclusion within community education programmes (Inland Revenue Service 2015).

Command & Control: As with any organised endeavour, the need for structure is paramount if the desired goals are to be achieved. However, US process often includes the use of different agencies whose roles and responsibilities overlap and for whom the idea of working as part of a team is seen as abhorrent (Freeman and Rossi 2012).

Hierarchy: this is very difficult to achieve within the US system due to the above federalisation of agencies and was significant during the resilience planning for the flood defence network. The USACE were given complete control over design and implementation of the system which followed standard military command protocols and was therefore based upon a top-down hierarchical structure with very little in the way of collaborative working as seen within modern Business (Fleischner, Hopkins and Montgomery 2012).

Unity: through the use of militaristic structure, the level of unity within USACE was very high but once outside of a military context, interaction with other organisations was difficult. This is frequently seen where military forces are tasked with activities outside of their core capabilities; for example, the policing of areas shortly after the end of conflict and before a stable government has been put in place (Weiss 2012).

Community: the use of Reservists went some way towards including community in the construction phase but, as was practice at the time, the desire for community engagement during the planning phase was not utilised; authorities believing in the power of experts over those of the community at large (Department of Homeland Security 2006).

Public/Private Investment: The Flood Control Act 1965 did not make provision for Public/Private Partnership (PPP) due to the non-profit nature of the undertaking; thus the entire burden of design and construction was shouldered by the taxpayer with \$738m being provided through federal commitment, combined with £210m from local authorities. This placed a large burden on the local population and therefore proved unpopular (US House of Representatives 2006).

Signal Identification: The identification of strong signals was adhered to with respect to historic hurricanes that had caused damage to the local area. Seeing as more than half of the populated area within Louisiana was below sea level, the argument for such a plan was irrefutable.

Infrastructure: this was effective during the resilience phase as the centralised method of operation allowed for a linear approach to design and problem solving. However, as previously mentioned a lack of interaction with external experts as to the modelling and resultant design of the system introduced flaws at a very early stage which only became apparent to all in the aftermath of Katrina.

8.6.2 Pre-Crisis Phase: Knowledge Management Ring

As with all aspects of the crisis wheel, everything needs to be scalable; this is true in particular with the triumvirate of people, process and technology which, when combined, offers everything needed within a Knowledge Management context, Figure 8-2.

Those in possession of knowledge during the Katrina event were unable to share what they knew with other actors due to incompatibility issues. This was further exacerbated by the political influence being executed from several different stakeholders around issues such as what to tell the public and how to handle news media outlets whose focus is often on presenting the most powerful and exciting images of an incident rather than documentary reporting of the situation at large.

Consultative: the consultation given to those within loci of control was regularly contradictory and misleading due to the aforementioned factors regarding bias and a lack of knowledge as to the current situation and unfolding events.

Democratised: because of this lack of cohesion, the democratisation of information and knowledge was never achieved, leaving interested parties without essential information as to the outlook and their place within any relief operation (Shklovski 2010).

Success-Driven: prior to the compulsory evacuation of areas directly in the path of the hurricane, much confusion reigned as to the areas, which needed to be considered. Requests for assistance were sent by the Senator for Louisiana to the President for an evacuation plan to be put into operation. However, the plan was only partially enacted upon; this would later lead to much embarrassment to those concerned as a Senate hearing was told areas had not requested assistance. This was later proved to be untrue, with documentation being brought to bear on the actual requests and their far-reaching implications (Bush 2010).

Process - International/National: the national process was all that was applied due to the nature of treat and coping resources available. This was taken from the initial response plans as set out by FEMA and corresponded to well-established protocols concerned with such events.

Non-Partisan: the major cause for concern of the pre-crisis readiness concerned different organisations making-ready their part of a co-ordinated response without fully integrating with the parent body (FEMA) in any way other than to announce their position and level of readiness. This resulted in a stagnant approach to the situation, which lacked any flexibility or fluidity with regards to the changing situation (Ebbert 2010). In addition, the wants and needs of local government officials were not met as they were not considered key stakeholders in the process. This prevented people and equipment being distributed to all of the areas required.

Outward-Facing: because of the above mentality, outward facing initiatives were not in place to ensure integration of emergency and relief services prior to the crises phase (US House of Representatives 2006).

Open: due to the structure of these organisations, the ability to operate as a coherent unit, sharing knowledge and information is almost impossible. People from each party often argued as to the best form of response; when their view was not taken as the solution, they continued regardless and thus degraded the unity of response required for a fully co-ordinated operation.

Honest: after the fact it was proven that the President's office lied regarding resources requested by the local Governor. This implies a lack of honesty during the deployment phase of the operation that resulted in relief and rescue not reaching those in most need in several severely-hit Parishes (Lipton 2006).

Bidirectional: during the build-up to crisis bidirectional communication provides an invaluable source of information as to the developing situation. The lack of interconnectivity between service personnel, prevented this from being performed at an optimal level (Ebbert 2010).

Universality: one again, the different command and control structures meant that personnel deployed to the area had to be managed by different hierarchies within the scenario which resulted in confused lines of authority and the ignoring of order received by those who were not directly answerable to those in overall charge; namely, FEMA.

Technology: as with any major undertaking, it is important that the technology is fit for purpose. Over recent decades what was previously known as the *space age* has been retitled the *technology age* which goes some way to illustrating the massive shift in available tools capable of supporting virtually all aspects of life and work.

This has created the opportunity for much greater levels of communication, information capture and transfer, and the ability to access knowledge on-demand. However, due to the rapid advances in technology it is difficult to keep pace. This means that particular technologies purchased as part of the resilience planning quickly becomes outmoded and obsolete. Combined with Governments reluctance to renew equipment on an ever-increasing basis and the financial restraints therein; it was inevitable that technologies would be unfit for purpose (Ebbert 2010).

Knowledge-Based: whilst the US has unparalleled access to information and Knowledge; being home to some of the world's most successful companies, universities and research institutions. The difficulty came, not from a lack of Knowledge but an abundance that made choosing the correct solution almost impossible. The answer employed was to retreat into respective political stances, accepting knowledge only from those who agreed with their standpoint. This was the case when National Hurricane Centre was ignored due to their estimation that the resources being put in place would prove inadequate (Wigginton 2007).

Expertise: with the introduction of complex technology, the expertise required for operation has increased, this placed an extra burden on the training of personnel; especially those operating as Reservists who do not interface with the technologies on a regular basis (US House of Representatives 2006).

Networked: the need to network cross-agency staff through common information storage and retrieval technologies led to duplication of effort and a lack of information sharing (Ebbert 2010).

Cloud-Based: it is unreasonable to expect that such a new technology would have been employed in 2005.

Open-Source: it is also the case that open-source platforms were much less utilised at the time of Hurricane Katrina, and is therefore excluded from analysis.

Platform Independent: the idea of platform independence would not have been taken into consideration, as the technology at the time was mostly firmware driven and not updatable.

Noise: The amount of information available was one factor of concern in the tracking of Katrina and the expected destruction path. The amount of conflicting data caused incorrect decisions to be made which spiralled once a state of crisis occurred.

Media: the pre-crisis phase is when news media organisations first become wholly interested in the available information. It is at this point that Media Liaison Officers are usually mobilised to cope with the demands of such organisations; this is intended to ensure that a balanced message is released to the public. However, in the case of Katrina, news outlets caused widespread panic; residents were leaving the area in such numbers as to cause grid-lock on surrounding roads. This further impeded the ability of response workers to access the pre-crisis area. It was at this boundary point that that of crisis superseded the pre-crisis phase (Voorhees, Vick, and Perkins 2007).

Social Network: as an adjunct to mass media, the use of social networking was becoming popular at the time; allowing individuals to create content rather than merely consume that produced by the recognised media outlets. This caused contradictory information to be circulated, some of which was true, some untrue and some intentionally untrue. The power of such content creation by locals has become known in the intervening years as citizen journalism and is a powerful force within the news-driven environment.

At the time, it was a cause for concern amongst the Liaison Officers who had been formed the core of official Knowledge as regards the pre-crisis environment. When combined with news media's own reporting, the message delivered to the public was considered straight forward. However, with the introduction of social networking within a Web 2.0 paradigm, the lines became blurred and government agencies had to readdress their approach to knowledge sharing (Jennex 2008).

News media's response during Katrina was to embrace the shocking side of citizen journalism to present dramatic and exciting reports for a consumer for whom Hollywood films was at the heart of their idea of entertainment. The shift from news to entertainment happened long before this event but was a turning point in the idea of rolling news based on drama rather than fact.

Infrastructure: as the Federal Emergency Management Agency had overall command of the relief effort surrounding Katrina and its aftermath; infrastructure as regards their operation and control of the Huston Astrodome is detailed in the following paragraphs.

Local Actors: a well-established response was enacted through the *Harris County Emergency Management Plan*, which was enacted by Harris County Officials (Hamilton et al. 2009). This consisted of an estimated capacity of 8,000 refugees but doubled as more people were bussed to the site. Therefore, convention centres were opened to house refugees as they arrived on site. Local Doctors and Nurses were utilised from surrounding areas under the plan along with National Guard and Local Law Enforcement Officers brought in to secure the venue (Tierney, Bevc and Kuligowski 2006). Such a mix of professional local actors caused breakdowns in communications to occurred which hampered the aid operation (Comfort and Haas 2006).

Social Groupings: due to refugees being brought to the venue from across the effected area, there was a large mixture of people from many different demographic groupings; financial, racial, geographical and age-related. This made relating to other *tribes* within the Astrodome difficult as refugees may not have had any previous contact with such groupings (Tierney, Bevc and Kuligowski 2006).

Gender: as the facility began to reach capacity, the ability to maintain law-and-order became increasingly difficult. The result of which was an increase in robberies and assault (Thornton and Voigt 2007). These were sometimes left without any investigation by Police and became part of an awareness campaign highlighting the plight of women and rape within the confines of a disaster scenario. (Thornton and Voigt 2007).

Women-Driven: No identifiable provision was made for women outside of separate washing facilities within the Astrodome. Segregation of sexes could have gone some way to mitigating sex crimes but was left without any proposed solution by officials. Women within the disaster area were not concentrated to help provide gender-driven solutions to such problems. This could be something for consideration in future planning for such crises.

Information Sharing: A lack of information sharing has been apparent throughout the analysis of Hurricane Katrina, having been attributed to jurisdictional, federal, and technological factors in the previous sections. Once again, the fact that many different agencies were on scene without formal information exchange protocols and a willing to share knowledge seriously hampered the effectiveness of operations, creating gaps and prompting duplication of effort (Comfort and Hass 2006).

National/International Groups: international groups were not brought into the scenario but a multitude of national influences were utilised. These included both federal and local actors and contributed to the above failings in communication.

Security of Supply: Water supply within the complex was sound for the first few hours but as water levels rose and the number of refugees significantly increased above that anticipated, supplies were stretched and in some instance ran out (Lipton et al. 2005). The need to have secure supplies to areas that form part of a disaster management plan should have been undertaken in order that clean water provision could be guaranteed.

Media: the modern essence of Media is to portray events in a dramatic fashion that ensures viewers continue to watch, rather than switching to another channel or turning away from the television set. Therefore, it is of no surprise that the coverage of Katrina focussed on the most dramatic elements with little in the way of considered analysis that could help those in crisis make a balanced assessment of their plight before deciding on the correct course of action (Littlefield and Quette 2007). Media needs to be controlled in a way that does not limit its freedom but provides viewers with a balanced appraisal of important situations, especially during time of crisis.

Clustering: has already been discussed in this work but explicit inclusion within Human Security affords the phenomenon a measure of control through official statements and the use of broadcasting technologies that do not rely upon the traditional news media for dissemination (Hopkins 2008).

Professional and local actors embedded within the crisis should be able to create and broadcast content which would mitigate the impact media clustering has on distorting the story presented to the public. This would aid officials for whom *courting the media* is common practice with the power to drive stories rather than merely guide them through attempting to placate those who create the artefacts for consumption of the viewer.

Misrepresentation: this has been covered on the part of media outlets in the previous section. However, victims within the crisis domain were also capable of misrepresentation as they attempt to garner the support of officials in making their wants and needs the priority of others (Voohees, Vick and Perkins 2007).

Secondary Crises: these form part of the crisis wheel but are also dealt with explicitly within the context of Human Security so as to allow for individualised analysis of the situation as it directly affects those inside the crisis event. Secondary crises in the context of Katrina and the Astrodome took on several guises, some of which have already been covered in previous paragraphs. These included, sex crime, robbery and access to water. Other such crisis includes the introduction of communicable diseases such as (Centre for Disease Control and Prevention 2005). These could have been reduced if refugees had been screened prior to entry. However, due to the sheer magnitude of people arriving, this proved impractical.

Affected Demographic: the affected demographic was not taken into consideration as the ability to segregate based on aforementioned taxonomy was infeasible. Whilst this entity remains a part of the framework, it should not be considered an important factor for Hurricane Katrina (Voohees, Vick and Perkins 2007). The idea of such demographic comes to the fore in such instances as civil unrest or war where conflicted parties may be brought into the same physical space whereupon their opposition to one another may become apparent.

Vulnerable: there were many women, children, elderly, infirm and disabled individuals contained in Houston. It is important that the individual needs of such people be taken into consideration when providing aid and relief. In the case of Katrina, the vulnerable were, on occasion, left without basic help and support (Adams et al. 2001).

Protection: as already mentioned, both National Guard units and Law Enforcement officers provided protection during the crisis with the former being brought-in to fill gaps in the ranks of Police officers. The need for protection by the military was deemed necessary even with the shortcomings of such organisations working outside of their remit and skill-set. This has been made plain after the event by the want of US government officials to repeal a statute that prevents military personnel of acting as fully-fledged law enforcement operatives in times of crisis (Nigg et al. 2006).

Empowerment: little in the way of empowerment of those affected by the crisis was utilised during the crisis phase of operation when the need for decisive action is paramount. This was somewhat justified in the case of *victims* being utilised as *actors* but does not excuse a lack of interagency cooperation which could have seen many more lives being saved and the plight of refugees improved (Ink 2006). The local population could have been given authority to take abandoned possessions as needed and to provide assistance to others in whatever way was considered reasonably practicable. However, those who chose to act without authority were criminalised which only further exacerbated the situation.

Contrived Victimhood: this became more apparent during the post-crisis phase as compensation was made available to the victims of Hurricane Katrina (Zeller 2005). This falls outside of the current analysis but is important to note.

Civil Unrest: during the crisis much was made of the violence and looting perpetrated by those trapped in the area. However, evidence suggests that whilst such incidents did increase, it was nowhere near the level inferred by news media. Much of the looting that took place was for food and water as many residents had been left without either for several days (Brezina and Kaufman 2008).

Government: the impact of government policy is explored throughout this entire chapter and as such does not require additional elucidation under this heading. However, during the crisis phase, government policy enacted needs to be assessed and changed made as appropriate.

Religion: impromptu prayer meetings and church gatherings were undertaken by refugees in the Astrodome that helped them cope with the associated emotional trauma of such an event. The need to make provision for those of other religions was not a problem as the majority were Christian and Jewish. However, the introduction of other religious ritual could have caused unrest amongst those with strong religious inclinations (Lawson and Thomas 2007).

Racial: there were racial factors inside the Astrodome as those from different backgrounds, not used to mixing, were placed in close proximity to one another. Black gangs were blamed for robberies and assaults whilst the white refugees were considered innocent victims. Much has been said about the response to the crisis in general; inferring the low social status of most of the victims directly impacted the slow and inadequate response by officials (Sommers et al. 2006).

Lingual: due to the location of the crisis, linguistics was not considered a problem. However, had the incidence occurred in another part of the USA or across national boundaries elsewhere, the need for translators and emergency relief in several languages becomes apparent.

People-Centric: the lack of people-centric activity undertaken by those in power was an important shortcoming that gave an impression of disengagement and disregard for those affected. People being left to fend for themselves after the flooding had taken their homes presented a potent image for those watching news media. This tainted the image of the United States as a superpower and presented an image of a country incapable of protecting its own people (Sylves 2006).

However, whilst media outlets made much of the antisocial behaviour, research by Rodriguez, Trainor, and Quarantelli (2007) suggests that prosocial behaviour was also in effect as people came together to help one another during the crisis. This could have been utilised by authority to aid in the crisis mitigation process.

Disparities: the disparity between those most effected by the hurricane and subsequent flooding with those on the periphery is to be expected. The disparity was between those who formed part of the relief operation; focussing on areas shown by news media as a priority rather than based on need (Bennett, Lawrence and Livingston 2007).

Education: a well-formulated plan for disaster response was in effect during the crisis (Hamilton et al. 2009). However, the affected people were mostly unaware of its existence, let alone the implications for their specific wants and needs. Education could have helped elevate some of the trauma in addition to providing strategies and actions for survival under such conditions (Eisenman et al. 2007).

Public: those members of the public who acted to provide food and water for themselves and their families were treated as looters by authorities rather than being left to gather whatever materials they could that did not impact on other victims. The exploitation of local stocks of essential items at stores and supermarkets could have been coordinated to aid those affected rather than being seen as a crime (Tierney, Bevc and Kuligowski 2006)

Sanitation: during the post-crisis phase the possibility of poor sanitation was not an issue as the affected populous had been moved to areas where water and sanitation were readily available.

Structures: both temporary and permanent structures were utilised in the immediate aftermath of Katrina. Such temporary accommodation continued for several weeks during the post-disaster segment, causing stress and trauma for those refugees without an alternative (Brodie 2006). It is difficult to see how such structures could have been better utilised. Rather the timeline for reinstatement of property should have been enacted as quickly as possible. There remains large tracks of domestic property which has never been reinstated due to a lack of insurance on the part of the homeowner coupled with little willingness to return to the sites (Hennessy-Fiske 2014).

Vermin - Assistance & Aid: the shortcomings of professional bodies such as FEMA have been highlighted throughout this chapter. However, the success of private sector endeavours such as those employed by *Wal-Mart* have gone largely without note. Private companies employed their skills in resource management, logistics and command and control hierarchies in order to provide assistance to those in need (Horwitz 2009). Thus, an argument can be made for the utilisation of local actors within the post-crisis domain as many work for organisations that can be considered as solution givers dependant on the scenario at hand.

Relief: as shown above, local businesses may be employed as part of the relief operation, bringing to bear their expertise in goods and service delivery within the local and/or national arena.

Injury: the non-physical injury is dealt with elsewhere in this section. Physical injury and the ramifications of long-term illness after the crisis event can have an impact on local community cohesion and local economy in so far as the ability to work and to spend earnings within the local area.

Social Cohesion: irreparable damage was done to local communities in wake of Katrina as large areas were left devastated for years. People never returned to the area as they lost faith in community and location.

Reinstatement: forms an integral part of this ring as is dealt with explicitly as it should be employed through the entire cycle; not merely reliant on the crisis segment within the post-crisis phase. However, there is no requirement for this element within the current phase.

Secondary Crises: such crises are expected to occur with the auspices of the crisis phase. However, due to the extended timeline invoked by the hurricane, secondary crises occurred in several guises; from prolonged unemployment due to the economic downturn, to chronic injury which impact local medical resources and personal insurance (Dass-Brailsford 2010).

Security: once the crisis had subsided, the ability to reinstate law-and-order became easier as instances of crime diminished (Banipal 2006). This could have been brought about sooner if those in positions of power had allocated correct resources at time of crisis. However, law-and-order was reinstated outside the crisis phase.

Loss of Infrastructure: due to the devastation caused, officials chose to suspend the Davis Bacon Act, which ensures that the local prevailing wages are paid to labourers engaged in public works (Olam 2006). Such exploitation of low-paid workers had a negative impact on their ability to sustain a living wage during their time working in the locale and thus their access to food and supplies of a standard commensurate with sustained health (Fletcher et al. 2007).

Psychological Trauma: the loss of home and work places has been previously discussed. The trauma felt by those affected goes beyond this to the loss of day-to-day routine and culture. The psychological trauma experienced has a lasting affect upon individual families and community. Greater emphasis on reinstatement could have reduced this trauma as the time taken for return to normality could have been greatly shortened (Dugan 2007).

Refugee: due to the lack of reinstatement operations immediately after the disaster based upon the sheer size of the event, refugees remained in temporary sanctuary for several weeks after the disaster had passed. This continued into the post-crisis phase as rehousing capacity was limited (Bates 2006).

Infighting: this concerned itself mostly with who was to blame once the crisis has subsided and constituted many years of argument amongst those who were held responsible for the mistakes and shortcomings of the crisis occurrence and response.

8.6.5 Crises In Developing Countries

Whilst Hurricane Katrina was a crisis that affected the USA, utilisation of the framework should not differ based upon country of origin or geographical location. Rather it is the application of subsequent scenario-specific models detailed in the next chapter that will tailor the framework to individual crisis modes and associated factors concerning developing versus developed countries. The resources that may be brought into play will obviously differ based on accessibility and *willingness to pay*. These factors are country-specific and driven by both economic and political imperatives that fall outside of the scope of this research. However, as the scenario-specific models are developed, such information will form part of the inputs utilised for individual crisis modes and methods of response.

8.6.6 Conclusion

The final framework was applied to Hurricane Katrina so as to test its validity based upon a real-world event. Through application of each of the applicable factors affecting this scenario, a critique of the disaster was achieved. It is the intention that multiple crises are taken into consideration in the future in order to provide a knowledge base for the construction of a *toolbox* of activities based upon the crisis wheel segment and associated discipline.

9 CONCLUSION & FURTHER WORK

The purpose of this research was to explore the concept of water resource management through the combined lens of Crisis Management, Knowledge Management, Public Health and Human Security. Early in the preparation it was decided that the resultant output should be a framework capable of delivering an amalgamation of the aforementioned elements. To this end, research questions were constructed to explore and evaluate the requirements for successful creation of such a framework.

In advance of this study, there was little in the way of frameworks that expressed the water resource utilisation in such a context. Therefore, the research was considered viable and the following questions constructed in order to facilitate the exploration of this topic:

- What are the problems facing Crisis Management where water is a key theme?
- What are the common failure modes regarding Crisis Management?
- What are other critical dimensions with regards to crisis?
- Can local actors be better employed within the crisis scenario?
- How can a holistic solution be created to provide guidance to all stakeholders?

9.1 Research Questions Answered

What are the problems facing Crisis Management where water is a key theme?

Within the early stages of this research, it was realised that the water resource management aspect was not an independent entity; rather, correct allocation and distribution of such assets was highly dependent on infrastructure and management paradigms.

Based on this realisation, the framework began to focus on the different aspects of crisis and their respective influence over infrastructure integrity, management strategy, organisational tactics and the operational concerns of actors engaged in aid/relief activities.

Therefore, the resultant framework placed a *crisis wheel* at its centre, surrounded by concentric rings encompassing the four research domains. All of the segments within these rings can be applied to factors that affect the democratisation of water. However, the framework created presents users with a fully-functioning, dynamic, scenario-specific tool which may be deployed to solve any given problem so long as sufficient information has been entered into the tool to allow for pertinent analysis and decision-making.

What are the common failure modes regarding Crisis Management?

From both primary and secondary research it became apparent that the three main factors contributing to failure were mostly concerned with people, process and technology; often driven by a lack of cohesion between actors and stakeholders and amongst themselves. This seemed to centre upon a lack of common goals, with disparate organisations placing greater focus on their own aim and objectives than that of the parent country or primary aid organisation. As such, much effort is put into the duplication of effort as one organisation's objectives are often paralleled with that of another without either ever coming into direct contact or existing in a state of conflict because of such closely related desires requiring use of similar or identical resources, which were often in short supply.

Much of this work was conducted through secondary information, as the time overhead required for primary investigation would have been prohibitive. However, several questions within the primary information collection explored the disparities between competing organisations and therefore, validated the secondary information.

In addition to the above, further failure modes included a lack of cohesion between projected objectives, leading to a breakdown between interrelated tasks; be they parallel or sequential. Thus, the ultimate goal of any endeavour was often mitigated or negated altogether. This, once again, was due to the need to employ multiple specialist organisations in any given undertaking, which introduced the partisan silo mentality previously mentioned.

During the primary information collection phase of this research, such behaviour was displayed by Informants from different organisations often viewing their work as the most important consideration when constructing a crisis response plan.

What are other critical dimensions with regards to crisis?

Besides the lack of cohesion between stakeholders, other failure modes were detected. Namely, the lack of commitment shown by those for whom a positive outcome should have been primary. This was apparent through the inability of governments to allocate suitable funds for resilience planning and infrastructure strengthening whilst spending great a great deal of money on vanity projects such as roads and sporting events which were neither needed or widely embraced by the populous at large.

The other critical dimensions were adopted as the multifaceted lens through which the framework was created:

Human Security - This became an important part of the framework due to the lack of integration between those providing aid during a given crisis and those for whom the physical and physiological well being of victims was paramount.

Can local actors be better employed within the crisis scenario?

The difficulty for local communities in times of crisis is often many-fold; from the basic requirements set out in *Maslow's Hierarchy of Needs*, to more subtly felt aspects around victim hood and self-worth. It is thus suggested that local actors are pivotal in transitioning the various phases as set out in the crisis wheel.

In addition to the above, local actors are also crucial to the mitigation or complete removal of risks associated with numerous secondary disasters: for example, reduction in violent and sexual crimes brought about by the failure of basic community cohesion.

When both factors are taken into consideration, the use of local actors in virtually all areas of implementation has a net benefit that can be felt through a variety of interactions. By creating a mutually inclusive crisis/disaster solution, aid organisations and governments can, not only mitigate the effects and long-term ramifications, but introduce local communities to methods of best practice whilst simultaneously gaining Knowledge and experience which may be employed in further instances with other communities.

Therefore it is essential that such local actors be trained, equipped and employed during each phase of the crisis wheel in order to best exploit their Knowledge and skills. In doing so, local communities and individuals are empowered throughout the entire lifecycle which helps greatly in the reduction of chaos within the crisis scenario, thus allowing for more effective and efficient solutions to be employed.

The framework produces an environment capable of providing interaction between governing bodies and local communities through consultation and involvement in every step of the crisis wheel.

How can a holistic solution be created to provide guidance to all stakeholders?

The very nature of crisis makes for a stakeholder network that is both complex and difficult to administer. As mentioned, governments and NGO's often constitute the upper echelons of any hierarchy, with victims at the very bottom. Greater consideration is often given to those for whom the original crisis was not a problem: for example, foreign contractors employed during the reconstruction phase. Therefore the framework was designed to provide a medium for collusion with Regis to planning and execution of a given crisis plan or response. It is common practice to comprise steering groups and the like with representatives of the concerned parties; however, this mostly follows the hierarchical structure descriptor above, rarely placing those who would be considered potential victims at the top. The crisis wheel and surrounding framework allows for each participant to partake in any of the undertakings as an equal, removing perceptions of superiority/inferiority most often shown in such circumstances.

When each of the experts was approached regarding this factor, they were in agreement as to the concept but have never brought such a paradigm into operation due to the complexities of such an undertaking. As part of the post-doctoral work required, consultation of the framework will take place with such individuals to ascertain their understanding of the principles based upon a non-technical background. This will form part of the Toolbox creation for operational deployment of the framework.

9.2 Research Implications

There were gaps in the construction and delivery of Crisis Management plans with respect to water resources and correction allocation in time of need. The water resource resilience plans available did not synergise with those concerned with Public Health and the interaction with victims as anything other than aid-related. As a result it was impossible to provide the levels of assistance needed for crisis and thus resulted in a greatly increased likelihood of extended timelines and resultant cost to human quality of life.

Infrastructure planning was not considered to be of great importance to those involved in Crisis Management as they are only put in place once such an event is brought into existence but rarely constitute part of the group making decisions as to the mitigation or removal of future risks. This results in much time, resource and financial input into the reactive elements of crisis rather than the proactive resilience planning and implementation concerned in the stability and weak signal stages of the process.

Stakeholder-management is at the heart of any good planning tool; allowing for the synergised interaction of all interested parties. This is not the case when representatives from different organisations with different missions are brought together. Infighting can quite often result in a lack of co-operation and the level of Knowledge sharing required for successful creation of such plans and their subsequent execution. Such problems can result in partisan behaviour where alliances are built between certain parties who then attempt to sabotage the work of their perceived enemy.

This has been apparent when such large-scale organisations as the UN arrive on-site and all other aid works are effectively side-lined due to the overwhelming presence of such a large and powerful organisation. Seeing as the world of crisis is often governed by such gigantic entities, this outcome is commonplace within the stakeholder community.

As the crisis wheel is segmented into phases and particular actionable sections, the need for predefined timeframes is both important and difficult to predict due to the chaotic dimensions to any crisis; be they planned for or not. Therefore, whilst specific temporal elements are almost impossible to ascribe to each phase, stakeholders need to set timeframes for each of their activities so as to be able to assess as to the effectiveness of their undertakings. As the stakeholders are many and varied, the need for sequential activities to be planned and executed in a timely manner becomes essential. However, this is where many of the plans fall-short in their real-world execution. Often, the planning phase grossly underestimates the amount of time required to complete tasks once a crisis situation has occurred. Also, the introduction of secondary crisis can further hamper the predefined timelines and thus cause project creep to occur, providing further negative pressures upon the execution of said plan.

Crisis and disaster modes are often poorly understood, with much credence being given to poor quality data, which compounds incorrect information gathering used for decision-making at each of the three structural tiers of strategic, tactic and operational. Initial assessments of crisis most often occur without interaction with local communities and the inclusion of individuals from these as local actors within the problem-solving and execution activities.

Perpetual crisis was briefly mentioned but is such a common problem that it is further discussed here as a separate issue. There are many entities within the crisis world for which a state of perpetual crisis is preferable than that of a permanent solution. The underlying reasons for such can be as simple as profiteering around resources and management, through corruption of officials in the governmental/agency structure, to the power struggles of criminal entities who see the crisis as an opportunity. The longer a state of crisis persists, the greater the chance of the above entities rising to prominence within the loci of control.

9.3 Implications for Professional Stakeholders

The professional stakeholder may be considered as one for whom the crisis scenario is deemed a place of work. Thus, dedicated knowledge and skills are brought to bear on the situation whilst, underpinned by associated organisations and their internal structures.

Policy Makers: the crisis wheel detailed in figure 7-2 clearly segments the crisis into phases. As such, policy makers can marshal their resource to create proactive plans based on each phase and their indicative risk assessment as to likelihood of occurrence and impact.

Furthermore, by segmenting their action plans, an overall strategy may be devised that deals with preventative measures and operational imperatives particular to each crisis instance.

Researchers: those concerned with research into both crisis and disaster may utilise the framework so as to focus their area of activity to a particular segment, Venn element or stakeholder perspective. The holistic nature of the framework affords practitioners the opportunity of selecting whichever element is of interest and exploiting the information therein. It is expected that *further work* detailed later in this chapter becomes a rich source of information for examination by researchers as it grows and interdependencies are identified.

Non-Profit Organisations: often rely upon open-source products for cost reduction within their fiscal policies. It is the intention that this framework be entered on to the internet alongside subsequent modelling as a free resource open to all. It is further intended that the framework be editable so that interested parties may update with ne models and refinements as part of a network of crowd-sourced labour.

9.4 Research Contribution

Framework: the production of a framework that provides for all stakeholders within the environment, regardless of perceived hierarchy or levels of power. The framework is based on findings from experts within the field of water resource management and crisis prevention/intervention. In addition, a second set of experts from industry and charity who are involved in execution and adherence to such frameworks were used to validate the proposed outputs and provide feedback into the final framework creation.

In addition to the above, the research has contributed to the body of Knowledge through a comprehensive literature review, which brought together previously disparate areas of research into crisis and disaster management, combined with the theories of water resource management.

Contribution to theory: has been articulated through the holistic nature of the framework, which may be applied to any crisis instance in order to derive useful information. As with any knowledge-based endeavour, the need for correct information delivered to the right stakeholders in a timely manner is paramount if response mechanisms and outcomes are to be maximised (Cook and Brown 1999).

The framework is designed to offer a solution that is based on existing theory detailed in the Literature Review chapter as to crisis avoidance, reduction, response, and reconstruction. In doing so, the framework creates a theoretical platform on which the aforementioned mechanisms may be realised within the given problem domain.

Contribution to practice: the framework's construction, which allows for all stakeholders to take part in crisis prevention, mitigation, response and reinstatement. Such involvement of all stakeholders is only possible if the authorities for whom crisis forms part of their remit are willing to provide interactive services that may be accessed at point of need. Therefore, the further work detailed, deals with creation of an interactive database that makes provision for information collection and collation capable of unifying existing knowledge in addition to new knowledge creation.

The framework allows practitioners to assemble information in a structured manner for analysis and dissemination to both stakeholders and actors within and without the crisis domain.

When both the framework and future models are combined, a powerful, tailored planning a response mechanism may be brought to bear on any crisis mode.

9.5 Further Work

The framework created displays a modular, dynamic capability that allows for the tailoring of its application to whichever crisis scenario is applicable. Due to this design, the need to create a toolbox of processes and guidance notes as to the application of each segment when associated to a particular crisis phase will allow for the codification of scenario-specific models. The models may be updated each time new information is entered into a database system that controls deployment of each toolbox process as defined by the users requirements.

The construction of an information flow diagram is given in figure 9-1: an overview of its operation is given in the following sections.

Data/Information Collection

Data may be collected from numerous instances of crisis/disaster in order to construct a data warehouse which would populate data-marts employed by different stakeholders for whom the analysis and utilisation of this content is pertinent.

The data collection could take almost any form so long as it is cleansed to reduce the number of incorrect entries or noise being introduced into the system. It is unreasonable to assume that everything entered will be correct during the first iteration.

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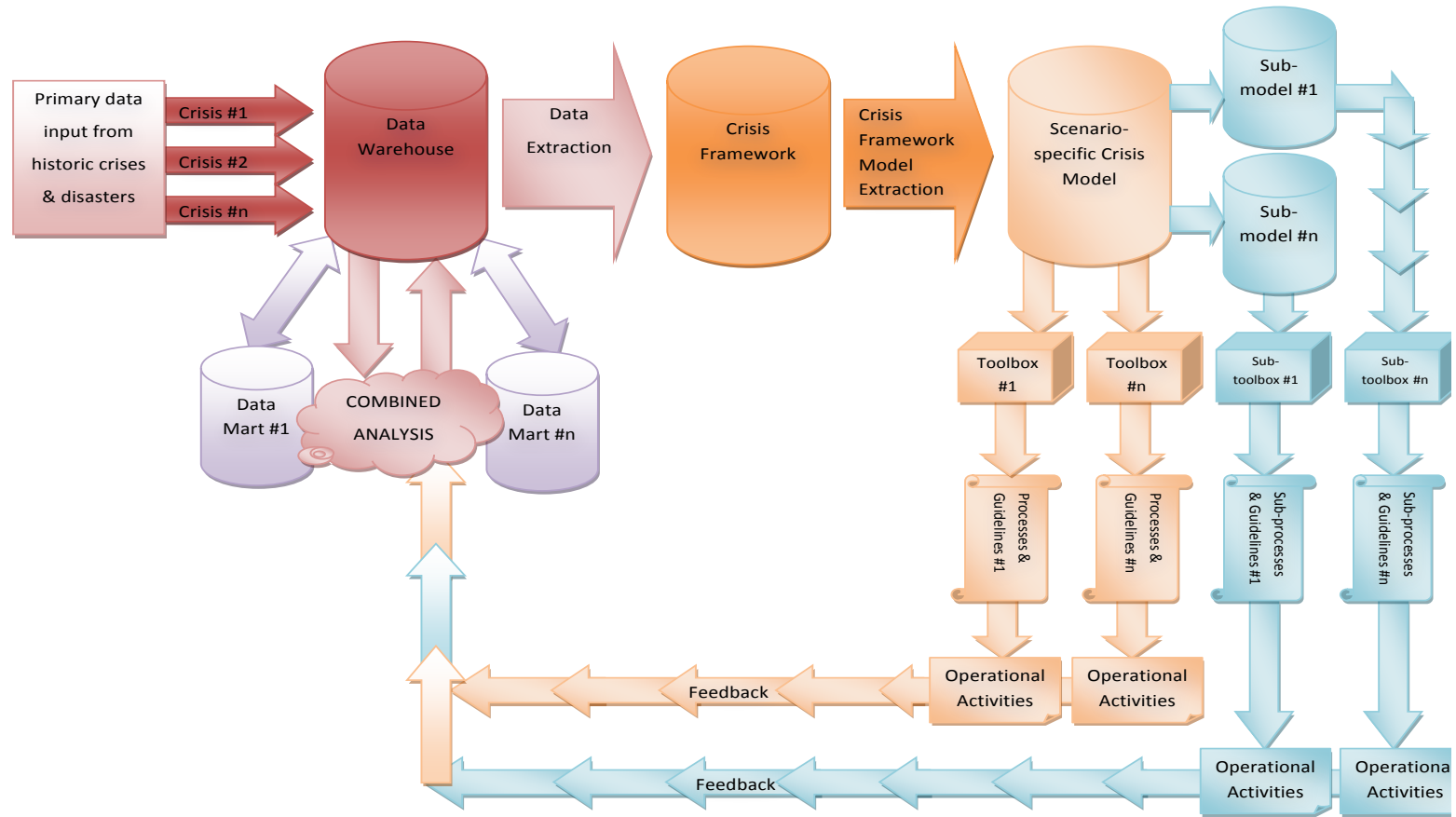


Figure 9-1: Framework Deployment Flowchart

Data Analysis

Artificial intelligence could be utilised by the system through fuzzy-logic algorithms in ordering data and assigning it to predetermined metadata so as to make provision for information creation. This would be coupled to existing information and, as such, could refine the existing data whilst simultaneously providing parity checks on new data for correctness and application.

Analysis could also be employed during any given crisis lifecycle which could be used to provide up-to-date data and information as regards current trends and new crisis modes. By combining the two analysis streams, new data and information being entered in to the system could strengthen existing entries whilst further reducing noise, incompleteness and incorrect entries.

Framework Version Control

Through utilisation of an ever-increasing data warehouse, the framework could be updated to reflect better understanding of the crisis domain. In addition, iterative improvements could also be made to the framework as new crisis modes and the methods with which they are dealt are identified and utilised.

Model Creation

As the framework operates at a every level, giving support to the planning of resilience schemes through to individual operational activities, individual models could be created. These could be based on crisis modes coupled with other variables such as geospatial information that would directly influence likelihood or impact of any given scenario.

Scenario-Specificity

The ability to create aforementioned scenario-specific models would provide a myriad of applications for the overall framework, covering individual situations pertinent to different stakeholder sets and sub-sets. Through the application of crisis models derivable from a single framework; actors would be able to reuse the framework without requiring training for each domain-specific model.

In addition, sub-models could be created for such things as secondary crisis, where the original crisis model is used to influence factors within the sub-model to create a scenario-specific secondary toolbox that synergises with the original model.

Toolbox Creation

Each resultant model would incorporate a set of toolbox activities commensurate with delivery of solutions specific to the particular crisis-phase under consideration. Through employment of these, stakeholders would be able to utilise a series of processes and guidelines which would structure application of any operational undertakings carried-out as part of each phase of the crisis wheel.

Process & Guidelines

The outputs from the toolbox would directly influence which processes and guidelines were activated so as to provide timely and pertinent action planning for actors and stakeholders. Each process and guideline would also be under constant review as part of the analysis function performed as new crises are recorded; this would be reinforced by feedback derived from the crisis theatre as regards application of this particular model and crisis instance. Thus, the latest and most accurate information would influence process and guidance, ensuring confidence in application of the framework, model and resultant processes & guidelines.

Operational Activities

Given the holistic nature of such a framework, creation of operational activities will form an integral part of its application. These are derived from the processes and policies utilising the overarching framework, domain-specific models and sub-models so as to create areas of operation and subsequent tasks relevant to the crisis wheel phase under consideration.

Feedback

As previously mentioned, data and information will be fed back into the system so as to provide updated models and framework versions. Feedback will combine with existing analysis so as to cleanse input streams and provide refined algorithms for system operation. Feedback can be provided by stakeholders and entered through their respective data marts without the need for centralised control. There will, however, be a requirement that all entries conform to a set of standards as set-out by the framework administrators.

Through the inclusion of iterative feedback, Radar charts could be utilised to create an application array based upon multivariate, multi-elemental factors that are scenario-specific. The Radar chart could be combined with nodal magnitudes, illustrating confidence-level or criticality for each applied segment within the aforementioned criteria.

9.6 Conclusion

It is not intended that the framework be owned by any particular organisation or stakeholder: rather, the administration of said framework could be carried-out by a central entity so as to provide unity-of-purpose. Every stakeholder and actor for who relies upon the framework to deliver value-added aspects to their working lives would share ownership. By consolidating all stakeholders into a shared-ownership paradigm, it is intended that each individual would feel a responsibility towards the data/information being entered and to the confidence level enjoyed by all actors who rely upon its outputs for operational guidance.

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GLOSSARY

Absorbing capacity — the ability to absorb the free energy of an event without sustaining a loss of essential functions of the affected society. Absorbing capacity is a part of the overall resilience of a society.

Amplitude — the degree of departure from the point of equilibrium (pre-event state); a measure of power at a given point in time.

Assessment — the product obtained from assessing; An interdisciplinary process that involves the collation, evaluation, and interpretation of information from various sources concerning both direct and indirect losses, and short and long-term effects.

Attenuate — reduce in force, value, or virulence; to lessen.

Audit — investigations that compare what was done or is being done with the actions prescribed by *established* standards or objectives.

Augment — to increase; add to.

Basic Societal Functions — major functional components of a society that may be affected either directly or indirectly by an event resulting in a disaster: (1) Medical; (2) Public Health; (3) Sanitation and water supplies; (4) Shelter and clothing; (5) Food; (6) Energy supplies; (7) Search and rescue; (8) Public works and engineering; (9) Environment; (10) Logistics and transport; (11) Security; (12) Communications; (13) Economy; and (14) Education. Each of these functional components is composed of many elements. All of the basic societal elements are linked together by a Coordination and Control function provided by the respective governments.

Benefit — whatever is for the good of a person or thing; a favourable or helpful factor or circumstance.

Blue-light phase — time-bound period in which emergency services are of primary importance (usually during and directly post crisis).

Bowser — a large scale clean water container usually mounted on wheels and drawn behind a motor vehicle.

Brown Water — *see Waste Water.*

Buffering capacity — the ability of a society to cope with the damage sustained from an event and to function in spite of damage. It is the ability of a society to

minimize the change in an essential function or functions for a given change in available resources (goods and/or services).

Built environment — an area in which buildings or other structures (canals, pylons, etc.) have been constructed. That part of the environment, which is predominantly constructed, as distinguished from the natural environment.

Capabilities — competencies or human abilities, of a personal, institutional, managerial or empirical nature that can reduce a designated population, structures, or a physical environment to severe loss or damage from the effects of a hazards or combination of hazards.

Capacity building — the concept of capacity building is currently widely used, in many different domains, especially in the United Nations and other international development organizations. In general, capacity building efforts aim to provide a defined target group or an organization with skills, resources, both human and financial, or technology needed to enable it to perform to its full potential.

Casualty — a person killed or injured by an event.

Civil society — public forms of organisation or activity within a society, which are not military or ecclesiastical in nature.

Climate change — a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate variability — description of deviations using climate statistics for a given period of time (such as a month, season, year) from the long-term statistics relating to the same calendar period.

Command and Control — military term. *See Coordination and Control.*

Communications — all forms used for interchange of information. Communications includes all public and private communication facilities (e.g., fire, police, military, government, private radio operators (HAM), newspapers, other news media, television, telephone and telex, facsimile, the Internet, satellite, and other facilities that can be used in time of disaster. It is a basic societal function.

Community — a group with a commonality of association and generally defined by location, shared experience, or function. A social group that has a number of things in common, such as shared experience, locality, culture, heritage, language, ethnicity, pastimes, occupation, workplace, etc.

Contingency — a future event or circumstance regarded as likely to occur or a influencing present action.

Contingency plans — plans to meet a crisis made with the assumption that an event will happen in a specific location; just in case.

Co-ordination and control — the process that directs and coordinates all activities encumbered in the responses to a disaster. Co-ordination and Control provides the structure for all of the disaster management functions. Its main role is to assure that responses meet identified needs of the affected society.

Conflict (inter-human) — inter-human conflicts consist of disagreements between two or more parties that have the potential to inflict harm upon one, both, or all of the parties involved.

Coping — the manner in which people and organisations act, using existing resources within a range of expectations of a situation, to achieve various ends. In general, this involves managing resources, both in normal times, as well as during unusual, abnormal, and adverse conditions of a disaster event or process.

Cost-benefit — the benefit derived from the response relative to the costs of gaining this benefit.

Cost-effectiveness — the measure of how effective the response was in terms of achieving its stated goals and objectives. Cost-effectiveness is useful in comparing the results from one response with those achieved by another.

Cost-efficiency — a measure of the efficiency with which the response was carried out. It is useful for comparing activities within one system.

Crisis Management — the discipline of dealing with and avoiding risks.

Crisis — a situation which poses a level of threat to life, health, property, or environment that negatively affects society.

Critical pathways — an outline of process that defines, in step, the best practice known at the time.

Critical threshold — the level of a good or services below which the crude mortality rate will increase.

Crude Mortality Rate — the number of deaths of a given population measured as deaths/10,000/day

Dam — (also barrage; barrier; weir) barrier constructed across a valley for impounding water or creating a reservoir.

Damage — the negative result from the impact of an event.

Data — known facts or things used as a basis for inference or reckoning. Data are not synonymous with numerical expressions.

Database — a structured set of data.

Decision-makers — Persons who have the ability, resources, and authority to make decisions or judgments and to act on them.

Deforestation — to clear of forest or trees; conversion of forest to non-forest.

Deficit — the condition that results when the available supply is less than the rate of consumption.

Definitive medical care — medical treatment that includes all equipment and procedures necessary to restore the health or provide palliation, if health can not be restored, to the individual patient.

Descriptive studies — attempts to answer questions such as, *What happened?*, or *What is it?* Descriptive studies do not need to evaluate an intervention, they may just describe in detail what happened, how it happened, and who was involved.

Development — the responses to the disaster of sufficient magnitude to render the functional status of the component above the pre-event state. Development occurs when the pre-event status of a basic component of society is raised to levels greater than in the pre-event conditions.

Development strategy — a set of principles or plan of action designed to promote the growth and output while emphasizing sustainable development objectives. More recently, development has been increasingly defined in terms of human development, with special emphasis on poverty eradication and protection of the environment.

Disaster — a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope using only its own resources; the result of a vast ecological breakdown in the relations between man and his environment, a

serious and sudden event (or slow as in drought) on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help or international aid. A disaster results when the absorbing capacity of the affected society is unable to maintain the functionality of an essential element above a threshold.

Health Disaster — a precipitous or gradual decline in the overall health status of a community for which the community is unable to cope without outside assistance.

Disaster Critical Control Point (DCCP) — the time at which the supplies balance all of the needs in terms of the function or sub-function being evaluated. Identification of this time depends on the correct, ongoing re-assessment of needs and available supplies.

Disaster management — the aggregate of all measures taken to reduce the likelihood of damage that will occur related to a hazard(s) and to minimize the damage once an event is occurring or has occurred and to direct recovery from the damage; the body of policy and administrative decisions and operational activities that pertain to the various stages of a disaster at all levels.

Disaster preparedness — the aggregate of all measures and policies taken by humans before the event for reduction of the damage that otherwise would have resulted from the event, and coping with the damage sustained.

Disaster prevention — the aggregate of approaches and measures taken to ensure that the hazard does not cause a disaster, either by preventing the event or by mitigating activities, or by activities/structure that is able to absorb the event.

Disaster reduction — all actions taken to reduce the consequences of an event (measures of prevention, mitigation, preparedness, response and research).

Disseminate — to spread widely.

Drinking water — water which is defined as safe to drink – this differs depending on the geographical location and sanitation authority.

Drought — period of deficiency of moisture in the soil such that there is inadequate water required for plants, animals, and human beings.

Duration — the length of time over which something continues (for disasters: brief = seconds to hours; short = hours to days; intermediate = days to weeks; prolonged = months to years).

Early warning — some timely form of either written or verbal indication of an impending event; advance notification of a problem in time for appropriate possible actions.

Earthquake — a sudden break within the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground.

Economy — the wealth and resources of a community, especially in terms of production and consumption of goods and services;⁵⁸ the main techniques for providing the resources essential for maintaining the basic functions and infrastructure of the affected society. It includes how these resources are used by the society and the sources of these resources, e.g., agriculture, crops, industry, and the products produced, jobs, foraging, trade and transport (import/exports), value of the currency, per capita income, etc. It is a Basic Societal Function.

Education — the basic societal function that is responsible for the education of the citizens. It includes all resources used in educating and training the affected population. It includes the buildings, teachers, libraries, and training facilities. Thus, it also includes training of the responders or potential responders, coordination and control personnel, etc. Education is closely related to culture.

Emergency — a situation that is out of control and requires immediate attention.

Emergency management — a range of measures to manage risks to communities and the environment; the organisation and management of resources for dealing with all aspects of emergencies. Emergency management involves the plans, structures and arrangements which are established to bring together the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to deal with the whole spectrum of emergency needs including prevention, response, and recovery.

Endpoint — the criterion or criteria used to judge the results of an intervention or action. *Primary endpoints* are the explicit variables that define the relationship being hypothesized. *Secondary endpoints* are measures that may result from the

research or be defined by the research that are not related directly to the question(s) being studied.

Energy — any property with the capability to transform or change a function or parts of the environment or the society.

Environment — the total infrastructure of the affected society including the existence, condition, of the nature as well as social factors such as population densities, topography, culture and existing social and governmental structures, as well as living conditions and known hazards and the risks associated with each hazard.

Environmental damage — adverse effects to the environment.

Environmental interference — modification of the environment by human actions.

Environmental risk — risks to natural ecosystems or to the beauty or amenity of the natural world.

Erosion — loosing or dissolving and removal of rock or soil as a result of water, ice or wind action.

Evacuation — moving persons and supplies from an unsafe to safe area.

Evaluate — to determine or fix a value to; to determine the significance or worth of, usually by careful appraisal or study.

Evaluation research — the investigation to affix a value to what is being studied.

Event — an occurrence that has the potential to affect living beings and/or their environment; a realization of a hazard. *Precipitating event*: event responsible for initiating the damage resulting directly from the occurrence of the event. *Secondary events*: events that occur as a result of the damage caused by the precipitating event.

Experimental studies — studies that use inferential statistics to compare the outcome of a given intervention with that of a control group that does not receive the intervention.

Explicit — expressly stated, leaving nothing merely implied; stated in detail. In research, explicit criteria are firm and based on scientific evidence (evidence-based without interpretation).

External validity — the ability to apply the findings of the research in other areas or applications.

Floods — too much water in the wrong place; overflows of areas not normally submerged with water.

Flood plains — an area adjacent to a river, formed by the repeated overflow of the natural channel bed. The land which may be covered by water when the river overflows its banks during floods.

Food — edible substance containing nutrients that, on ingestion, maintain the vital functions of a person or other living organism. Part of the Basic Societal Function Food and Nutrition.

Framework — a structure supporting a theory or practice.

Function — a mode of action or activity by which a thing fulfils its purpose.

Functional threshold — the level of service/goods provided for any given component that is insufficient to allow it to continue to provide a minimum level of service essential to meet the needs of the affected population. At levels below the functional threshold, the societal component becomes dysfunctional.

Gross Domestic Product (GDP) — the value of all goods and services produced within a nation's boundaries, regardless of ownership.

Gross National Product (GNP) — the value of all goods and services produced by a country during a given period. It includes all production by facilities owned by a nation's citizens, even if the facilities are in another country.

Gross World Product (GWP) — the value of all goods and services produced on earth.

Guidelines — principle or criterion guiding action; a general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.

Habitat — the natural home or environment of an organism; area or type of environment in which an organism or ecological community normally lives or occurs: a marine habitat; place in which a person or thing is most likely to be found.

Hazard — anything that may pose a danger; it is used in this discussion to mean a natural or human-made phenomenon or a mixture of both, that has the potential to adversely affect human health, property, activity, and/or the

environment. Hazards are specific as to type, and as a general rule contain energy.

Hazard assessment — identification and scaling of latent conditions that represent a threat.

Hazard identification — the detection and identification of hazards.

Hazard mapping — the process of establishing geographically where and to what extent particular phenomena are likely to pose a threat to people, property, infrastructure, and economic activities. Hazard mapping represents the result of hazard assessment on a map, showing the frequency/probability of occurrences of various magnitudes or duration. Hazard mapping comprises the cartographic depiction of possible future events accompanied by qualitative analysis; it is not only the mapping of past events.

Human Security — freedom from fear and want.

Impact — impact is defined as the actual process of contact between an event and a society or a society's immediate perimeter; an effect or influence, especially when strong; Impact has a broad connotation and refers to both positive and negative influences produced by events on the environment.

Implicit — implied though not plainly expressed; implicit standards are implied, usually through judgments of experts in the field through consensus among the experts. Such standards generally are used when the science cannot provide sufficient data for the explicit definition of a standard.

Incident command system (ICS) — a system of command and control used in the management of incidents.

Indicate — to point out, make known, show; a sign or symptom of; show to be necessary.

Indicator — a thing that indicates; signs or markers that define the status of a specific component or element.

Information — the interpretation and processing of available and new data for a specific context, giving the data a purposeful meaning.

Infrastructure — the built environment; encompasses all societal structures including buildings, bridges, roads, sanitary facilities, railroads, waterways, water facilities, and other essential societal structures and functions.

Intensity — as refers to an event, the integral of the amplitudes over a given period of time (amplitudes/time interval).

Integrate — combine into a whole; complete by addition of parts.

Knowledge Management — A range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences.

Mains Water — water provided via a piped network to designated points such as home or standpipes within a given infrastructure.

Mass casualties — a large number of casualties.

Medical care — the Basic Societal Function that relates to the system that provides medical treatment to *individual* patients. The Medical System provides for the detection of signs and symptoms, and the diagnosis and treatment of patients. It includes primary, secondary, and tertiary care. It also includes psychological support and treatment.

Methodologies — a system of methods used in a particular field; A body of practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; a set of working methods.

Mitigate — to lessen or decrease the seriousness of the process to which the word is applied.

Mitigation (disaster mitigation) — alterations that are achieved before an event occurs that decrease vulnerability.

Modify — to make partial changes in.

Modification —is the aggregate of all approaches and measures to modify the amplitude, intensity, scope, scale, and/or magnitude of an event, or measures that change the hazard and/or the risk that a hazard will evolve into an event.

Model — A simplified version of reality used to test theory.

Multi-casualty event — an event that produces many casualties, but is managed completely with the resources available within the area in which the event occurred.

Natural resources — material source of wealth, such as timber, freshwater, or mineral deposit, etc. that occurs in a natural state and has economic value.

Outcome — the result of a specific intervention(s) or project(s) relative to their pre-established goals and objectives.

Planning — the process used to develop contingencies in preparation for an event that is likely to occur at some time. Planning includes warning systems, evacuation, relocation of dwellings (e.g., for floods), stores of food and water, temporary shelter, energy, management strategies, disaster drills and exercises, etc. Contingency plans and responses are included in the preparedness in the Interventions, Effects, Outcomes, Benefits, and Costs sense used in this document.

Strategic planning — preparing the organization to respond to threats in locations that are not specified and not immediately threatened.

Contingency planning — planning that is site-specific and recognizes that a disaster could occur at any time.

Forward planning — planning that occurs when an event is imminent and some details regarding the threat are known to the crisis manager.

Population-at-risk — the location and number of persons likely to be affected if the hazard becomes actualized into an event.

Potable Water — *see Drinking Water.*

Prediction (of event) — statement of the expected time, place, and magnitude of a future event (for earthquakes and volcanic eruptions).

Pre-event health status — description of the health situation in a society that existed before a disaster occurs.

Preparedness — the aggregate of all measures and policies taken by humans before the event; to be prepared for the event.

Public authorities — government officials, or officially designated authorities at any level of government responsibility, entrusted with either policy, administrative or technical/sectoral functions.

Public awareness — the state of the community of having Knowledge and being well-informed.

Public Health — the Basic Societal Function that is concerned with the health of *groups* of people or a population.

Public information — information, facts, or Knowledge provided or learned as a result of research or study, which is public, open to the people as a whole”.

1. Knowledge derived from study, experience, or instruction;
2. Knowledge of a specific event or situation; intelligence;

3. A collection of facts or data: statistical information;
4. The act of informing or the condition of being informed: safety instructions are provided for the information of our passengers.

Public Works and Engineering — the Basic Societal Function that includes the process of application of *technical* Knowledge and assistance to develop and maintain the infrastructure of the affected society. It involves what the society provides to sustain its infrastructure including all physical structures needed for a society to function (railroads, roads, buildings, etc.)

Qualitative techniques — methods used to identify phenomena that occur and to develop hypotheses about why or how they occurred. In qualitative research, hypotheses can not be proven to statistical significance relative to cause and effect (internal validity). Observations can be made and the formulation of hypotheses is a reasonable outcome. Such observations, particularly when they are supported by observations in other similar events, may have high external validity and thus, may affect responses to future events that have similar characteristics to the event being studied.

Quasi-experimental studies — studies that compare the effects of two similar, but not identical interventions.

Reconstruction — reorganization of the affected territory, reconstruction of the built environment, restoration of basic services, and the development of the economy with a view to re-establishing the pre-disaster conditions.

Rainwater Harvesting — Collection of rain as an alternative source of water for specific or non-specific purposes.

Recovery — returning the state of an organism to the state it had before it was temporarily reduced. For disasters this means bringing all of the societal components back to their pre-event functional status (level of function).

Rehabilitation — recovery of human function and /or society.

Reliability — the extent to which a data gathering method will give the same results when the process is repeated. Reliability includes the amount of error (random or systematic [bias]) that is inherent in the method used for data collection.

Relief — efforts directed at the alleviation of pain or distress.

Reorganize — to organize differently.

Requirement — an imperative; depend on for fulfillment; a necessity (see necessity)

Research — studious inquiry or examination; to investigate thoroughly; investigation *or* experimentation aimed at the discovery and interpretation of facts, revisions of accepted theories or laws in the light of new facts, or the practical application of such new or revised theories or laws.

Resilience — resilience is the pliability, flexibility, or elasticity of the population/environment to absorb, buffer, and/or manage the event/damage.

Resources — goods (in kind), consumables and services available to achieve an end; means available to achieve an end, fulfil a function, etc.

Richter scale — Devised by C.F. Richter in 1935, an index of the seismic energy released by an earthquake (as contrasted to intensity that describes its effects at a particular place), expressed in terms of the motion that would be measured by a specific type of seismograph located 100 km from the epicentre of an earthquake. Nowadays several *magnitude scale*” are in use. They are based on amplitudes of different types of seismic waves, on signal duration or on the seismic moment.

Risk — the objective (mathematical) or subjective (inductive) *probability* that some thing negative will occur (happen).

Risk assessment (risk analysis) — prediction and estimation of risk.

Risk factor — a factor that modifies the risk.

Risk management — human actions that are directed towards modification of the probability that a hazard will be converted into an event and eventually into a disaster.

Risk marker — the presence of an attribute of the hazard that is associated with an increased probability that an event *may* occur and can be used as an indicator of an increased or increasing risk that the specific hazard will occur.

Risk mapping — the presentation of the result of risk assessment on a map, showing the levels of expected losses which can be anticipated in specific areas, during a particular time period, as a result of particular disaster hazards.

Risk reduction — A selective application of appropriate techniques and management principles to reduce either likelihood of an occurrence or its consequences, or both.

River Abstraction — Removal of water from watercourses for utilization by the local population or a wider audience.

Scale — intensity of an event over a given geographical area.

Scope — a real or abstract border or limitation of actions, processes or a geographical area; extent to which it is possible to range.

Search and rescue — the process of finding and freeing (disengaging) persons (or animals) affected by a disaster. The Basic Societal Function that provides search and rescue.

Security — the state of being protected from injury inflicted by other beings or natural events; Security is the basic societal function that is responsible for the security of a given (defined) population.

Seismic — is the adjective derived from the noun *seism*, which is derived from the Greek meaning *earthquake*. In the context of disaster, seismic means related to vibrations of the earth and its crust. Such vibrations are produced either by movement of the tectonic plates of the earth, volcanic eruptions, or from artificial causes as result from explosions. (Secondary event includes tsunamis.)

Service — the act of helping or doing work for another or for a community.

Sewage — Contaminated water dangerous to human and animal health.

Sewerage — The network through which sewage passes and in which it is treated.

Shelter — anything that serves as a shield or protection from danger, bad weather, etc; A place of refuge provided.¹⁴⁰ Sheltering is an action that consists of providing asylum or provisional lodgings to an individual or group.

Shelter and Clothing — the Basic Societal Function that encompasses the provision of protection against harmful environmental elements.

Stabilization — to stabilize means to achieve a stable state. To bring a situation, a function or a structure to stay functionally or statically between defined lines or limits.

Standard — an object or quality or measure serving as a basis or example or principle to which others conform or by which others conform or should conform or by which the accuracy or quality of others is judged.

Storm surge — a sudden rise of sea as a result of high winds and low atmospheric pressure; sometimes called a storm tide, storm wave, or tidal wave. Generally affects only coastal areas, but may intrude some distance inland.

Structure — a set of interconnecting parts of any complex thing; a framework; the equipment and personnel, and the way in which these resources are organized.

Surveillance — continuous observation, measurement, and evaluation of the progress of a process or phenomenon with the view to taking corrective measures.

Susceptibility — the degree of ease by which a person is affected by a given phenomenon; synonymous with vulnerability. Individuals and populations have different susceptibilities to different types of events. Susceptibility is used in this document to denote the degree of ease by which a person or a population is affected by a given phenomenon; susceptibility and vulnerability are used interchangeably.

Sustainability — the ability to maintain or keep going continuously.

Tanker (Tankered Supply) — Clean water carried in purpose-built tanks by motorised vehicles.

Technological event — the result of realization of human-made hazards. They do not occur in nature. Such events may be predictable or non-predictable, be accidental, intentional or caused by negligence. The hazards associated with such events may be known prior to the occurrence of the event or may become known only after the event has occurred.

Terrorism — an act to create extreme, persistent fear or intimidation.

Threshold — a limit below which a stimulus causes no reaction; a limit below which no reaction occurs. In these Guidelines, it signifies a level of functional status or resources that separates two different levels of function.

Training — the act or process of teaching or learning a skill or discipline.

Triage — is the sorting into pre-established priorities. In reference to medical care and disasters, it means that scarce resources will be used to provide the maximum benefit to the population at large. The traditional triage is the transversal triage (takes place within a short time frame). Longitudinal triage means sacrificing victims at the moment for the benefit of future victims.

Tsunami — a sea wave that may become one or more massive waves of water as it makes landfall. It is a secondary event caused by another natural event, usually an earthquake or underwater volcanic eruption or landslide.

Urban Health — Characteristics by which urban environment may affect population health.

Venn Diagram — diagrams which illustrate hypothetically possible logical relations between a finite collection of sets.

Volcano — vent or chimney to the earth's surface from a reservoir of molten matter, known as magma, in the depths of the crust of the earth; The mountain formed by local accumulation of volcanic materials around an erupting vent.

Volcanic eruption — the discharge (aerial explosive) of fragmentary ejects, lava and gases from a volcanic vent.

Vulnerability — the susceptibility of the population and environment to the nature of an event; the susceptibility of an individual or population to injury or contagion; the degree of possible/potential loss to a given element at risk resulting from a given hazard at a given intensity.

Water (potable) — potable water is the provision of adequate supplies of water suitable for drinking and for the preparation of food.

Water Resources — Available water in a geospatial environment which may be of differing quality and utilised to meet social needs.

Water and Sanitation — the Basic Societal Function that includes the application of measures and techniques aimed at ensuring and improving environmental health in a community through the collection and distribution of water and the evacuation, and disposal of rain and liquid and solid wastes and human waste with or without prior treatment. In this context, potable water is the provision of adequate supplies of water suitable for drinking and for the preparation of food regardless of means.

Waster Sanitation — Water of a consumable standard combined with the removal and treatment of waste.

Waste Water — Water which has been used and is now in need of cleansing.

Water Utilization — The use of *Water Resources* to an effective end.

APPENDICES

Appendix A. Ethics Form

Ethics - Alan Richards.doc

Version: 2

Low Risk Research Ethics Approval Checklist

Applicant Details

Name Alan Clifford Richards	E-mail aa4277@coventry.ac.uk
Department Faculty of Engineering and Computing	Date 15 th December 2010
Course PhD	Title of Project A Knowledge-Based Framework for Crisis Management of Water
Student number 955334	

Project Details

Summary of the project in jargon-free language and in not more than 120 words:

- A framework to aid in resource deployment before, during and after crisis/disaster
- Primary information collection to be from industry experts
- Validation of draft framework to be undertaken by domain experts from UK (unidentified as yet)

Participants in your research

1. Will the project involve human participants?	Yes	No
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If you answered **Yes** to this questions, this may **not** be a low risk project.

- If you are a student, please discuss your project with your Supervisor.
- If you are a member of staff, please discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval or NHS or Medical Approval Routes.

Risk to Participants

2. Will the project involve human patients/clients, health professionals, and/or patient (client) data and/or health professional data?	Yes	<u>No</u>
3. Will any invasive physical procedure, including collecting tissue or other samples, be used in the research?	Yes	<u>No</u>
4. Is there a risk of physical discomfort to those taking part?	Yes	<u>No</u>
5. Is there a risk of psychological or emotional distress to those taking part?	Yes	<u>No</u>
6. Is there a risk of challenging the deeply held beliefs of those taking part?	Yes	<u>No</u>
7. Is there a risk that previous, current or proposed criminal or illegal acts will be revealed by those taking part?	Yes	<u>No</u>
8. Will the project involve giving any form of professional, medical or legal advice, either directly or indirectly to those taking part?	Yes	<u>No</u>

If you answered **Yes** to **any** of these questions, this may **not** be a low risk project.

- If you are a student, please discuss your project with your Supervisor.
- If you are a member of staff, please discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval or NHS or Medical Approval Routes.

Risk to Researcher

9. Will this project put you or others at risk of physical harm, injury or death?	Yes	No
10. Will project put you or others at risk of abduction, physical, mental or sexual abuse?	Yes	No
11. Will this project involve participating in acts that may cause psychological or emotional distress to you or to others?	Yes	No
12. Will this project involve observing acts which may cause psychological or emotional distress to you or to others?	Yes	No
13. Will this project involve reading about, listening to or viewing materials that may cause psychological or emotional distress to you or to others?	Yes	No
14. Will this project involve you disclosing personal data to the participants other than your name and the University as your contact and e-mail address?	Yes	No
15. Will this project involve you in unsupervised private discussion with people who are not already known to you?	Yes	No
16. Will this project potentially place you in the situation where you may receive unwelcome media attention?	Yes	No
17. Could the topic or results of this project be seen as illegal or attract the attention of the security services or other agencies?	Yes	No
18. Could the topic or results of this project be viewed as controversial by anyone?	Yes	No

If you answered **Yes** to **any** of these questions, this is **not** a low risk project. Please:

- If you are a student, discuss your project with your Supervisor.
- If you are a member of staff, discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval route.

Informed Consent of the Participant

19. Are any of the participants under the age of 18?	Yes	No
20. Are any of the participants unable mentally or physically to give consent?	Yes	No
21. Do you intend to observe the activities of individuals or groups without their knowledge and/or informed consent from each participant (or from his or her parent or guardian)?	Yes	No

If you answered **Yes** to **any** of these questions, this may **not** be a low risk project. Please:

- If you are a student, discuss your project with your Supervisor.
- If you are a member of staff, discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval route.

Participant Confidentiality and Data Protection

22. Will the project involve collecting data and information from human participants who will be identifiable in the final report?	Yes	No
23. Will information not already in the public domain about specific individuals or institutions be identifiable through data published or otherwise made available?	Yes	No
24. Do you intend to record, photograph or film individuals or groups without their knowledge or informed consent?	Yes	No
25. Do you intend to use the confidential information, knowledge or trade secrets gathered for any purpose other than this research project?	Yes	No

If you answered **Yes** to **any** of these questions, this may **not** be a low risk project:

- If you are a student, discuss your project with your Supervisor.
- If you are a member of staff, discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval or NHS or Medical Approval routes.

Gatekeeper Risk

26. Will this project involve collecting data outside University buildings?	Yes	No
27. Do you intend to collect data in shopping centres or other public places?	Yes	No
28. Do you intend to gather data within nurseries, schools or colleges?	Yes	No
29. Do you intend to gather data within National Health Service premises?	Yes	No

If you answered **Yes** to **any** of these questions, this is **not** a low risk project. Please:

- If you are a student, discuss your project with your Supervisor.
- If you are a member of staff, discuss your project with your Faculty Research Ethics Leader or use the Medium to High Risk Ethical Approval or NHS or Medical Approval routes.

Other Ethical Issues

30. Is there any other risk or issue not covered above that may pose a risk to you or any of the participants?	Yes	No
31. Will any activity associated with this project put you or the participants at an ethical, moral or legal risk?	Yes	No

If you answered **Yes** to these questions, this may **not** be a low risk project. Please:

- If you are a student, discuss your project with your Supervisor.
- If you are a member of staff, discuss your project with your Faculty Research Ethics Leader.

Principal Investigator Certification

If you answered **No** to all of the above questions, then you have described a low risk project. Please complete the following declaration to certify your project and keep a copy for your record as you may be asked for this at any time.

Agreed restrictions to project to allow Principal Investigator Certification

Please identify any restrictions to the project, agreed with your Supervisor or Faculty Research Ethics Leader to allow you to sign the Principal Investigator Certification declaration.

None.

Principal Investigator's Declaration

Please ensure that you:

- Tick all the boxes below and sign this checklist.
- Students must get their Supervisor to countersign this declaration.

I believe that this project does not require research ethics approval . I have completed the checklist and kept a copy for my own records. I realise I may be asked to provide a copy of this checklist at any time.	X
I confirm that I have answered all relevant questions in this checklist honestly.	X
I confirm that I will carry out the project in the ways described in this checklist. I will immediately suspend research and request a new ethical approval if the project subsequently changes the information I have given in this checklist.	X

Signatures

If you or your supervisor do not have electronic signatures, please type your name in the signature space. An email sent from the Supervisor's University inbox will be accepted as having been signed electronically.

Principal Investigator

Signed  (Principal Investigator or Student)

Date 15TH DECEMBER 2010

Students storing this checklist electronically must append to it an email from your Supervisor confirming that they are prepared to make the declaration above and to countersign this checklist. This-email will be taken as an electronic countersignature.

Student's Supervisor

Countersigned  (Supervisor)

Date 15TH DECEMBER 2010

I have read this checklist and confirm that it covers all the ethical issues raised by this project fully and frankly. I also confirm that these issues have been discussed with the student and will continue to be reviewed in the course of supervision.

Appendix B. Collaboration Letter

FINNISH WATER FORUM



Finnish Water Forum Aleksanterinkatu 17 00100 Helsinki Finland Phone: +358 40 5722 468

Dr Rajeev K Bali Reader in Healthcare Knowledge Management
(BIOCORE Applied Research Group Health Design and Technology Institute (HDTI))
COVENTRY UNIVERSITY
Coventry University Technology Park
Puma Way
Coventry
CV1 2TT
United Kingdom
November 21, 2011

Dear Dr Bali

Re: Research collaboration

This is to confirm that we agree to collaborate with you (for the purposes of data collection) on your water-based research project.

Finnish Water Forum (FWF) is a joint network of the Finnish private and public water sectors. It serves as a platform through which commercial enterprises, government and non-government organizations, scientific institutions and water-related associations can consolidate their water knowledge to find solutions for global water challenges.

Finnish Water Forum serves as a contact point for any enquiries addressing the Finnish water industry, technology, science and management. The expertise and high standards of its members make FWF an excellent entry point to the Finnish water sector and its services.

Our members have a long experience in the world market, offering efficient engineering and consulting services. Through FWF this competence is supplemented with high quality expertise in institutional and administrative matters and in education and research.

Best of luck with the project.
Kind regards,

Ms. Katri Mehtonen Managing Director Finnish Water Forum

www.finnishwaterforum.fi

Appendix C. Primary Data Questionnaire & Mind Maps

Original Research Questionnaire

The Consent Statement

Participant Reference Code: _____
I have read and understand the attached participant information sheet and by signing below I consent to participate in this study.
I understand that I have the right to withdraw from the study without giving a reason at any time during the study itself.
I understand that I also have the right to change my mind about participating in the study for a short period after the study has concluded (insert deadline here).
Signed: _____
Print Name: _____
Witnessed by: _____
Print Name: _____
Researcher's Signature: _____

You can adapt and develop this to suit your own project, but this is the minimum standard for a consent statement.

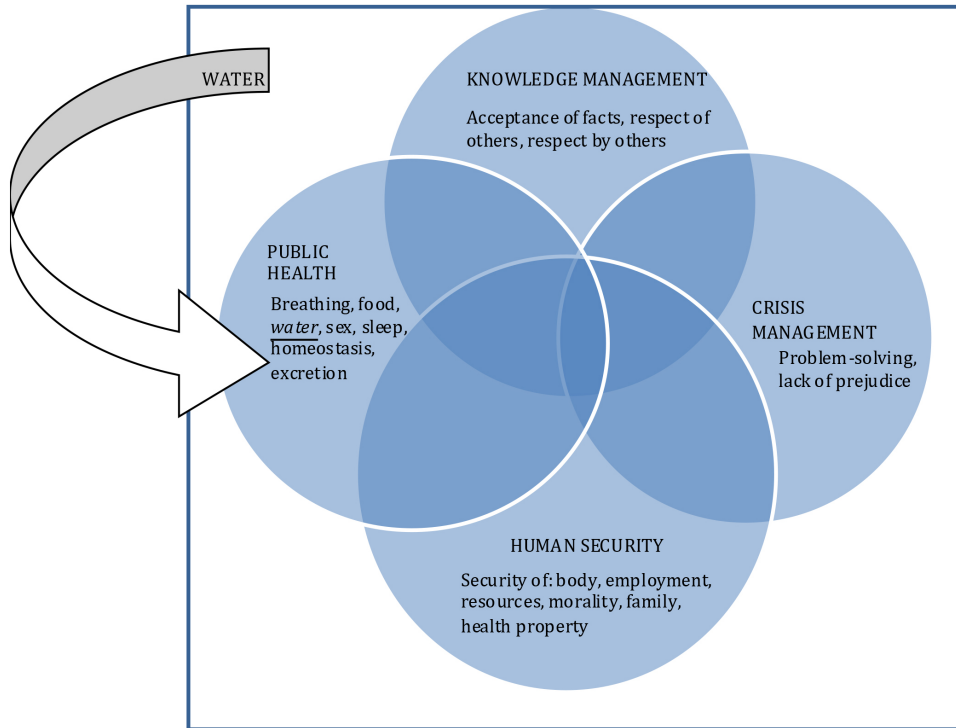
- **All signatures must be witnessed.** You, as the researcher, can act as the witness.
- **You must give all participants a copy of the signed consent form with the participant information sheet.** However, the consent form and information sheet must be on separate pages. Rather than photocopy signatures, you could produce two consent statements on one page, ask the participant to sign both parts, and give them the bottom half of the page. Make sure their copy has their participant code on it.

Consent and Questionnaires

You do not need to obtain signed consent from a participant if you are only handing out questionnaires. In this instance you would, instead of a consent sheet, put the following on the front page of your questionnaire. However, you do need to get signed consent if you are using a questionnaire in combination with a task or other activity.

I have read and I understand the participant information sheet for this study.	<input type="checkbox"/>
By handing this questionnaire back to you, completed, I am giving my consent for you to use my questionnaire answers in this research study.	<input type="checkbox"/>
I understand that I have the right to withdraw my questionnaire at any point, but contacting the researcher using the details on the participant information sheet and quoting the participant reference code written at the top of this questionnaire.	<input type="checkbox"/>
I have made a note of my participant reference code	<input type="checkbox"/>

RESEARCH ELEMENTS



QUESTIONNAIRE

1. With which types of crisis are you most familiar?
2. How would you describe the culture of your organization?
3. Describe your organization's method of operation?
4. What are the benefits/dis-benefits of using professional staff and local actors with any given crisis?
5. How does unity of command (strategic direction) affect your deployment within any given crisis scenario?
6. Describe lines and forms of communication employed by your organization and how this impacts strategy.
7. Does your organization currently employ any form of model or framework for crisis?
8. How do temporary repairs made compare to permanent infrastructure repairs undertaken within the crisis period?
9. What Information Systems and technologies do you employ during Business-as-Usual and crisis scenarios?
10. How are technologies utilised to best effect and what do you consider to be lacking?
11. Do you think there is a role for social networking in Crisis Management?
12. What are the key strategic elements for successful organisation?
13. How is Knowledge Management employed throughout your organisation?
14. Which crises have largest impact on clean water supply and reclamation and why?
15. What are the most important areas for water resource allocation in crisis and why?

Original Research Mind Maps

Answer One



Answer Two



Answer Three



Answer Four



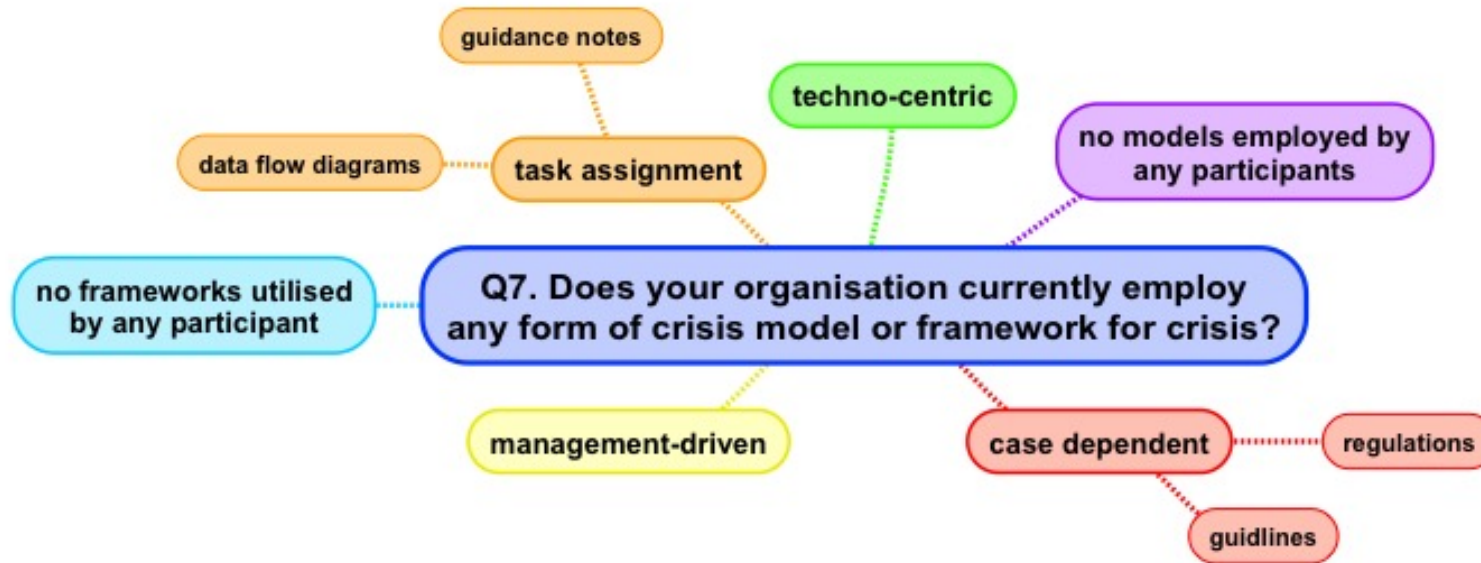
Answer Five



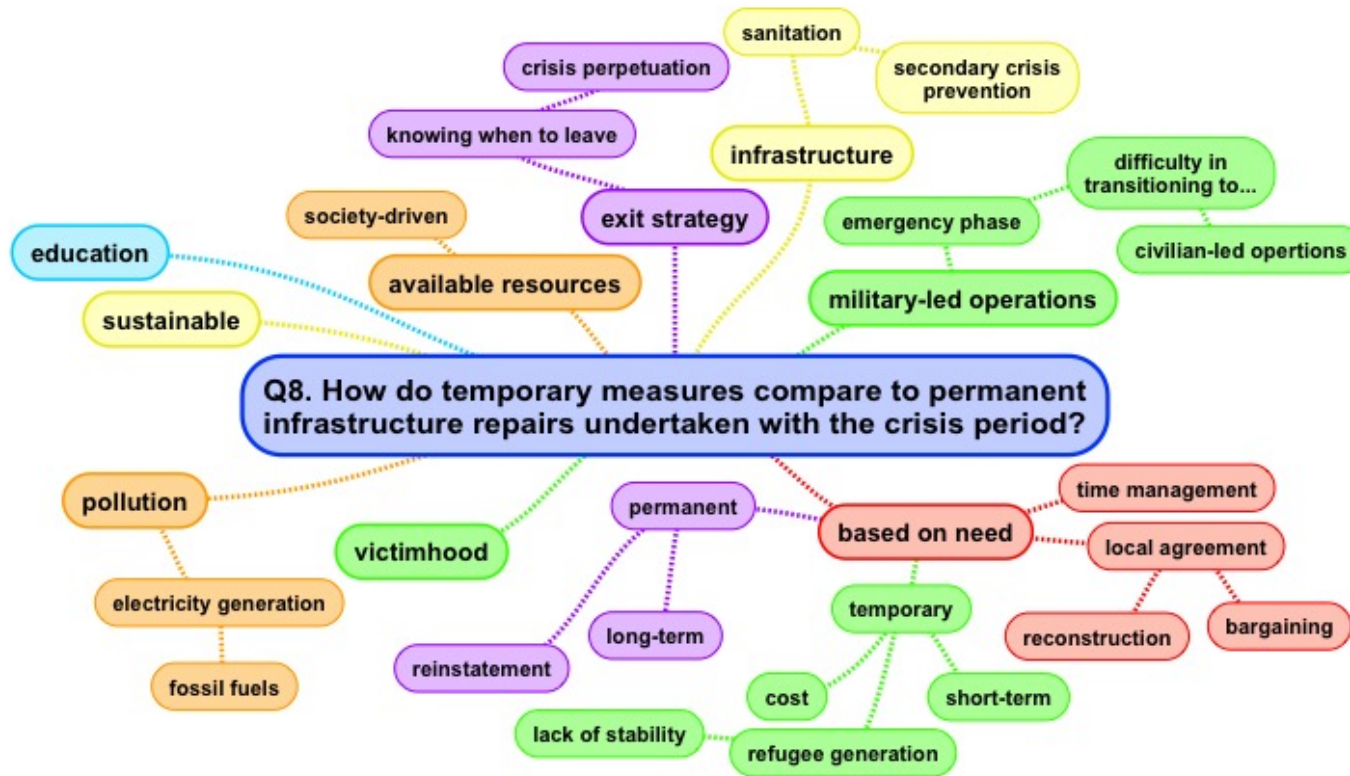
Answer Six



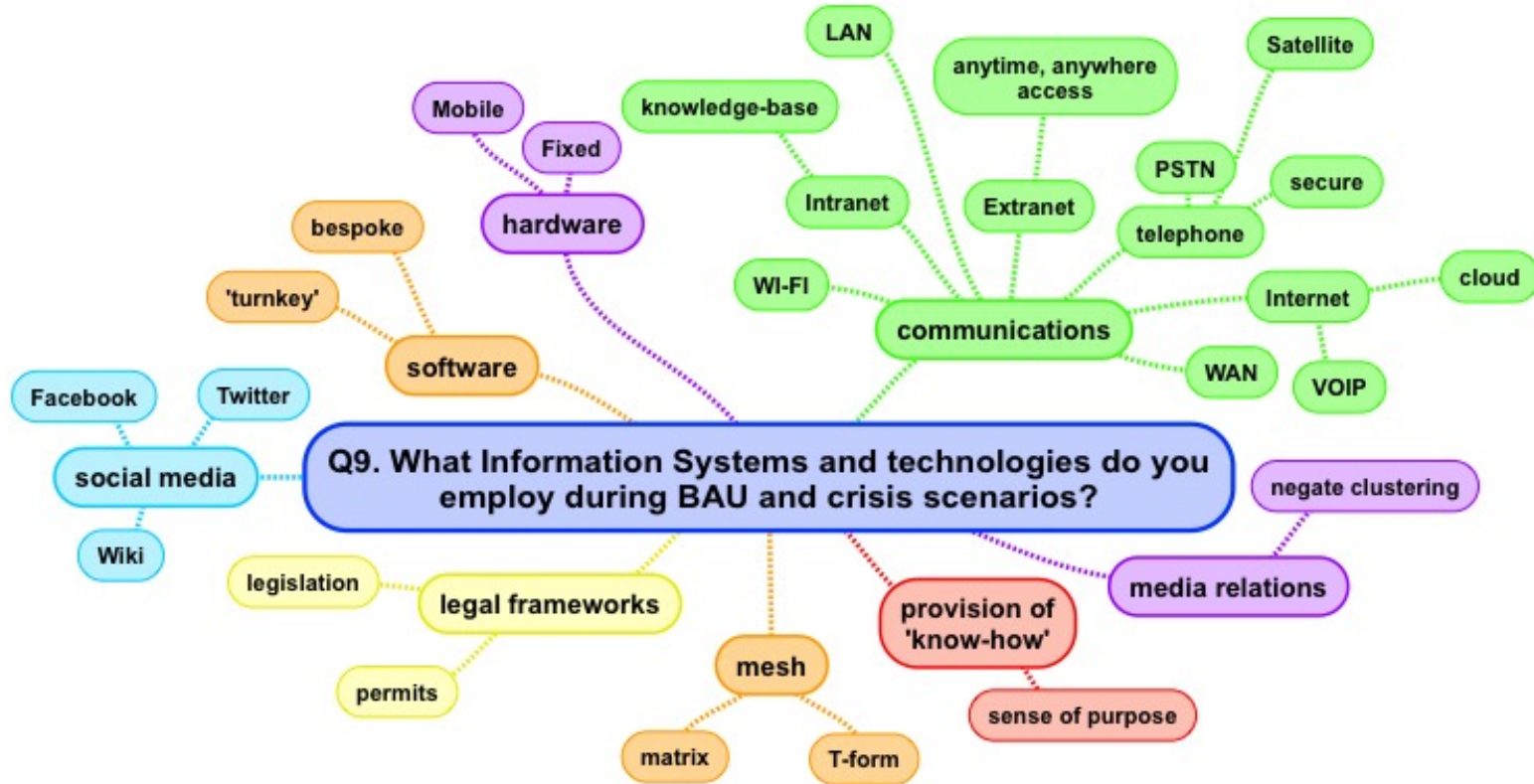
Answer Seven



Answer Eight



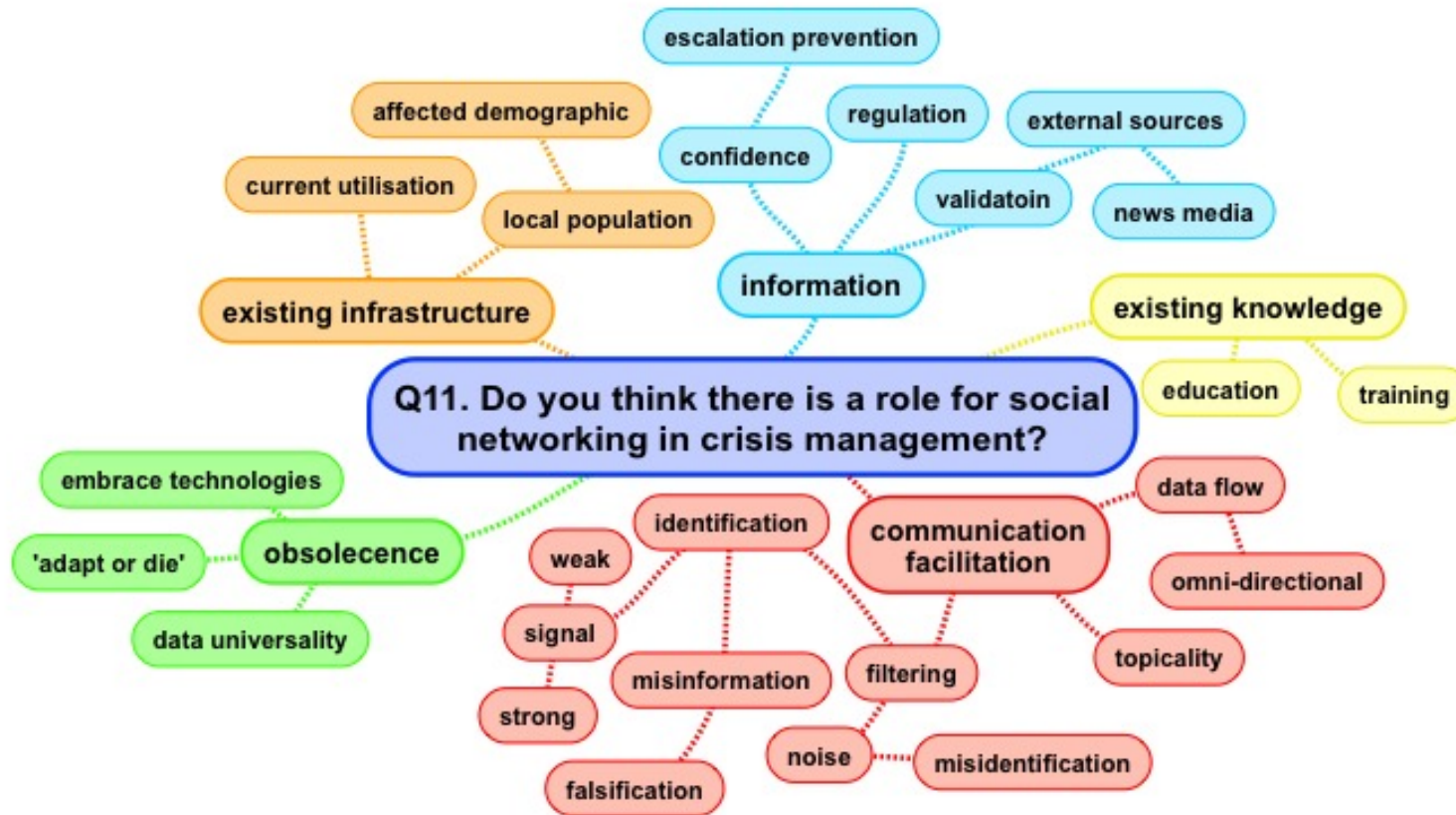
Answer Nine



Answer Ten



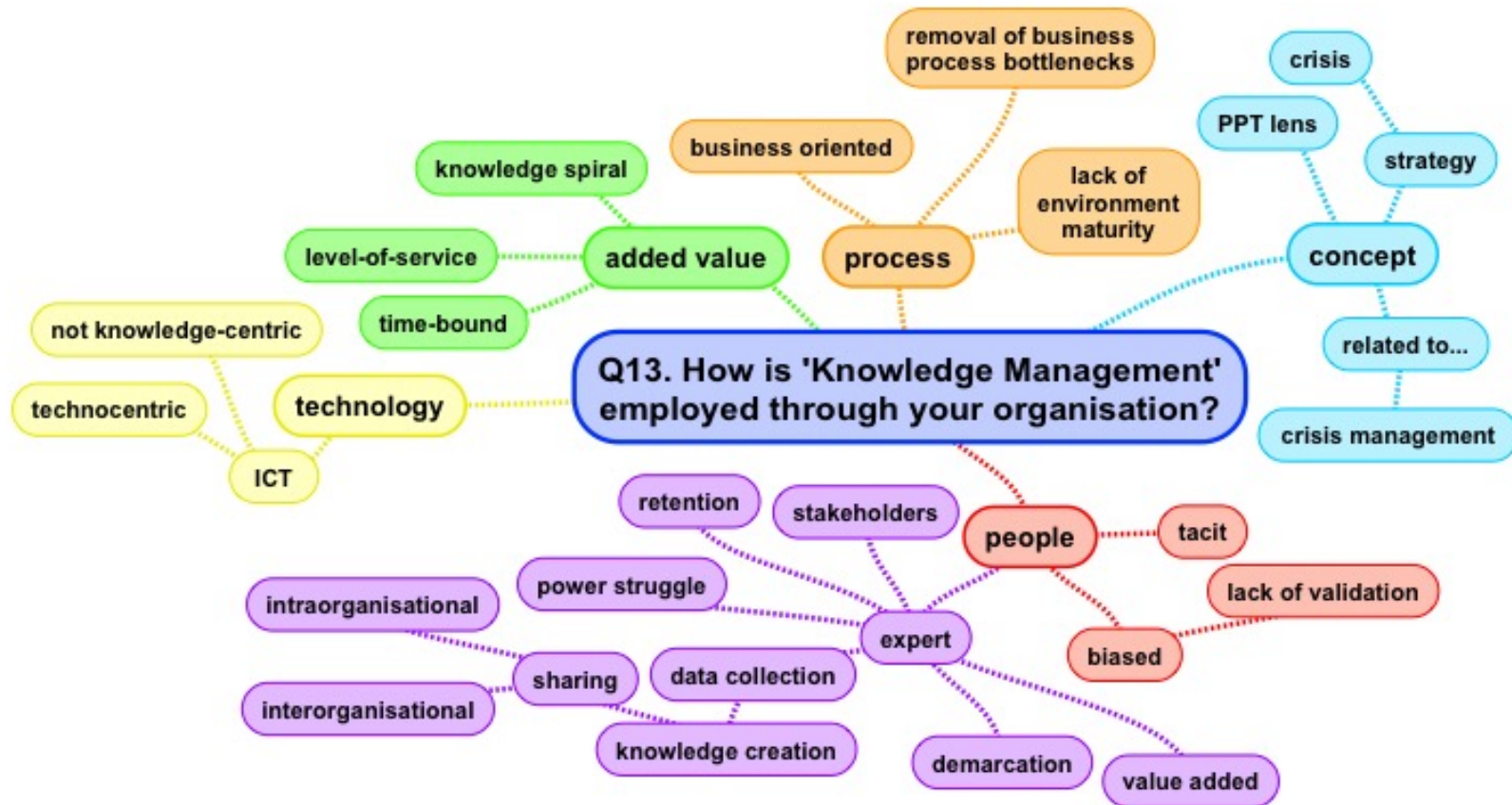
Answer Eleven



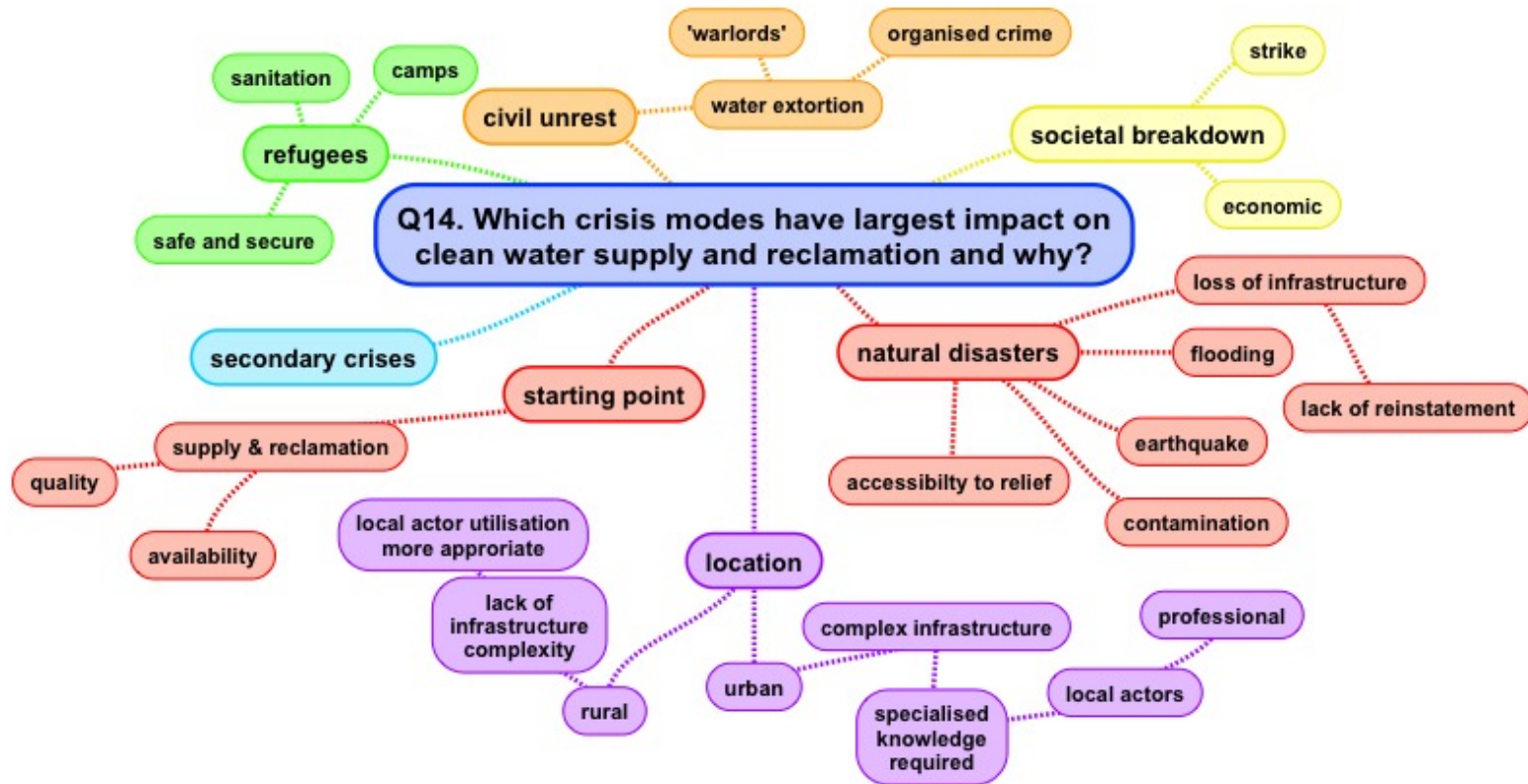
Answer Twelve



Answer Thirteen



Answer Fourteen



Answer Fifteen



Appendix D. Primary Data Results Categorisation Table

WATER		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Clean water provision and dirty water removal at the center of water provision. • Adequate road infrastructure required for bowser/tanker transportation to be effective. 	100% (7/7)
		43% (3/7)
I2: CM/KM	<ul style="list-style-type: none"> • Potable water provision to ensure health of populace. • The need for supply and reclamation infrastructure integrity: agreed level-of-service to ensure compliance with demand and quality. 	100% (7/7)
		86% (6/7)
I3: CM/HS	<ul style="list-style-type: none"> • Clean water as a health issue: health quickly deteriorates without access. • Ability to provide clean water to those in need essential to management of situation. • Crisis management of treatment plants as part of resilience planning. • Assessment of crisis situation with regards to supply and reclamation: how improvements can be made during crisis. 	100% (7/7)
		100% (7/7)
		29% (2/7)
		71% (5/7)
I4: PH/Water	<ul style="list-style-type: none"> • Provision of brown water (excrement) reclamation to reduce chance of secondary contamination, infection or disease. 	100% (7/7)
I5: Water	<ul style="list-style-type: none"> • Water standards and current supply quality used as a baseline for crisis quality expectations. 	29% (2/7)

	<ul style="list-style-type: none"> • Sanitation as prevention of secondary issues: displaced persons affected by lack of hygiene. • Introduction of temporary treatment plant to alleviate 	29% (2/7)
I6: PH/Water	<ul style="list-style-type: none"> • Drinking water for all: bottle, bowser, or mains supply imperative to stave-off secondary crises. • Washing to maintain hygiene important for health and mental wellbeing. 	100% (7/7) 86% (6/7)
I7: CM/HS	<ul style="list-style-type: none"> • Getting water to those in need in a timely manner • Equipment reinstatement after crisis has occurred. 	100% (7/7) 71% (5/7)
KEY ELEMENT #1: CRISIS MANAGEMENT		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Command and control of crisis scenario required to facilitate efficient and effective solution in shortest possible timeframe. • Availability of financial resources for workers and goods procurement. • Introduction of skilled personnel into crisis arena. • Inclusion of Knowledge Management strategy to allow for command of scenario. • Entry/Exit strategy: knowing the identified metrics for insertion and withdrawal. • Resilience planning in preparation for common/major crisis modes. • 	100% (7/7) 86% (6/7) 100% (7/7) 43% (3/7) 43% (3/7) 100% (7/7)

	<ul style="list-style-type: none"> • Education of locals to provide crisis relief and reinstatement of assets; e.g. Reservists. 	57% (4/7)
	<ul style="list-style-type: none"> • Removal of media <i>hotspots</i> to ensure aid gets to those most in need. 	29% (2/7)
I2: CM/KM	<ul style="list-style-type: none"> • Defined reporting lines for aid/relief organisations. • Security of expensive resources to prevent theft. • Resource utilization to manage crisis. • Availability of skilled personnel as responders. • Cash availability as payment for people and services/goods and equipment. • Data collection and analysis to provided effectiveness and efficiency improvements for future instances. • Refugee reduction through a safe environment from which nobody need leave. • Integration of software for monitoring and information sharing within the crisis. • Knowledge-bases capable of providing key information and learning for those effected by crisis before, during and after the event. 	71% (5/7) 29% (2/7) 71% (5/7) 71% (5/7) 100% (7/7) 43% (3/7) 43% (3/7) 43% (3/7) 57% (4/7)
I3: CM/HS	<ul style="list-style-type: none"> • Secure resource compounds to protect valuable assets. • Skills and knowledge within crisis arena needs consolidating for application of solutions. • Paying for actors in a timely manner. • Utilisation of information technology to co-ordinate efforts. • Use of mobile phone technology beyond that of phone calls: data gathering, internet, etc. 	71% (5/7) 57% (4/7) 86% (6/7) 86% (6/7) 71% (5/7)

I4: PH/Water	<ul style="list-style-type: none"> • Interorganisational co-operation to facilitate coordinated response strategy and operational activities. • Supply integrity of water as an integral part of CM • Telemetry and automation of assets through mobile technologies. 	<p style="text-align: right;">71% (5/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">57% 4/7)</p>
I5: Water	<ul style="list-style-type: none"> • Identification of who has what skill set and how can it be utilized in an efficient and effective manner? • Sustainability of supply and reclamation within the crisis scenario. • Level-of-service as regards availability and quality of crisis relief efforts. • Money and how to allocate. • Secondary crisis – sewage pollution. • Use of mobile phone technologies for near real-time reporting of crisis escalation. 	<p style="text-align: right;">71% (5/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">71% (5/7)</p> <p style="text-align: right;">86% (6/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">86% (6/7)</p>
I6: PH/Water	<ul style="list-style-type: none"> • Scenario ownership by both locals and professionals. • Law-and-order through both military and policing. • Application of stakeholder management and its implications for social cohesion as a force for good within any given crisis. • Cash required for reinstatement and running costs. • Fossil-fuel pollution due to localized electricity generation. • Risk management to facilitate speedy crisis reduction. • Scenario planning based on previous crisis occurrences. 	<p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">100% (7/7)</p> <p style="text-align: right;">86% (6/7)</p> <p style="text-align: right;">86% (6/7)</p> <p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">100% (7/7)</p>

I7: CM/KM	<ul style="list-style-type: none"> • Situation appraisal utilising reporting lines through which information is transferred. • Resource management to facilitate efficiency and effectiveness. • Financial management to <i>sweat</i> resources. • Risk management to prevent crisis escalation. • Use of locals to reduce professional aid agency presence. • Leverage from existing technology available to general public, such as mobile phones, computers and social media. • Ownership remaining with locals to encourage involvement in solution planning and execution: prevention of water trading. • Exploitation of BYOD to coordinate efforts at every stage. 	<p>43% (3/7)</p> <p>86% (6/7)</p> <p>71% (5/7)</p> <p>71% (5/7)</p> <p>86% (6/7)</p> <p>100% (7/7)</p> <p>86% (6/7)</p> <p>43% (3/7)</p>
KEY ELEMENT #2: KNOWLEDGE MANAGEMENT		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Information confidence and its application to dissemination (information democracy). • Leverage must be gained from people, process and technology to fully utilize environment. • Process-orientation rather than results-driven diminishes the effect of good Knowledge Management. • Exploitation of social media is on the rise and should be embraced before, during and after, crisis. • Success-driven rewards for aid workers based upon good information gathering. 	<p>29% (2/7)</p> <p>43% (3/7)</p> <p>100% (7/7)</p> <p>29% (2/7)</p> <p>43% (3/7)</p>

I2: CM/KM	<ul style="list-style-type: none"> • Lack of confidence in information available from unconfirmed sources or those without any professional standing. • Use of people, process and technology to define the crisis scenario and arena thereof. • Avoid process focus and embraced goal setting as the best way to utilize Knowledge Management. 	<p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">43% (3/7)</p>
I3: CM/HS	<ul style="list-style-type: none"> • <i>Stakeholders</i> versus <i>actors</i> within the crisis domain: who is given what responsibility? • Use of <i>victims</i> as <i>actors</i> so as to maintain Human Security and social cohesion. • Use of technology in possession of such <i>victims</i> in order to provide an information grid to facilitate coordinated crisis response. 	<p style="text-align: right;">29% (2/7)</p> <p style="text-align: right;">29% (2/7)</p> <p style="text-align: right;">57% (4/7)</p>
I4: PH/Water	<ul style="list-style-type: none"> • Knowledge Management is the means, not an end in itself. • Use of local population as part of solution in order to enfranchise community. 	<p style="text-align: right;">29% (2/7)</p> <p style="text-align: right;">57% (4/7)</p>
I5: Water	<ul style="list-style-type: none"> • Water supply and reclamation exists within a complex environment which is reliant on key stakeholders/actors for it success. • Good processes are required for good practice to be employed and tested through metrics. 	<p style="text-align: right;">43% (3/7)</p> <p style="text-align: right;">71% (5/7)</p>
I6: PH/Water	<ul style="list-style-type: none"> • Use of short, medium and long-term HRM aids in the effective use of water for Public Health. 	<p style="text-align: right;">29% (2/7)</p>
I7: CM/KM	<ul style="list-style-type: none"> • People, process and technology are key to any Knowledge Management solution as they cover each and every aspect. 	<p style="text-align: right;">43% (3/7)</p>

	<ul style="list-style-type: none"> • Governmental/NGO intervention and guidance as to data collection, collation and dissemination inside and outside of the crisis environment required to formulate efficient and effective response plans. 	100% (7/7)
KEY ELEMENT #3: PUBLIC HEALTH		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Introduction of normal routine into the crisis scenario so as to provide emotional anchor point reminiscent of pre-crisis behavior. • Public Health should form a part of the Crisis Management plan so as to provide holistic solutions. 	86% (6/7)
		100% (7/7)
I2: CM/KM	<ul style="list-style-type: none"> • Knowledge as to pre-crisis health of population so as to ascertain tolerance level and survival rates. • Focus on potential secondary crises and risk management thereof. • Speed of response is important for reducing the overall impact of crisis and the shortening of timelines. 	43% (3/7)
		43% (3/7)
		86% (6/7)
I3: CM/HS	<ul style="list-style-type: none"> • Good sanitation is key to reducing the crisis timeline and impact. • Infrastructure reinstatement so as to provide victims with amenities. • Provision of consumables to aid in victim recovery. • Use of community leaders to rally victims and aid in coordinated response to, and management of, crisis. 	71% (5/7)
		43% (3/7)
		43% (3/7)
		86% (6/7)

I4: PH/Water	<ul style="list-style-type: none"> • Water is integral to general Public Health and crisis prevention. • Prevention of secondary crisis occurrence through access to clean water and sanitation. • Personal hygiene for self-respect and the respect of others. 	<p>100% (7/7)</p> <p>86% (6/7)</p> <p>86% (6/7)</p>
I5: Water	<ul style="list-style-type: none"> • Water is essential to health and wellbeing. • Emergency provision for short-term relief whilst making medium/long-term plans for renewal and/or reinstatement. • Use of local community in providing short-term solutions to water and sanitation problems; collecting and purifying water whilst dealing with localized waste. 	<p>100% (7/7)</p> <p>43% (3/7)</p> <p>57% (4/7)</p>
I6: PH/Water	<ul style="list-style-type: none"> • The mitigation of crisis through water applications cannot be underestimated as it informs all aspects of our lives. • Utilisation of community leaders is organizational buy-in from community at large. 	<p>86% (6/7)</p> <p>57% (4/7)</p>
I7: CM/KM	<ul style="list-style-type: none"> • Infrastructure integrity crucial to supply and reclamation. • Mental health of social cohesion and family/community structures. 	<p>43% (3/7)</p> <p>43% (3/7)</p>
KEY ELEMENT #4: HUMAN SECURITY		
INFORMANT NUMBER & EXPERTISE	PRIMARY DATA FACTS (Finish Water Forum)	INFORMANT CORROBORATION CONFIDENCE XX% and (Y out of 7): any two informants in agreement constitutes acceptable confidence for entry into framework
I1: Strategy/KM	<ul style="list-style-type: none"> • Resilience planning caters for Human Security through established protocols and scenario-specific responses. • Leaders must be included in Human Security process in order to ensure political will is applied to departments and operatives within governmental structures. 	<p>57% (4/7)</p> <p>43% (3/7)</p>

	<ul style="list-style-type: none"> • Good media relations are important if the required aid is to be maximized and <i>clustering</i> avoided. • Utilisation of <i>media relations</i> personnel can aid in the process of directing media to those in most need. 	43% (3/7)
I2: CM/KM	<ul style="list-style-type: none"> • Retaining law-and-order reduces criminality and makes victims feel safe. • Inclusion of Business community in all areas helps to leverage skills and knowledge. • Business can be part of the solution where <i>Public</i> resources may be limited. 	<p>43% (3/7)</p> <p>100% (7/7)</p> <p>29% (2/7)</p> <p>71% (5/7)</p>
I3: CM/HS	<ul style="list-style-type: none"> • Criminality and the threat to citizens that can cause secondary crises. • Crisis response needs to be specific to place and time to ensure Human Security is maximized. 	<p>71% (5/7)</p> <p>100% (7/7)</p>
I4: PH/Water	<ul style="list-style-type: none"> • Structure required to implement pre-designed plans in an effective manner. • Water resources need to be applied in an effective manner, as they may be limited. • Water standards will vary due to geographical location and availability of resources. • Use locals to provide solutions; their knowledge is invaluable. 	<p>71% (5/7)</p> <p>57% (4/7)</p> <p>100% (7/7)</p> <p>86% (6/7)</p>
I5: Water	<ul style="list-style-type: none"> • Safety and security of water supply to ensure drinking water reaches those in need and cannot be diverted by criminal elements. 	71% (5/7)
I6: PH/Water	<ul style="list-style-type: none"> • Which parties have what designation; are <i>victims</i> transient or permanent. Can they be brought to bear as crisis responders? 	57% (4/7)

	<ul style="list-style-type: none"> • Social media could be used to direct actions and identify problem areas, helping to produce a knowledge map of the crisis domain. 	57% (4/7)
I7: CM/KM	<ul style="list-style-type: none"> • Military personnel do not provide Policing to the level of dedicated specialists and thus should only be used when essential. • Validation is important if any plans or frameworks are to be considered sound. 	<p>100% (7/7)</p> <p>100% (7/7)</p>

Appendix E. Validation Questionnaire & Mind Maps

Draft Framework Validation Questionnaire

The Consent Statement

Participant Reference Code: _____
I have read and understand the attached participant information sheet and by signing below I consent to participate in this study.
I understand that I have the right to withdraw from the study without giving a reason at any time during the study itself.
I understand that I also have the right to change my mind about participating in the study for a short period after the study has concluded (insert deadline here).
Signed: _____
Print Name: _____
Witnessed by: _____
Print Name: _____
Researcher's Signature: _____

You can adapt and develop this to suit your own project, but this is the minimum standard for a consent statement.

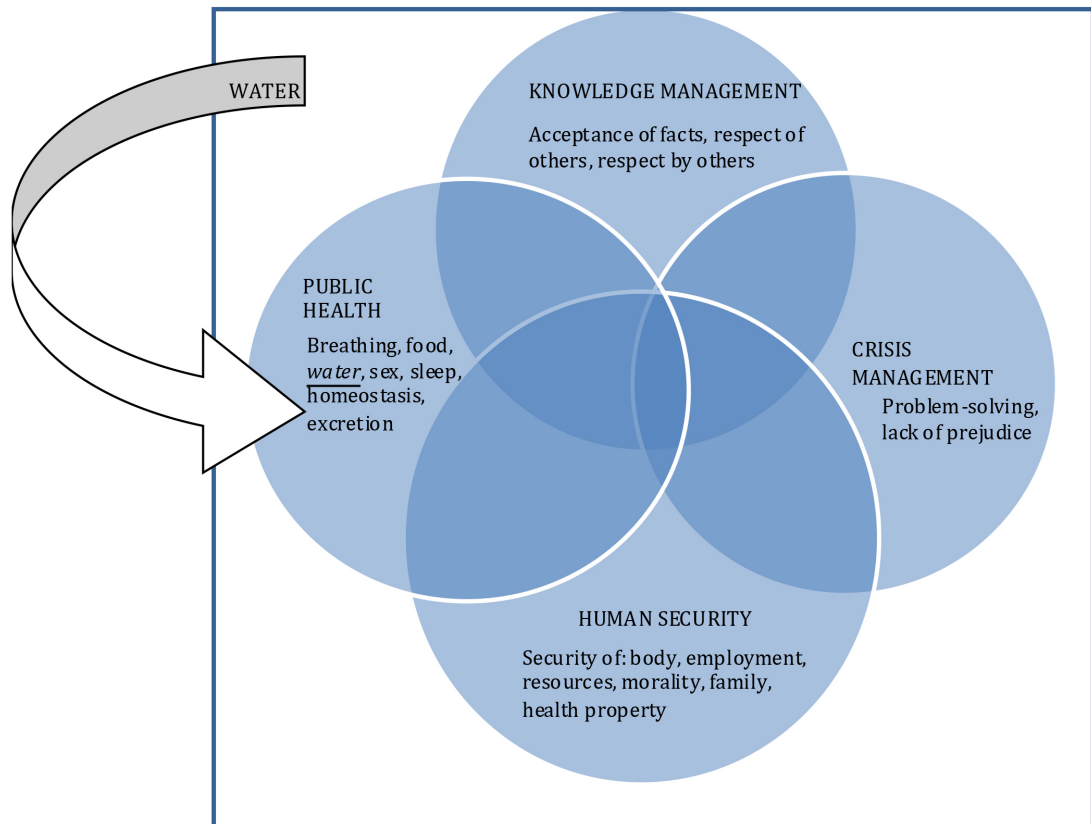
- **All signatures must be witnessed.** You, as the researcher, can act as the witness.
- **You must give all participants a copy of the signed consent form with the participant information sheet.** However, the consent form and information sheet must be on separate pages. Rather than photocopy signatures, you could produce two consent statements on one page, ask the participant to sign both parts, and give them the bottom half of the page. Make sure their copy has their participant code on it.

Consent and Questionnaires

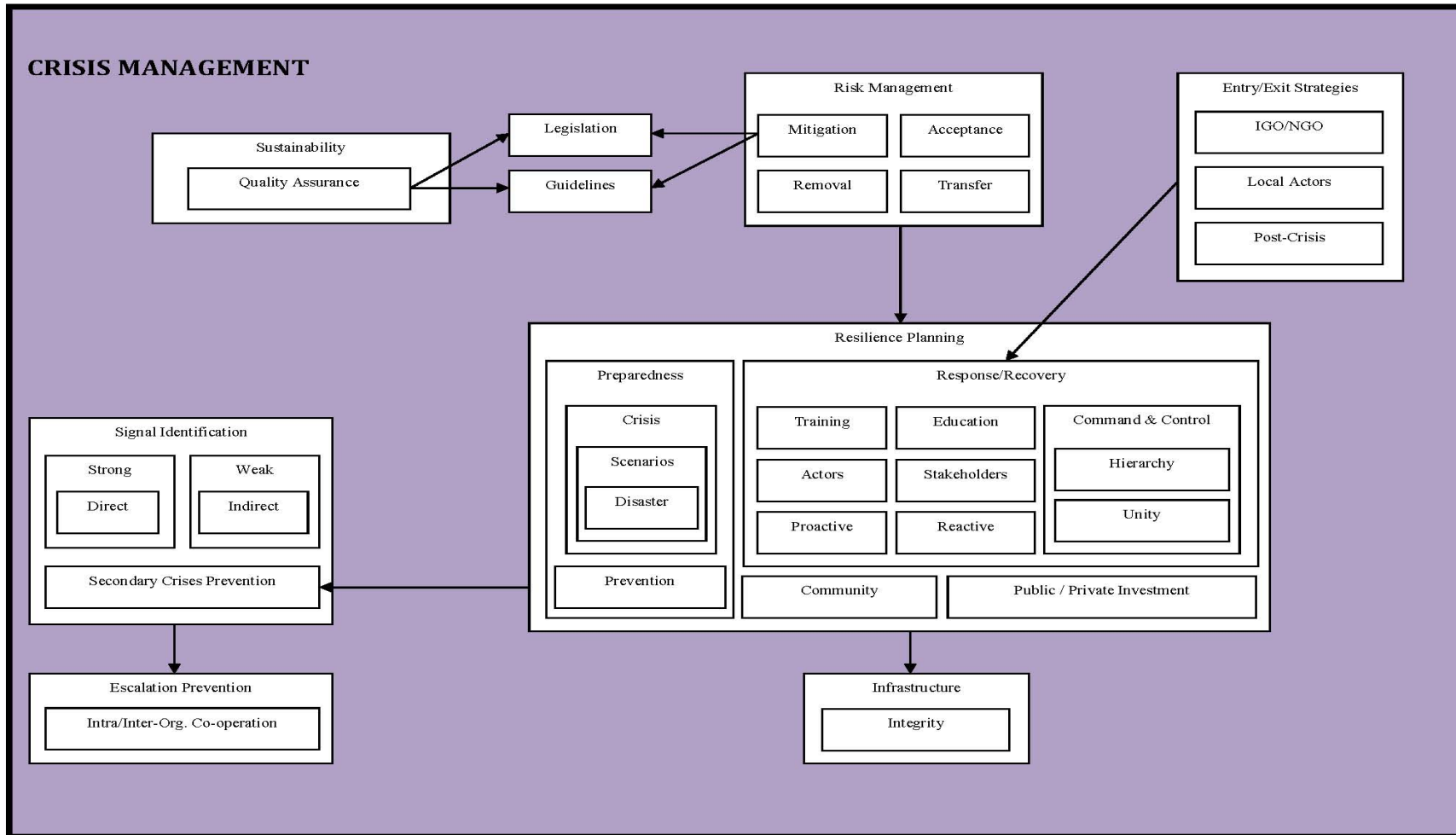
You do not need to obtain signed consent from a participant if you are only handing out questionnaires. In this instance you would, instead of a consent sheet, put the following on the front page of your questionnaire. However, you do need to get signed consent if you are using a questionnaire in combination with a task or other activity.

I have read and I understand the participant information sheet for this study.	<input type="checkbox"/>
By handing this questionnaire back to you, completed, I am giving my consent for you to use my questionnaire answers in this research study.	<input type="checkbox"/>
I understand that I have the right to withdraw my questionnaire at any point, but contacting the researcher using the details on the participant information sheet and quoting the participant reference code written at the top of this questionnaire.	<input type="checkbox"/>
I have made a note of my participant reference code	<input type="checkbox"/>

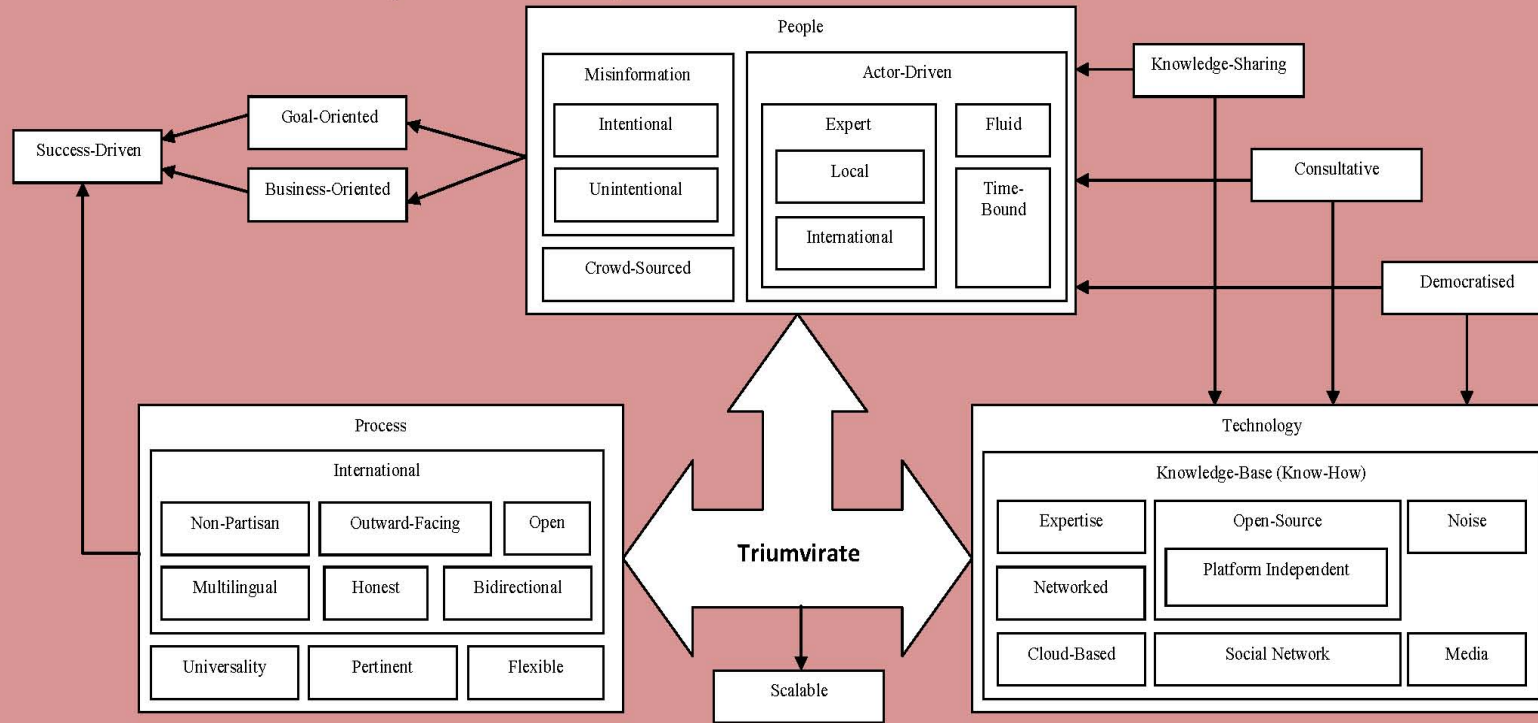
RESEARCH ELEMENTS

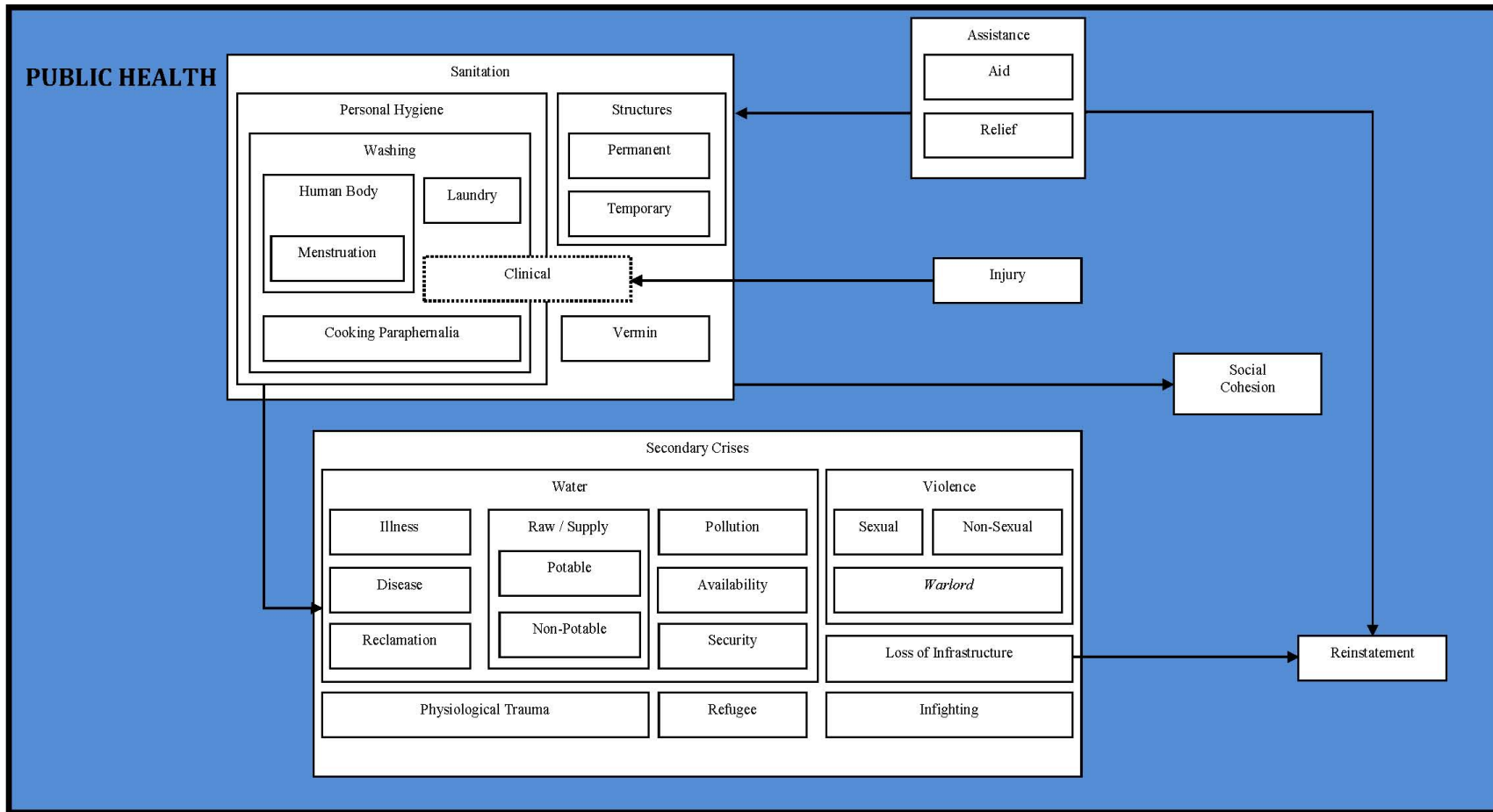


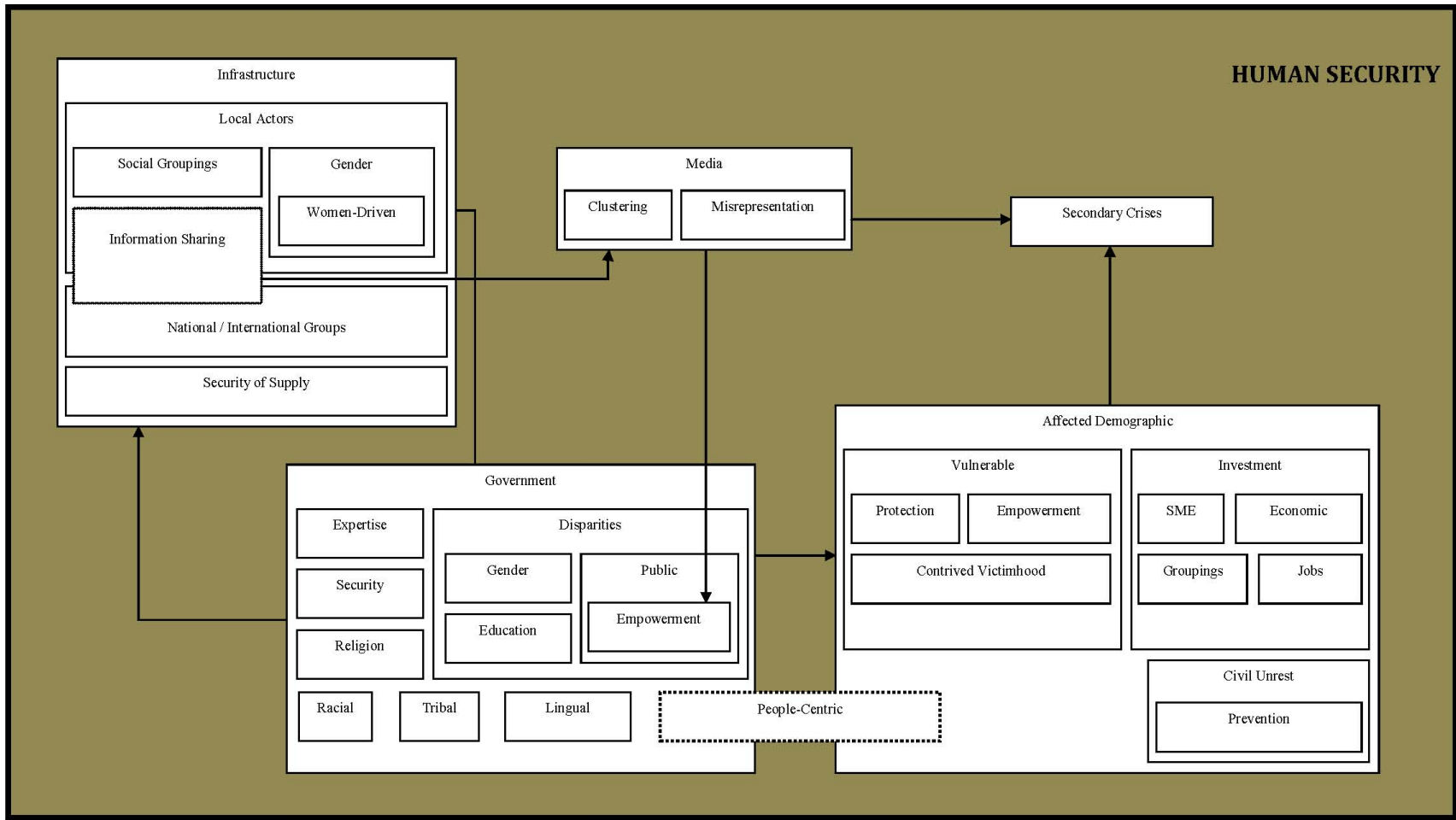
The following pages contain the draft framework based on the four research elements listed in the Venn diagram above.



KNOWLEDGE MANAGEMENT (Near Real-Time)





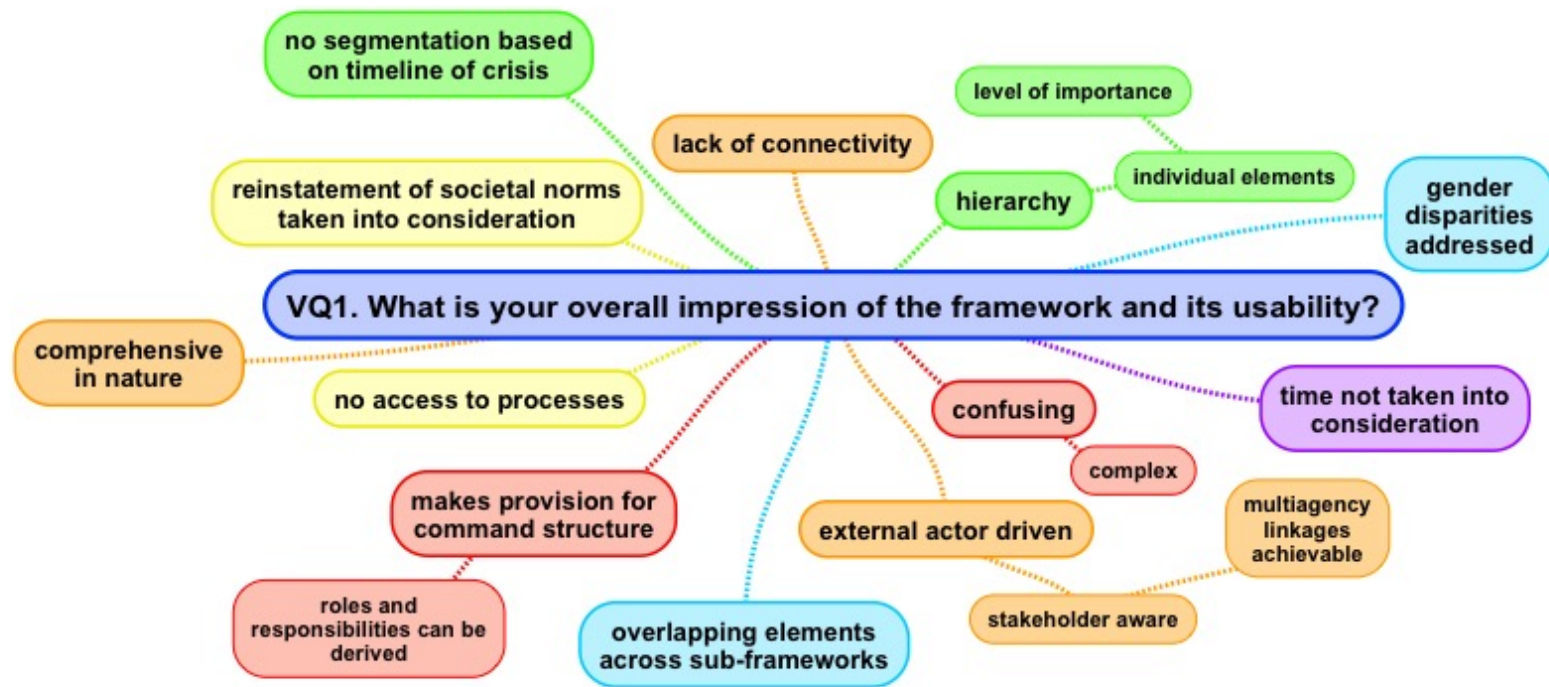


QUESTIONNAIRE

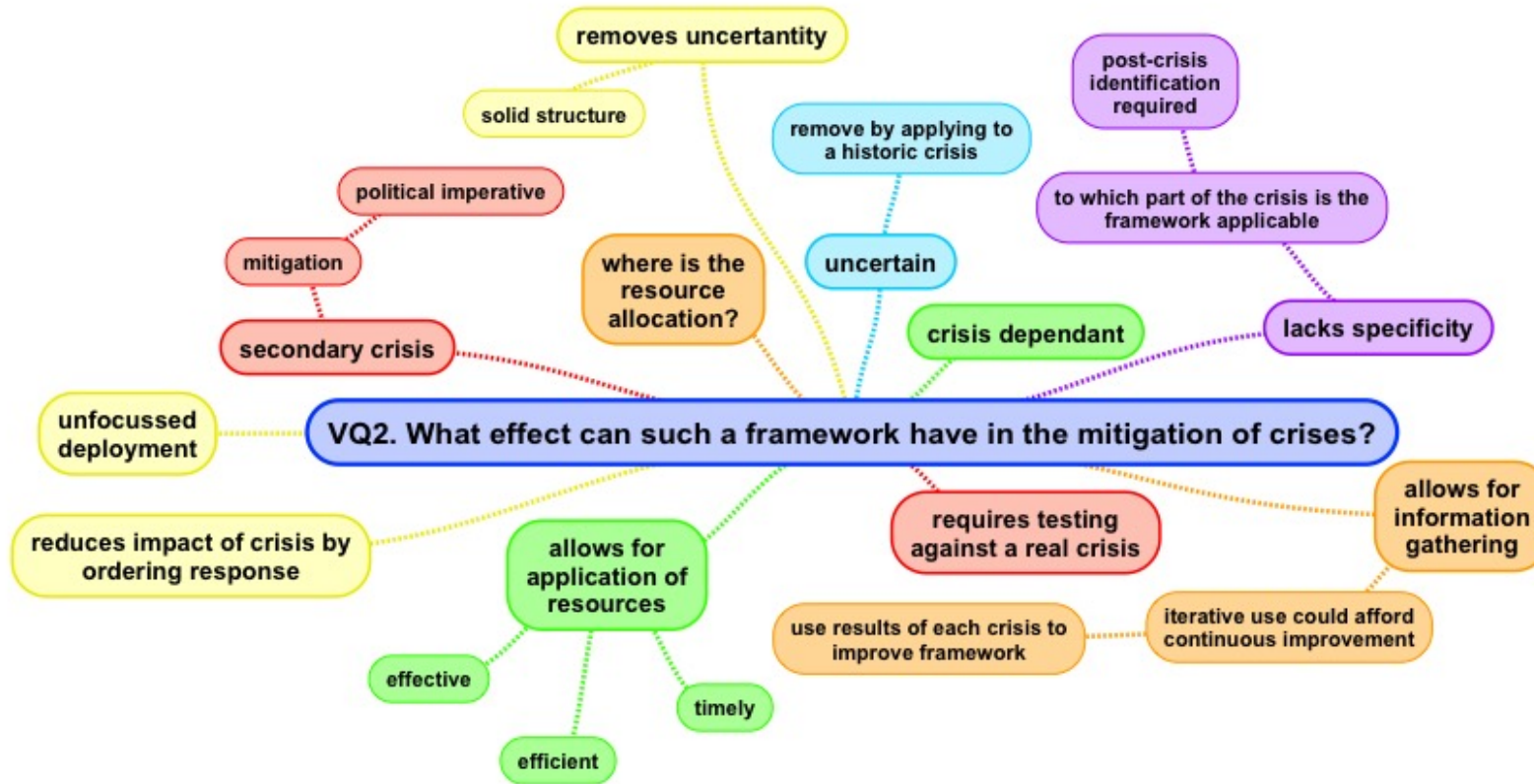
1. What is your overall impression of the framework and its usability?
2. What impact can such a framework have on the mitigation of crises?
3. Are there any parts of the framework that appear disjointed or lack cohesion?
4. Which elements would you add in order to fulfill core competencies based within your Knowledge domain?
5. Which elements would you remove or alter and why?
6. How would you describe the complexity of the framework and its validity within a Knowledge-based environment?
7. How would you describe the validity of the framework within a Knowledge-base environment?
8. How would you rate the modular aspects of the framework based on the four Venn spheres?
9. What do you consider the key facets of Crisis Management when related to your Knowledge domain?
10. What is the primary importance of water supply and reclamation when applied to your field of expertise?

Draft Framework Validation Mind Maps

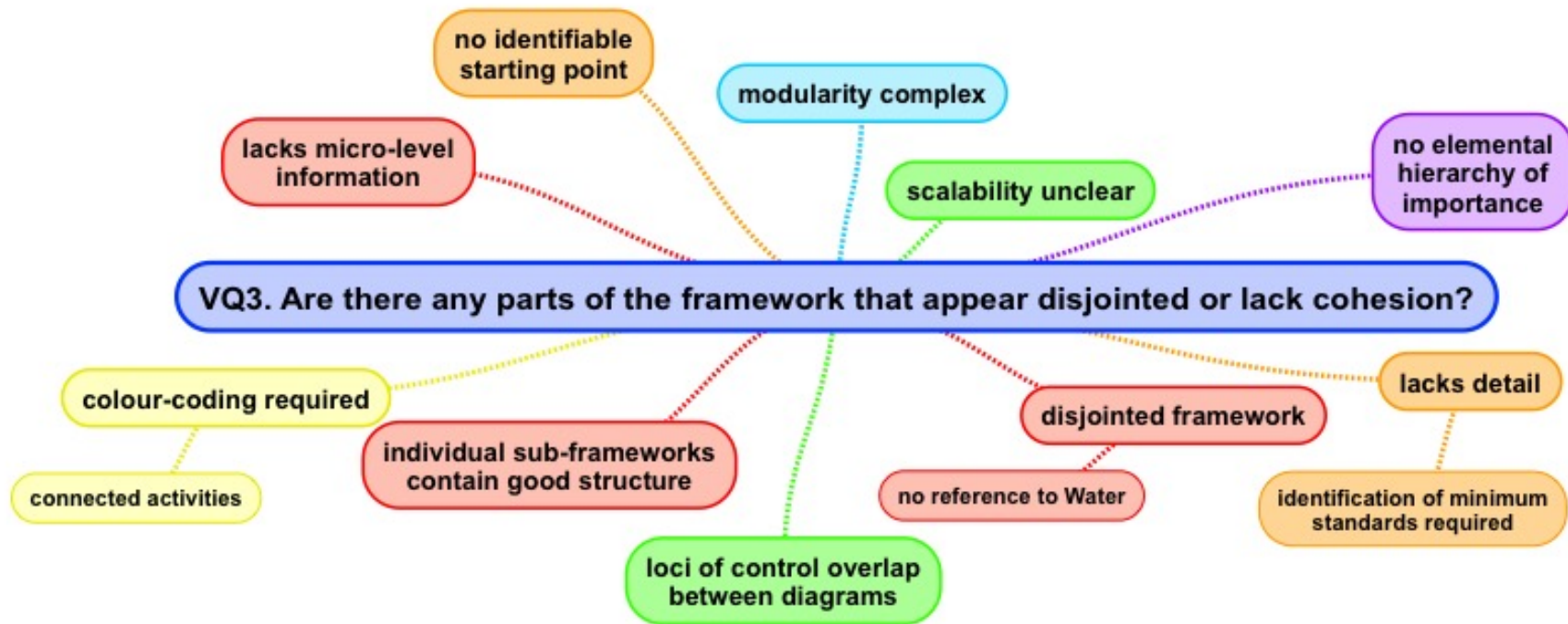
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Answer Two



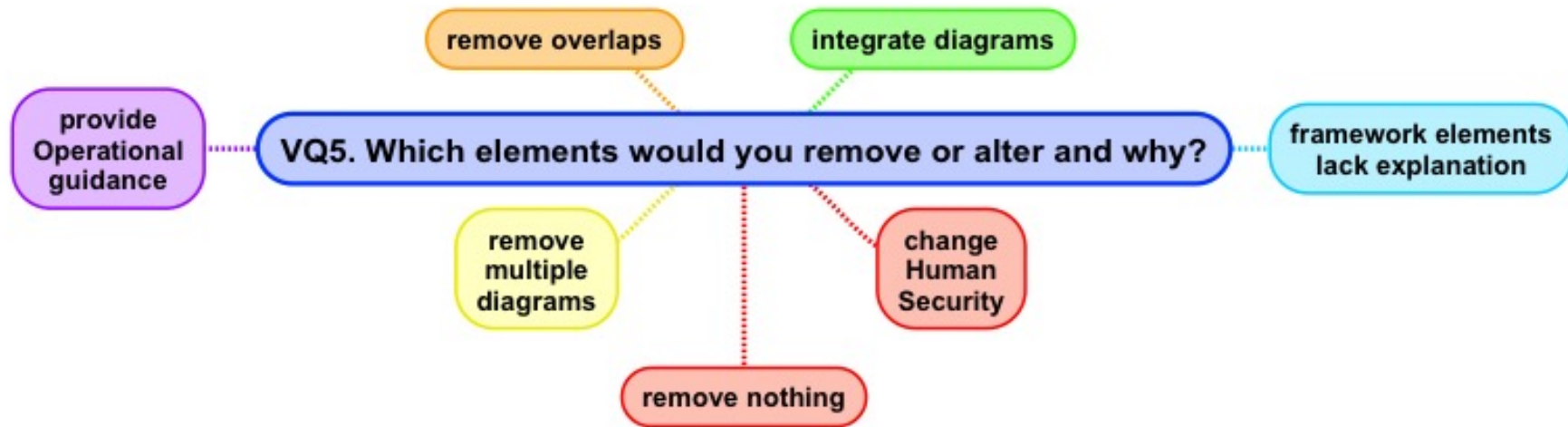
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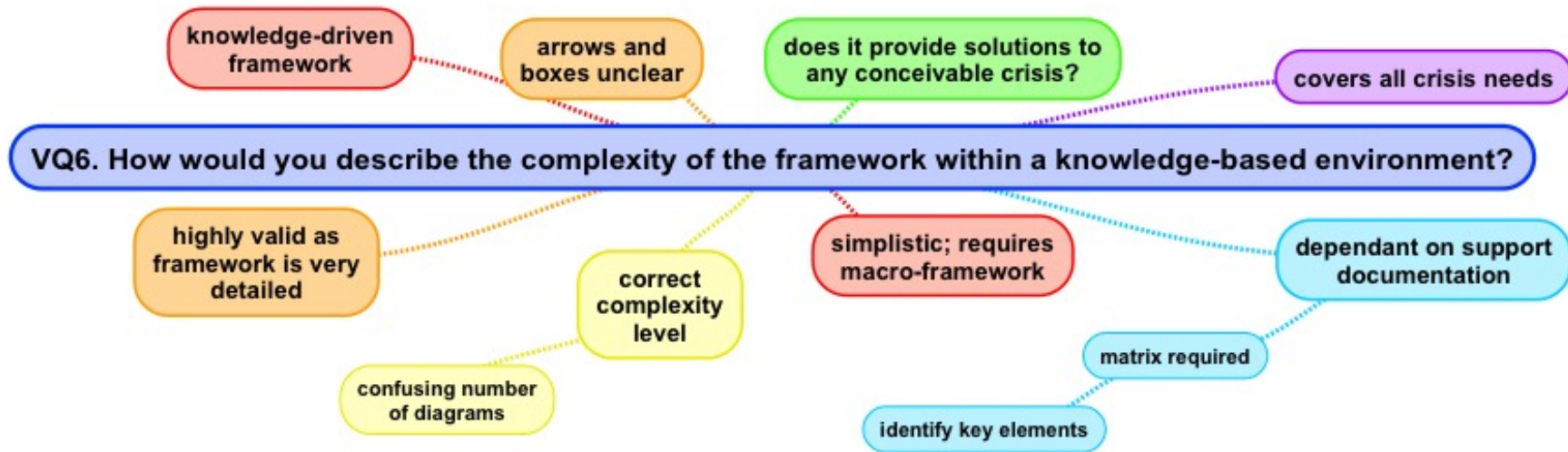
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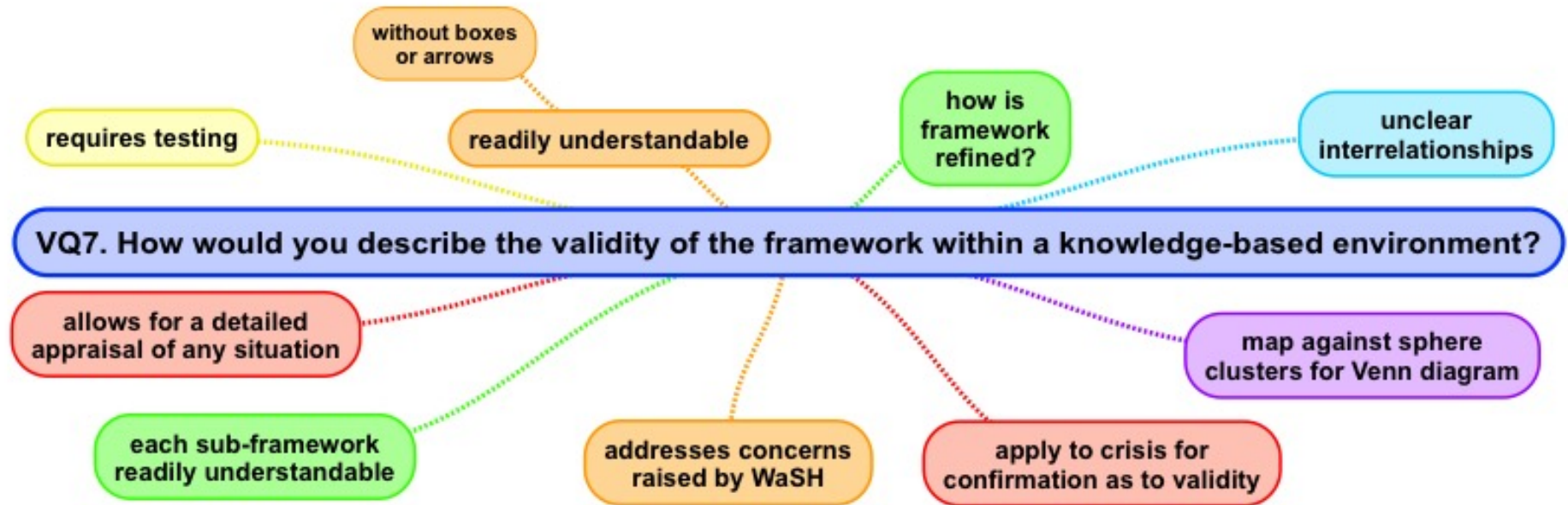
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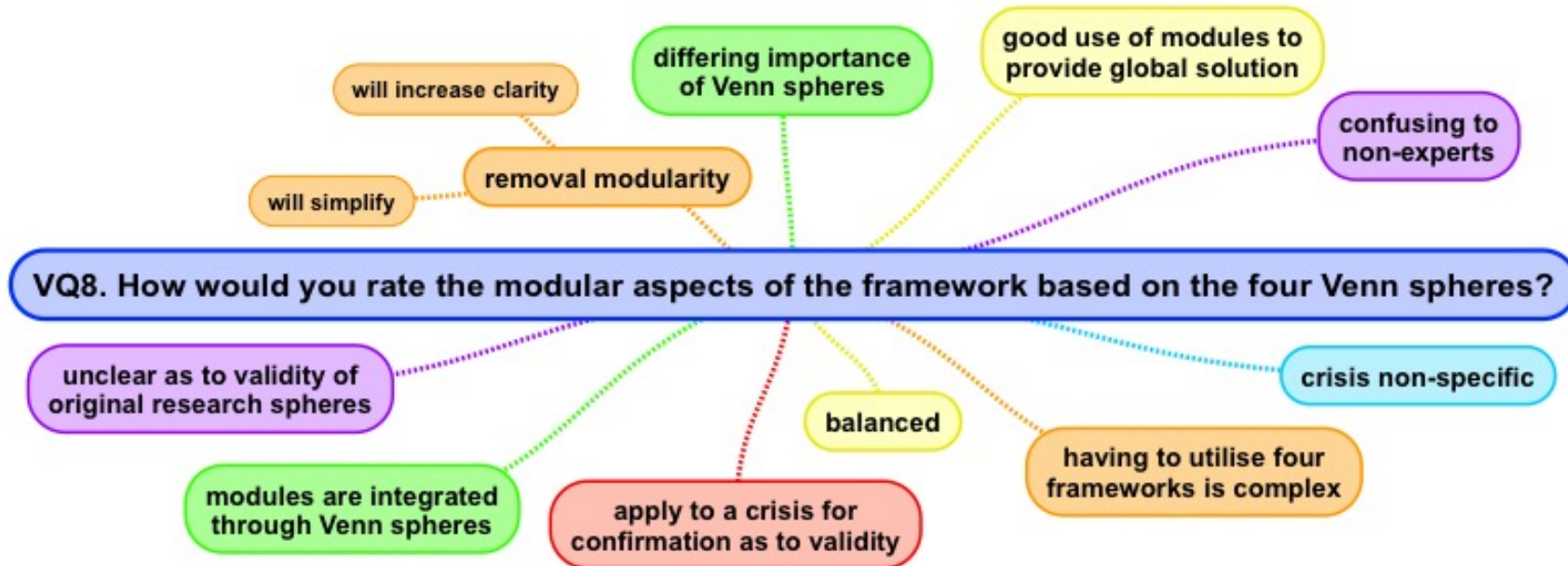
Answer Six



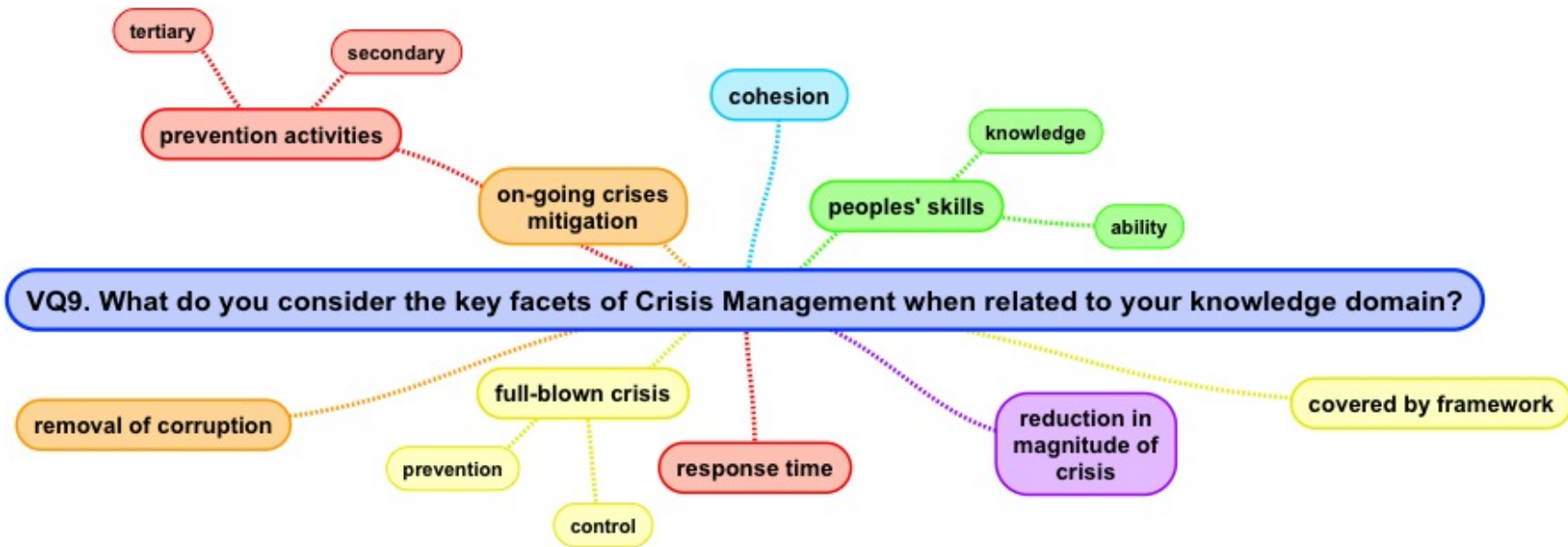
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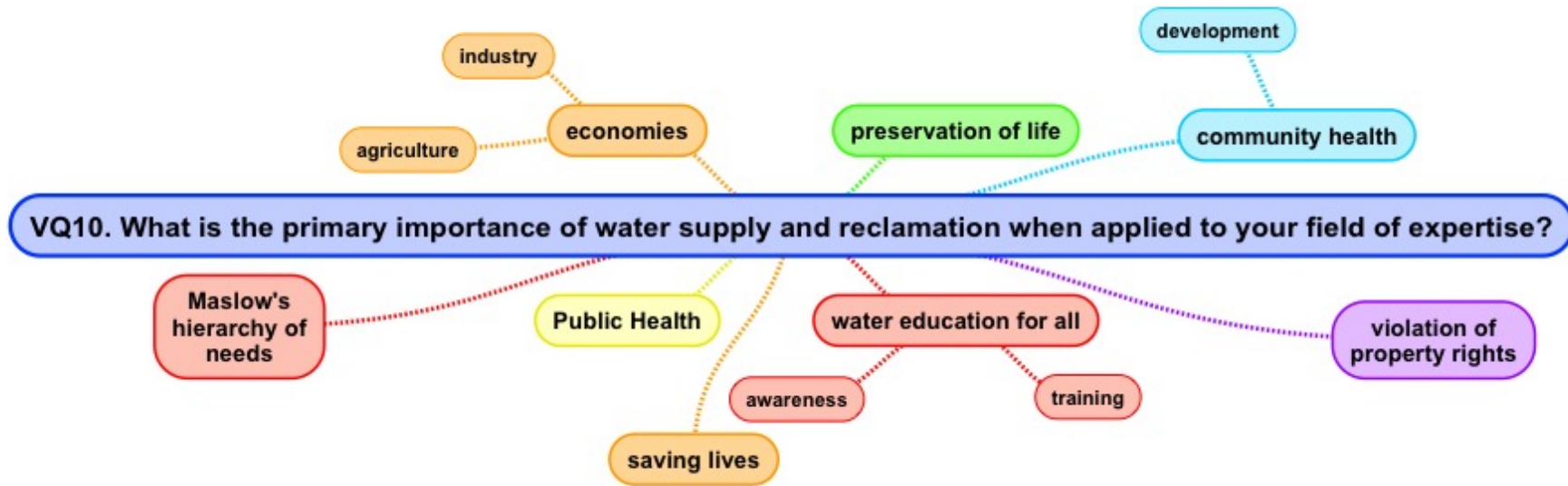
Answer Eight



Answer Nine



Answer Ten



Appendix F. Validation Data Results Categorisation Table

KNOWLEDGE-BASED FRAMEWORK FOR WATER SECURITY IN CRISIS SCENARIOS	Stability	Pre-Crisis Weak Signals	Pre-Crisis Strong Signals	Disaster	Post-Disaster Crisis/Crises Prevention	Reconstruction
Crisis Management	<ul style="list-style-type: none"> • Resilience planning • Disaster planning • BPM/mapping <ul style="list-style-type: none"> ○ Command and control ○ Local actor involvement ○ Unity of command ○ Weak signal type identification • Disaster preparedness training • Public/private investment • Legislation/guidelines <ul style="list-style-type: none"> ○ Infrastructure standards ○ Secondary crises prevention 	<ul style="list-style-type: none"> • Poverty • Low levels of education • Family size • Analysis of factors • Escalation prevention 	<ul style="list-style-type: none"> • Societal infringements • Loss of supply integrity • Loss of reclamation integrity 	<ul style="list-style-type: none"> • Proactive planned response • Reactive unplanned response • Inter-organisational cooperation • Case dependant (disaster type) 	<ul style="list-style-type: none"> • Proactive planned response • Reactive unplanned response • NGO/IGO exit strategy • Crisis perpetuation negation 	<ul style="list-style-type: none"> • Risk reduction • Sustainably infrastructure installation & maintenance • Build quality

KNOWLEDGE-BASED FRAMEWORK FOR WATER SECURITY IN CRISIS SCENARIOS	Stability	Pre-Crisis Weak Signals	Pre-Crisis Strong Signals	Disaster	Post-Disaster Crisis/Crises Prevention	Reconstruction
Knowledge Management	<ul style="list-style-type: none"> • Networked Knowledge bases • Cross discipline IS/IT (preferable OTS) • Cloud computing (SaaS) • Open-source applications • Inter-discipline Knowledge transfer • Flexibility • International (outward facing) • Research • Non-partisan • Consultative • Dissemination • Provision of 'know how' • Data universality • Business-oriented • Use of experts • Three lenses (people, process, technology) 	<ul style="list-style-type: none"> • Political instability <ul style="list-style-type: none"> ○ Public sector investment • Economics • Corruption • Socio-cultural conflict • Macro-environmental pressures • Microenvironment pressures 	<ul style="list-style-type: none"> • Social networks • Misinformation • Panic • Civil unrest <ul style="list-style-type: none"> ○ Looting ○ Vandalism ○ GDACS etc 	<ul style="list-style-type: none"> • Honest • Open • Bi-directional <ul style="list-style-type: none"> ○ Critical communications ○ Knowledge sharing • Multiple sources • Validate • Planned response • Bureaucracy reduction • Stakeholder involvement • Tacit Knowledge 	<ul style="list-style-type: none"> • Near real-time information flow • Information availability • Return to 'stable' state • Goal-oriented task assignment • Communication infrastructure • Telemetry integrity • Manual intervention • Guidance notes 	<ul style="list-style-type: none"> • National/ international lessons learnt • International influences on rebuild programme • Network enhancement • Alternative supplies/ reclamation • Strategic/tactical/operational focus • Multimedia-driven

KNOWLEDGE-BASED FRAMEWORK FOR WATER SECURITY IN CRISIS SCENARIOS	Stability	Pre-Crisis Weak Signals	Pre-Crisis Strong Signals	Disaster	Post-Disaster Crisis/Crisis Prevention	Reconstruction
Public Health	<ul style="list-style-type: none"> • Sanitation <ul style="list-style-type: none"> ○ Washing ○ Laundry • Hygiene ○ Cooking ○ Menstrual • Potable water • Water reclamation • Security of supply • Local actor education (train the trainer) 	<ul style="list-style-type: none"> • Water quality • Illness • Disease • Mortality • Morbidity • Supply interruptions • Reclamation interruptions 	<ul style="list-style-type: none"> • Use of emergency services • Injury/illness classification • Loss of supply • Hospital patient admissions 	<ul style="list-style-type: none"> • Raw water quality • Water availability • Water supply types (ground, lake, river, surface) • Contamination • Self-help motivation • Victim bargaining negation • Victim concentration (eg. refugee camps) • Agriculture • Personal consumption 	<ul style="list-style-type: none"> • Secondary crises <ul style="list-style-type: none"> ○ Bio ○ Infection ○ Water pollution ○ Sexual violence ○ Physical violence (Warlords taking control of water supplies) ○ Crime • Short-term supply and reclamation relief • Infrastructure reinstatement • Time management • Society-driven implementation 	<ul style="list-style-type: none"> • Whole-life costs • Demand mapping • Future conurbation expansion allowance • Society-driven modelling • IS/IT as an enabler • Redundancy of supply-reclamation • Utility availability

KNOWLEDGE-BASED FRAMEWORK FOR WATER SECURITY IN CRISIS SCENARIOS	Stability	Pre-Crisis Weak Signals	Pre-Crisis Strong Signals	Disaster	Post-Disaster Crisis/Crises Prevention	Reconstruction
Human Security	<ul style="list-style-type: none"> • Law and order • Rule of government • Trust in government & community • Public awareness • Gender awareness • Education centres • People-centric • Local empowerment 	<ul style="list-style-type: none"> • Gender disparities • Demographics <ul style="list-style-type: none"> ○ Tribal ○ Social ○ Religious ○ Lingual 	<ul style="list-style-type: none"> • Information <i>noise</i> • Exploitation of vulnerable • Social disintegration • <i>Power struggles</i> • Civil unrest <ul style="list-style-type: none"> ○ Looting ○ Vandalism ○ Violence ○ Crime 	<ul style="list-style-type: none"> • Triage-style prioritisation of relief • Protection of vulnerable • Unconditional aid • Aid provision by women for women • Information gathering & dissemination • Short-term water supply/reclamation • Use of local infrastructures <ul style="list-style-type: none"> ○ Physical ○ Social 	<ul style="list-style-type: none"> • Empowerment of vulnerable • Re-establishment of Law and Order • Governmental re-stabilisation • Autonomous sovereignty • Local actor informed • Unity of effort • Media clustering • Victimhood prevention 	<ul style="list-style-type: none"> • Local actor tendering • Local agreements • Creation of SMEs • Rapid move from international aid to local aid (where viable) • Long-term investment • Interoperability

Appendix G. Validation Case Study Additional Testing

In order that the framework be tested further, a *US House of Representatives* report entitled: “A Failure of Initiative: Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina” was utilised (US House of Representatives 2006). This report was chosen due to its status as an unequivocal account of proceedings as laid down by the US government. Appendix G tests random aspects of the framework and embedded crisis wheel based on information in this report.

Stability Phase: Knowledge Management Ring

The need for scalability is important so as to avoid information overload due to the immense amount of data being collected and processed at the time of the resilience plan formulation. The outcome of such information intolerance in the face of flood defence creation was to rely on the data and model created in-house, rather than making comparison with other models produced by different agencies. Figure G-1 illustrates the focus for this section based upon the KM triumvirate of People, Process and Technology.

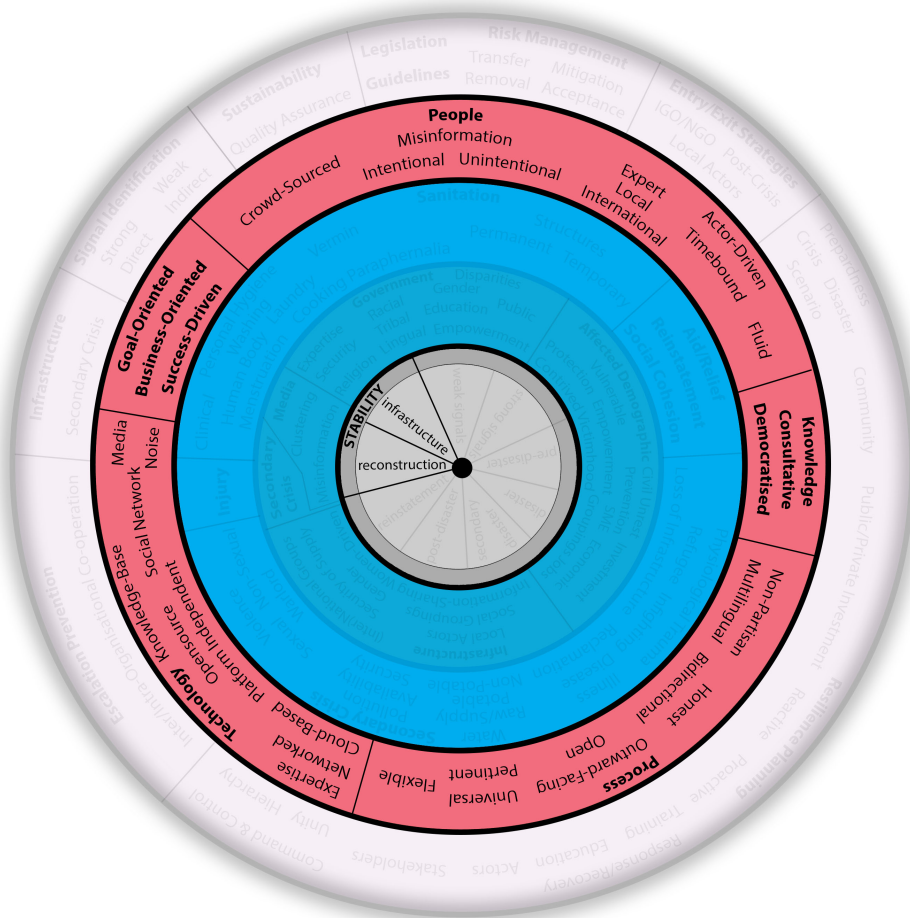


Figure G: 1 – Stability Phase Knowledge Management Ring

People: whenever large-scale public works are recommended, the need for political buy-in is fundamental to successful delivery. The very nature of adversarial politics is to do the reverse, taking an opposing standpoint on every subject so as to provide a balanced view of the situation. However, this usually remains even when the argument for action is overwhelming, placing unnecessary argument to the contrary, which is often attractive to taxpayers who do not wish to pay for the enterprise.

Misinformation: politics has long suffered from the use of information to support their argument whilst ignoring anything to the contrary. This sometimes goes so far as to wilfully mislead the public with the express intention of discrediting their political opponents.

Actor-Driven: as discussed the entire programme of projects was covered by the USACE who were solely responsible for actors involved in the process. Therefore, the utilisation of external experts when largely unrealised and result in a stilted product which was unfit for purpose.

Fluid: the very nature of militaristic structures is their lack of fluidity, thus decisions are often based on rank rather than skill-set which was detrimental to the overall design and governance of the programme.

Time-Bound: when such large undertakings are brought into being by government, the timeframes for completion can seem unreasonable. In the case of the entire programme, a lead-time in excess of fifty years could not have been envisaged. It was at the planning stage that strict milestones should have been created to ensure each stage was completed within a quantifiable window of time.

Knowledge-Sharing: the need for Knowledge sharing is important for the sake of finding the best solution. Thus, the ability to ignore advice from external experts should not have been allowed to occur. However, if parties are unwilling to share information or take on the opinions of others, it is difficult to make them comply. Cultural changes needed to have been made to encourage collaborative working based on a well-research consensus of opinion.

Success-Driven: as is common with public projects, the focus is on process rather than results; allowing for much work to be done without the checks and measures put in place to quantify the level of success achieved. Katrina was a stark indication as to the lack of suitability of the levees under a high-stress scenario; this was known to the engineers prior to construction but was ignore due to political pressure to begin the physical phase of the project and reassure local residents as well as Congress.

Process: as has been covered in previous sections, the idea of process is important due to the implications of not completing each stage to an acceptable level. Lensed through KM and Katrina, the process for resilience planning was centred on threat mitigation for populations within Louisiana. When such large-scale schemes are considered, process can become the main objective for Informants rather than the actual intended goal of the final artefact. This was the case for the planning of defences due to complexity issues and in-fighting.

International/National: the international element was not realised through inclusion of consultants from other countries whose experience of flood defences could have been brought-to-bear on the problem at hand. National expertise was also under-utilised due to the nature of USACE practice in providing all of its resources in-house; and being allowed to do so by the Secretary of the Army who had overall responsibility for enacting any given resilience plan. This allowed planners to transfer responsibility to the Army prior to completion of the planning manuscripts.

Technology

Knowledge-Based: the employment of technology in 1965 was somewhat different to today as regards microchip utilisation and computer modelling. Most of the planning was done using manual, human-operator-intensive processes which required a much higher level of personnel control than is seen today. This is not to underestimate the capabilities of pre-integrated circuit projects; rather, it is a caveat placed upon the feasibility of catastrophe modelling to the problem at hand where large-scale water tanks were used alongside physical models.

Expertise: this was never in short supply but experts often went unheard regardless of their opinion, simply because of their affiliation to organisations outside of the locus of control of planners and USACE.

Noise: the inclusion of noise within the planning of flood control measures came in the form of conflicting data and information based on different opinions as to the severity of future hurricanes and their impact on any defence mechanism. Without the benefit of hindsight, it is difficult to understand the parameters within which a plan such as this will need to operate; airing on the side of caution would have seen significant increase in expenditure, the opposite resulted in the devastation caused by Katrina.

Media: the management of media services has always been important in gaining public approval for such projects. During the time of planning, such media tended to be more on the side of government and, as such, provided little in the way of opposition to the proposed plans. This allowed government to create the scheme with little in the way of insightful criticism that reached the public.

Stability Phase: Public Health Ring

Within the resilience-planning phase of the flood defences, little in the way of Public Health was considered due to the defensive nature of the proposed solution. Therefore, these two dimensions are not utilised but will come into play during future phases of the crisis wheel when attributed to the disaster scenario at hand. None-the-less, figure G-2 illustrates the key elements that may be applicable to other crisis modes and scenarios.

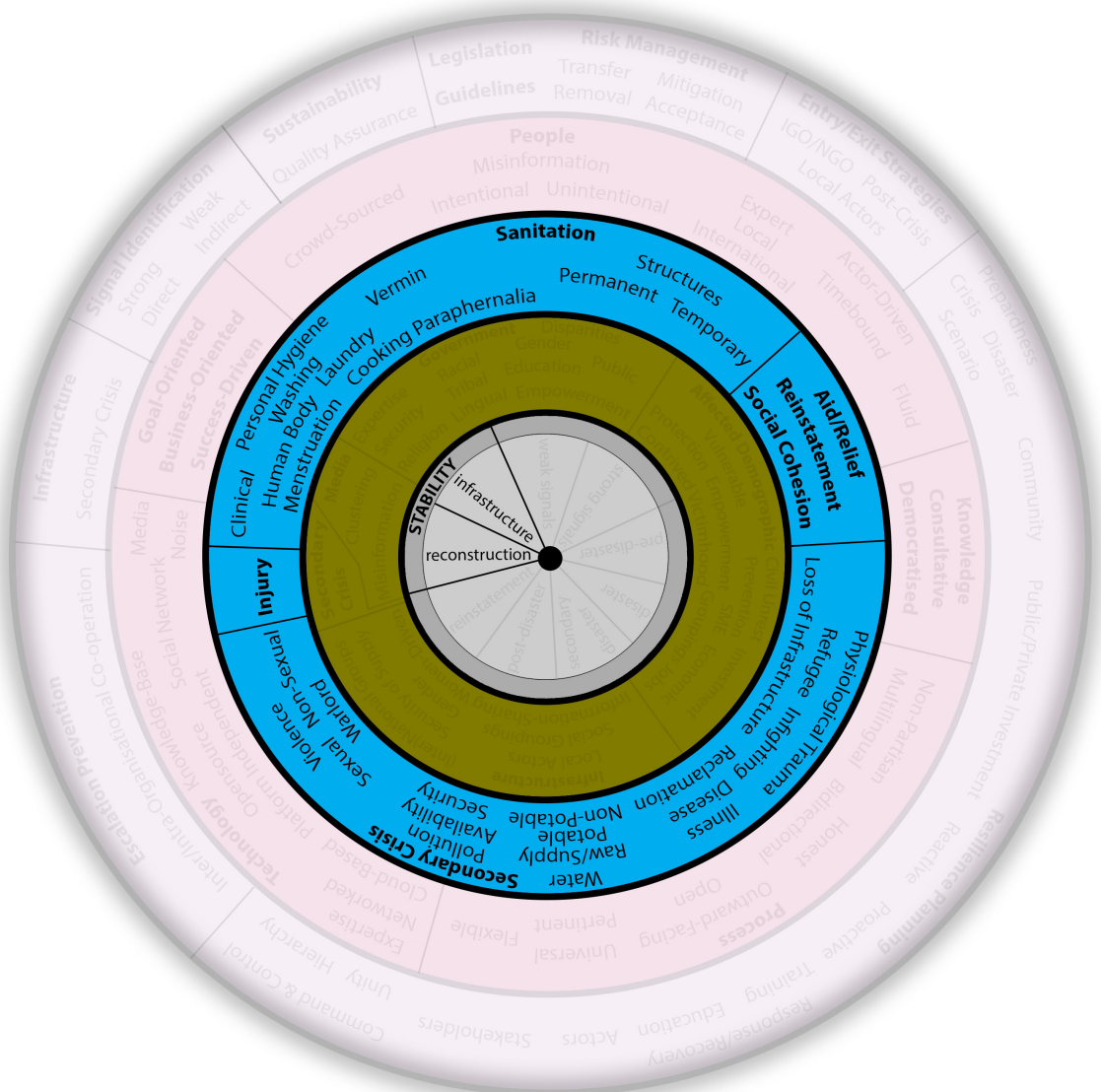


Figure G: 2 Stability Phase Public Health Ring

This is always a fault line inherent in a world governed by men; as 65% of the world's population is female, it is not unreasonable to think that their contribution may be useful at any stage of an operation to construct systems which are designed to provide protection to all concerned.

Women-Driven: this idea is still relatively new and largely untapped; given the above stipulations regarding time and resources, it is unsurprising to see that such women-driven incentives were not even considered when planning of the levees was in effect.

Affected Demographic: this was taken into consideration during the planning stage as the number of residents and severity of crisis were used to model the regions proposed defences. However, what was not taken into consideration was the drastic increase in conurbation sizes and population density during the intervening half century that rendered the impact of defence breaches much higher than initially anticipated.

Investment: investment was solely through public funds applied to a public body with little in the way of interaction with Business. This led to vast overspend as the profit motive was largely unrealised. It is only through said Business operates at ever-increasing levels of efficiency and effectiveness. Once this is removed, the incentive for lean and applicable application of resources often goes along with it; leaving projects vastly over-budget and incomplete.

Government: the underpinning ideas as to Government have changed in the USA and other countries since 1965. Once it was considered the role of Government to conceive and carry-out such large enterprises on behalf of the people who had elected them. Now, the thinking is that Government is there to stimulate Enterprise as a separate entity; driven by for-profit organisations that can provide working capital and core-skills, which are in short supply within the formalised governmental structure. Therefore, it is unfair to judge the original planning phase of the operation on modern paradigms. Rather, the plans that were drawn-up during the 1960s should have been revised to reflect said changes as, and when, they became an overwhelming influence on proceedings. This was not the case, with compliance to original plans and thinking being pursued with vim long after their original design had become outmoded.

If they had been able to station resources close to the proposed disaster area, then the response times could have been greatly reduced even having been compounded by delay in the issuing of executive order

Quality Assurance: as with everything within a modern service context, the idea of quality has become a key factor as regards delivery to the intended recipient. The quality imperative was not made a reality when constructing the levees, nor was it when maintaining the structures in the intervening years before the crisis situation was reached. Such pre-crisis conditions form strong signals as to the effectiveness of proposed edifices.

Legislation: this failed to move with the times, allowing those with vested interests in continuing the construction stage of the operation to eek-out employment in this protracted phase of the programme of defences. If legislation had kept pace, then the impact on pre-crisis could have been mitigated; if not completely removed given the fifty-year timeframe.

Risk Management: always a difficult matter and was largely ignored. Little in the way of temporary measures was employed as to the desired outputs. The work was merely undertaken systematically with little regard as to the importance of their task in rendering such crises void. The strategy seemed to centre on a risk management paradigm of acceptance which was fatal in the event of sever weather.

Entry/Exit Strategies: plenty of consideration was given in the pre-crisis stage as to the deployment of emergency resources around the predicted area of crisis. However, these were removed once the severity of the impending hurricane was understood. US Coast Guard (USGC) had been placed in a ring around the region so as to provide rapid response once the event had occurred. These resources were removed before being utilised due to the fear that responders and their extremely expensive equipment would be incapacitated during the disaster-phase.

Resilience Planning

Whilst the desirable state in which to conceive resilience plans is that of stability, it is not without cause that plans be created in a time of pre-crisis or event crisis. This may be the only option when a state of perpetual crisis is in effect due to a countries instability or lack of resources.

The initiation of such plans when a crisis is already on the way by be hampered by the looming crisis which inhibits full exploration of available options and imposes tight timeframes on decision-making and subsequent implementation. Hence, the proactive measures enacted by FEMA during the build-up to hurricane Katrina were not fully realised due to a lack of Knowledge as to the exact location and severity of the storm.

Response/Recovery: this usually takes the form of preventative, proactive measures and were utilised through an evacuation plan once the impending disaster had been positively identified.

Actors: local actors were employed through the National Guard scheme, deploying Reservists to key points as set-out in the resilience plan. Once again, many of these were recalled when it became apparent that the disaster would be on a scale previously unimagined.

Command & Control: the major shortcoming of the entire crisis cycle lay with the indecisive and impotent management who were slow to react and reluctant to allocate required resources.

Hierarchy: the differences between hierarchical control can be readily demonstrated in the way the USCG places a greater level of responsibility on junior officers within its structure, allowing them to behave in a much more autonomous way which presents itself in their ability to respond quickly whilst maintaining a high level of flexibility both around the impending crisis and their response methodology. When juxtaposed with USACE, the differences a glaring, with Army hierarchy rigid and unable to adapt.

This can be attributed to the many and varied activities undertaken by USCG which are often in remote regions and in dangerous situation without the ready availability of back-up. Military endeavours, on the other hand, are usually managed in a much more structured fashion and as part of a larger organisation for which the individual skills of each Corp is utilised within strict parameters.

Signal Identification: this was the responsibility of the National Hurricane Centre (NHC) in Florida who monitors all weather fronts effecting mainland USA and their outlying islands. Because the signals were strong and, to a certain degree, predictable, NHC were able to provide solid information upon which reliable decision could be made.

Sanitation: as soon as people begin to leave their homes in search of a safe place, the need for sanitation rises: congested roads result in people urinating and defecating on the roadside. This is not often followed by hand-washing which results in a massive increase in bacteria within the closed vehicle environment.

As time moved on, the roadsides began to display large amounts of fecal matter which were transported from vehicle-to-vehicle on the shoes of drivers and passengers.

Personal Hygiene: other than hand washing, the dangers attributed to a lack of personal hygiene did not become problematic. This was mostly attributed to the crisis and disaster phases of Katrina.

Structures

Permanent: the utilisation of permanent structures as refugee centres was integral to the Crisis Management plan for Louisiana. Therefore, utilised buildings were made ready for reception of evacuated persons.

Temporary: there was considered little need for temporary structures at this time, as the impact of levee failure was not part of the relief plan. This was to prove misguided as many of the permanent structures were quickly filled to capacity.

Vermin: as is always the case, vermin exist alongside humans as a natural part of our habitat. However, with the increase in rubbish and human feces, the danger of infection and disease began to rise rapidly; this was not immediately apparent as there is a buffer time between heightened chance of infection and a noticeable increase in human cases.

Injury: as soon as people began to leave their places of residence in the hope of reaching safety, instances of injury increased due to the heightened sense of panic that is accompanied by an increase in risk-taking. This impacted on the medical facilities in local areas that saw an increase in admissions at the very time, as they were busy making-ready for increased intake once the crisis was in full swing.

Local Actors: for the most part the only local actors who were mobilised resided in the Reservist authorities deployed to the locale. Deputation by law enforcement officers was not considered, as there was no need to think that the levees would not resist the flow of water as it had done many times in the past.

Media

Clustering: media organisations always cluster in areas where the biggest news stories are expected to occur. Therefore, they had not yet realised the true extent of the imposing disaster and were mostly concentrated on local emergency service locations and weather reporting.

Investment

Small to Medium Enterprise (SME): small business owners were concerned with securing their premises and stock in case they were asked to evacuate the area. This later proved to be inadequate as looting began shortly after a state of emergency was declared.

Government

Security: a greater number of law enforcement officers were brought in to the vicinity mostly with the remit of helping those who wished to leave and to administer law and order at a low-level.

Public

Empowerment: up until the state of emergency was declared, local people were asked to voluntarily leave the area; allowing them time to pack and to secure their property. Thus, empowerment of the local population as to whether or not they should leave was left solely in the hands of the individual.

Disaster

It was at this point that the hurricane struck land, causing a stark line to be drawn between crisis and disaster. As the hurricane progressed, emergency response teams and command & control co-ordinators were assured that measures in place were up to the job. It was only at the point of levee breach that it became acutely apparent that the crisis planning was inadequate. The responses from this point onwards became sporadic and disjointed, compounding problems that quickly spiralled out of control.

Crisis Phase: Knowledge Management Ring

Prior to the disaster phase of Hurricane Katrina becoming a reality, little in the way of water resource allocation had been considered: there were stores of bottled water as part of FEMA's emergency plan but this had not been deployed as estimates as to the severity of the hurricane were slight with respect to loss of life and human displacement (figure G-8).

The Governor of Florida had declared a state of emergency on 24th August but with the instruction that only the vulnerable or those living in mobile homes should be encouraged to evacuate. This proved to be the correct instruction, as the storm that hit Florida had not yet intensified to that which struck Louisiana.

As can be seen from the above, storm prediction is difficult as the variable nature of such weather fronts can create variable conditions for which severity categorisation may change within very short periods of time.

Risk Management: on 29th August 2005, fifty-three levee breaches occurred, covering over eighty per cent of the city in water. The lack of a response plan to such catastrophic failure of the defences for Greater New Orleans meant that risk management was no longer considered, as the need for search and rescue became a purely reactive operation.

Entry/Exit Strategies

Local Actors: Entry strategies quickly became pleas for help as the local emergency services were almost immediately overwhelmed. This called upon FEMA to take control of the operation and bring-to-bear its response resources. The federal disaster declaration thus covered some ninety thousand square miles which made FEMA's operation an almost impossible one due destruction of road and rail which placed great strain on airborne resources.

Response/Recovery: the idea of a National Response Plan was relatively new in political terms, having only come into being in 1979 with the creation of FEMA. However, FEMA had only been charge within national planning in 1992 and had, as of yet, not been tested on such an enormously scale. FEMA had been absorbed into the Department of Homeland Security that was more concerned at the time with issues relating to post 911 anti-terrorist strategies. Thus FEMA was underfunded and understaffed by the time Katrina struck.

Actors: as FEMA was the primary actor, state-operated plans were created under their guidance. These included the use of local volunteers who would provide assistance but were ordered not to enter the disaster area as the severity proved too great a risk to such undertrained staff.

Stakeholders: the various government agencies have been discussed in detail but so other stakeholders are considered here. The damage to residences and businesses was immense; forming the major share of the estimated overall cost of \$105bn for reconstruction alone. This resulted in a protracted reconstruction phase that is detailed later in the chapter.

Training: the training of FEMA volunteers reflected the authorised plans and their theatres of operation; none of the plans was geared to cope with such large-scale disaster, covering such a geographically dispersed area which was comparable to the entire size of mainland UK.

Command & Control: as detailed throughout this chapter, command and control had major problems due to lack of foresight and preparation. In addition, they also suffered from action paralysis, concerned about making the wrong decision, which in turn, caused them to delay making any decision. When the disaster occurred, sixty-six thousand people were strapped within the locale; The USCG managed to rescue over thirty-three thousand, which in itself was a major achievement.

In addition to the aforementioned actors, the recently established Joint Task Force Katrina (JTFK) mobilised fifty-eight thousand National Guard troops from every state (including Alaska and Hawaii); this presented even more strain on the command and control structure, making communication and co-ordination of such a large task force a major endeavour.

Hierarchy: as the response was now owned and operated by the military, hierarchical command became much more manageable as it was the de-facto state for such an organisation. Lieutenant General Honore was placed in overall command; proceeding with a tried-and-tested military approach that began to get the emergency state more under control. However, there were many mistakes made by FEMA who did not provide JTFK with the provisions required in a timely manner. This led to widespread violence and looting that will be explored later in the chapter.

Community: community leaders attempted to provide support through church groups and community halls but the extent of the flooding pushed this to the edge of the disaster zone.

Signal Identification

Strong: these signals were already being received by FEMA and JTFK in the form of food and water shortages being experienced by those for whom homes and businesses had been destroyed. By this time, the signals were not the problem; rather, an inability to respond given the extent of the disaster was to blame.

Integrity: as previously explored, signal integrity was always of concern. Noise from multiple sources, combined with a myriad of requests for assistance combined to make confidence checking of identified signal incredibly complicated. When this was appended to the fact that resources were overwhelmed with requests for assistance, it is no surprise that signal overload occurred early on in the operation.

Knowledge Management

Scalable: one of the primary concerns during the disaster phase of Katrina was the management of Knowledge and information being derived by within and without the affected zone. The Knowledge required to provide adequate services was not universal; many residents who were requesting assistance were either ignore or refused due to a perceived lack of need or the inability to provide what was requested. This quickly degraded confidence in victims who rightly believed that rescue may not be on the way and that their survival may well be in their own hands.

People: the USCG were performing twenty-four hour rescue missions but the number of victims requiring evacuation was of such number that many began to seek their own alternatives. People began to band into groups with the express purpose of gathering food, water and supplies as part of their own evacuation plan or so as to make weather the conditions feasible.

Law enforcement and military forces deployed in the area saw this as looting rather than gathering of essential supplies and saw conflict occur between the two parties. The could have been averted had the authorities placed an amnesty on such activity, allowing victims to garner whatever support needed from local business stocks and supplies.

Misinformation: in many areas there was no electricity or access to news media that made receiving information from authorities almost impossible. Those who have battery-operated radios were able to keep pace with the rescue operation but were few and far between.

Intentional: as is always the case with a lack of reliable information, people began to report to others as to the severity and extent of the disaster; often stating things they knew to be untrue but were communicated none-the-less. This caused panic in some quarters that led to unnecessary looting and violence.

Unintentional: coupled with intentional misinformation was the unintentional form, usually consisting of rumour and the assumption that third-hand information was true. This had much the same effect as intentional misinformation that also resulted in crime as a result of desperation.

Actor-Driven

Local: for those capable of receiving official, validated information, the outlook was no less bleak. Many residents were many hours or days away from rescue. The rising water level and a lack of safe haven saw many resorting to their rooftops as they attempted to avoid drowning and to catch the attention of any rescue services in the local area.

International: such international intervention was not sought due to the resources available to the USA along with such tight timeframes under which deployment needed to occur.

Knowledge Sharing: this has been a historic problem within competing arms of the US military. During the second world war, intelligence was not wholly shared between the Army and Navy; some scholars argue that this extended the war unnecessarily, causing the deaths of thousands more people than would have occurred had such information been shared.

Consultative: the fact that JTFK were in overall command but FEMA was responsible for the planning, they required to be utilised as consultants during the military deployment. This caused consternation amongst staff as the military simply wanted to follow their own instincts, citing the plan as having been unsuccessful up to this point, so why trust it for the remainder of the operation. This can be seen as the main cause for failure in past undertakings, when plans are ignored because of initial problems due to a loss of credibility amongst those within the command and control structure; as well as operational staff in theatre.

Democratised: the non-democratisation of Knowledge within the disaster timeframe is understandable due pressures placed upon those considered Gatekeepers as to the level to which availability of information should be granted and to whom. The primary concern at the time was that of search and rescue; time for information collation and dissemination to non-operational staff was considered of secondary concern.

Goal-Oriented: goal oriented initiative were sometimes successful in the disaster phase; providing search and rescue to over half of those requiring assistance was an unprecedented achievement considering USCG's anticipated role in the scenario.

Rescue where USCG were not the main deliverer were somewhat less successful; military operations in the area were often concerned with the capture of those engaged in criminal activities rather than the rescue of those requiring assistance. This was misguided, as the primary objective was to prevent loss of life, not the protection of property.

Success-Driven: On the ground, success was the primary area for assessment at to the validity of operations; were people being rescued; was loss-of-life being prevented, etc? With the upper echelons of command, executive orders, which could have mitigated risk, were not always executed. This prevented local actors and government agencies from participating to the zenith of their operational capability. Such fundamental error was later cited when the USACE was involved in a class-action law suet as a result of their inadequacy in preventing the crisis becoming a disaster.

Process: robust processes were in place to deal with the disaster but their anticipated operational scale was vastly underestimated. Had the levees done their job, crisis plans would have been more than sufficient to cope with scenario. Because such an incident had not be accounted for; processes began to disintegrate as more personnel were brought-in to deal with reactive duties. This caused the command and control structure to show signs of weakness as the coordination of such a large force, consisting military and civilian services proved difficult to manage given their hierarchical structures and inherent organisational cultures.

Technology: the technology available was, for the most part, adequate if the original plan had been fit for purpose. However, as personnel from organisations who were not originally thought to form part of the required response were brought to bear, incompatibility between employed technologies became apparent. This led to individual actors and domain commanders splintering from the main command and control structure to follow their own hastily created response plans.

Noise: this became a factor during the disaster as information was coming into the various network centres in volume and was, in some cases, contradictory. Those in command often agreed with information streams that agreed with their perception as to the current state of affairs. This was due to increased confidence in information which tallies with a preconceived viewpoint and is common in all human-centred information gathering. Whilst human interpretation of information should not be underestimated, noise mitigation could be better served by the introduction of software solutions that involve pattern recognition algorithms (amongst others), which can produce confidence ratings for information groupings.

Personal Hygiene: as time passed after the initial flooding had taken place and displaced persons were beginning to feel the onset of their refugee status, the idea of personal hygiene became an issue. Due the normal hygiene standards enjoyed by the USA, tolerance for a loss of this basic need became apparent more quickly than, perhaps is felt in other parts of the world from whom hygiene is not taken to the same level.

Because of the need for relief workers to prioritise search and rescue operations, fewer resources were made available for the administering of personal hygiene services. Even though the threat to those who were not injured was low at this time, the psychological impact of this state can have an affect on an individual's morale and thus reduce their chance of survival.

Cooking Paraphernalia: even though there were many disaster preparation guides made available by numerous organisations, including FEMEA themselves, many of the victims had not made provision for the cooking of food nor had they stockpiled water or canned goods. Therefore, very quickly after the disaster had come into effect, people were beginning to feel the effects of hunger. This was of most concern to relief workers when faced with the elderly of pregnant women. Only as the disaster progressed did the need to feed able-bodied refugees become a pressing issue.

Structures: many municipal buildings were converted to house the displaced, as per the relief plan. For those outside of the flooding zone, this proved sufficient in all but one aspect; the overwhelming number of people who were arriving at the centres; far outstripping the estimated number and often forcing such buildings to close themselves to newcomers.

Assistance: the provision of medical services also incorporated these municipal buildings in addition to the existing medical infrastructure of hospital and centres.

Aid: this came in the form of supplies being dropped to individuals who could not immediately be rescued. Once rescued, aid was delivered through the aforementioned infrastructure

Injury: this occurred most often as people attempted to escape the disaster area and resulted in many broken limbs, head injuries, and drowning.

Resilience Planning

At this point of the crisis wheel the arc closes, returning stakeholders to resilience planning (figure G-10). It is at this point that information is collated that allows for lessons learnt to be incorporated into future resilience plans. Regardless of the perceived success level of any plans executed, it is important to review the process so as to undertake incremental improvements in order to reinforce already robust plans.

Crisis Management

From the previous statement it is obvious that Crisis Management is the primary motive for any resilience plan. Thus, Crisis Management is often considered as a separate entity. It is proven in this framework utilisation example that without including all four domains, the probable outcome is one that may not deliver any aim or objectives in an efficient and effective manner.

Knowledge Management

The inclusion of Knowledge Management within any resilience plan has become much more important as the amount of available data and information has become super-massive. The availability of such data/information has also increased which basically allows anyone to perform analysis. Whilst this provides an opportunity to outsource/crowdsourcing analysis, it also empowers any interested party to create their own interpretation of the outcomes that places greater pressure on official sources to ensure that their resultant plans are robust and comprehensive.

Public Health

The focus of this entire framework is the application of water resources in crisis. The Public Health aspect explicitly atones the virtues of water as core to Public Health. In the context of Katrina, Public Health issues such as a lack of access to clean water and sanitation was a great surprise due to a lack of preparedness for what should have been a predictable event.

Human Security

The use of law enforcement and military personal to provide security to vulnerable displaced persons was enacted with variable success. The reviewed plan needs to take into consideration the inability of military personnel in providing law enforcement support in all but the most extreme circumstances.

The need for training of support staff outside of a military paradigm would help in law enforcement alongside first aid and the organisation of support work within the theatre of crisis/disaster.