

**MOBILISATION OF AN INTERNATIONAL URBAN SEARCH AND  
RESCUE TEAM**

by

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## Executive Summary

This project aims to create context surrounding the field of disaster management and the structures functioning within this specified field. As this field is relatively young much work is still needed, especially at organisational level. To this end this document aims to outline a detailed plan on assisting a Non-Governmental Organisation, Rescue South Africa, in improving its reaction time with regards to disaster response.

Due to natural disasters becoming more powerful, it has a pronounced effect on people living in disaster prone areas. One of the critical phases of disaster management is the Response phase. This is the phase in which Rescue South Africa predominantly functions. This project will focus on the mobilisation phase of disaster response. Critical to mobilisation is securing a structured mobilisation plan, customised for the South African environment. Another crucial aspect of mobilisation is assembling the team with the correct competencies to respond to the unannounced disaster. Current literature available in this field is extremely limited and current models will need to be adapted to suit the needs of disaster management in Southern Africa.

A comprehensive research question has been formulated to deal with the identified problems. A set of concurrent objectives with a two-pronged approach has been set out, accompanied by a methodology to solve this question.

Following this methodology, solutions are presented. In order to aid the development of the structured mobilisation plan, business process mapping is employed. A team composition strategy used for the selection of soccer players is utilised to select the best USAR technicians for a specified disaster scenario.

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## List of Acronyms

AHP	Analytical Hierarchy Process
BPMN	Business Process Mapping Notation
CEO	Chief Executive Officer
DG	Director-General
DIRCO	Department of International Relations and Cooperation
DST	Decision Support Tool
IDEF	Integrated Definition for Function Modelling
INSARAG	International Search and Rescue Advisory Group
LEMA	Local Emergency Management Agency
NGO	Non-Governmental Organisation
OCHA	Office for the Coordination of Humanitarian Affairs
OSOCC	On-Site Operations Coordination Centre
QFD	Quality Function Deployment
RDC	Reception and Departure Centre
SADC	Southern African Development Community
SOP	Standard Operating Procedure
UN	United Nations
UNDAC	United Nations Disaster Assessment- and Coordination Agency
USAR	Urban Search and Rescue
VO	Virtual On-Site Operations Coordination Centre

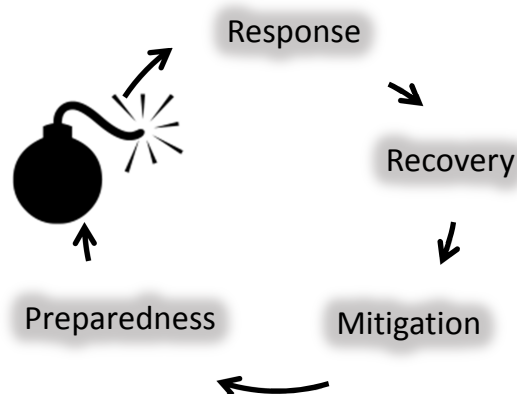
# Chapter 1

## 1.1 Background

In the present day with the combination of a cumulative populace, increased urbanisation and a shifting climate, we are confronted with pronounced challenges which are further escalated with a demonstrated increase in the prevalence and brutality of natural and manmade disasters (Flemming, 2014). The extent of the damage and loss of human life becomes increasingly apparent when the following recent events are studied:

- The Boxing Day Tsunami, 2004 (National Geographic News, 2005)
- Hurricane Katrina, 2005 (National Geographic News, 2005)
- Haiti Earthquake, 2010 (National Geographic News, 2010)
- Japanese Tsunami, 2011 (National Geographic News, 2013)

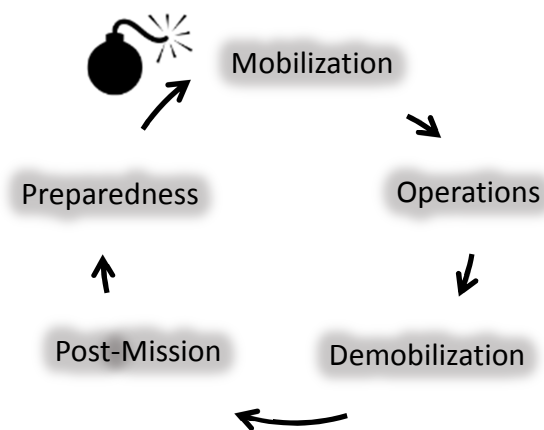
According to the United Nations Office for Disaster Risk Reduction statistics (2012), \$ 1.3 trillion (USD) in damage has been caused, 2.9 billion lives have been affected and 1.2 million lives have been lost due to disasters during the period from 2000 – 2012 (UN ISDR, 2013). The power and destructive forces of nature can no longer be ignored or taken lightly. To this end, much research and development has been done in the field of disaster management, which can be described in four phases, commonly known as the Disaster Life Cycle, namely; Mitigation, Preparedness, Response, and Recovery (Altay & Green, 2006). This is illustrated in *Figure 1*.



*Figure 1: Disaster Life Cycle (Ciottone, 2006)*

The project focuses on the Response phase, of which the timeframe can be simply defined as the immediate moment after a disaster has occurred until the call is made to withdraw relief teams, and stabilisation of the area takes place during the Recovery phase.

In 1991 the United Nations (UN) Office for the Coordination of Humanitarian Affairs (OCHA) established the International Search and Rescue Advisory Group (INSARAG) to which Rescue South Africa, or RescueSA, is affiliated. RescueSA is a registered Non-Government Organisation (NGO) established in 2000 with the goal of expanding the Urban Search and Rescue (USAR) capacity within South Africa and the Southern African Development Community (SADC) region. It is the only official South African Disaster Response Team made up of volunteer emergency response specialists from the South African public and private sector's emergency and ancillary services (Rescue South Africa, 2014). Copious amounts of their operations take place during the Response phase of the previously mentioned Disaster Cycle. The INSARAG Guidelines address international USAR response in a cycle, as illustrated in *Figure 2*, which includes the following phases: Preparedness, Mobilisation, Operations, Demobilisation, and Post-Mission (INSARAG, 2012).



*Figure 2: Disaster Response Cycle*

RescueSA aims to (Rescue South Africa, 2014):

1. Organise and facilitate co-operation between all relevant bodies with the aim of rendering the best possible technical rescue and emergency medical care, should such a need arise.
2. Use specialised equipment to respond in the event of such an emergency, if an official request is made.
3. Represent South Africa with pride in a positive and professional manner during international rescue operations.



RescueSA has responded to numerous sudden onset disasters including earthquakes, floods, volcanic eruptions, aeroplane crashes, as well as structural and trench collapses. They have also provided logistical and management support to large scale incidents including the Xenophobia camps in 2008. During an initial interview with the Chief Executive Officer (CEO) of Rescue South Africa, Mr Ian Scher, to gain a basic understanding of the capabilities of RescueSA, it became apparent that the importance of the efficiency of the activities within the response phase cannot be overstated. The response phase is time-dependent and plays a critical role in the race to minimise the loss of life in the event of a disaster. The INSARAG Guidelines also make special mention of the fact that assisting countries should be operational in the affected country within 48 hours (INSARAG, 2012) . This guideline immediately draws the focus of the RescueSA operations towards a more efficient mobilisation phase, as many of the hours available to respond is taken up by extensive travel time.

The mobilisation phase describes the actions required immediately following the occurrence of a disaster as an international USAR team prepares to respond to assist the affected country (INSARAG, 2012). This can be brought into perspective by describing it as the timeframe from the moment RescueSA is activated (the affected country has accepted the offer to assist) until the USAR team's departure for the affected country. These actions include the organisation of the adequate travel documentation, permissions and mode of travel, team availability and capabilities, equipment and supplies preparation, as well as social awareness campaigns.

## 1.2 Research Question

There is a lack of a formal document outlining the Mobilisation phase for RescueSA in case of a disaster. Without this document it will prove difficult to identify and improve critical areas in the mobilisation plan. Furthermore, without a comprehensive mobilisation document the successful continuity of the company is at risk, as the execution of the current mobilisation plan is highly dependent on a specific individual within the company, the company CEO, Mr Ian Scher.

The second aspect of this problem is the selection of the team members that will make up the best possible team to respond to the disaster for which RescueSA has been activated. There are specific guidelines in terms of the team structure, and underneath these structures specific competencies in which each component member should be skilled. Currently, teams are being selected on an ad-hoc basis, depending on the availability of the voluntary members from the different regions and ancillary services where they are employed. This approach, in collaboration with the lack of a seasoned USAR professional at the head of selection, might lead to the team not having an adequate amount of skills for the specific disaster, compromising their relief efforts and having to revert to a 'Do what you can, with what you have' approach.

This statement of the problem gives rise to the research question, which is formulated as follows: "How can a structured mobilisation plan be developed, which will also lend support to the selection of a well suited urban search and rescue team?"

### 1.3 Research Design

To aid in giving a comprehensive and fulfilling answer to the formulated research question, a number of objectives need to be defined. These objectives will help to not only understand the complexities within the question, but also guide in finding the best suited answer.

Considering Rescue South Africa's objectives (Rescue South Africa, 2014), the following key objectives were identified:

- 1) Formalise a comprehensive disaster response plan including but not limited to equipment, personnel, operational procedures and logistics.
- 2) Create a rapid deployment team equipped to respond to a range of complex emergency and relief events including on-going rescue operations and mass casualty.

These two objectives will serve as the guidelines for the design of the project. The research question is two-pronged, and thus the objectives will lend themselves to be suited to this approach.

The main aim of the project is to assist Rescue South Africa to deploy the appropriately skilled team with the adequate and well-suited equipment and sufficient supplies in the disaster stricken area as soon as possible.

The first objective in order to satisfy this main objective, relates to RescueSA objective (1):

- Creation of a structure mobilisation plan to outline the mobilisation process that will evolve as best practices is established within the USAR industry internationally, facilitated by INSARAG.

The second objective, which relates to RescueSA objective (2), will be the following:

- Development of a Decision Support Tool (DST) that will aid coordinating personnel of RescueSA in assembling the best suited team for the disaster to which they are responding.

Although these objectives are defined separately, it is important to note that a great deal of information overlaps and that the DST development is wholly integrated into the Mobilisation Plan development.

## 1.4 Research Methodology

The stated research problem and objectives are two-fold. Therefore two separate approaches need to be followed to adequately satisfy the directives, the first being to develop a structured mobilisation plan, and secondly to develop a DST to optimise the team composition that will integrate with the mobilisation plan.

### 1.4.1 Development of a Structured Mobilisation Plan

Firstly, it is imperative to better understand the project environment. Research needs to be done on the topic of disaster management, the sub-categories thereof and the local and international structures which operate in this field. Related to this is understanding the need for USAR and the role that it plays in disaster management. Furthermore, the role that RescueSA plays in the response phase of disaster management should also be fully comprehended to be able to achieve a holistic view of where an effective, or ineffective mobilisation plan will have a ripple-effect, if any, on the rest of the disaster response phase, especially with regards to the Operations phase.

Activities relating to this objective will include:

- i. Studying articles, reports and documents relating to the field of disaster management.
- ii. Learning about the development of USAR and how it has had an effect on disaster management principles and procedures.
- iii. Studying documentation held by RescueSA with regards to past missions and other procedural activities.
- iv. Interviews with the administrative staff and coordinating personnel of RescueSA.
- v. Doing a preliminary assessment of the current mobilisation plan with regards to knowledge gained.

To ensure that the INSARAG Guidelines are fully understood to a level where they can be applied successfully, the context of the guidelines needs to be studied first. This will mean that all information that has led to the development and subsequent improvement of the guidelines will need to be studied and comprehended. The structures relating to the guidelines, such as the United Nations and more specifically the functioning and role of the UN Office for the Coordination of Humanitarian Affairs (OCHA), will need to be brought into perspective. The relevant sections and articles within the guidelines will then also need to be identified and correlated to generate a full overview of the relevant phase and the responsibilities of RescueSA during that phase.

Activities relating to this objective will include:

- i. Understanding the functioning of the UN OCHA by studying online information about the Office.
- ii. Understanding the events that brought about the establishment of INSARAG.
- iii. Comprehending the UN General Assembly Resolution 57/150 of 16 December 2002 “Strengthening the Effectiveness and Coordination of international USAR assistance.”
- iv. Studying the INSARAG Guidelines in their totality to generate complete understanding of the actions and responsibilities that are expected of assisting countries during the entire Response phase.
- v. Identifying, collating and analysing the guidelines pertaining to the mobilisation of a USAR team and understanding how it will affect the success of the mission.

The creation of the Structured Mobilisation Plan will be the primary focus of this project. It will have to be in line with the INSARAG Guidelines, without contravening any of the South African laws or policies. As aiding a foreign country is of great diplomatic and political importance for both affected and assisting countries, it is key that these most sensitive issues are fully addressed and complete transparency is maintained in these processes. As most of the time spent in the mobilisation phase is usually spent on acquiring entry permissions, visas and import/export validation, the processes behind obtaining these documents have to be comprehended and included into the mobilisation plan.

Activities relating to this objective will include:

- i. Studying South African foreign policy with regards to international assistance.
- ii. Interviews with RescueSA staff who are experienced in foreign policy and the obtaining of required documents.
- iii. Creating business process maps using applicable techniques.
- iv. Creating a document that will outline the entire Mobilisation plan, acknowledging all information and insight gained during the preparation towards this activity. This document needs to be effortlessly understood and structured in such a way that it will be easily readable and referenced.
- v. In parallel with the last mentioned, process maps will be created to act as a supportive visual aid for the document.

The deliverable of this set of objectives will be a complete and comprehensive Structured Mobilisation Plan, by using Process Mapping principles and Operations Management principles. By using these principles to simplify the understanding of the mobilisation phase, as well as to incorporate some of the fundamental Industrial Engineering principles relating to these techniques, a document and supporting visual aids will be produced, which can be effortlessly updated as new best practices are developed. This will ensure the continued success of RescueSA as a leading provider of USAR capacity, long after the current management staff has vacated their positions.

#### 1.4.2 Development of a Decision Support Tool

Understanding the cause and effect of the different disaster types will go a long way towards understanding and developing the appropriate response to specific disasters. Each disaster type is unique; therefore the response to each type of disaster should be unique and customised to best suit the scenario brought forth by the disaster. This knowledge will play an important role in creating the team compositions.

Activities relating to this objective will include:

- i. Sourcing information related to the different disaster types.
- ii. Understanding the effect of each disaster type on the area and the communities.

According to INSARAG Guidelines, each responding USAR team should consist of the following components: Managerial, Logistics, Search, Rescue, and Medical (INSARAG, 2012). Having all teams structured in this way paves the way for stress-free integration with already functioning teams on the ground. Each of these parts of the team structure has standard competencies and carries a certain responsibility to ensure a successful mission for the team as a whole.

Activities relating to this objective will include:

- i. Learning about the different USAR competencies by doing applicable reading.
- ii. Understanding the development thereof.
- iii. Gaining insight into the application of these competencies in different disaster types.
- iv. Understanding the limitations and resources needed for each competency.
- v. Developing a cross-contextual understanding of the relationship between different team components.

Having a thorough knowledge of the different disaster types and also the multiple USAR competencies is not enough. Insight and understanding has to be fostered with regards to the link between disaster and the appropriate response team. Experience in this regard is the best teacher, but for less experienced USAR technicians it is of great importance to come to realise how each competency can be most effectively utilised in every scenario.

Activities relating to this objective will include:

- i. Reviewing mission reports, whilst paying special attention to the disaster type, team composition and successes achieved by the team.
- ii. Using past missions as case studies to assess what difference a variation of the team composition could have had.
- iii. Understanding what makes a specific competency most applicable to a specific disaster.

A DST will be created to help the USAR Team Management select the best team, determined by the competency and needs for a specific mission. In some cases more medical personnel may be needed, in others more USAR technicians will be requested, depending on the type and magnitude of the disaster. The DST will aim to combine, (1) information pertaining to the disaster, relayed through the Virtual On-Site Operations Coordination Centre (OSOCC) in the affected country, (2) the skillset of the voluntary personnel available to respond, and (3) the team composition guidelines as set out by INSARAG that will ensure easy integration into other responding teams.

Activities relating to this objective will include:

- i. Identifying and modifying the most appropriate operational modelling approach to utilise.
- ii. Identifying the inputs and required outputs of what is to be retrieved from this model.
- iii. Formulating the assumptions.
- iv. Model formulation.
- v. Solving the model.
- vi. Testing and validating the model by using data from past missions.
- vii. Sensitivity analysis using various scenarios.

The deliverable of this set of objectives will be a DST, in the form of a deterministic model based on the work of Boon and Sierksma (2003). This model should be created in such a way as to be effortlessly manipulated by staff, which might not have technical knowledge of deterministic models. This is an effort to adapt to incoming information about each disaster to which RescueSA is responding. The model must also be simple enough to generate a full report in seconds, as time is a critical factor during the Mobilisation phase. This DST will be integrated into the Structured Mobilisation Plan to assist in the further overall improvement of the Mobilisation phase.

### 1.5 Research Limitations

The INSARAG Guidelines requires a responding USAR team to be wholly self-sufficient for the duration of their deployment (except with regards to travel, fuel and compressed gases). This is to ensure that the responding teams do not place an extra unnecessary burden on the already stretched resources. The RescueSA objective (1) mentions the personnel and equipment requirements, operational procedures, and logistics, which this study will cover in the development of the mobilisation plan. The decision support tool developed in this study will however only focus on the man-power requirements for the response operations. This leaves room for further study for candidates interested in expanding the disaster response plan.

### 1.6 Document Structure

In order to create a broad context for disaster management, and more specifically disaster response, a comprehensive literature review is included in Chapter 2. This consists of background to role players within disaster management, locally and internationally. Furthermore a review of relevant literature pertaining to the development of a structured mobilisation plan using business process mapping, as well as the development of a decision support tool using operations research methodologies are included.

Chapter 3 aims to give a complete description of the Structured Mobilisation Plan, in the form of a Mobilisation Manual. This is a daunting prospect as care has to be taken to capture the key procedures found within the manual, without overwhelming the report with information. The objective here is to outline the areas where the manual assists in preventing short-comings.

Chapter 4 is dedicated to presenting the Decision Support Tool in a clear and comprehensive manner. The results of the model are interpreted and a validation plan, with a sensitivity analysis is outlined.

Chapter 5 concludes the project and aims to map the way forward for Rescue South Africa.



## Chapter 2

### Preliminary literature review

#### 2.1 Disaster Management

##### *Breaking down the phases of Disaster Management*

A disaster is defined as “a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources” (UN ISDR, 2009). Disaster management (or emergency management) is the term used to designate the efforts of communities or businesses to plan for and coordinate all the personnel and materials required to either mitigate the effects of, or recover from, natural or man-made disasters or acts of terrorism (Maine Emergency Management Agency, 2008). Disaster management is often described in terms of four phases (Altay & Green, 2006):

1. Mitigation - the application of measures that will either prevent the onset of a disaster or reduce the impacts, should one occur.
2. Preparedness - activities preparing the community to respond when a disaster occurs.
3. Response - the employment of resources and emergency procedures as guided by plans to preserve life, property, the environment, and the social, economic, and political structure of the community.
4. Recovery - involves the actions taken in the long term after the immediate impact of the disaster has passed, to stabilise the community and to restore some semblance of normalcy.

During the response phase, actions are typically keyed to the specific threat and may include activities such as activating the emergency operations plan, activating the emergency operations centre, evacuating threatened populations, opening of shelters and providing mass care, emergency rescue and medical care, fire fighting, urban search and rescue, emergency infrastructure protection and recovery of lifeline services (ranging from sandbagging levees [creating embankments with large bags filled with sand to cordon off designated areas, for flood protection] to restoring electric power), and fatality management (Green, 2002).

Furthermore the INSARAG Guidelines sub-divides the response phase into five phases (INSARAG, 2012):

1. Preparedness – describes the period between disaster responses during which time lessons learned from previous experience are reviewed and relevant amendments and improvements to Standard Operating Procedures (SOP's) are made, training is conducted, and planning for future response occurs.
2. Mobilisation – describes the actions required immediately following the occurrence of a disaster as an international USAR team prepares to respond to assist the affected country.
3. Operations – describes all the actions required when an international USAR team arrives at the Reception and Departure Centre (RDC), registers with the On Site Operations Coordination Centre (OSOCC), reports to the Local Emergency Management Agency (LEMA) and performs USAR operations until it is instructed to cease those operations.
4. Demobilisation – describes the actions required when the USAR team has been instructed that USAR operations are to cease and commences its withdrawal, coordinates its departure through the OSOCC and departs from the affected country through the RDC.
5. Post-Mission – describes the actions required when an international USAR team has returned home and is required to complete and submit a post-mission report and conduct a lessons learned review to improve the overall effectiveness and efficiency for response to future disasters.

#### *Research done with the Response phase*

Some of the work already done on the Response phase includes Humanitarian logistics, with regards to creating an original framework for the planning and carrying out of logistics operations during disaster relief (Kovács & Spens, 2007). Kovács and Spens (2007) aimed to differentiate between the actors, phases and logistical processes involved during disaster relief. Whilst drawing parallels, the paper recognises the need for disaster logistics to learn from business logistics, while at the same time highlighting unique characteristics of disaster, or humanitarian logistics.

A further study is the medical supply location and distribution optimisation (Metz & Zabinsky, 2010). In this study a stochastic model is used to determine storage locations as well as inventory levels for the storage facilities. An added benefit to the model is that the sub-problem relating to the locations of the storage facilities and the inventory levels at each can further be utilised to suggest loading and routing for the transportation of the medical supplies during a disaster.

Balancing operational effectiveness and cost efficiency has also been addressed (Kelly, 1995). Kelly, (1995) proposes this balancing by systematically and proactively planning the requirements, cost projections, procurement, and resource mobilisation of the response efforts.

Resource management in a post-disaster environment recently came under the spotlight (Chang, et al., 2012). This paper garners an understanding of the critical factors that influence resource availability in a post-disaster situation from the point of view of construction professionals and relevant stakeholders.

Many 'Cause and effect'-reports have been written to illustrate post-disaster lessons learned, for example a report on the administrative breakdowns during Hurricane Katrina (Schneider, 2005), where the failure of coherent and rapid decision making among the different tiers of government lead to the exacerbation of the devastation of the disaster, is analysed and discussed.

Another article studies management stress in disaster response (Paton, 2003). A comprehensive risk analysis, combined with stress factor identification, is done for emergency managers operating at a tactical, coordinating level during the mobilisation, response and post-mission phases of disaster response.

As can be seen, most existing work relates to the Preparedness and Operations phases of Response. There is much room for improvement within the response phase and even small improvements in these sub-phases can lead to 'quick wins' where the immediate effects will be most visible during disaster relief. Therefore they have become the primary study focus areas in the relatively young field of disaster management. To date limited work has been done to better understand and improve the Mobilisation phase.

## 2.2 Disaster Response

### *INSARAG Guidelines and Methodology*

As each country has its own foreign policies, National Disaster Management Plans, and international cooperation agreements, it will prove an extremely cumbersome task to generate a generic mobilisation plan that will work for each organisation, be it governmental or an NGO, in every country. Thus INSARAG has developed a set of guidelines and standards to which affiliate organisations should aspire to adhere to. The use of the INSARAG Guidelines has been endorsed by the UN General Assembly (United Nations, 2003). These guidelines have been developed in cooperation between numerous actors who have gained invaluable experience in developing domestic USAR capability, responding to major domestic USAR incidents, and responding to international USAR incidents. Lessons learned from these efforts resulted in the development of the INSARAG Guidelines and Methodology, which will continue to evolve as experience is gained from future disaster response and preparedness exercises. These guidelines provide a comprehensive framework of all USAR actions during the Response phase, and also present the best framework and guidance for the development of a customised mobilisation plan for affiliated organisations.

Developing USAR capacity is no mean feat and should not be taken lightly. It is the result of intensive planning, procurement, training and also a healthy initial capital expenditure. Organisations will do well if they can establish themselves as part of a provincial or national USAR capability development plan, where they would be able to receive the necessary budgetary support.

Unfortunately, when several previous International Foreign Disaster Assistance efforts were reviewed, teams have responded ineffectively, operated unsafely, and achieved limited success. In some instances they even became a burden to the country they have been trying to assist. In 1991, the United Nations (UN) Office for the Coordination of Humanitarian Affairs (OCHA) established the International Search and Rescue Advisory Group (INSARAG) in the aftermath of the response to the 1988 Armenian Earthquake. Numerous lessons were learnt from the international response, which has been at best described as chaotic.

The international response was totally uncoordinated and some of the following points were observed (Rescue South Africa, 2013):

1. There was little to no overall command and control.
2. Most teams experienced significant problems with Visas and with the importing of equipment.
3. There were two major aircraft accidents related to the response.
4. There was no uniform standard or methodology amongst responding teams.
5. Certain teams were poorly equipped and trained and ended up being a drain on the already insufficient resources.
6. Certain teams experienced difficulty with the weather conditions and ended up requiring assistance themselves.
7. Due to the lack of command and control, high profile structures were searched numerous times, while certain other structures were never searched.

The INSARAG Guidelines were established by Technical Experts in the field and are continuously reviewed and updated from lessons learnt during real disaster responses, as well as numerous exercises conducted worldwide. To participate in international USAR professionally and to form part of a solution and not the problem, organisations would do well to become part of the INSARAG system.

#### *The International Search and Rescue Advisory Group*

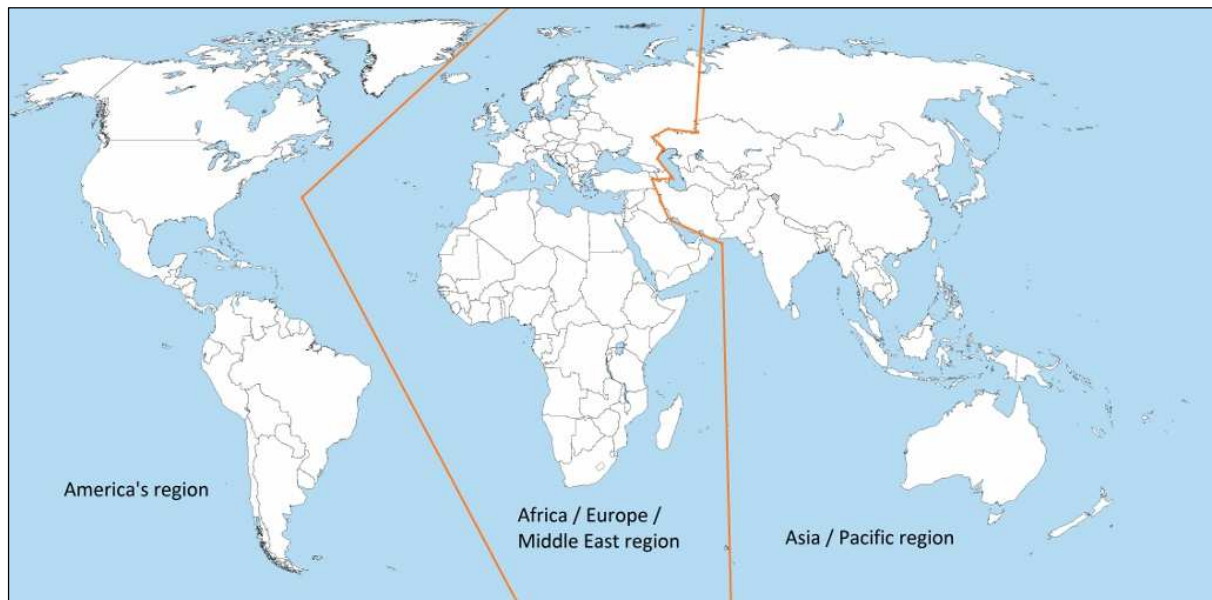
INSARAG is mandated to (INSARAG, 2014):

- Render emergency preparedness and response activities more effective and thereby save more lives, reduce suffering and minimise adverse consequences.
- Improve efficiency in cooperation among international USAR teams working in collapsed structures at a disaster site.
- Promote activities designed to improve search-and-rescue preparedness in disaster-prone countries, thereby prioritising developing countries.
- Develop internationally accepted procedures and systems for sustained cooperation between national USAR teams operating on the international scene.
- Develop USAR procedures, guidelines and best practices, and strengthen cooperation between interested organisations during the emergency relief phase.

The composition of INSARAG is as follows: a Steering Group, three Regional Groups (Africa-Europe-Middle East, Americas, and Asia- Pacific) and a Secretariat (which is seated in the UN OCHA Geneva). International USAR team leader conferences are hosted annually. These are complimented by ad-hoc groups working towards dealing with specialised issues (UN OCHA, 2012).

The primary function of the Steering Group is to determine the INSARAG policy. It comprises of delegates from the three Regional Groups, the chairpersons of the ad-hoc groups, the International Federation of Red Cross and Red Crescent Societies, and delegates from the OCHA in Geneva, as the INSARAG Secretariat. Annual meetings cover the definition of improved INSARAG strategy, the revision of recent accomplishments, and classification of areas for enhancement and improvement (UN OCHA, 2012).

Three Regional Groups are organised in such a manner as to better facilitate international involvement. The Regional Groups are Africa-Europe-Middle East, Americas, and Asia-Pacific. They have annual meetings with the specific agenda to discuss experiences from recent operations. They converse on concepts for enhanced collaboration and synergy amongst international response teams within the group. They are also to present recommendations regarding international matters to the Steering Group (UN OCHA, 2012).



*Figure 3: INSARAG Regional Groups*

To focus on developing solutions for specified problems, INSARAG has established ad-hoc working groups. Participation is encouraged amongst all members of INSARAG. Before being implemented, these solutions have to be revised by the Regional Groups, where after they need to be approved by the Steering Group (UN OCHA, 2012).

The Field Coordination Support Section (FCSS) within the Emergencies Services Branch (ESB) of OCHA Geneva functions as the INSARAG Secretariat (UN OCHA, 2012).

### *Areas of Concern*

Even though INSARAG creates the best policies and guidelines, some response teams that are not necessarily affiliated to INSARAG, but still responding to the disaster, are not compliant and as a result causes further distress to a country already under pressure, when arriving in the affected country. Problems that have reportedly occurred with teams after arriving in Port-Au-Prince with the Haiti Earthquake are the following (van Hoving, et al., 2010):

- Inadequate pre-departure medical checks, up to date documentation, vaccinations, and prophylaxis medication, which lead to many of responders being unfit to perform their duties.
- Key roles were not assigned to dedicated personnel, which lead to inefficiencies and time wasting.
- Inadequate arrangements regarding transportation to the affected country resulted in crucial equipment and supplies that had to be left behind, resulting in a team with only limited operational capacity.
- Lacking a formal pre-departure briefing left team members with many uncertainties as to what to expect and caused unnecessary stress. Some Standard Operating Procedures (SOP's) were also not discussed prior to departure.
- There was lacking adherence to International Guidelines regarding daily calorie requirements. This resulted in teams being prematurely exhausted and unable to successfully and effectively fulfil duties to the expected level. Local food supply is also very limited in these situations and may also be unsafe. This also adds extra strain to an already resource low environment.
- Poor choices with regards to adequate clothing considerations for the local conditions left team members susceptible to dehydration and other heat-related illnesses.

These are just a few of the areas of concern for a responding USAR team. These concerns are all a result of an inadequate mobilisation strategy and could have been avoided if the responding team had adhered to the INSARAG Guidelines, especially regarding mobilisation requirements.

## 2.3 A Structured Mobilisation Plan

### *Business Process Analysis*

Adherence to these guidelines are critical for successful mobilisation and avoiding errors that lead to inefficiencies and precious time going to waste. Taking care to include and consider every guideline will be the foundation of the mobilisation plan for an international USAR team.

To better understand the complexities of the mobilisation phase, as well as the interrelated responsibilities of each of the management positions, it would be helpful to firstly create a process map. Regardless of which of the many techniques one selects to utilise, the goal is to create a visual representation of the work process, which should serve as an aid to the analyst in understanding the current 'As-is' process. A sound process map will also aid in the identification of possible problems and also the identification of opportunities for process improvement. Further it will also garner a common understanding of the process as a whole and emphasise specific contributions and roles fulfilled by the process participants. If you cannot understand your process, you cannot improve it (Deas, 2009).

### *Common pitfalls of Process Mapping*

Process mapping is an analytical tool and the effectiveness thereof is determined by the correct selection, planning and execution of the technique. According to Pang, (2011) there are four common process mapping mistakes that negatively impact on identifying areas of improvement within the process (Pang, 2011).

The first mistake is that process mapping is applied to processes that are not suitable for mapping. It is important to note that most business processes can be distinguished by three main types of process: Transformational, Transactional and Decision-making processes. Transformational processes have to do with the physical transformation of the input into a desired shape or form, which is then received as the output. Manufacturing is a good example of this. Transactional processes have to do with the input interactions amongst the process contributors to achieve a specific goal. Call centres and sales support are generally good examples of a transactional process. Later it will also become apparent that the mobilisation process is a transactional process. Decision-making processes refer to the input interactions amongst the process contributors to make a decision, which could either be specific or open-ended (Pang, 2011).



Process mapping is usually more suited to transformational and transaction processes, which are more specifically defined and have more predictable outcomes. Decision-making processes are generally not suited for process mapping, especially high-level open-ended decision-making. This is mostly due to a large number of unknown factors and unspecified outcomes which could occur (Pang, 2011).

Secondly, when a clear focus for the process being mapped has not been established it will diminish the ability to identify problems and recognise improvement opportunities. It could also transpire that during a preliminary assessment a specific process is at fault, but the underlying problems will not be identified even in the most detailed process map (Pang, 2011).

Thirdly, improvement professionals sometimes forget the goal of improvement. The focus is so much on creating 'perfect' process maps to visualise the process, instead of capturing the essence of the process for improvement purposes (Pang, 2011).

Lastly, process mapping has difficulty capturing multiple responsibilities amongst different parties, especially when a leadership element is present. There are certain challenges in successfully representing these types of roles graphically and thus could be easily overlooked during the process analysis (Pang, 2011).

#### *Guidelines for successful Process Mapping*

Pang, (2011) also suggests some guidelines towards better process mapping practices. Firstly, analysts should determine clear objectives and goals for the improvement initiative. It is important at the beginning to understand the goals, objectives and requirements of the initiative. Furthermore the strengths, weaknesses and applicability of the different techniques should be understood to be able to select the best suited method. This will assist in identifying the areas in which process mapping will be the most appropriate method of improvement. It should also be identified whether process mapping can be used as a stand-alone tool or if it should be used in concurrence with other analysis techniques. To address the limitation of cross-party responsibilities, additional analytical tools, such as documentation analysis, should be implemented to assess and ascertain the details of the responsibilities to be able to allocate them to the specific process contributors (Pang, 2011).

The key to successful process mapping lies within the ability to select the appropriate techniques. The effectiveness of the initiative however lies within the planning and execution of the selected technique. It is therefore imperative that one understands the capabilities and limitations of the different techniques. The techniques that will be considered in this paper are the Integrated Definition for Function Modelling (IDEF), and Business Process Modelling Notation (BPMN). Other

techniques are not further researched as BPMN developers reviewed many other notations and methodologies, including: UML Activity Diagram, UML EDOC Business Processes, ebXML BPSS, Activity-Decision Flow (ADF) Diagram, RosettaNet, LOVeM, and Event-Process Chains (EPCs) (White, 2004).

### 2.3.1 Integrated Definition for Function Modelling

IDEF is in fact a family of methods that supports a paradigm capable of addressing the modelling needs of an enterprise and its business areas. IDEF originated in response to the establishment of Integrated Computer-Aided Manufacturing in mid-1970, when the need was identified to improve manufacturing operations within the US Army. The Structured Analysis and Design Technique (SADT) was selected to model activities, data and behavioural elements within the manufacturing operations. SADT is in fact not just a technique, but a complete methodology to analyse an enterprise. IDEF $\emptyset$ , IDEF1, IDEF1x, IDEF2, IDEF3, IDEF4 and IDEF5 are the most used members of the IDEF family. Each of these parts has a specific application, where IDEF $\emptyset$ : Function Modelling is one of the most useful in business mapping applications and will be further discussed (Aguilar-Savén, 2004).

IDEF $\emptyset$  is a graphical representation of the process at a high level and is used to specify functions of each activity. IDEF $\emptyset$  has three distinct components of information namely, the graphical diagram, text, and glossary. These components are cross-referenced to each other to create a complete representation. On the graphical diagrams, the high-level activities are depicted where the inputs, outputs, mechanisms and controls attributed to each of the major activities are captured. Lower-level activities can then be defined in the same manner for each of the high-level activities (IDEF, 2010).

IDEF $\emptyset$  is one of the most popular process mapping techniques available. Due to the hierarchical structure it is a tool that can be used with ease and mapping can be done quickly. The strict rules associated with IDEF $\emptyset$  make it simple to convert to a web-based application. A weakness of IDEF $\emptyset$  is the trend to be interpreted as a sequence of activities, rather than the interrelation between activities. Sequence can still be embedded within the diagram, as it is natural to connect the output of an activity to the input of the next activity when modelling from left to right. Another weakness of IDEF $\emptyset$  is the lack of role representation (Aguilar-Savén, 2004).

Successful disaster mobilisation hinges on the combined efforts of the management team to successfully execute their duties. The interaction between the different process contributors is of cardinal importance to achieve their specified output, which is the successful deployment of a

disaster response mission team. Considering the definition given by Pang, (2011) this is a transactional process. Due to the lack of role specification in IDEFØ, it will not be a suitable method to model the mobilisation phase, in support of generating a structured mobilisation plan.

### 2.3.2 Business Process Modelling Notation

Business Process Modelling Notation (BPMN) was released for the first time in May 2004, after more than two years of development by the Business Process Modelling Initiative Notation Working Group (White, 2004). Subsequently, version 2.0 has been released to the public in January 2011 (OMG, 2011). It is also sometimes commonly referred to as Swimlane-diagrams

This graphic flowchart-based notation has already gained wide-spread acceptance and aims to close the disparity between business analysts and IT technicians. One of the more profound capabilities of BPMN is that the elements, such as the processes, gateways, events and connectors conform to all the basic flow-charting standards of notations, but further offers more precise semantics regarding process flow control. By defining specified roles (also known as swimlanes), BPMN is able to model: (i) processes as private, for example internal to a department, (ii) public or more abstract processes and (iii) processes structured collaboratively in a global manner, all the while modelling at varying levels of granularity (Ko, et al., 2009).

One of the strengths of BPMN is the clear ability to define specified roles through the use of pools and swimlanes, which can be modelled at varying levels of granularity. This quality, for example, gives the business analyst free-range to be able to model processes within a certain department, across different departments within a company, as well as the interactions among companies in the value chain. Similar to IDEFØ, BPMN can also be translated into web-based code with relative ease (Ko, et al., 2009). One drawback experienced with BPMN is that to users unfamiliar with the notation, it could become quite a challenge to read and interpret the model. This could hamper the use of this modelling technique in industries not specifically inclined to apply process mapping methods for process improvement purposes.

The consolidation of best practices within BPMN by the Business Process Modelling Initiative, combined with the ability to define roles, makes BPMN a good method to model the mobilisation phase. BPMN is selected for exactly the reason that IDEFØ was rejected. BPMN can be successfully applied to model the interactions between the different process contributors, i.e. the management team, being able to collaborate their efforts towards the swift deployment of the disaster response mission team.

After the process contributors responsible for each activity in the mobilisation phase have been identified and their interactions with other contributors have been clearly defined by the use of BPMN, this information can be extracted to formulate the documented mobilisation plan.

The contributor's activities can be further detailed within the document, including allocated persons responsible, SOP's and checklists, thus not cluttering an already seemingly unintuitive model.

In terms of dealing with the readability of the model when considering the end-user, which is the management team, additional charts can be modelled as visual aids, determined by the needs of the management team. This should be done in a manner as to simplify the process and facilitate comprehension of the plan at a glance.

## 2.4 Urban Search and Rescue Capacity

USAR teams are structured according to the INSARAG Guidelines to promote ease of integration into the On-Site Operations Coordination Centre (OSOCC) on arrival, together with the United Nations Disaster Assessment- and Coordination Agency (UNDAC) and the already functioning USAR teams from other responding organisations. INSARAG has identified three tiers of classification for USAR teams. These are Light, Medium and Heavy (INSARAG, 2012):

1. Light USAR Teams have the operational capability to assist with surface search and rescue in the immediate aftermath of the disaster. Light USAR teams usually come from the affected country and neighbouring countries. It is normally not recommended that Light USAR teams deploy internationally to emergencies.
2. Medium USAR Teams have the operational capability for technical search and rescue operations in structural collapse incidents. Medium USAR teams are required to be able to search for entrapped persons. International Medium USAR teams travelling to an affected country should be operational in the affected country within 32 hours of the posting of the disaster on the Virtual OSOCC (VO). A medium team must be adequately staffed to allow for 24 hour operations at 1 site for up to 7 days.
3. Heavy USAR Teams have the operational capability for difficult and complex technical search and rescue operations. Heavy USAR teams are required to be able to search for entrapped persons using both canine and technical systems, and are envisaged for international assistance in disasters resulting in the collapse of multiple structures, typically found in urban settings, when national response capacity has either been overwhelmed or does not possess the required capability. International Heavy USAR teams travelling to an affected country should be operational in the affected country within 48 hours of the posting of the disaster on the VO. A heavy team must be adequately staffed to allow for 24 hour operations at 2 separate sites for up to 10 days.

Since Rescue South Africa is classified as a Medium USAR team, further literature will be focusing on the requirements of Medium USAR teams.

### *Team Composition*

INSARAG USAR teams are required to consist of five key components as listed in the adapted Table 1 (INSARAG, 2014). The suggested number of staff to be allocated to each component is also given in the last column. This will ensure that the team is able to perform search and rescue operations for 24 hours at a single site. Personnel working in two 12 hour shifts will ensure adequate rest time for the members to be able to perform their duties safely, effectively and continuously to an expected level for several days during their deployment.

Table 1: Suggested USAR Team Composition

Component	Role	Function	Suggested number
Management	Team Leader	Command	1
	Deputy Team Leader/Operations Officer	Coordination/Operational Control	1
	Planning Officer	Planning	1
	Liaison Officer/Deputy Liaison Officer	Liaison/Media/Reporting/RDC/OSOCC/USAR Operations Cell	1
	Structural Engineer	Structural Assessment/Analysis	1
	Safety Officer	Safety/Security	1
Search	Technical Search Specialist	Technical Search	2
	Search Dog Handler	Dog Search	2
	HAZMAT (Hazardous Materials)	HAZMAT Assessment	2
Rescue	Rescue Team Officer	Breaking/breaching/cutting/shoring/tactical rope	2 (2 teams, 1 team lead per team)
	Rescuer	Breaking/breaching/cutting/shoring/tactical rope	12 (2 teams comprising of 6 rescuers)
	Heavy Rigging Specialist	Lifting/Moving	2
Medical	Medical Team Manager (Medical Doctor)	Team Care (Personnel/search dogs)	1
	Paramedic/Nurse	Patient Care	3
Logistics	Logistics Team Manager	Base of Operations Management	1
	Logistics Specialist	Food and water supply/base camp operations/transport capacity/fuel supply	4
	Communications Specialist	Communications	1

Each member of the team should be highly trained in each of the specialised fields of USAR, and should be competent and capable to perform their duties for at least 10 days (which is the generally accepted deployment period), 24 hours per day (Rescue South Africa, 2013).

USAR teams are trained in a range of different capabilities, including but not limited to: High Angle 1, Motor Vehicle Rescue, Fire Search and Rescue, Urban Search and Rescue, Industrial and Agricultural Rescue, Hazardous Materials Rescue, Confined Space Rescue, Trench Rescue, Structural Collapse Rescue (High Angle 2) (Rescue South Africa, 2012). A full list of available courses, their structures and requisites are available on the Rescue South Africa website (Rescue South Africa, 2014).

### *Beyond the rubble*

The concept of 'Beyond the rubble' has also been introduced at a recent annual team leaders meeting. Essentially this means that once the chances of rescuing live victims has diminished, teams should look at what else they can do in order to assist the affected country (Rescue South Africa, 2013). As the major costs of deploying the team arise from transportation (Charter Flights), teams should be encouraged to stay for the full period of deployment and if necessary then consider sending in relief personnel. This has also brought on the development of team members which are multi-skilled, that have the capacity to operate within most team structures.

To illustrate this it would be appropriate to mention the most recent mission of RescueSA to the Philippines, responding to the chaos left in the aftermath of Typhoon Haiyan (Yolanda). On arrival the USAR team got to work on the primary function of fulfilling the basic requirements of an assisting country to the affected area. During the disaster a great deal of damage was done to the local hospital, which severely compromised local medical assistance. The RescueSA team assisted in structural repairs and also assisted in erecting the new roof for the hospital. After this was completed, the team completed four lifesaving surgeries and were able to treat approximately 800 patients affected by the disaster before returning home (Scher, 2014).

Due to this new concept and the further complexities that arise with disaster management, the selection of team capabilities and competencies has come into the spotlight and USAR teams will reap enormous benefits in selecting the best team comprising of the most applicable competencies. The applicability of these competencies will differ depending on the type of disaster, its magnitude and the amount of people affected. For example, urban structural collapse due to an earthquake or terrorist attack, such as 9-11, would require more Structural Collapse Rescue and Confined Space Rescue, whereas floods or a tsunami in a suburban or rural area (Boxing Day Tsunami) will require more medical proficiency on the team.

## 2.5 Response Team Composition

### *Team composition models*

Currently USAR technician skills are matched to different disaster scenarios by experienced management personnel of RescueSA, using previous response experience and their intuition to guide them in selecting technicians with the appropriate skills. Technicians are currently selected on an ad-hoc basis, depending on the availability of technicians from the various emergency ancillary services.

Although the first attempt at making new in-roads into local emergency response team composition in real-time in an optimal, or near optimal way was made by (Markov & Varone, 2013), limited literature still exists pertaining to disaster response teams, thus other team optimisation models could be studied and adapted as necessary.

Developing models for team compositions using fuzzy optimisation have been topics for research (Baykasoglua, et al., 2007), where a spectrum of human and nonhuman factors are accounted for. Because of the imprecise nature of these factors, a fuzzy approach is best suited to the problem. Budgetary and time constraints are also added to the model. A simulated annealing heuristic is then developed to adequately solve the fuzzy optimisation algorithm. They aimed to address a gap in the quantitative approach to team formation research through their proposed model, for which only a few articles are available.

Although the complexities of the work done in this model can be applauded, for the aim of this project it becomes too complex. This statement arises from the fact that Baykasoglua, et al. (2007) draws their candidates from a larger labour pool and qualities such as team member compatibility and interpersonal skills, such as personality preference, can be formulated into the model. Unfortunately, in the case of RescueSA, the labour pool is much smaller, because of the limited availability of competent USAR technicians in South Africa and the SADC, from which RescueSA may draw available technicians. Further, due to a heuristic that is needed to solve the fuzzy optimisation algorithm, it may take longer to solve, which is not ideal as time is a valuable asset during disaster response. An additional drawback is that the staff at RescueSA might not have the time or competency to understand, interpret and correct the model should a problem occur, thus the model should be kept as simple and as intuitive as possible.

Predecessors to the above mentioned work, an analytical approach to forming teams using methodologies based on the Analytical Hierarchy Process (AHP) and the Quality Function Deployment (QFD) method were also formulated (Zakarian & Kusiak, 1999).



According to Zakarian & Kusiak (1999), their paper is the first to suggest an analytical solution to team composition, despite the emphasised importance of correct team formation, in especially their field of study regarding Concurrent Engineering.

QFD, also known as “House of Quality” was first introduced in 1972 by Akao at Mitsubishi Industries Kobe shipyard. This concept is used in an attempt to reconcile the customers’ product requirements within the product development phase. The AHP is then used to link the appropriate team member which possesses the appropriate skills to the deliver the correct quality of the product as defined by the customer, which has been translated into the QFD. This ensures that the best team member with the most appropriate skills is selected for the specific team project (Zakarian & Kusiak, 1999).

Although this is a commendable first attempt at team composition using analytical methods, it lacks the sophistication to deliver fast results in an intuitive fashion that could realistically make a significant difference to the team selection methods of RescueSA.

Similar to this model a deterministic linear optimisation model has been formulated to headhunt or scout a new team in soccer and volleyball to enhance the quality of a team. Boon and Sierksma, (2003) aimed to form the optimal teams by combining the qualities of players with the functional requirements in order to assign the right person to the right position on the right team (Boon & Sierksma, 2003). This is the first analytical model found to utilise this approach for team composition.

In the case of soccer, the technical management is requested to compile a player-score table and a position-score table, as seen in figure 4. With the player-score table each player is evaluated against a predetermined set of the required skills for the team to succeed as a whole. Similarly in the position-score table the importance of each skill is determined for every position on the field. Last mentioned may reflect the team strategy that the coach would like to implement in the relevant game, thus a position-score table can be created and varied for each strategy the coach would like to implement. The selected ratings on each score table are then transformed into a list of weights, demonstrating how well suited each player is in each position.

These weights then become the input values for the model to calculate the highest total player-position weight. This is then presumed to be the ‘optimal team.’

The formulation of the model after the weighted player-position table is calculated is straight-forward.

### Player-score table

Nr.	Taak / Kwaliteit	Speler 1	Speler 2	Speler 3	Speler 4	Speler 5	Speler 6	Speler 7	Speler 8	Speler 9	Speler 10	Speler 11	Speler 12
1	Keepen	10	10	1	3	1	1	1	2	3	3	4	3
2	Coachen verdediging (achterste lijn)	8	8	6	4	6	7	8	6	8	6	7	6
3	Zorgen voor rust in spel	8	8	6	4	6	7	8	6	8	6	7	6
4	Passeren	2	4	2	2	2	2	2	4	3	4	5	7
5	Rugslakking geven	8	8	8	8	8	8	8	8	8	7	8	6
6	Altijd aanseelbaar zijn	7	7	6	6	6	6	6	6	7	7	7	7
7	Vorm	8	7	6	5	6	5	7	6	8	8	7	7
8	Oog voor de diepte	7	7	7	7	7	7	8	7	8	8	8	8
9	Uitschakelen (schakelen) spitsen tegenstander	7	7	7	8	8	8	8	9	8	7	6	5
10	Verd. storen/ophouden directe tegenstander	9	9	7	8	8	8	8	8	8	7	7	6
11	Snelle spelvervalting diep ingaan	2	2	3	2	2	2	2	5	3	5	4	7
12	Driehoekjes kunnen maken / bal rondspelen	3	3	4	5	5	5	4	5	4	7	7	6
13	Aanpakken met bal (balbezit en balverlies)	2	2	4	4	5	4	5	4	7	7	8	7
14	Snel schakelen balbezit naar balverlies	7	7	6	6	6	6	6	6	7	7	6	6
15	Snel schakelen balverlies naar balbezit	7	7	7	7	7	7	7	7	8	7	8	7
16	Initiatief tonen	6	6	7	6	6	6	6	6	7	6	7	7
17	Ruimte maken met en zonder de bal	2	2	5	5	5	5	5	6	5	6	6	6
18	Vast bewegen t.o.v. (andere) spits	2	2	3	3	3	3	3	3	4	4	4	7
19	Voorzet / shering	3	3	5	4	4	4	4	5	4	6	6	7
20	Bal oememen van tegenstander	8	8	8	8	9	9	9	9	9	7	7	6
21	Scoren	0	0	3	4	4	4	5	7	5	7	5	7
22	Laten scoren	1	1	2	2	2	2	2	5	3	7	6	7
23	Druk uitloef op keeper tegenstander/kippen	0	0	0	0	0	0	0	1	0	3	2	6
24	Coachen aangel (voorst. lijn)	2	2	3	3	3	3	3	3	4	7	7	6
25	Passen kort (precisie)	7	7	8	8	8	8	8	8	8	8	8	8
26	Passen lang (precisie)	8	8	8	5	6	7	5	7	7	8	8	6
27	Dribbelen / techniek	1	2	4	3	4	4	4	4	4	5	5	7
28	Aan - en meenemen	4	4	5	5	5	5	6	7	7	7	8	8
29	Aanvallend koppen	1	1	2	2	5	5	6	7	7	8	7	7
30	Verdedgend koppen	2	3	3	5	8	8	7	8	8	6	5	5
31	Duel 1 op 1	9	7	7	6	7	7	7	7	8	6	6	6
32	Uithoudingsvermogen	5	8	8	7	7	7	7	8	7	8	7	8
33	Agressie / Blessure bestendigheid	8	8	7	6	7	7	7	8	7	7	8	7
34	Kracht	8	8	8	8	7	8	7	8	8	7	8	7
35	Snelheid	4	6	8	6	6	6	6	8	7	7	7	6
36	Incasseringsvermogen	8	9	7	6	7	7	7	8	7	7	7	7
37	Zakvertrouwen	9	8	7	6	6	7	7	7	8	8	8	7
38	Wiskunst	8	8	8	8	7	7	7	8	8	8	9	7
39	Concentratie	9	8	7	7	7	7	7	8	8	8	8	6
40	Persoonlijkheid / Uitstraling	9	7	7	6	7	7	7	7	7	7	5	5
41	Overschot	7	7	6	6	6	6	6	7	7	8	7	7
42	Positie kiezen t.o.v. de bal	9	8	7	6	6	6	7	5	7	7	8	7
43	Coördinatie	6	7	8	7	6	6	6	7	6	6	7	6
44	Rechtsbenig	8	8	8	6	6	6	6	7	5	8	7	6
45	Linksbenig	5	6	6	4	5	8	5	8	5	9	7	7
46	Envering	8	8	6	6	6	7	7	7	7	7	6	6
47	Publiekwaarde	9	7	7	6	6	6	6	6	7	7	7	4
48	Ploegdiscipline	9	9	7	7	6	6	6	6	8	8	8	7
49	Balvastheid	9	8	8	5	5	6	5	6	7	7	7	7

### Position-score table

Nr.	Taak / Kwaliteit	Keeper	Rechter Vuurk. Verded.	Centrale Verdediger	Linker Vuurk. Verded.	Rechts Aanv.	Midden Aanv.	Links Aanv.	Centrale Spits	Links Spits	Rechts Spits	
1	Keepen	10	2	2	1	2	1	2	1	0	0	0
2	Coachen verdediging (achterste lijn)	8	8	8	8	8	2	2	2	2	1	1
3	Zorgen voor rust in spel	8	7	8	8	7	8	7	8	7	8	6
4	Passeren	2	4	2	2	2	2	4	3	4	5	7
5	Rugslakking geven	8	8	8	8	8	8	8	8	7	8	6
6	Altijd aanseelbaar zijn	7	7	6	6	6	6	6	6	7	7	7
7	Vorm	8	7	6	5	6	5	7	6	8	8	7
8	Oog voor de diepte	7	7	7	7	7	7	8	7	8	8	8
9	Uitschakelen (schakelen) spitsen tegenstander	7	7	7	8	8	8	8	9	8	7	6
10	Verd. storen/ophouden directe tegenstander	9	9	7	8	8	8	8	8	8	7	6
11	Snelle spelvervalting diep ingaan	2	2	3	2	2	2	2	5	3	5	4
12	Driehoekjes kunnen maken / bal rondspelen	3	3	4	5	5	5	4	5	4	6	6
13	Aanpakken met bal (balbezit en balverlies)	2	2	4	4	5	4	5	4	7	7	8
14	Snel schakelen balbezit naar balverlies	7	7	6	6	6	6	6	6	7	7	6
15	Snel schakelen balverlies naar balbezit	7	7	7	7	7	7	7	7	8	7	8
16	Initiatief tonen	6	6	7	6	6	6	6	6	7	6	7
17	Ruimte maken met en zonder de bal	2	2	5	5	5	5	5	6	5	6	6
18	Vast bewegen t.o.v. (andere) spits	2	2	3	3	3	3	3	3	4	4	7
19	Voorzet / shering	3	3	5	4	4	4	4	5	4	6	6
20	Bal oememen van tegenstander	8	8	8	8	9	9	9	9	7	7	6
21	Scoren	0	0	3	4	4	4	5	7	5	7	5
22	Laten scoren	1	1	2	2	2	2	2	5	3	7	6
23	Druk uitloef op keeper tegenstander/kippen	0	0	0	0	0	0	1	0	3	2	6
24	Coachen aangel (voorst. lijn)	2	2	3	3	3	3	3	3	4	7	7
25	Passen kort (precisie)	7	7	8	8	8	8	8	8	8	8	8
26	Passen lang (precisie)	8	8	8	5	6	7	5	7	7	8	8
27	Dribbelen / techniek	1	2	4	3	4	4	4	4	4	5	5
28	Aan - en meenemen	4	4	5	5	5	5	6	7	7	7	8
29	Aanvallend koppen	1	1	2	2	5	5	6	7	7	8	7
30	Verdedgend koppen	2	3	3	5	8	8	7	8	8	6	5
31	Duel 1 op 1	9	7	7	6	7	7	7	7	8	6	6
32	Uithoudingsvermogen	5	8	8	7	7	7	7	8	7	8	7
33	Agressie / Blessure bestendigheid	8	8	7	6	7	7	7	8	7	7	8
34	Kracht	8	8	8	8	7	8	7	8	8	7	8
35	Snelheid	4	6	8	6	6	6	6	8	7	7	6
36	Incasseringsvermogen	8	9	7	6	7	7	7	8	7	7	7
37	Zakvertrouwen	9	8	7	6	6	7	7	7	8	8	7
38	Wiskunst	8	8	8	8	7	7	7	8	8	8	9
39	Concentratie	9	8	7	7	7	7	7	8	8	8	6
40	Persoonlijkheid / Uitstraling	9	7	7	6	7	7	7	7	7	5	5
41	Overschot	7	7	6	6	6	6	6	7	7	8	7
42	Positie kiezen t.o.v. de bal	9	8	7	6	6	6	7	5	7	7	8
43	Coördinatie	6	7	8	7	6	6	6	7	6	6	7
44	Rechtsbenig	8	8	8	6	6	6	6	7	5	8	7
45	Linksbenig	5	6	6	4	5	8	5	8	5	9	7
46	Envering	8	8	6	6	6	7	7	7	7	7	6
47	Publiekwaarde	9	7	7	6	6	6	6	6	7	7	4
48	Ploegdiscipline	9	9	7	7	6	6	6	6	8	8	7
49	Balvastheid	9	8	8	5	5	6	5	6	7	7	7

Figure 4: Examples of a Player-score table and a Position-score table for soccer. (Boon & Sierksma, 2003)

When formulating the model let:

I be the set of the total number available players, where  $i \in I = \{1, \dots, m\}$ , where m is the maximum

J be the set of the total amount of positions, where  $j \in J = \{1, \dots, n\}$ , where n is the maximum

*\*When considering soccer  $n = 11$ .*

$w_{ij} \triangleq$  weighted player-position score

$$x_{ij} \triangleq \begin{cases} 1 & \text{if player } i \text{ is selected for position } j, \quad i \in I, j \in J \\ 0 & \text{otherwise} \end{cases}$$

The optimization function will be to maximise:

$$\sum_{i=1}^m \sum_{j=1}^n w_{ij} x_{ij} \quad (1)$$

Subject to:

$$\sum_{j=1}^n x_{ij} \leq 1, \forall i \in I \quad (2)$$

$$\sum_{i=1}^m x_{ij} \leq 1, \forall j \in J \quad (3)$$

$$x_{ij} \in \{0,1\} \forall i \in I, j \in J$$

The maximising function selects from all the possible combinations the players which lead to the highest weighted player-position score (1). The first constraint ensures that each player is assigned to only one position (2). The second constraint ensures that only one player is assigned to each position (3).

#### *A Disaster Management Team Composition Model*

The last mentioned approach could be modified to model disaster response team requirements. For disaster management the player-score table could be converted to a volunteer-score table, measuring their USAR skills, and the position-score table to a scenario-score table to determine the

skills required to respond to the disaster. Through the formulation of the response team composition model with this approach will ensure that the most competent members for a specific scenario will be selected. The volunteer-score table that will be developed to be easily updatable as the USAR technicians and management receive further qualifications and experiences. Furthermore, as many different scenario-score tables can be developed as management deems necessary. New scenarios can then also be added as the field of disaster management develops.

It is well noted that this approach is dwarfed by more recent developments in team composition research. To motivate the use of this older method it is important to mention that most of the more recent operations research models have a tendency to over-complicate the model with formulations which are not relevant to the particular application, and which without the model is compromised. Further, this approach is well suited to the needs of RescueSA. It presents the user with a list of candidates which can be easily updated and the model reiterated. Despite its age, and apparent simplicity this approach is none the less effective and efficient in executing the task for which it was designed.

Analytical models allow team management officers to substantiate their judgement based on their experiences in a more transparent and logical manner, rather than just having to rely on their intuition. This leads to a higher professionalism in decision making, getting 'more' out of the money spent when sending a team and ultimately to better performance in the field when deployed. It is important to note that all USAR technicians are trained in all 12 USAR modules, but levels of performance in each module may vary. This could also lead to USAR technicians working harder at their qualifications, as they will now be able to measure themselves against other USAR technicians also contending for a much sought after position on the next disaster mission. Ultimately, this could result in a higher standard of USAR technician being deployed.

## 2.6 Concluding Remarks

Meticulous care has been taken to create context for the field of disaster management. Disaster response as the primary area of operations is also further discussed. Section 2.3 highlights the importance of satisfactory mobilisation and applicable business process mapping techniques are studied. Section 2.4 aims to create context for the importance of USAR capacity, followed by an investigation in search of an adequate team composition approach.

## Chapter 3

### The Structured Mobilisation Plan

#### 3.1 Mobilisation in Concept

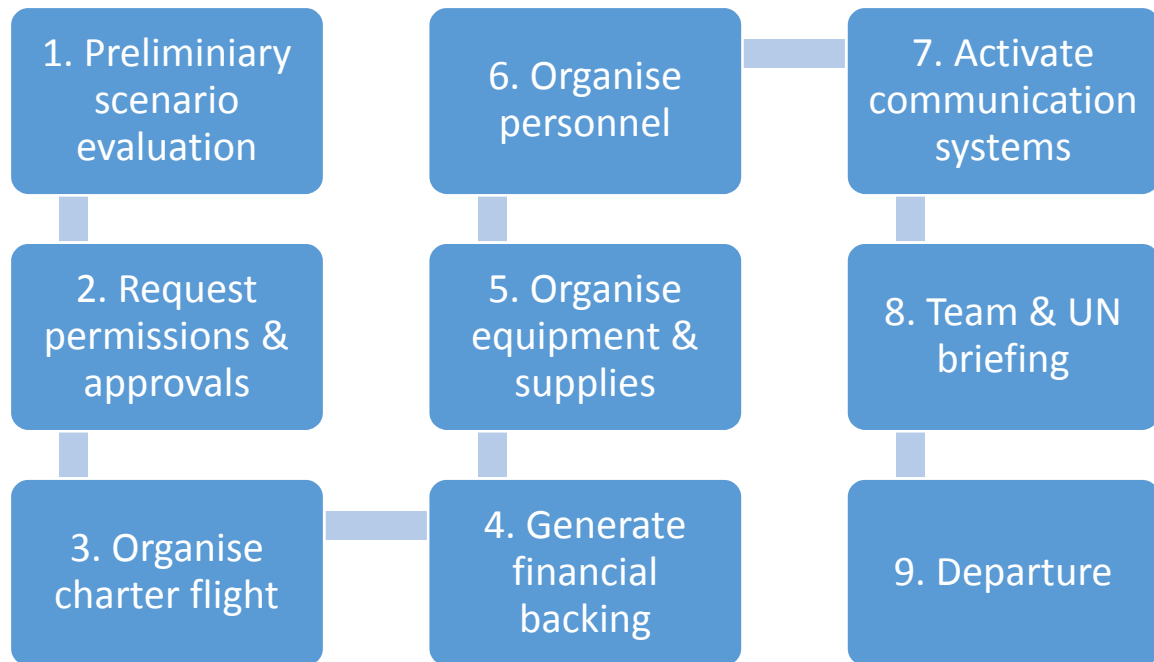
To comprehend the complexities and intricacies of the actions that need to be taken in the couple of hours between that critical moment when disaster strikes, until an International Urban Search and Rescue team boards the aircraft to the affected country, is no mean feat. The decisions taken during this phase will play an enormous role in determining the success of a mission. The success of a mission not only impacts on the recovery of an affected country, but also affects the diplomatic ties between affected and assisting countries, which has a far reaching effect.

“Everything should be as simple as possible, but not simpler” – Einstein (Sessions, 1950). This section will aim to simply explain this process, firstly through a detailed explanation of the process and accompanying Business Process Mapping Notation models, illustrating the process flow. Further, it will provide a backbone for the development of the Mobilisation Plan document through a preliminary structure adapted from Emergency Management Australia (Emergency Management Australia, 2004). Upon completion this document will then also serve as a reference tool for the BPMN model. This document will serve as a legacy plan for the future management of Rescue South Africa, for them to continue to build on the lessons that the establishing members of RescueSA have now learnt through ‘trial-and-terror’.

All of this should be done in the simplest terms, with a logical flow up to the point where the process becomes intuitive, coining the phrase of being Africanised. At all times keeping in mind that all International Search and Rescue Advisory Group Guidelines are adhered to.

To ensure that the wheel is not reinvented, but also to keep this mobilisation process in line with the world leaders of USAR, the creation process of the RescueSA Mobilisation Manual will be using the Fairfax County (VA-TF1, 2008), as well as the Michigan Urban Search and Rescue Task Force Mobilisation Manuals (MI-TF1, 2008) as a guideline. Although the abovementioned Task Forces mobilisation plans are more mature and structured, the basic principles remain and a great deal can be learnt. Furthermore, in-depth interviews will be held with the current management team to ensure that their experienced based knowledge is captured, their individual needs are addressed and that the Mobilisation Manual is completely compatible with their current operations.

A simplified version of the process from management’s perspective is presented in figure 5 and briefly discussed to create background to the mobilisation phase description and accompanying BPMN phase models presented in the section hereafter.



*Figure 5: Simplified mobilisation process from managerial perspective*

1. After information has been made available and the UN has played their initial role during Phase 0, the role of the Management contingent starts in Phase 1: “Feasibility and assembling a ‘Shadow team’”. The phase starts by management doing a preliminary scenario evaluation based upon the relayed information.

2. Permissions and approvals are requested from the relevant embassy of the affected country, as well as the Department of International Relations and Cooperation, to ensure all applicable diplomatic aspects have been addressed.

3. By calling upon the Memorandum of Understanding with the Charter Company, the flight plan is set in motion.

4. The Financial Manager calls upon DIRCO, existing corporate relationships, other identified corporates and especially the public to obtain financial backing for the mission. This is crucial as the total bill for a mission comfortably settles in the millions.

5. The Equipment and Supply department is called upon to select the correct equipment to successfully respond to the disaster. A preliminary list of additional supplies is also readied.
6. The Personnel manager has to identify the best candidates for the scenario, inform them of the situation and establish availability. (Steps 4 – 6 happen co-currently)
7. Phase 2: Activation after all approvals have been received, all arrangements are confirmed and finalised. Additionally the communication systems, such as the Satellite phones are activated.
8. Management oversees the final team briefing in Phase 3: Departure. This is to ensure that every aspect of the mobilisation phase has been addressed and that the team is aware of the expectations of the mission. A last post is also made to the VO to update the UN of the imminent arrival.
9. The disaster mission response team is now ready to depart to the affected country.

### 3.1.1 The Mobilisation Process

The Disaster management industry constantly finds itself within the Recovery, Mitigation or Preparedness phases. Response is activated as soon as the disaster strikes, and concurrently Mobilisation, starting with Phase 0, so called because the mobilisation of a response team only truly commences when the management team of a mission response team initiates their processes. The Mobilisation Process is broken down into a further four phases to enable an intuitive description of process. Each section hereafter contains a BPMN Phase model, starting with Figure 6, illustrating Phase 0. Annexure B contains the full BPMN model.

#### 3.1.1.1 Phase 0: Advisory Response Mobilisation

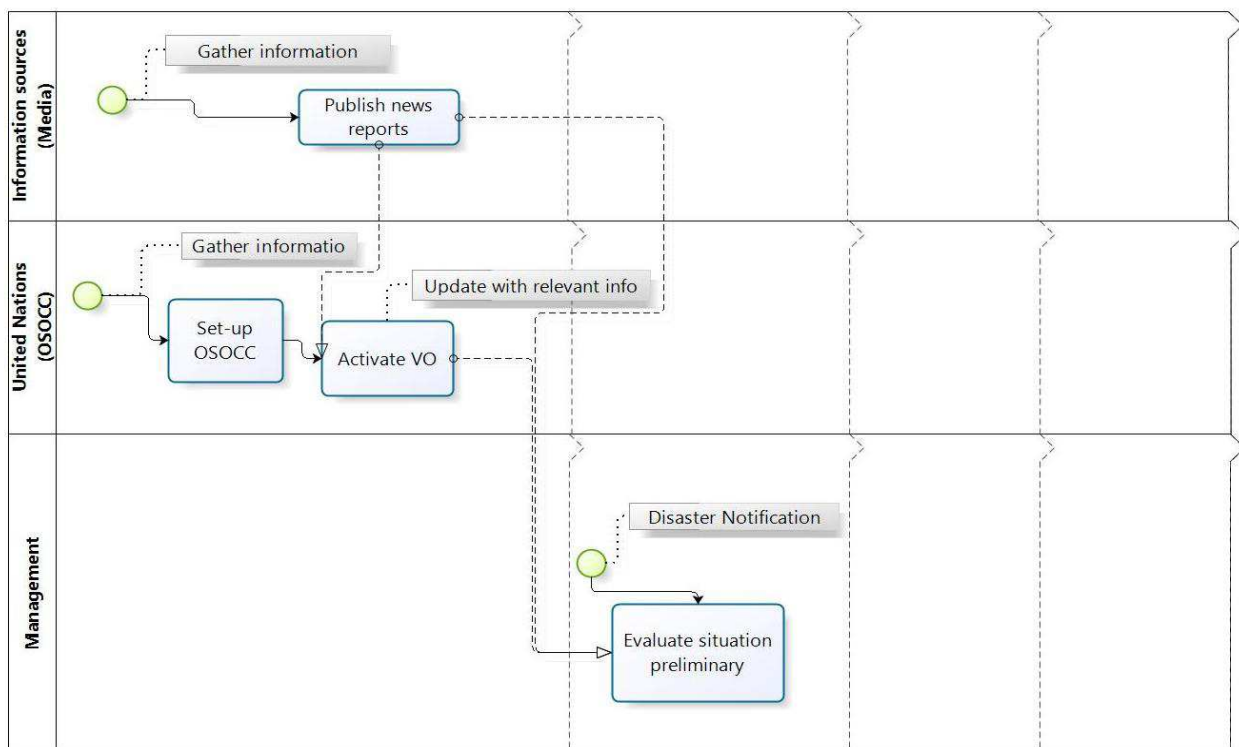


Figure 6: Phase 0: Response Mobilisation

The United Nations Disaster Assessment and Coordination Agency and the Local Emergency Management Agency of the affected country start monitoring and assessing the situation. They will establish a Reception and Departure Centre and On-Site Operations Coordination Centre. Relevant information is posted on the Virtual On-Site Operations Coordination Centre as it becomes available. Detailed information posted on the VO is only accessible to USAR teams registered with INSARAG that have the required log in details. The affected country, together with the UN, here has the opportunity to call for international assistance if they deem it necessary.



### 3.1.1.2 Phase 1: Feasibility and assembling a ‘Shadow team.’

As soon as the management of RescueSA become aware of the situation, it is constantly monitored through information posted on the VO, news reports and dedicated news channels such as SkyNews, CNN and BBC. This is the point where the Mobilisation Process enters Phase 1, as successfully illustrated in Figure 7. If a call for international assistance has not yet been issued, but RescueSA’s evaluation through available information leads them to believe international assistance is required, they will contact the relevant embassy. The ambassador will be informed of the offer for assistance and all relevant information to prove the professionalism of RescueSA operations. The ambassador will then contact the relevant disaster management staffing at what is known as ‘the Desk’ in the affected country and organise the necessary ‘Go ahead’ for RescueSA. The approval from the affected country becomes crucial to expedite visas and customs processing, usually done under the Oslo Guidelines (UN OCHA, 2006). If a call for international assistance has been issued, RescueSA needs to communicate their intent to assist on the VO. If the affected country is aware of the imminent response the necessary measures can be taken to receive the teams accordingly so that they can commence with USAR operations as soon as possible.

All of RescueSA’s international operations are done under the South African flag. For this to happen the relevant staff member at the South African Department for International Relations and Cooperation (DIRCO) is also contacted. This is usually the Director-General (DG) or Deputy DG. The DG is then informed of RescueSA’s intent to respond and government approval and support is sought. Though support in terms of monetary assistance is important, it is crucial that a letter needs to be issued to the relevant City Councils and Metropolitans to make their staff available to RescueSA. This is due to the fact that RescueSA is a NGO and does not have the authority to issue a request to draw the volunteers from their full-time service in the ancillary services of the metropolitans. Thus, without the letter from DIRCO, RescueSA will not be able to assemble a response unit. DIRCO also play a role to expedite the visas and customs procedures.

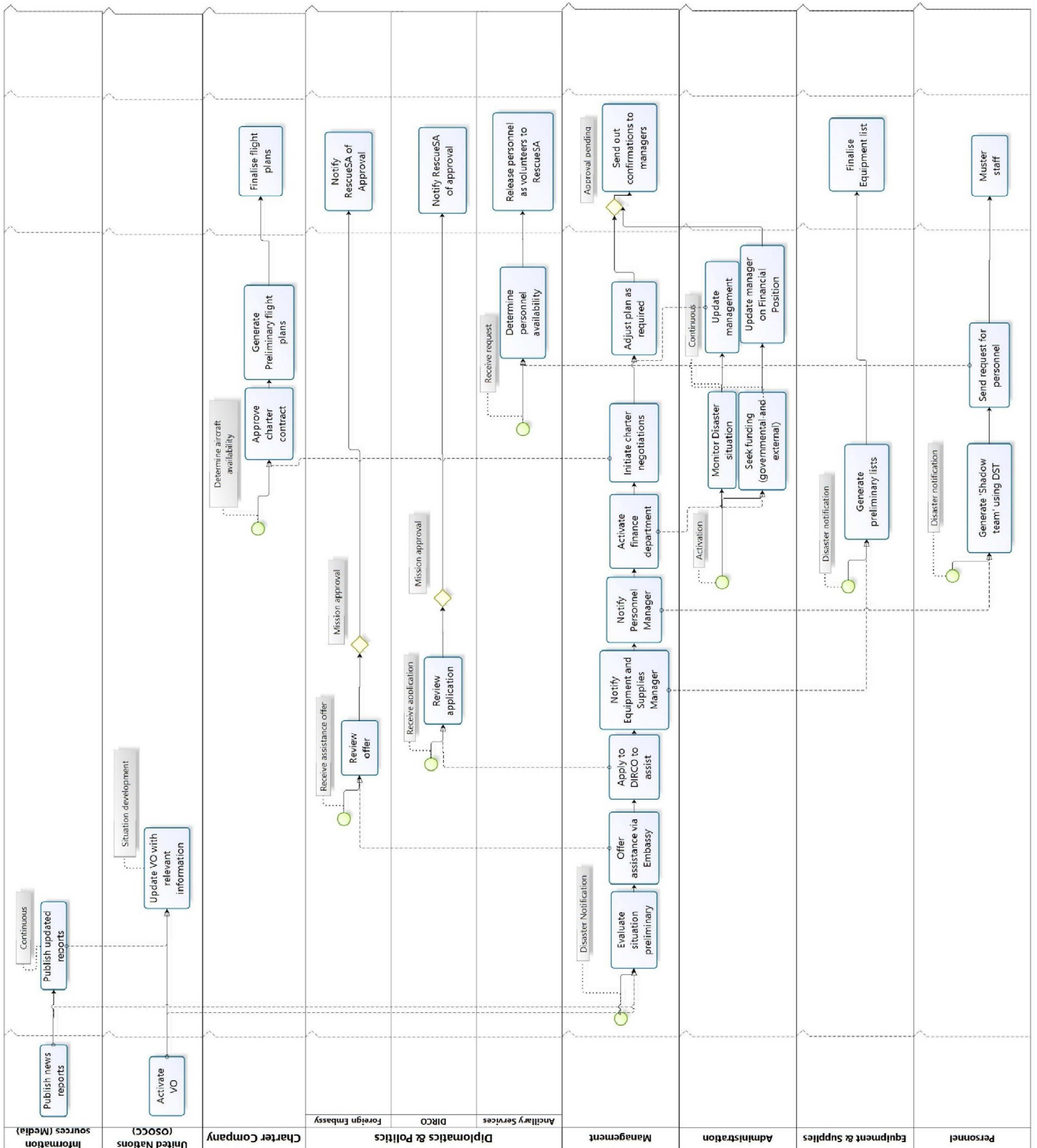


Figure 7: Phase 1: Feasibility and assembling a 'Shadow team'

During this phase management also has to start drawing up a preliminary Mission Team Structure. The USAR technicians, their employers (be it the City Council or a Medical Service Provider) and other independent members that usually make up the backbone of the response team, such as the structural engineers, medical managers and communication specialists need to be contacted, their availability confirmed and be put on stand-by. Based on the preliminary assessment and evaluation of the scenario, USAR technicians with the best relevant skills will be contacted first.

The equipment cache has to be prepared, with the relevant equipment and supplies being identified and made easily accessible. Logistic arrangements also need to be put in place to transport the equipment from the cache to the airport, which will be either OR Tambo International Airport or Waterkloof Air Force Base.

Furthermore, an aircraft has to be chartered. This aircraft should have the capacity to accommodate all of the critical equipment and staff of RescueSA. Pilots should be arranged, flight plans drawn up and customs documentation has to be prepared. Depending on the size of the aircraft, the equipment cache will be adjusted to suit the aircraft carrying capacity.

Most importantly donations have to be sought to finance the mission. Most of the time the aircraft charter company will only agree to the charter agreement once a certain amount of the total cost can be paid. DIRCO is also cautious of approving a mission before necessary funds are available. It is up to the management of RescueSA to decide how much of the total cost they want covered before leaving. The money does not have to physically be deposited to RescueSA, as long as there are formal written promises.

All of the above mentioned takes place for RescueSA to position themselves to immediately react when all of the approvals come through, ergo all of the above mentioned takes place without any guarantee of the mission taking off.

The scenario is monitored throughout and the plans are adjusted as deemed necessary by management. Donations are continuously sought through press releases, dedicated SMS-lines, and social media pages, such as Facebook and Twitter, which are created and run to gain public support for the mission. These activities are done continuously throughout the response phase by the support staff.

### 3.1.1.3 Phase 2: Activation

In principle, all necessary approvals and permissions have been granted. Mission has been approved at all levels. It is up to the discretion of RescueSA if they are to continue with the mobilisation process if approvals are still pending, but imminent. Figure 8 illustrates Phase 2.

Aircraft charter and all the relevant arrangement are confirmed and the agreed upon cash amount is transferred.

The staff is mustered at the predetermined rendezvous point with all of their personal kit. This will include all management staff, the selected USAR technicians, medical personnel, independents, communication specialists, media contingent, K9 units, and interpreters, if they are included for the operations. Here all relevant administration will be handled. This includes, but is not limited to, personal identification documentation, spousal information and medical information. Medical check-ups are also performed on all members of the response team including the media, vaccinations/inoculations are updated and, if necessary, prophylactics are issued. A preliminary team briefing is done covering scenario information, weather conditions, cultural aspects, the mission team structure, task allocation and the INSARAG Code of Ethics is reinforced.

Management is also required to make a posting on the VO to communicate their preliminary travel arrangements, their transportation needs on arrival and the capacity and competency of the team they can expect to receive. Satellite phones are also activated at this stage.

Simultaneously the equipment cache for the mission is finalised, inventoried, palletised and loaded for transport. Bottled water, food and other consumables are acquired. All this is done according to the carrying capacity of the aircraft.

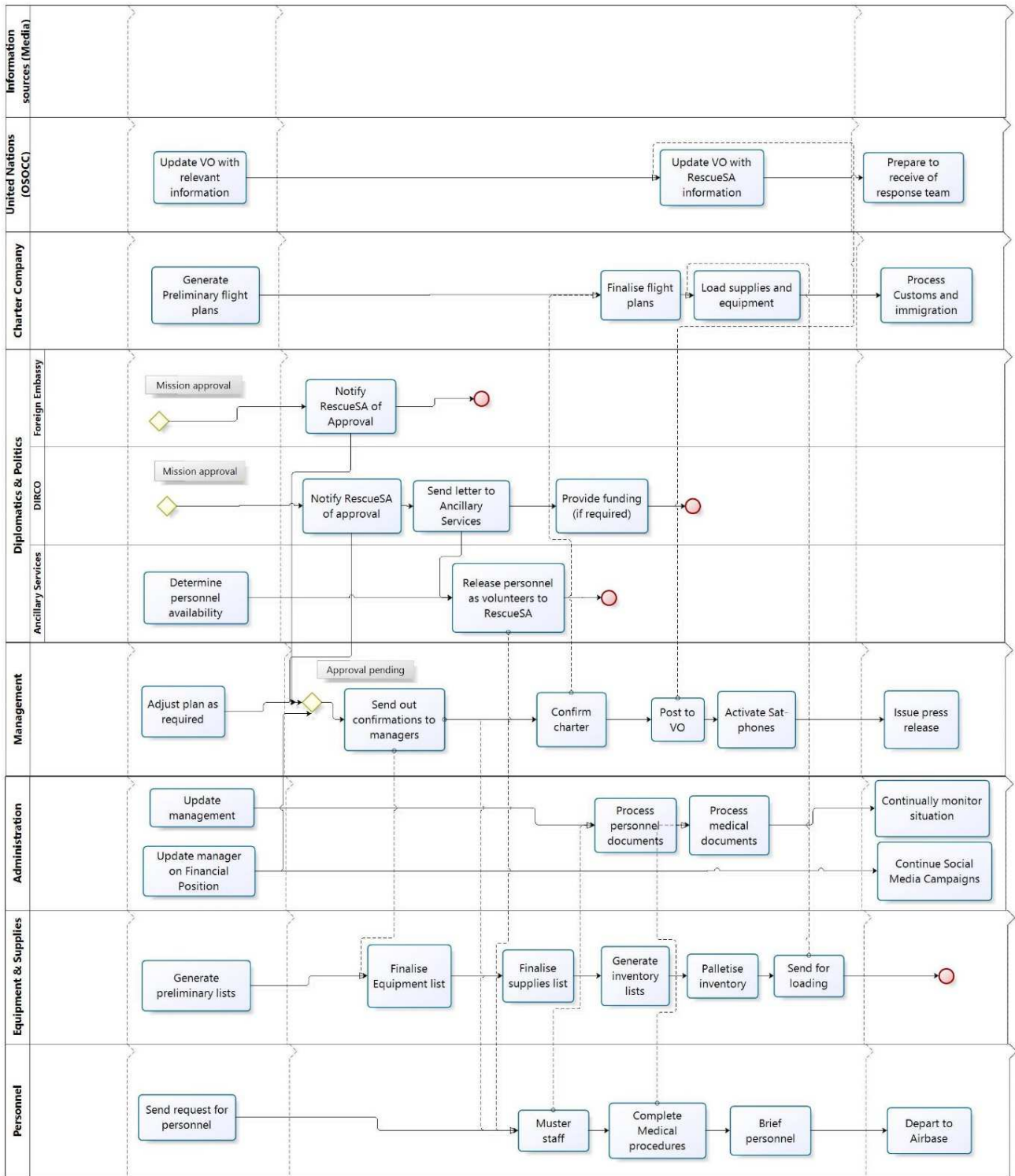


Figure 8: Phase 2: Activation

### 3.1.1.4 Phase 3: Departure

The entire inventory is transported to the relevant airport and goes through the expedited customs processing, together with the entire mission response team. Just before departure press releases are issued, another update to the VO is posted to communicate the final itinerary and a final team briefing is done. The team can now depart. Figure 9 contains this BPMN Phase model.

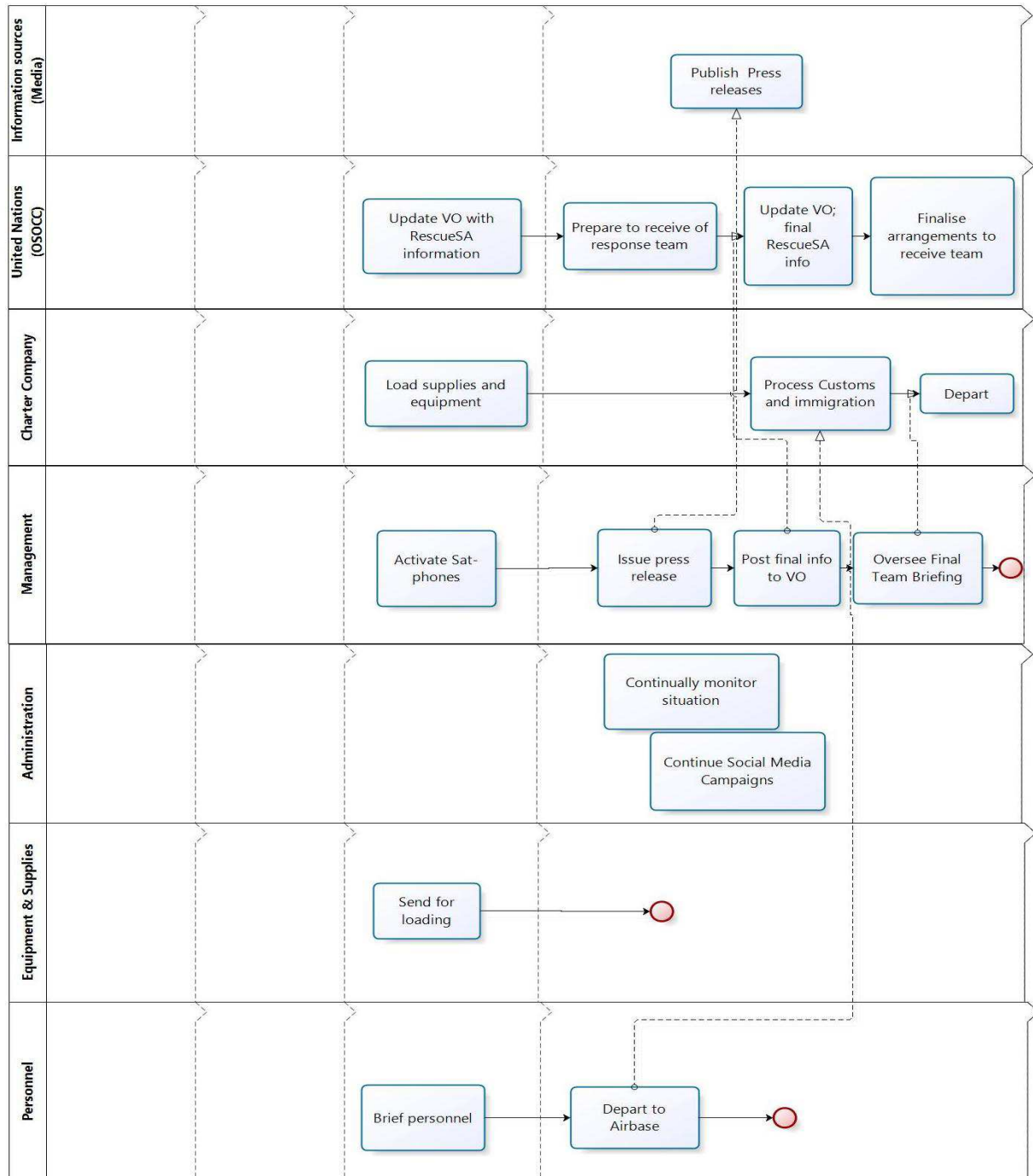


Figure 9: Phase 3: Departure

### 3.2. The Mobilisation Manual

By using the information available it will now be possible to formulate a document to supplement the BPMN model. With each role player's activities clearly allocated, it becomes a simple task of attributing the responsibilities to a member of the management team. The sequence of events for each member of management is now also clearly defined.

Each process can now be further investigated to determine which supplementary resources and information will be needed to enable the responsible member of management to successfully complete the activity. All of the supplementary aids can then be listed, made available in the documentation or at the very least furnish the responsible member with information on how or where to attain the resource. This could include important documentation templates, checklists, relevant contact details and inventory lists.

During the development of this manual it is inherently assumed the assigned management team have the ability to analyse the operational requirements arising from the scenario and to determine the requisite team capabilities needed. These capabilities include not only selecting the correct volunteers from the available pool, but also ensuring that the correct equipment is selected, the correct supplies, and the correct amount of supplies are sourced.

Prior to determining the operational requirements of the scenario, the management team should apply their experience and knowledge to the available incoming information from the various news sources and over the VO to firstly make the crucial decision whether or not the mobilisation of the USAR mission team is in fact a feasible option.

The rest of this section contains the layout of the Mobilisation Manual, including an explanation of each of the manual section headings, which attempts to create a brief overview of the information contained within the Manual.

# RESCUE SOUTH AFRICA: MOBILISATION MANUAL FOR INTERNATIONAL RESPONSE

## 1. Introduction

### 1.1 Authority

A declaration is made by the author of the Mobilisation Plan, in which capacity the author has performed these duties, and for which company this document has been prepared. In addition, guidelines for the amendment of the document are stated.

### 1.2 Aim

This is a clear and concise statement, broadly outlining the objectives of the document. The aim provides the mission statement, which is to be followed for successful application of the manual.

### 1.3 Scope

The statement of the scope gives the user a clear indication of what content can be expected in the manual. It includes a description for the type of disaster response and the conditions for mobilisation. Limitations of the manual are also stated here.



## 2. Management structure

### 2.1 Command, control and coordination

The complete Chain-of-Command during disaster response is stated under this heading. This provides clarity on the roles of each of the mobilisation management team positions, who is accountable to whom, and to which extent. Furthermore it gives an indication of the level of authority each of the mobilisation management team members have. Lastly, it provides guidelines with regards to the level of coordination amongst the different positions.

### 2.2 Communications

This section provides a clearer indication of the cross-swim lane communications, as found in the BPMN. It aims to highlight all channels of communications, the flow of information, and the role players needed to successfully complete the objectives for each of the processes found within the BPMN.

### 2.3 Stakeholders

For each of the stakeholders mention hereafter, a complete guide to the level of coordination and cooperation which is expected from each of the stakeholders for a successful response mobilisation is found. This serves as a guide to the user to ensure that all of the necessary administration, documentation and relevant diplomatic endeavours are successfully undertaken, which will lead to a speedy and efficient mobilisation phase.

#### 2.3.1 Embassy

This section pertains to the embassy of the country/countries affected by the disaster being responded to. Although regulations may differ amongst countries, there are still generic guidelines to which these affairs are to be handled.

#### 2.3.2 DIRCO

The Department for International Relations and Coordination play an integral role for the successful deployment of a response team. It should be absolutely clear who is responsible for which parts of the process for obtaining the approval of DIRCO for the intended response mission. Furthermore, the specific approval procedures are documented, as well as further expectations extending that of the approval, such as funding.

### *2.3.3 Rescue SA*

A full list of managerial responsibilities, including the procedures to successfully gain full approval for a response mission, is listed and integrated with the above-mentioned stakeholders. This includes the internal housekeeping and external communications and expectations from the management contingent.

### *2.4 Response responsibilities by organisation*

RescueSA only possess the core of the response mobilisation, and to be successful in a full disaster response mobilisation deployment RescueSA relies on many other organisations. This section contains the expected responsibilities of all affiliated organisations and independent role-players. RescueSA's responsibilities towards these organisations and independent role-players are also discussed. Guidelines for communication and coordination for mobilisation are briefly stated here.

### 3. Management systems for response

Systems for managing the topics of each of the sub sections hereafter mentioned will be described in order to ensure a complete understanding of each, and the role of each of the units in the successful deployment of the response team. The responsible member of the managerial team will be appointed to each, and their duties regarding each unit will be clearly and concisely stated.

#### 3.1 Information management

This section pertains to information relating to the disaster that is valuable for the mobilisation effort. Information such as the type of event, location, magnitude, current situation, damage assessment and country security information are to be communicated via the VO. This is crucial for the selection of the correct equipment and the best suited team for the specific disaster.

#### 3.2 Financial management

This pertains to the financial status of the mobilisation effort; the scouting for sponsorships and donations, corporate and public in nature to successfully fund the mission. Financial management includes the management of the SMS-line.

#### 3.3 Public information and education

This pertains to specific information relayed to the public about the disaster and the disaster response mission. This is mostly in an effort to garner monetary support for the mission. Guidelines for media, as well as their role in supporting the efforts to secure financial assistance are stipulated. This includes the management of the social media campaigns.

#### 3.4 Resource management

This pertains to the management of the equipment cache (including the food preparation equipment), the consumables and medication. Each of these aspects is fully addressed. Personnel is also classified as a resource and discussed under this heading.

#### 3.5 Mobilisation Centre Management

All information pertaining to the Mobilisation Centre, including location, layout and basic procedures are described in this sub section.

## 4. Activation of plan

This section stipulates guidelines for each of the activation phases of the mobilisation process, the authority of each of the notifications as well as the actions to be taken with each notification that is issued.

### 4.1 Advisory

This notification is received during Phase 0, in which notice of the disaster is formally issued by UNDAC and the affected country. This alert is relayed to all management members and volunteers.

### 4.2 Alert

This notification is made by the managerial team to alert all staff, organisations and independent role-players of RescueSA's intent to respond, after application has been filed with the Embassy and DIRCO to respond.

### 4.3 Activation

This notification is made by the managerial team to the assembled response mission team, to indicate that all approvals have been granted and the mobilisation process has entered Phase 2: Activation.

### 4.4 Stand down Notice

A Stand down Notice may be issued at any time to cancel the response for any reason. The reason for the stand down and the person initiating the stand down should be clearly communicated. It is therefore important that management constantly monitor the VO.

## 5. Functional Plans

### Plans by Phase

A responsible position of the managerial response team will be appointed for each step of the process.

#### 5.1. Phase 0: Advisory Response Mobilisation

This contains listed sources for reliable disaster information.

Sources include:

- ReliefWeb
- IRIN
- CNN
- Virtual OSOCC

Website and login details of the Virtual On-Site Operations Coordination Centre are noted here.

Additional factors to be considered before mobilising:

- ✓ Is the type of disaster within RescueSA's operational abilities?
- ✓ Geographical/climatic conditions
- ✓ Travel Requirements – Visas, customs, Oslo Guidelines
- ✓ Travel – will the aircraft be able to reasonably access the affected country, and will in-country surface transport be available?
- ✓ Resource limitations – equipment, staff, operations
- ✓ Can the affected site or region be reached within such a time-span for RescueSA to be of value?

## 5.2. Phase 1: Feasibility and assembling a ‘Shadow team.’

### *5.2.1 Approvals and Permissions*

The procedures, as well as contact information of the applicable persons of interest, are found in this section in a table format. This includes the procedures to obtain the approval from the relevant embassy, as well as DIRCO.

### *5.2.2 Mission Team*

This pertains to the procedure for identifying the correct personnel for the disaster scenario, as sketched by the available information. The DST, which will be further discussed in Chapter 4, is implemented in this section. Thereafter the procedure of sending out an Alert notification to all of the identified and selected personnel is discussed. Personal kit checklists, which are issued alongside the notification, are also included here.

In addition, guidelines as to how the selected response team is to be updated as new information becomes available are stipulated.

### *5.2.3 Equipment*

The selection of the correct equipment is crucial for the success of the response mission. Based upon the available information equipment is preliminarily identified and readied for mobilisation. The selected cache must be updated as new information becomes available.

This will also outline the numbering and colour coding system of the equipment cache.

### *5.2.4 Charter*

Calling upon the Memorandum of Understanding (MOU) with the charter company, RescueSA needs to follow the correct procedure to secure an aircraft for the response mission. This aircraft must comply with the mission’s needed carrying capacity. In the event that the aircraft does not meet the requirements, the size of the responding team and the goods have to be re-evaluated and adjusted. Pilots, flight plans and customs documentation also needs to be secured. All of the relevant procedures for securing the charter as explained above are found here.

### *5.2.5. Finance*

The securing of the financial means to support the mission is of absolute importance. The set-up of a dedicated SMS-line, social media campaigns and other means of gaining public and corporate support for the mission, such as press releases is outlined in this section.

### 5.3. Phase 2: Activation

#### 5.3.1 Charter

Authority for the confirmation of the charter flight is stipulated here. The procedures for the official documentation, including customs, are described here. Information pertaining to the transfer of the agreed upon amount is also found here.

#### 5.3.2 Mission Team

Check-in procedures at the Rendezvous location for each of the mission team components are outlined. These are:

- Management staff: Integrates with the OSOCC to coordinate operations
- USAR technicians: Footmen doing the hard yards
- Medical personnel: Administers emergency medical treatment to survivors and the responding team
- Communication specialists: Ensures successful communication abroad in compromised infrastructure
- Media: Keeps the local public informed of the situation to gain public support
- Structural Engineers: Evaluates structural integrity before a structural collapse rescue commences
- Interpreters: Help to bridge any possible linguistic divides
- K9 unit: Trained dogs with their handlers assist in locating victims

Special care should be taken to consider the acceptability for the deployment of canines for a mission. This should include:

- ✓ Conducting a health exam
- ✓ Ensuring current health certificate
- ✓ Ensuring specific immunization for the affected country
- ✓ Ensuring adequate food stock for mission duration
- ✓ Canine support equipment including crates and harnesses

#### 5.3.3 Documentation

All administrative procedures are outlined. Documentation requirements for each of the components, as well as templates of the relevant forms to be photocopied and completed by each member of the team are included in this section.

Completed USAR Team Fact Sheets made available by INSARAG should be ready in hard copy format for the RDC and OSOCC upon arrival.

#### *5.3.4 Medical*

Procedures regarding the medical desk are stipulated here. Duties such as medical check-ups, vaccinations and issuing of prophylactics are dealt with. Due to the nature of medical practice it is important that there is a broad awareness regarding the medical risks of being part of a response mission team.

Medical information should be gathered regarding any prevailing endemic medical situations, altitude and/or extreme weather considerations, as well as the local health and medical infrastructure (including veterinary facilities).

USAR Medical personnel have to ensure they are in possession of their passport, personal issue equipment, documentation to support their right to clinical practice, and an issued name and number contact list.

#### *5.3.5 Equipment*

It is important that all selected equipment are correctly inventoried for customs control and palletized for transportation. Guidelines and templates of the applicable forms to be completed are included here.

#### *5.3.6 Consumables*

Pre-worked out menus for the duration of the deployment period, as well as the shopping lists for the fulfilment thereof is located in this section. This is to ensure a balanced diet that sustains the team's energy levels for the duration of the deployment is adhered to.

#### *5.3.7 Communication*

This is divided into two sections:

Firstly, the procedure for the activation of satellite phones is presented.

This includes ensuring VHF and UHF equipment compatibility with local systems.

Secondly, the procedure and guidelines for making an accurate and complete update on the VO pre-departure is presented.

Information stating the USAR team size, volume and weight of the equipment, flight information, Estimated Time of Arrival and team contact details are to be provided.



### *5.3.8 Briefing*

A checklist is provided for all the information that has to be covered in the team briefing. This is to ensure that the team is holistically prepared – emotionally and psychologically – for what they are to expect at the disaster stricken area.

## 5.4. Phase 3: Departure

### 5.4.1 Departure

Airport customs and emigration procedures are outlined for the expedited processing of personnel and cargo.

### 5.4.2 Communication

This is again divided into two sections:

Firstly, the guidelines for the issuing of an official press release by all members of the media contingent are presented.

Secondly, the procedure and guidelines for making an accurate and complete updated post at this phase of the mobilisation on the VO is presented.

Lastly, to expedite the entry process into the affected country, information pertaining to visa requirements, logistics requirements, specialised communications equipment, search, rescue and medical equipment, emergency medical pharmaceuticals and search dogs need to be provided to the officials of the affected country, as per the Oslo Guidelines.

### 5.4.3 Briefing

This briefing will include all updated situation information. This briefing will also clearly define the following current information:

- ✓ Team organisational structure
- ✓ Chain-of-command
- ✓ Latest disaster information
- ✓ Code of Ethics
- ✓ Medical Concerns
- ✓ Environmental conditions
- ✓ Media issues and procedures
- ✓ Safety and security issues
- ✓ Communication procedures
- ✓ Affected county's political climate
- ✓ Affected country's cultural norms
- ✓ Transportation mode and departure information

## 6. Annexures

The titles the annexures are mostly self-explanatory and will be populated with the relevant information for ease of access.

### A. Managerial Mobilisation Aid

Due to the intricate and integrated tasks of the managerial team, a brief summary of the managerial team positions and responsibilities are outlined in this annexure. This is to aid the managerial team to navigate through all the applicable phases of the mobilisation plan. It will highlight the critical path for management, as well as serve as a reminder for specific communications between other role-players for a successful mobilisation process.

### B. Amendment list

### C. Glossary

### D. Organisation charts

### E. Flow charts

### F. Contact lists

### G. Key resources list

### H. Memorandum of Understanding

### I. Checklists

### 3.3 The Mobilisation Manual Validation

The value of this Mobilisation Manual will only become apparent after a full validation of the contents and the way in which it is presented to the user. Two important aspects will be tested and validated, namely comprehensiveness and efficiency.

The first method put into practice to validate the comprehensiveness of the manual will be to measure the contents of the Manual to the standards and objectives that have been set in the previous sections. This entailed ensuring that the mobilisation process complies with the INSARAG Guidelines, and also that it adequately prepares the mission response team to be able to perform their operations within the set guidelines. Secondly, it is also important to ensure that the issues recognised arising from a pitiable mobilisation attempt, as described in section 2.2 have been adequately dealt with in this Mobilisation Manual.

Secondly, the Manual was distributed to all of the managerial staff at RescueSA for their perusal. If anything should be amiss or incorrect, the error should be rectified immediately. This is an on-going practice as best practices are developed and refined internally.

After the comprehensiveness of the Mobilisation Manual was established, the efficiency had to be validated. Due to fact that a real life scenario cannot be instigated to validate the Manual using actual events, the next best option was to comprehensively run through a Mobilisation phase scenario, using only the manual as guidance in a 'Table top exercise.' During this exercise it was of importance that every responsible member identified in the Manual was present.

The ultimate validation of this Mobilisation manual will only be realised after it has been used by the new leadership of RescueSA to respond to an actual disaster.

### 3.4 Concluding Remarks

This chapter provided an overview of the Mobilisation Manual. A thorough description of the complete mobilisation process was given in Section 3.1, accompanied by the relevant fragments of the BPMN model. In Section 3.2 an attempt has also been made to capture the key essence of the full Mobilisation Manual, to illustrate meticulousness, without congesting the report with content. Section 3.3 outlined the process of the validation for the completed Mobilisation Manual.

## Chapter 4

### Decision Support Tool

#### 4.1 The Decision Support Tool in Concept

It should always be kept in mind that a Decision Support Tool is just that, a tool used to support the decisions of the user. It always remains at the discretion of the user to accept, reject or alter the results. The DST that will be developed for Rescue South Africa will be based exclusively on the work of Boon and Sierksma (2003) as described in Section 2.5.

Based on Table 1 provided by the International Search and Rescue Advisory Group, RescueSA have developed their own Mission Team Structure template. As an example, see Annexure A, which is the Mission Team Structure for the mission to the Philippines. It is now important to note that the Management and Logistics personnel are key role players that make up the backbone of the mission team. Currently in South Africa there are only a select few Medical personnel who are trained to be eligible for a spot on a mission response team. The media contingent is variable depending on which journalists are provided by their respective news agencies.

Thus we are left with the Rescue Team members whose selection is the decision of management. These positions will become the focus of the DST. A Rescue Team Leader will be appointed for each of the four Rescue teams.

Firstly, all the qualities that the applicable team members must have competence in have to be identified. This can be done by assessing the outcomes of their training programmes. Next, a list of all Urban Search and Rescue technicians should be compiled. Management will rank them according to their competencies as identified in the previous step, using their training results as a guideline.

The importance of each of these competencies will then be ranked for a specific position to create the scenario specific score table.

These values given in the score tables will then be transformed to become the input for a volunteer-scenario weighted score, which will become the input for the model.

Volunteers can easily be added or removed from the list, or their ratings can be reassessed when necessary. With results being calculated in real-time management can have unbiased results within seconds and start making the necessary preparations.

## 4.2 Development of the Model

### 4.2.1 Basic Information

The first step towards the successful development of this model was the task of identifying and collating all of the qualities that a USAR technician should possess. This task was accomplished by using the formal training manuals that RescueSA use when training the volunteers. The 12 main qualities were identified as follows:

- Agricultural and Industrial Rescue
  - This relates to rescues involving machinery, lifts and lift shafts, electrical hazards, hazardous substances, mechanical rescues and also non-mechanical rescues.
- Aquatic Rescue
  - This quality describes skills relating to boat handling, understanding river movements, basic swift water rescues, successfully undertaking line crossings and swift water boat rescues.
- Aviation Rescue
  - Here rescues undertaken by the response team from an aircraft is described. This includes rescues over land and water, and the relevant skills needed, such as lowering and hoisting.
- Confined Space Rescue
  - This type of rescue can be either horizontal or vertical. Rescues from a tank are also included.
- Fire Search and Rescue
  - Due to the nature of this type of rescue, Personal Protective Equipment and the correct usage thereof is crucial. Identifying classes of fires and the behaviour thereof is also essential, especially compartmental fire behaviour. Fire fighting techniques, as well as search and rescue procedures are included.
- Hazardous Materials
  - Again, Personal Protective Equipment plays a significant role. The recognition, assessment and control of an incident are of importance. Defensive control strategies and Decontamination round out this quality.

- High Angle 1
  - High Angle rescue refers to rescue operations done off the ground. This includes the art of knot tying, identifying anchor points, and rigging systems. Skills such as belaying, abseiling, ascending and ultimately patient packaging are of importance.
  
- High Angle 2
  - High Angle 2 builds on the foundation of High Angle 1 to include specialised equipment, the application of advanced anchoring systems and suspension systems. Climbing emergencies and Pole Top rescues are also included. Lastly, patient management is also covered.
  
- Motor Vehicle Rescue
  - Motor Vehicle Rescue firstly discusses the design and construction of vehicles. Further, the use of hand tools, pneumatic power equipment, hydraulic power equipment and other miscellaneous equipment, along with incident control are covered. Aspects of specialised vehicle rescue are also addressed.
  
- Structural Collapse Rescue
  - This is one of the most important qualities. The assessment and management of the hazard is covered and appropriate shoring systems are encompassed. The appropriate rescue sequence is included. Rescues pertaining to concrete and metal are discussed along with the correct heavy lifting and moving systems. A further aspect of importance is the technical search operations with the specialised equipment, as well as the canine search operations.
  
- Trench Rescue
  - The Trench Rescue System is described with regards to having an action plan, covering aspects including trench stabilisation, different shapes of trench (straight, X, T, and L), sidewall collapse, slough-in, and non-collapse rescue operations.
  
- Wilderness Search and Rescue
  - Wilderness Search and Rescue includes the aspects of camp craft and navigation. Applicable search techniques and rescue operations are covered.

From these 12 main qualities, a further 89 sub-qualities have been identified and hinted at in the description of each, although they will not be used for this project. As this is only an introductory DST the information to use all sub-qualities are not yet readily available, thus this model will only utilise the 12 main qualities.

Due to the fact that many of the volunteers do not have formal training in each of the qualities, but have extensive experience from previous response missions, it will have to be taken into consideration when awarding ratings to each of the volunteers.

Further information needed for this model is a list of the trained and/or experienced volunteers, with a complete record of their formal training and practical incident response experiences. Currently 34 volunteers have been identified for use in the model.

Lastly, using the RescueSA Philippines Mission Team Structure, as found in Annexure A, a possible 22 Rescuer positions have been identified.

#### 4.2.2 The Volunteer-score table

By using Windows Office Excel, a simplistic spreadsheet is compiled to measure each of the volunteers against each of the 12 qualities. A screenshot of the table is presented in Figure 10.

	Agricultural and Industrial Rescue	Aquatic Rescue	Aviation Rescue	Confined Space Rescue	Fire Search and Rescue	Hazardous Materials	High Angle 1	High Angle 2	Motor Vehicle Rescue	Structural Collapse Rescue	Trench Rescue	Wilderness Search and Rescue
Alistair Lithgow												
Muso Lehlokoa												
David Chinunda												
Ntithi David Tshabalala												

Figure 10: Volunteer-score table

Ratings are assigned to each of the volunteers according to their formal education and practical experience. The volunteer is awarded a base point of 50 points per quality if he has undergone formal training in the specified quality. Practical experience points are then added according to the importance of the applicable quality with regards to the scenario. For instance, if the volunteer responded to an earthquake and the importance rating of the structural collapse quality was 10 (this allocation is further discussed in Section 4.2.3), the volunteer would add 10 points. Points are accumulated in this manner for every scenario responded to. If the volunteer has no formal training in the quality, but has practical experience, a base point of 25 points are awarded, as well as the additional experience point calculated from the quality rating.

In an effort to have the ratings reflect the competency of a volunteer as accurately as possible, the training instructors, as well as team leaders, will be consulted to validate these ratings.



The nature of this score table is such that it is simple to update ratings, add or remove volunteers, and is intuitive to understand.

#### 4.2.3 The Scenario-score table

Again using Windows Office Excel, the Scenario-score table spreadsheet is similarly constructed. This score table measures the importance of each quality for a specific scenario. A screenshot of the table is presented in Figure 11.

		Agricultural and Industrial Rescue	Aquatic Rescue	Aviation Rescue	Confined Space Rescue	Fire Search and Rescue	Hazardous Materials	High Angle 1	High Angle 2	Motor Vehicle Rescue	Structural Collapse Rescue	Trench Rescue	Wilderness Search and Rescue
1	Rescuer 1	5	5	5	9	8	9	8	8	7	10	10	4
2	Rescuer 2	5	5	5	9	8	9	8	8	7	10	10	4
3	Rescuer 3	5	5	5	9	8	9	8	8	7	10	10	4
4	Rescuer 4	5	5	5	9	8	9	8	8	7	10	10	4

Figure 11: A Scenario-score table

Again, the team leaders and training instructors have been consulted to assign ratings for the rescuers against the qualities. These ratings are based purely upon the experience of the team leaders, who have responded to multiple incidents. In this scenario-score table we consider an earthquake. Due to the nature of the disaster the qualities will have varying ratings, for example; Structural Collapse Rescue will carry a rating of high importance and Aquatic Rescue a lesser rating. If, for instance considering a Flood scenario, Aquatic Rescue would carry a higher rating than Structural Collapse Rescue would.

Currently the model is being used to select a mixture of the most competent rescuers; this is due to an improvement of the ratings allocated for the different rescuer positions versus the qualities, thus varying quality weights for each position. With later development and further refinement of the table different types of positions, such as medical staff, can be added. This will only become a possibility when there is a much larger pool of volunteers to draw from.

Scenario-score tables for the following disaster scenarios are to be considered: Earthquake, Flood, Hurricane, Tsunami and Volcano. The assigned ratings for each scenario will be further discussed in section 4.4.1, in justification of the results.

When referring back to figure 4 in section 2.5, the similarity between the score tables of this model and Boon and Sierksma’s model is clearly noticeable.

#### 4.2.4 The Weighted-score table

By using a simple formulation, the logic to create the Weighted-score table can now be masterfully executed. The formulation to calculate the rating of the volunteer in the position is the sum of the products of the rating of the volunteer and the importance rating of the quality, for each of the 12 qualities. By combining the ratings for each of the qualities of the volunteer with the importance of the quality for each of the positions available for the earthquake scenario, each volunteer is now rated for each of the positions, creating a weighted volunteer-scenario score. For example, to determine Alistair's (the first listed volunteer) rating as Rescuer 1, his score for Agricultural and Industrial Rescue will be multiplied by the assigned quality rating for Rescuer 1's required Agricultural and Industrial Rescue score added to his Aquatic Rescue score, multiplied by the assigned quality rating for Rescuer 1's required Aquatic Rescue score, and so forth for all 12 qualities, and then divided by 120 to make the weighted score more user-friendly. This is then done for Alistair for all 22 available rescuer positions. This matrix of ratings is used as the input for our linear programming model. A screenshot of this table is presented in Figure 12.

	Rescuer 1	Rescuer 2	Rescuer 3	Rescuer 4	Rescuer 5	Rescuer 6	Rescuer 7	Rescuer 8	Rescuer 9	Rescuer 10	Rescuer 11	Rescuer 12	Rescuer 13	Rescuer 14	Rescuer 15	Rescuer 16	Rescuer 17	Rescuer 18	Rescuer 19	Rescuer 20	Rescuer 21	Rescuer 22
Alistair Lithgow	72	55	45	56	47	39	41	76	82	60	54	76	35	90	64	37	80	41	77	89	77	81
Gert Pienaar	35	77	46	56	71	44	69	76	80	69	67	67	49	46	89	36	71	80	74	58	55	62
Muso Lehlokoa	36	54	85	75	50	44	41	72	60	48	71	42	88	68	88	64	58	55	89	66	69	46
David Chinunda	75	45	80	74	48	75	77	56	88	82	66	73	54	63	37	65	49	60	80	76	50	66
Mtiki David Tshabalala	84	57	37	81	88	81	77	67	67	48	56	42	67	76	46	46	88	46	73	88	43	38

Figure 12: An example of the Weighted-score table

This rating indicates how competent each of the volunteers is for each of the positions. In this case, where all the positions are rescuer positions, the model will select the 22 best rescuers for the earthquake mission response team. When the Volunteer-score table is combined with a different Scenario-score table it is expected that the weighted ratings will somewhat differ and the 22 best volunteers will be selected for that scenario mission response team. This will be further discussed in section 4.6 as part of the validation.

### 4.3 The Model

With the completed Weighted-score table all the information necessary to execute the model is now available. Due to the simplicity of the score table the linear programming model is straight-forward (Boon & Sierksma, 2003).

When formulating the model let:

I be the set of the total number of volunteers, where  $i \in I = \{1, \dots, m\}$ , where m is the maximum

J be the set of the total amount of positions available, where  $j \in J = \{1, \dots, n\}$ , where n is the maximum

$w_{ij} \triangleq$  weighted volunteer-scenario score

$$x_{ij} \triangleq \begin{cases} 1 & \text{if volunteer } i \text{ is selected for position } j, \\ 0 & \text{otherwise} \end{cases} \quad i \in I, j \in J$$

The optimization function will be to maximise:

$$\max(z) = \sum_{i=1}^m \sum_{j=1}^n w_{ij} x_{ij} \quad (1)$$

Subject to:

$$\sum_{j=1}^n x_{ij} \leq 1, \forall i \in I \quad (2)$$

$$\sum_{i=1}^m x_{ij} \leq 1, \forall j \in J \quad (3)$$

$$x_{ij} \in \{0,1\} \forall i \in I, j \in J$$

The maximising function selects from all the possible combinations the volunteers which lead to the highest weighted volunteer-scenario score (1). The first constraint ensures that each volunteer is assigned to only one position (2). The second constraint ensures that only one volunteer is assigned to each position (3).

LINGO 14.0, Optimization Modelling Software for Linear, Nonlinear, and Integer Programming was used to generate a solution for this model. The formulation thereof can be found in Annexure D.

Adapting the approach of Boon and Sierksma (2003) from a player-position model to a volunteer-scenario model has proven to be successful. The next step will be to solve the model and validate the results by using real-world data.

## 4.4 The Solution and Analysis of the Results

### 4.4.1 Solutions from the Disaster Scenario's

For each of the Disaster Scenarios considered, a similar, wholly satisfying solution is obtained from the Lingo formulation of the model. As an example a filtered extract of the solution sheet of the Earthquake Scenario is presented in Table 2. Solutions for the other scenarios can be found in Annexure E.

*Table 2: Extract of Lingo Solution for the Earthquake Scenario*

<b>Lingo Solution</b>		
Global optimal solution found.		
Objective value:	1029.958	
Infeasibilities:	0	
Total solver iterations:	123	
Elapsed runtime seconds:	0.11	
Model Class:	PILP	
<b>Solution:</b>		
XSELECTED( I1, J1)	0	-42.6333
XSELECTED( I5, J4)	1.0000	-51.65
XSELECTED( I6, J2)	1.0000	-52.475
XSELECTED( I7, J16)	1.0000	-44.4
XSELECTED( I9, J1)	1.0000	-48.0833
XSELECTED( I11, J14)	1.0000	-44.2083
XSELECTED( I12, J12)	1.0000	-47.6833
XSELECTED( I13, J13)	1.0000	-44.1333
XSELECTED( I14, J8)	1.0000	-51.0917
XSELECTED( I16, J6)	1.0000	-50.375
XSELECTED( I17, J5)	1.0000	-50.7333
XSELECTED( I18, J17)	1.0000	-43.0667
XSELECTED( I19, J10)	1.0000	-43.3
XSELECTED( I20, J15)	1.0000	-42.6833
XSELECTED( I22, J22)	1.0000	-44.9083
XSELECTED( I24, J18)	1.0000	-42.3
XSELECTED( I25, J19)	1.0000	-43.9083
XSELECTED( I26, J20)	1.0000	-40.8917
XSELECTED( I27, J21)	1.0000	-43.125
XSELECTED( I29, J9)	1.0000	-50.2
XSELECTED( I30, J11)	1.0000	-48.9417
XSELECTED( I32, J3)	1.0000	-55.425
XSELECTED( I33, J7)	1.0000	-46.375

It is clearly visible from the extract which volunteers have been allocated to the available rescuer positions, as well as the rating they were selected on. Due to the successful formulation of the constraints every rescuer position has been filled, and every volunteer has only been selected for one position, if at all.

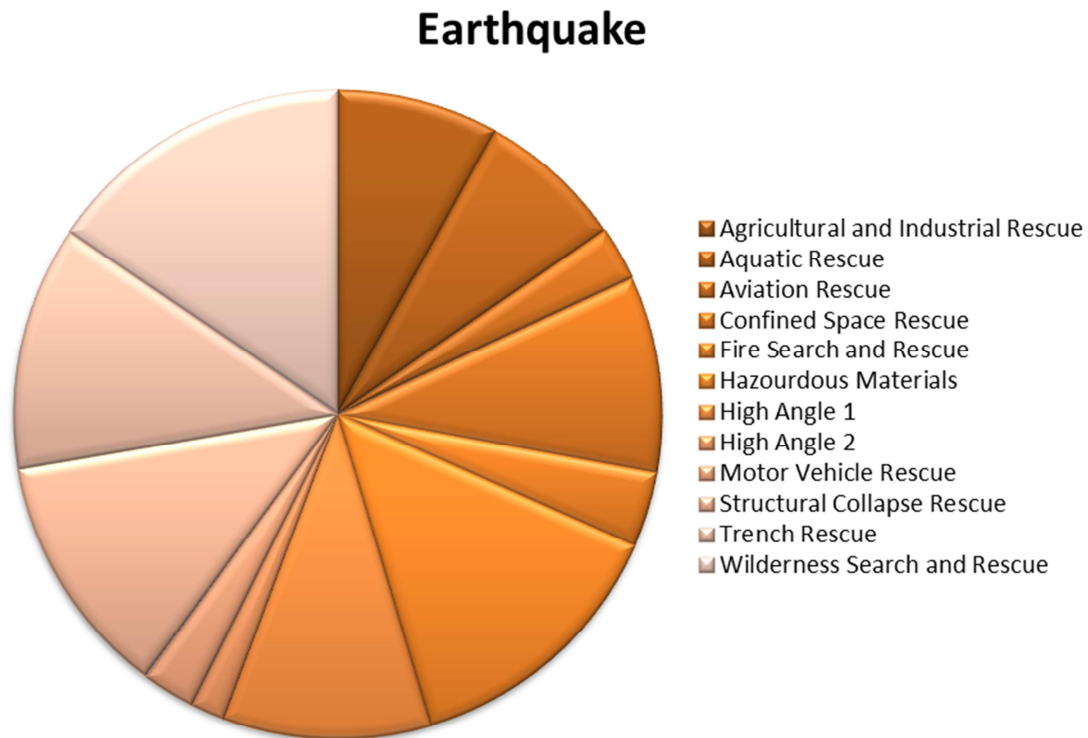
For example the line reading: XSELECTED (I5, J4) leads to the conclusion that Volunteer 1 has been selected for rescuer position 14, based on a weighted rating of 51.65 points.

Note that for instance the line reading: XSELECTED (I1, J1) has a zero-value, indicating that Volunteer 1 has not been selected for rescuer position 1. It can also be deduced that some volunteers have not been included in this selection of the model, for example Volunteer 10 has not been allocated to any of the positions.

A comprehensive analysis of the data acquired for each disaster scenario can now be presented.

#### 4.4.1.1 Earthquake Scenario

After summing the totals of each quality of the selected volunteers, an insightful chart can be generated for the Earthquake Scenario, as seen in figure 13. This is done for each Disaster Scenario.



*Figure 13: Earthquake Quality Rating*

When referring to section 4.2.1, it becomes apparent that the acquired qualities are well matched against the competencies one would expect when responding to an earthquake scenario.

A high Hazardous Material component is to be expected, as many industrial safety measures can be compromised by an earthquake.

Due to the incredibly destructive nature of major earthquakes in urban area large components of Structural Collapse Rescue, Trench Rescue and, to a slightly lesser extent, Confined Space Rescue are present.

#### 4.4.1.2 Flood Scenario

When considering the Flood Scenario graph in figure 14, it is already clear that there is a priority shift regarding the qualities.

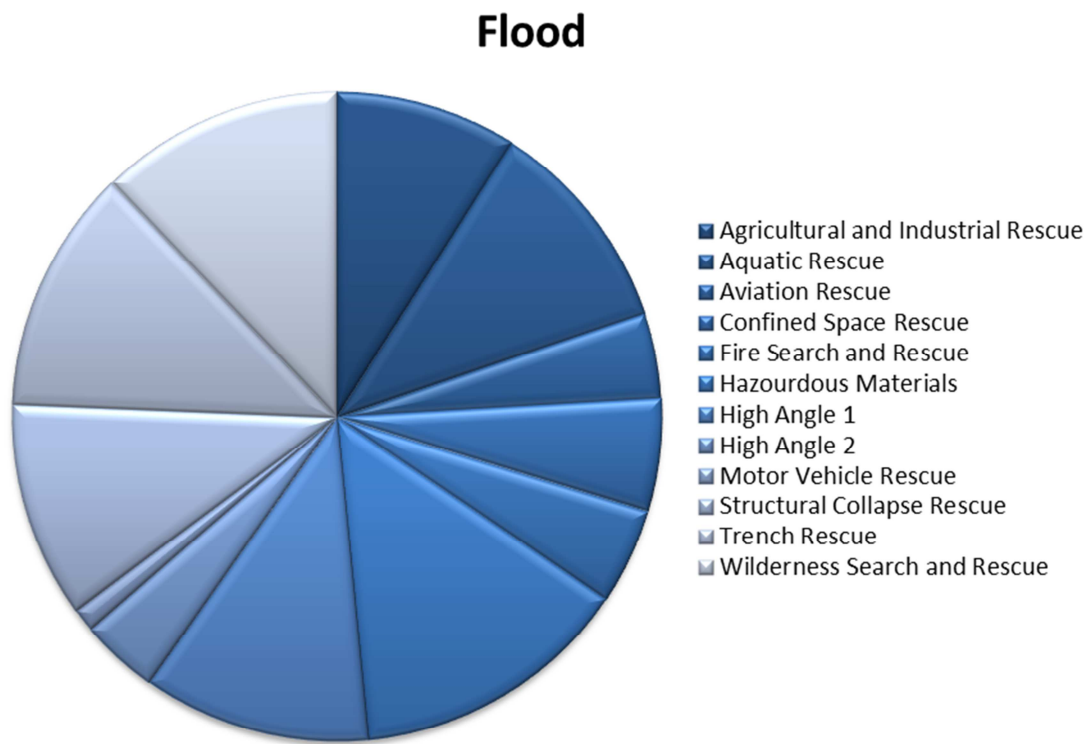


Figure 14: Flood Quality Rating

As per expectation, Aquatic Rescue is a larger component of the Flood Scenario. A point of contention could arise from the fact that Aquatic Rescue is not a larger component. This could be explained by understanding that by the time the mission response team will arrive in the affected country most of the water would have receded, leaving the chaos of the aftermath that needs to be dealt with swiftly.

Again, a significant Structural Collapse and Trench Rescue component is present. As mentioned in section 4.2.1, these are some of the most important qualities and will have a strong presence in most scenarios.

A strong High Angle 1 component, which might seem surprising, is also featured. This would be due to many of the skills taught in this module, such as knot tying and anchor and rigging systems, play an important role as part of a successful flood rescue.



#### 4.4.1.3 Hurricane Scenario

Figure 15 presents the quality distribution for the Hurricane Scenario. Again it features a ratio of qualities which could be expected from a team responding to a Hurricane disaster scenario.

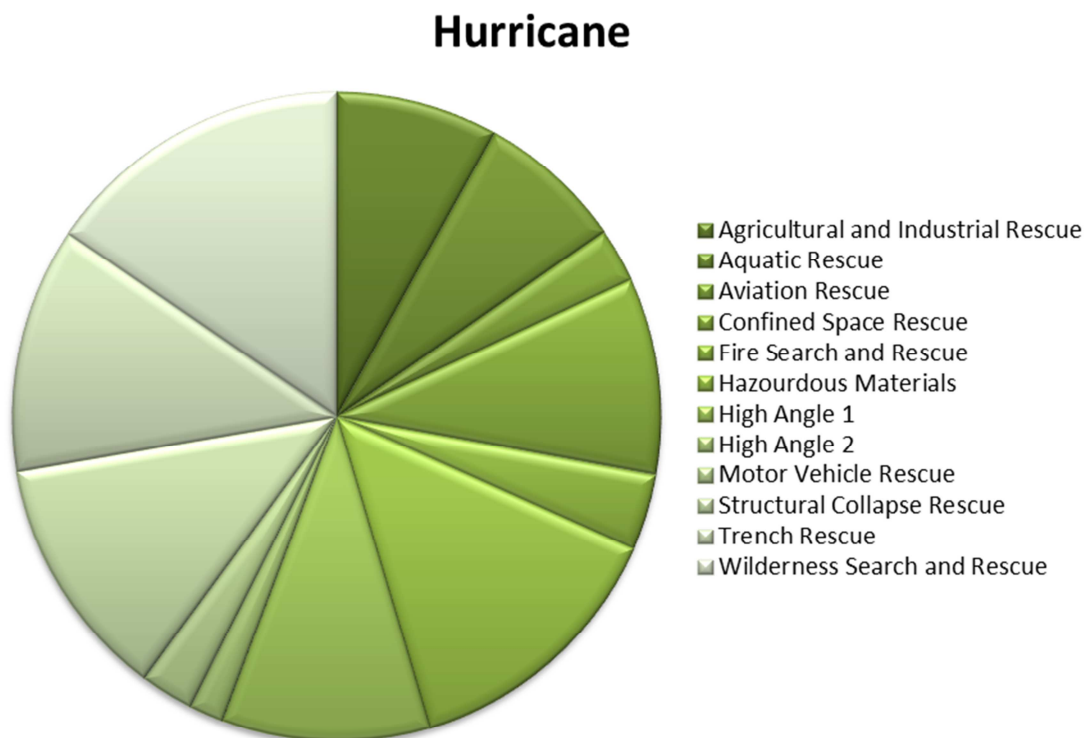


Figure 15: Hurricane Quality Rating

Most disaster rescue mission deployments are in urban areas, hence USAR. Disaster prone areas are habitually overlapping with areas where old or poor infrastructure is mostly present. This is one of the many reasons why, regardless of the disaster type, Structural Collapse Rescue, Trench Rescue and Confined Space Rescue play a significant role during the rescue operations. The Hurricane scenario is no exception. Due to the Industrial areas of urban settings Hazardous Materials will also almost always have a key role. The element of the great 'Unknown' also takes precedence here, where it is better to be prepared for hazardous materials which could potentially be life-threatening to the rescuers.

The skillset brought from High Angle 1 is also strongly represented for the Hurricane scenario.

#### 4.4.1.4 Tsunami Scenario

In recent years Tsunamis have been one of the most destructive types of disasters. Figure 16 represents the results of the DST with regards to this Disaster Scenario.

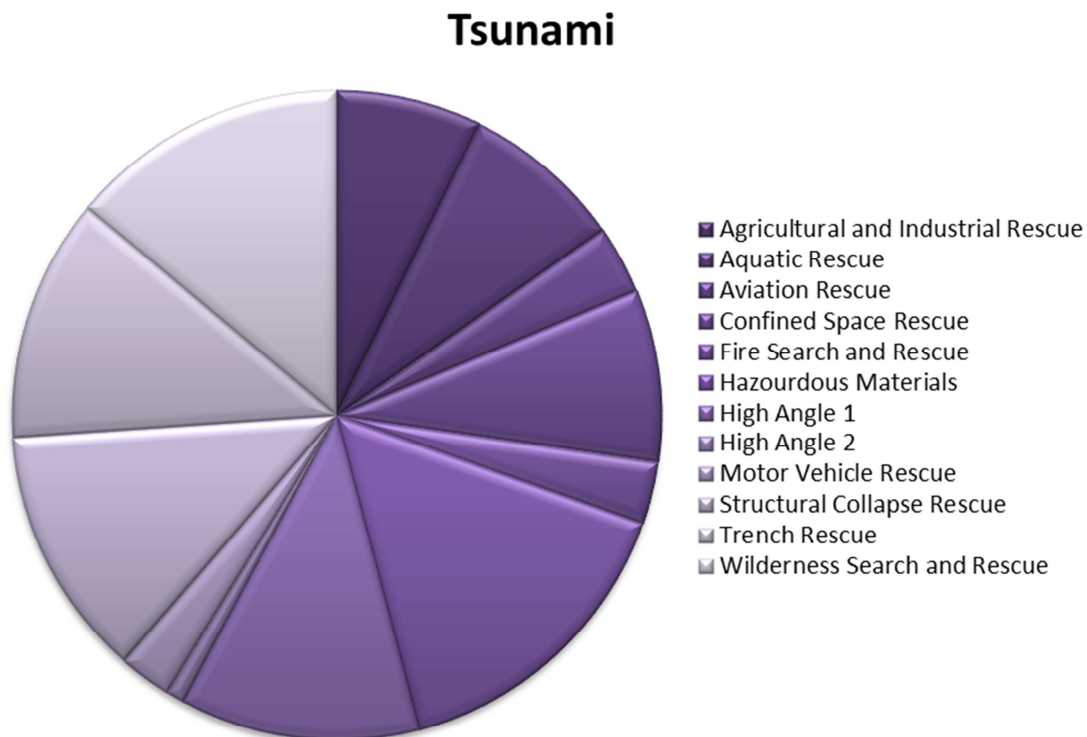


Figure 16: Tsunami Quality Rating

The trend of a strong core for an urban rescue mission is also found to be present with the Tsunami Scenario. Many times these millions of metric-tons of water, which move at thrilling speeds only aid in aggravating the destruction that has already been caused by the preceding earthquake, instigating the tsunami.

The most notable example worth mentioning here is the disaster that struck Japan in 2011. With reference to this disaster, an explanation can also be conveyed regarding the high Hazardous Materials component. Weeks after the disaster struck, the largest remaining concern was the struggle to control the radiation from the stricken Fukushima nuclear plant (BBC News, 2011). Correctly handling these types of threats is crucial for a successful rescue mission.

#### 4.4.1.5 Volcano Scenario

A much more balanced quality distribution profile pertaining to the Volcano scenario is presented in figure 17.

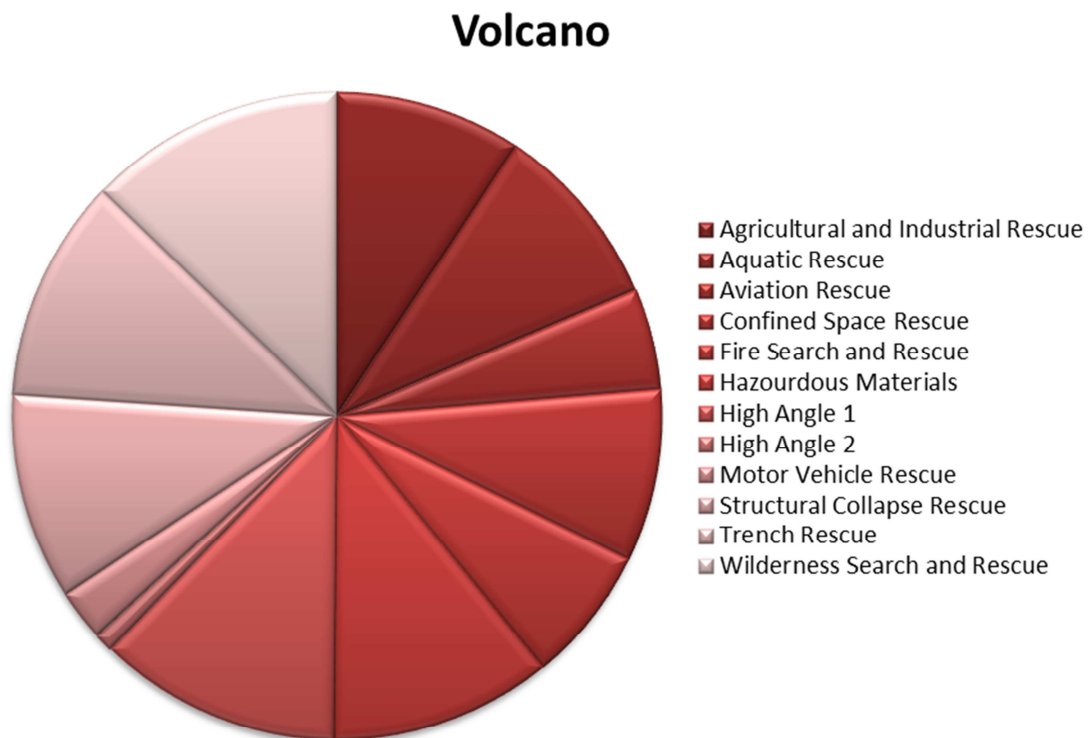


Figure 17: Volcano Quality Rating

Although uncommon, volcanic eruptions have enormous destructive power. Due to the unpredictability and inherent danger of thereof it is rare that large urban settings are affected by volcanoes due to their more remote locations. In some instances it does become necessary to deploy a USAR mission team, therefore again the strong presence of the urban quality group.

For the first time, we see an increase of Fire Search and Rescue component, for obvious reasons. All aspects of this quality is of extreme importance in this scenario, especially complying to all Personal Protection Equipment regulations and being to cope in this highly unpredictable circumstances.

A contentious point for this distribution could arise from the size of the Aquatic Rescue component. It seems that some river crossing techniques are also employed for crossing streams of molten lava, if necessary. This, combined with the rope skills applied from High Angle 1 could be significant.

#### 4.4.2 General Comments

Unfortunately one of the consequences of having varying ratings of importance per quality throughout the rescuer positions is that the importance of some of these qualities seems marginal in comparison to the other qualities, as well as in comparison to expectations.

High Angle 2 is such a quality. When considering any of the five Disaster Scenarios it seems as if though the High Angle 2 quality is of lesser importance, when there is an expectation that it might play a bigger role. This representation of data is due to the fact that High Angle 2 is an important quality for only a portion of the rescuers, whereas for instance High Angle 1 is a priority in which all rescuers must be competent. Motor Vehicle Rescue is another such a case.

Fire Search and Rescue is also slightly lower in most of the scenarios, because by the time the rescue mission team arrives at the affected area, most fires are already out or under control and only new fires need to be dealt with in their limited capacity. Aviation Rescue is mostly low due to the fact that these types of rescues take place very seldom, and again, only a few rescuers are deemed to have Aviation Rescue as a priority quality for most scenarios.

Finally, an interesting observation is the fact that in all of the scenarios Wilderness Search and Rescue is a major component. Even more perplexing is the fact that it goes hand-in-hand with the strong representation of the urban quality group (Structural Collapse, Trench and Confined Space Rescue). The simple reality is that after a devastating disaster where most infrastructure has been entirely demolished, the camp craft skillset of Wilderness Search and Rescue plays a major part in the assistance to survival of the local people in the affected area.

#### 4.4.3 Disaster Scenario mission team selection comparison

To further drive home the realisation that different disaster scenarios require varying levels of the various USAR qualities, figures 18 - 28 present a comparison of the total volunteer score per quality with regards to each disaster. This comparison is truly insightful, in that it even more clearly states the subtle differences of qualities than the figures found in section 4.4.1 do. By taking into consideration the knowledge of the application of the different qualities from section 4.2 and the discussions in section 4.4.1, the reasons for the varying levels regarding each disaster are only logical.

Here is an opportunity to comment on the rescuer positions the volunteers have been assigned. Upon close inspection the totals for the qualities for the Earthquake and Hurricane Scenarios are exactly the same for all of the qualities. This is due to the exact same 22 volunteers being selected from the pool of 34. What is interesting to note is the fact that almost all of these volunteers have been assigned to a different rescuer position. This can be further perused in Annexure E. The significance in this lies therein that the composition of the 4 USAR teams will look completely different for these two scenarios so that there will be a completely different distribution of qualities within these teams.

Some observations from the comparative graphs:

- 1) In figure 19 it can clearly be seen that Aquatic Rescue is a larger priority in the Flood Scenario.
- 2) Higher Aviation Rescue totals for Volcano and Tsunami scenarios as these are most often the effective methods in these situations.
- 3) The Volcano Scenario is an obvious stand out of the Fire Search and Rescue quality.
- 4) The Flood and Tsunami Scenarios require a higher Hazardous Material component, due to the water being able to distribute and further spread contaminants.
- 5) Motor Vehicle and especially Structural Collapse Rescue are valued qualities amongst the urban setting disasters (Earthquake, Hurricane and Tsunami).

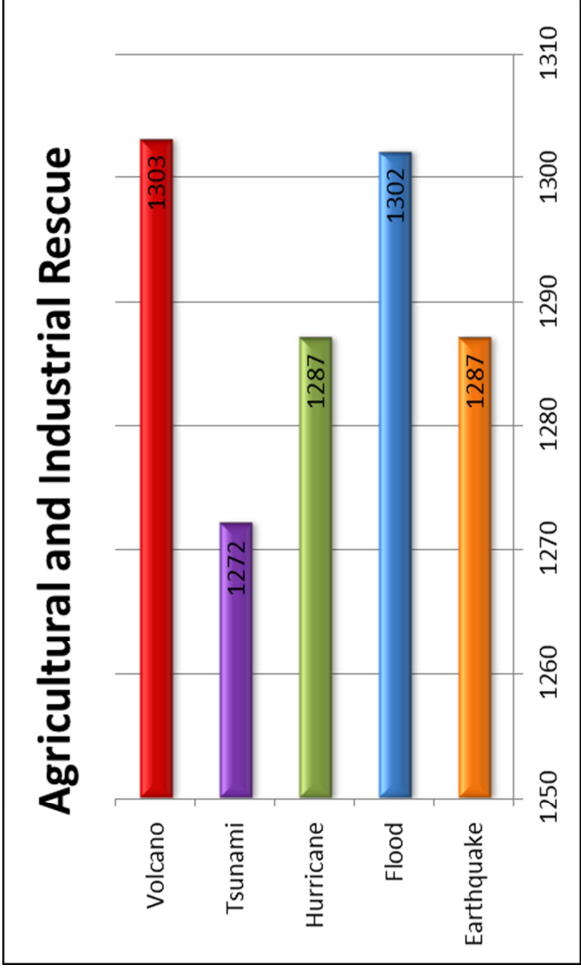


Figure18: Agricultural and Industrial Rescue

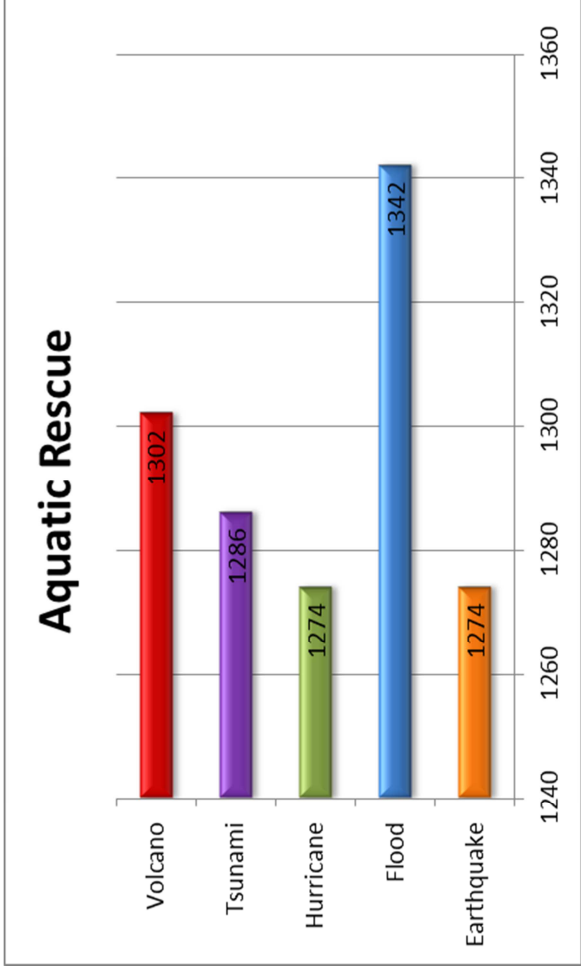


Figure 19: Aquatic Rescue

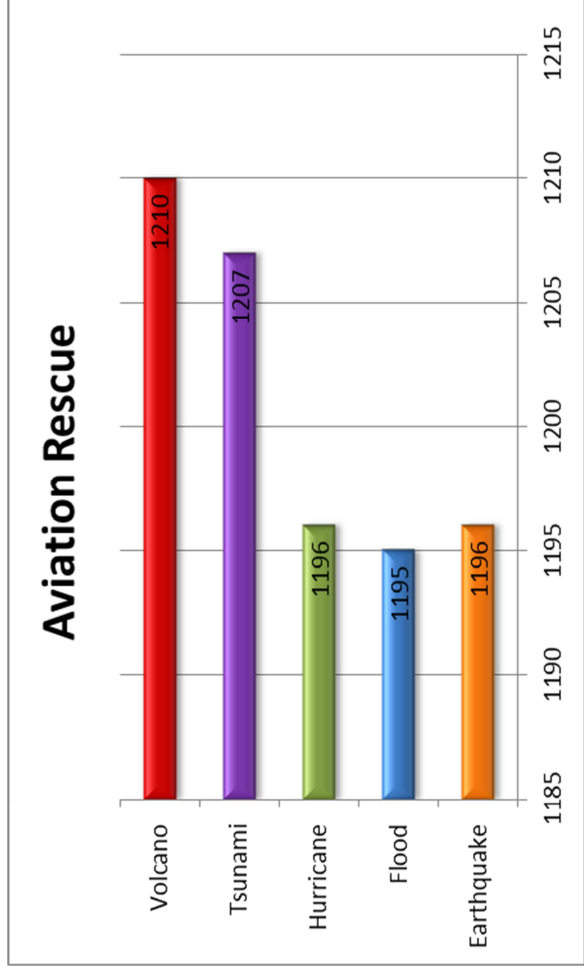


Figure20: Aviation Rescue

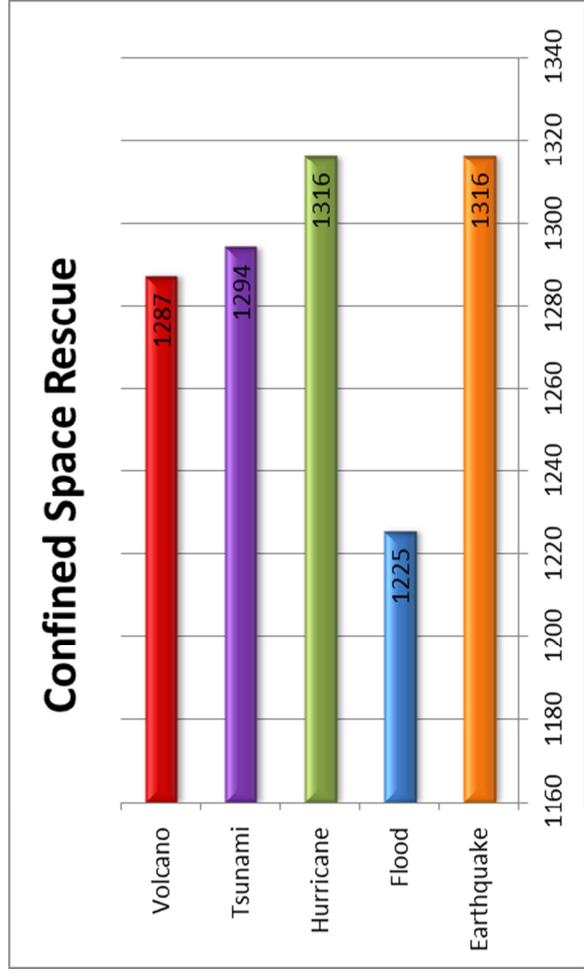


Figure21: Confined Space Rescue

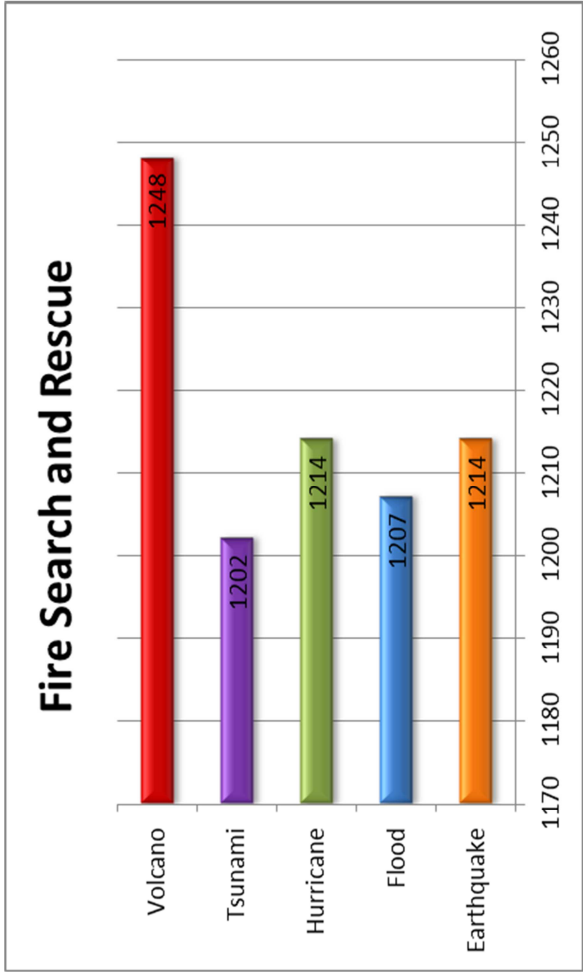


Figure22: Fire Search and

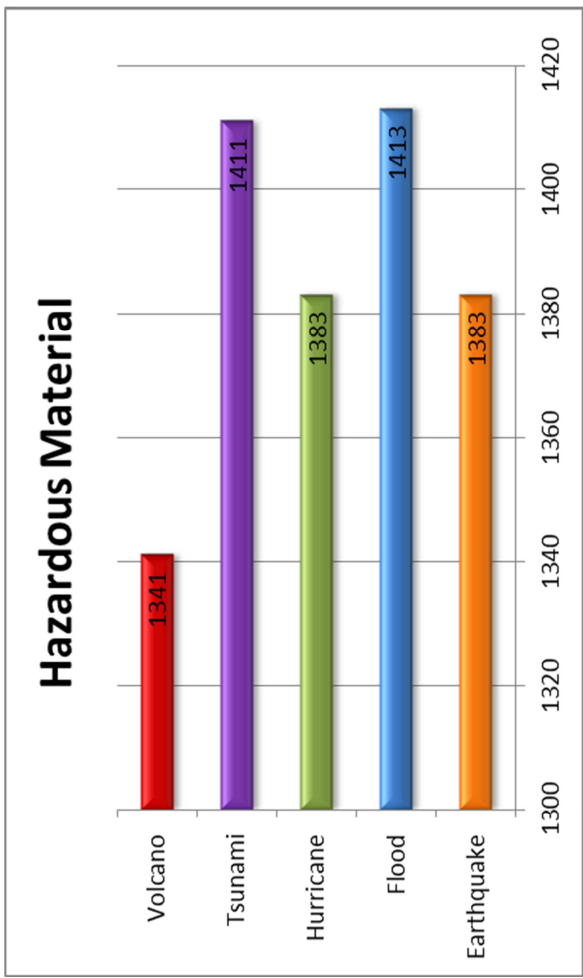


Figure 23: Hazardous Materials

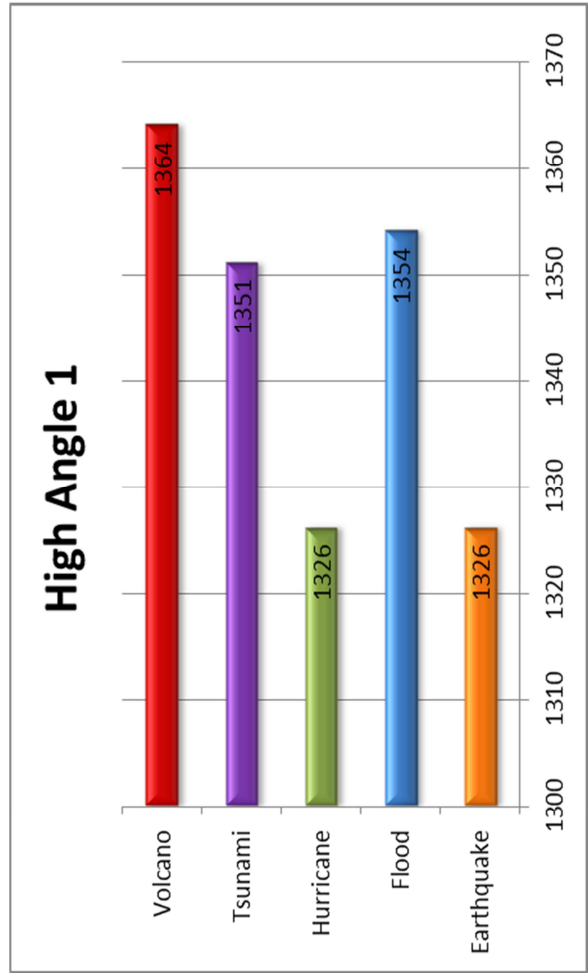


Figure24: High Angle 1

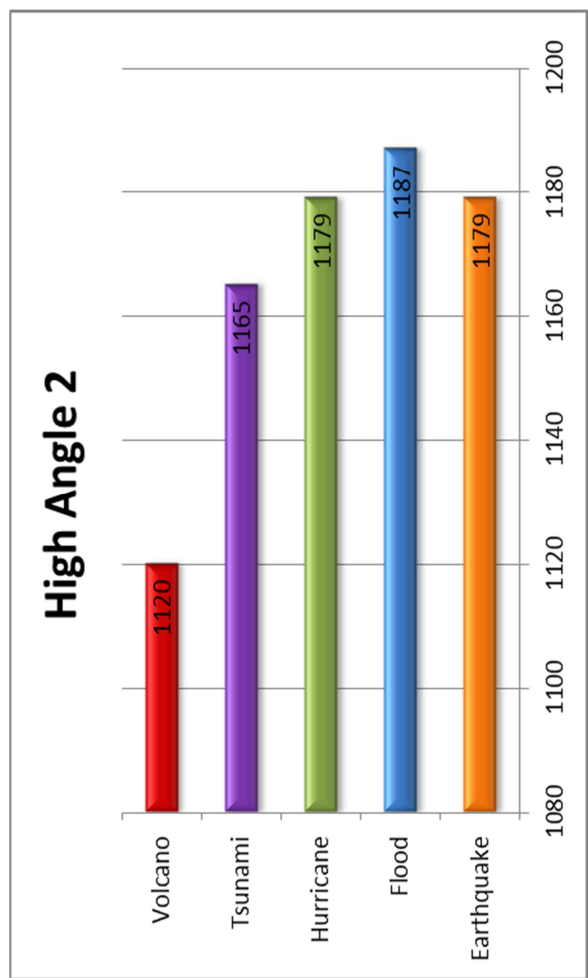
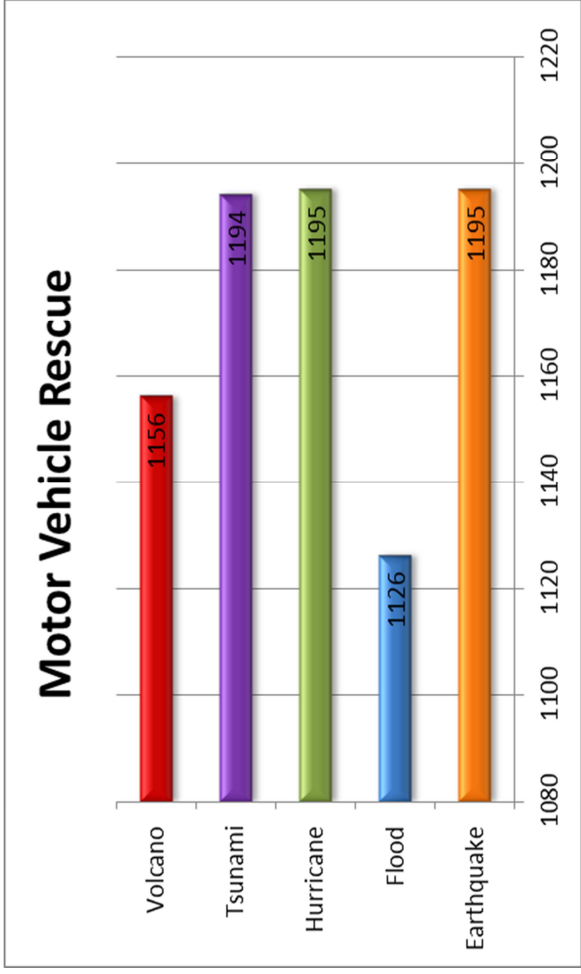


Figure25: High Angle 2



Fig

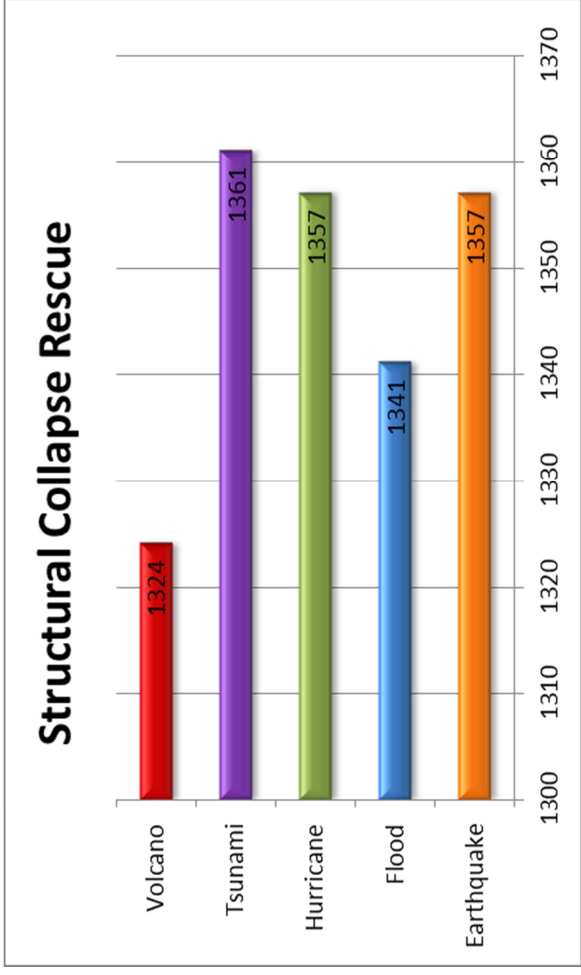
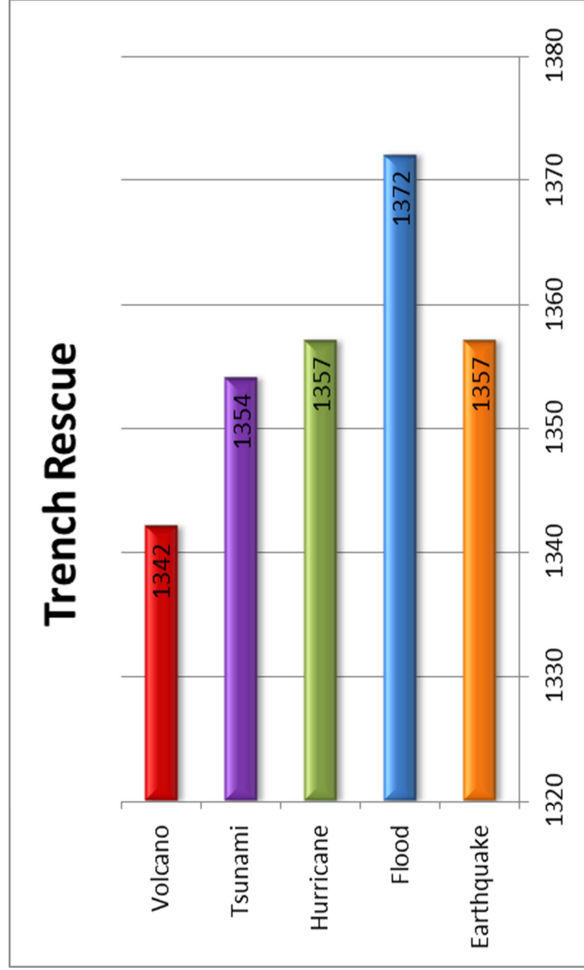


Figure 19: Structural Collapse Rescue



F

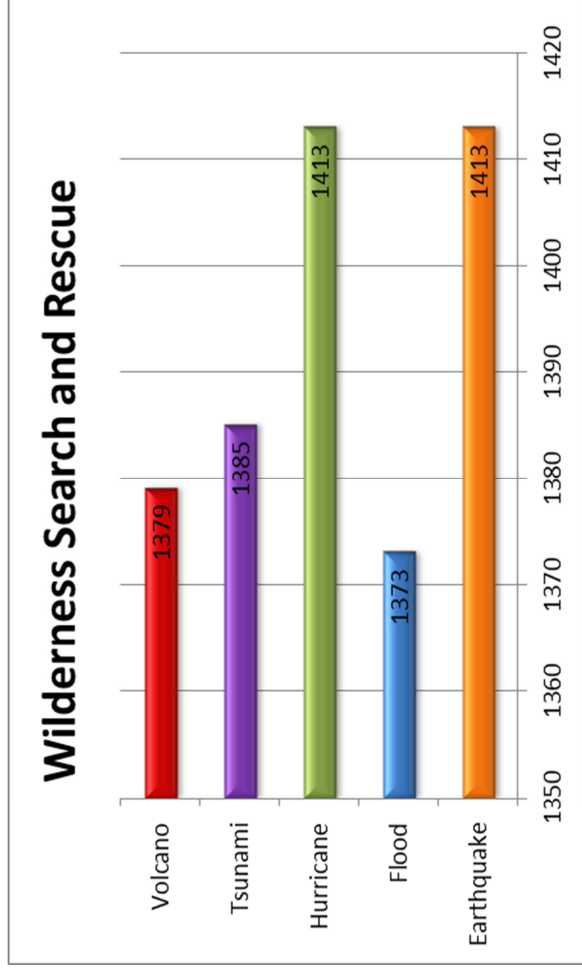


Figure 18: Wilderness Search and Rescue



## 4.5 Validation of the Results

The validation of the results is extremely important, especially for this model. The selection of a sub-optimal team for a response mission will lead to sub-optimal performance out in the disaster field, where every second is valuable.

Firstly, validation can take place by manually cross-referencing the selected team with the volunteer score-table to assure that the best volunteers for the specific scenario have in fact been chosen. This will become a tedious process as soon as the pool of eligible volunteers becomes quite large, so it is of great importance that the model is verified in this manner with a relatively small pool of volunteers.

It is clear from the correlation between the ratings assigned and the results as discussed in section 4.4 that there is an accurate representation of the qualities required and the number of qualities selected. Based on this observation the DST does in fact deliver the optimal team as required, subject to the ratings of the volunteers.

Secondly, team leaders have been asked to comment on the results of the DST to determine if they agree with the results of this artificial selection process. This is one of the most significant validations, as the team leaders are familiar with the competencies of each of the volunteers and are able to distinguish whether the results accurately reflect reality for the given scenario.

Lastly, a sensitivity analysis was done by generating additional scenario-score tables. These were used to create additional weighted-score tables to be used as input for the linear model. After solving these additional score tables it became evident that the model does in fact select the best volunteers for the specific scenario. The first two validation techniques were then implemented again to revalidate the results from these additional score tables.

The outlined validation process instilled a sense of surety of the DST amongst the users thereof, which will lead to the management confidently relying on the DST to help select the optimal mission response team.

## 4.6 Concluding Remarks

In this chapter a thorough and explanation of the DST is given. Section 4.2 describes the information needed for the DST, how it has been sourced and how it is structured. The formulation of the model is given in Section 4.3, while the solution and results achieved by using the model are discussed in Section 4.4. To determine if the results obtained do in fact reflect reality, a thorough validation process is outlined at the end of the chapter. The results should be reproducible, accurate and trustworthy.

## Chapter 5

### Conclusion, recommendations and the way forward

The Mobilisation of an International Urban Search and Rescue team is the first phase of Response when a disaster strikes. It is during this phase that the groundwork is laid down for the rest of the operations during the USAR mission. An improvement here, no matter how small, will have a ripple-effect in subsequent phases where gains will be measured in human lives saved. Any shortcomings of the team during their mobilisation will be disastrously magnified.

Chapter 2 has aimed to create sufficient context for the Disaster Management industry, identifying the role players, locally and internationally. A closer look is taken at the Disaster response phase, in which the primary function of RescueSA is located. It becomes apparent that every phase of disaster response is critical, but importantly, to quote the old adage: “Proper prior planning prevents poor performance.” Poor performance cannot be tolerated in disaster response, as this equals lives lost.

To this extent the main objective of this project is to improve the mobilisation phase for RescueSA. This will be done firstly by developing a structured mobilisation plan as set out in Chapter 3. This plan presents an opportunity to more easily identify areas for improvement and efficiency. In the literature BPMN was identified as the most suitable mapping technique and is utilised for the conceptual design of the plan. A clear high-level explanation towards the content of the outlined document structure is given, without congesting the report with information. The information contained within this manual is at such a level of detail as to be able to successfully guide a new management corps towards the deployment of a disaster response mission team. Visual aids to support the Mobilisation Manual were developed after the document had formally been validated through the ‘Table-top exercise’. In the end, the possibility exists to utilise the BPMN model to create a web-based application to guide management through every step of this tedious process. The application will be able to, for example, generate and send correspondence, such as e-mails, to the relevant members of management to simplify communication. Being guided by the application will ensure that none of the activities are overlooked, guaranteeing that the best suited team, along with all the correct equipment and supplies are mobilised in a fashion which complies with all of the INSARAG Guidelines. This web application is not included in the scope of the project.

The mobilisation phase was further improved by the development of a decision support tool to assist USAR Team Management to select team members that have the necessary competencies to best deal with the disaster. Research has led to a simple model used for the selection of soccer players and, as set out in the conceptual design of the DST, has been adequately adjusted to be utilised for the selection of the most proficient USAR technicians for a specified scenario. The volunteer-score

tables and the scenario-score tables have already been generated in a manner which is intuitive and easily updatable. The volunteer-score table reflects the marks obtained by the USAR technicians during their formal training and practical experiences, as a rating. It will be at the discretion of the senior management personnel to revise these ratings. The scenario-score table relied heavily on the experience of the management team to provide ratings for the importance of the specified USAR skills for a predetermined scenario. The real challenge emerged when attempting to combine the score tables for a Weighted-score table to function as input for the model. The model executed successfully using Lingo 14.0, where acceptable results were returned. With the functioning DST in place, a sensitivity analysis was done using the real-world data to fully validate the DST.

The DST has proven to be a powerful and helpful tool in determining the optimal USAR mission team to respond to various disasters. It is highly recommended that RescueSA implement this tool in their mobilisation operations, in addition to the manual. An area for auxiliary development of the DST is the addition of different types of positions, such as the medical staff. As previously stated, this will only become a reality when there is a much larger pool of volunteers to select from. It is recommended that RescueSA keep a comprehensive database of volunteers being deployed, as well as in which position, to be able to accurately update their experience ratings.

After the completion of the project, Rescue South Africa has an accurate and functional living document, as well as a powerful decision support tool which will enable management to improve on the critical time to mobilise the ideal USAR team.

## Annexures

Annexure A: Industry Sponsorship Form

Annexure B: Rescue South Africa Philippines Mission Team Structure

Annexure C: Business Process Modelling Notation Model

Annexure D: Lingo 14.0 Model Formulation for the Decision Support Tool

Annexure E: Team Selection of the Earthquake and Hurricane Scenarios

**Department of Industrial & Systems Engineering**  
**Final Year Projects**  
**Identification and Responsibility of Project Sponsors**

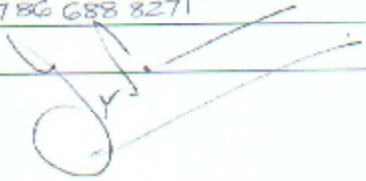
All Final Year Projects are published by the University of Pretoria on **UPSpace** and thus freely available on the Internet. These publications portray the quality of education at the University and have the potential of exposing sensitive company information. It is important that both students and company representatives or sponsors are aware of such implications.

**Key responsibilities of Project Sponsors:**

A project sponsor is the key contact person within the company. This person should thus be able to provide the best guidance to the student on the project. The sponsor is also very likely to gain from the success of the project. The project sponsor has the following important responsibilities:

1. Confirm his/her role as project sponsor, duly authorised by the company. Multiple sponsors can be appointed, but this is not advised. The duly completed form will be considered as acceptance of sponsor role.
2. Review and approve the Project Proposal, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable from the company's perspective.
3. Review the Final Project Report (delivered during the second semester), ensuring that information is accurate and that the solution addresses the problems and/or design requirements of the defined project.
4. Acknowledges the intended publication of the Project Report on UP Space.
5. Ensures that any sensitive, confidential information or intellectual property of the company is not disclosed in the Final Project Report.

**Project Sponsor Details:**

Company:	RESCUE SOUTH AFRICA
Project Description:	
Student Name:	
Student number:	
Student Signature:	
Sponsor Name:	IAN SCHEE
Designation:	CEO
E-mail:	IAN@RESCUE-SA.CO.ZA
Tel No:	
Cell No:	+2782 459 9765
Fax No:	+2786 688 8271
Sponsor Signature:	

## Annexure B: Rescue South Africa Philippines Mission Team Structure

### PHILIPPINES MISSION TEAM STRUCTURE

Names	Region/Company	Squad	Squad Position
P Groenewald	Media		Media
L Sello	Media		Media
F Dlangamandla	Media		Media
N McCartney	Media		Media
Lourensa Eckard	The Beeld		Media
Shelley Christians	Press/The Times		Media

E Kramer		Management	Safety Officer/Paramedic
Tim Norris		Management	Structural Engineer
M du Toit	Rescue SA	Management	Team Leader/Liaison Officer
P van der Spuy	ER24	Medical/Manager	Medical Team Manager / Liaison Officer

P van der Spuy	ER24	Medical/Manager	Medical Team Manager / Liaison Officer
A Lithgow		Medical	ALS/Paramedic
G Pienaar		Medical	Paramedic
Sylvia Mannyana Maimane	Tshwane	Medical	Paramedic
Refilwe Sabina Kgokane	Tshwane	Medical	Paramedic
Robin L Charles	Gauteng	Medical	Paramedic
Rona Livanos	Gauteng	Medical	Paramedic

I Scher	Rescue SA	Logistics	Logistics Team Manager
Klaas Prinsloo		Logistics	Logistician
F Brill	Rescue SA	Logistics	Logistics Specialist
S McDonnell	Rescue SA	Logistics	Communication Specialist
Chris Barnard	Offroad Rescue	Logistics	Communication Specialist

G Vosloo	Rescue SA	Rescue Team 1	Rescue Team Officer
Johannes Hendrik Malan	Joburg	Team 1	Rescuer / Als
Muso Lehlokoa	Lesotho	Team 1	Rescuer
David Chinunda	Zambia	Team 1	Rescuer
Chris Coetzee	Joburg	Team 1	Rescuer
Ludwig Goldschagg	Tshwane	Team 1	Rescuer
Chris Smit	Ekurhuleni	Team 1	Rescuer
Mfaukhona Thomas Zulu	Ekurhuleni	Team 1	Rescuer

C van Niekerk		Rescue Team 2	Rescue Team Officer
Anban Ganasen Nair	Joburg	Team 2	Rescuer / ALS
Rudy Nell	Joburg	Team 2	Rescuer
Wayne Martin Harvey	Joburg	Team 2	Rescuer
Bernard Edward Gessing	Joburg	Team 2	Rescuer
Cornelius Johannes Kruger	gauteng	Team 2	Rescuer
Gerald Moswathupa	Ekurhuleni	Team 2	Rescuer
Prince Manganye	Tshwane	Team 2	Rescuer

Thabo Charles Mabaso	Tshwane	Rescue Team 3	Rescue Team Officer
Jurgens Johannes Vorster	Joburg	Team 3	Rescuer / ALS
Rachel Martin	Joburg	Team 3	Rescuer
Derek Gavin Bouwer	Joburg	Team 3	Rescuer
Lucas Masalesa Kekana	Joburg	Team 3	Rescuer
William Mogale Ntladi	Ekurhuleni	Team 3	Rescuer
Eric Gerhardus Bothma	Ekurhuleni	Team3	Rescuer

Paul Gershin Chetty	Joburg	Team 4	Rescue Team Officer
Ntibi David Tshabalala	Ekurhuleni	Team 4	Rescuer
Andrew Murray Louis Faure	Joburg	Team 4	Rescuer/ALS

Pat Cass	Joburg	Team 4	Rescuer
Lindsay Zwelithini Mnguni	Tshwane	Team 4	Rescuer
Kwena George Moabelo	Joburg	Team 4	Rescuer
Barend, Johannes Bothma (Ben)	Ekurhuleni	Rescue Team 4	Rescuer





## Annexure D: Lingo 14.0 Model Formulation

SETS:

```
Volunteers / I1, I2, I3, I4, I5, I6, I7, I8, I9, I10,  
            I11, I12, I13, I14, I15, I16, I17, I18, I19, I20,  
            I21, I22, I23, I24, I25, I26, I27, I28, I29, I30,  
            I31, I32, I33, I34, I35/ ;  
  
Positions / J1, J2, J3, J4, J5, J6, J7, J8, J9, J10,  
           J11, J12, J13, J14, J15, J16, J17, J18, J19, J20,  
           J21, J22/ ;  
  
Weighted ( Volunteers, Positions)  
:WWeighted;  
  
Selected ( Volunteers, Positions) :XSelected;
```

ENDSETS

! The objective;

[OBJ] MAX = @SUM( Volunteers (I):

@SUM( Positions (J): WWeighted(I,J)\*XSelected(I,J)));

@FOR( Positions (J):

@SUM( Volunteers (I): XSelected(I,J))<=1);

@FOR( Volunteers (I):

@SUM( Positions (J): XSelected(I,J))<=1);

@FOR( Volunteers (I):

@FOR( Positions (J): @BIN( XSelected(I,J)));

DATA:

WWeighted =

42.6333	,	42.6333	,	42.6333	,	42.6333	,
42.0333	,	42.0333	,	42.0333	,	42.0333	,
38.9583	,	38.9583	,	38.9583	,	38.9583	,
37.4917	,	37.4917	,	37.4917	,	37.4917	,
37.4917	,	37.4917	,	37.4917	,	37.4917	,
37.4917	,	37.4917	,				
45.4833	,	45.4833	,	45.4833	,	45.4833	,
44.9500	,	44.9500	,	44.9500	,	44.9500	,
42.5500	,	42.5500	,	42.5500	,	42.5500	,
40.4833	,	40.4833	,	40.4833	,	40.4833	,
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40.4833	,	40.4833	,				
45.7167	,	45.7167	,	45.7167	,	45.7167	,
45.2000	,	45.2000	,	45.2000	,	45.2000	,
42.0500	,	42.0500	,	42.0500	,	42.0500	,
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40.4833	,	40.4833	,	40.4833	,	40.4833	,
40.4833	,	40.4833	,				
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36.1750	,	36.1750	,	36.1750	,	36.1750	,
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34.7083	,	34.7083	,				
51.6500	,	51.6500	,	51.6500	,	51.6500	,
50.9750	,	50.9750	,	50.9750	,	50.9750	,
46.2083	,	46.2083	,	46.2083	,	46.2083	,
45.0417	,	45.0417	,	45.0417	,	45.0417	,
45.0417	,	45.0417	,	45.0417	,	45.0417	,
45.0417	,	45.0417	,				
52.4750	,	52.4750	,	52.4750	,	52.4750	,
51.7667	,	51.7667	,	51.7667	,	51.7667	,
46.9417	,	46.9417	,	46.9417	,	46.9417	,
45.6083	,	45.6083	,	45.6083	,	45.6083	,
45.6083	,	45.6083	,	45.6083	,	45.6083	,
45.6083	,	45.6083	,				
49.2000	,	49.2000	,	49.2000	,	49.2000	,
48.8667	,	48.8667	,	48.8667	,	48.8667	,
46.0667	,	46.0667	,	46.0667	,	46.0667	,
44.4000	,	44.4000	,	44.4000	,	44.4000	,
44.4000	,	44.4000	,	44.4000	,	44.4000	,
44.4000	,	44.4000	,				
44.0417	,	44.0417	,	44.0417	,	44.0417	,
43.6000	,	43.6000	,	43.6000	,	43.6000	,
39.4667	,	39.4667	,	39.4667	,	39.4667	,
37.9000	,	37.9000	,	37.9000	,	37.9000	,
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37.9000	,	37.9000	,				
48.0833	,	48.0833	,	48.0833	,	48.0833	,
47.5083	,	47.5083	,	47.5083	,	47.5083	,
42.9833	,	42.9833	,	42.9833	,	42.9833	,
40.9500	,	40.9500	,	40.9500	,	40.9500	,
40.9500	,	40.9500	,	40.9500	,	40.9500	,
40.9500	,	40.9500	,				

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47.6833	,	47.6833	,	47.6833	,	47.6833	,
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45.7500	,	45.7500	,	45.7500	,	45.7500	,
45.7500	,	45.7500	,	45.7500	,	45.7500	,
49.3083	,	49.3083	,	49.3083	,	49.3083	,
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45.3000	,	45.3000	,	45.3000	,	45.3000	,
45.3000	,	45.3000	,	45.3000	,	45.3000	,
44.8417	,	44.8417	,	44.8417	,	44.8417	,
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38.5833	,	38.5833	,	38.5833	,	38.5833	,
38.5833	,	38.5833	,	38.5833	,	38.5833	,
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46.3167	,	46.3167	,	46.3167	,	46.3167	,
44.8833	,	44.8833	,	44.8833	,	44.8833	,
44.8833	,	44.8833	,	44.8833	,	44.8833	,
44.8833	,	44.8833	,	44.8833	,	44.8833	,
51.0667	,	51.0667	,	51.0667	,	51.0667	,
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44.0917	,	44.0917	,	44.0917	,	44.0917	,
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41.2000	,	41.2000	,	41.2000	,	41.2000	,
41.2000	,	41.2000	,	41.2000	,	41.2000	,
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37.8667	,	37.8667	,	37.8667	,	37.8667	,
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49.9333	,	49.9333	,	49.9333	,	49.9333	,
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44.9083	,	44.9083	,	44.9083	,	44.9083	,
44.9083	,	44.9083	,	44.9083	,	44.9083	,
44.9083	,	44.9083	,	44.9083	,	44.9083	,
44.7750	,	44.7750	,	44.7750	,	44.7750	,
44.4833	,	44.4833	,	44.4833	,	44.4833	,
40.4083	,	40.4083	,	40.4083	,	40.4083	,
39.1750	,	39.1750	,	39.1750	,	39.1750	,
39.1750	,	39.1750	,	39.1750	,	39.1750	,
39.1750	,	39.1750	,	39.1750	,	39.1750	,
47.3500	,	47.3500	,	47.3500	,	47.3500	,
46.7083	,	46.7083	,	46.7083	,	46.7083	,
43.4333	,	43.4333	,	43.4333	,	43.4333	,
42.3000	,	42.3000	,	42.3000	,	42.3000	,
42.3000	,	42.3000	,	42.3000	,	42.3000	,
42.3000	,	42.3000	,	42.3000	,	42.3000	,
48.9000	,	48.9000	,	48.9000	,	48.9000	,
48.1833	,	48.1833	,	48.1833	,	48.1833	,
45.4417	,	45.4417	,	45.4417	,	45.4417	,
43.9083	,	43.9083	,	43.9083	,	43.9083	,
43.9083	,	43.9083	,	43.9083	,	43.9083	,
43.9083	,	43.9083	,	43.9083	,	43.9083	,
45.5917	,	45.5917	,	45.5917	,	45.5917	,
45.2917	,	45.2917	,	45.2917	,	45.2917	,
42.5917	,	42.5917	,	42.5917	,	42.5917	,
40.8917	,	40.8917	,	40.8917	,	40.8917	,
40.8917	,	40.8917	,	40.8917	,	40.8917	,
40.8917	,	40.8917	,	40.8917	,	40.8917	,
40.8917	,	40.8917	,	40.8917	,	40.8917	,
48.5417	,	48.5417	,	48.5417	,	48.5417	,
47.9750	,	47.9750	,	47.9750	,	47.9750	,
44.7583	,	44.7583	,	44.7583	,	44.7583	,
43.1250	,	43.1250	,	43.1250	,	43.1250	,
43.1250	,	43.1250	,	43.1250	,	43.1250	,
43.1250	,	43.1250	,	43.1250	,	43.1250	,
41.2833	,	41.2833	,	41.2833	,	41.2833	,
40.6833	,	40.6833	,	40.6833	,	40.6833	,
37.9833	,	37.9833	,	37.9833	,	37.9833	,
36.5167	,	36.5167	,	36.5167	,	36.5167	,
36.5167	,	36.5167	,	36.5167	,	36.5167	,
36.5167	,	36.5167	,	36.5167	,	36.5167	,
53.6167	,	53.6167	,	53.6167	,	53.6167	,
53.0917	,	53.0917	,	53.0917	,	53.0917	,
50.2000	,	50.2000	,	50.2000	,	50.2000	,
47.8667	,	47.8667	,	47.8667	,	47.8667	,
47.8667	,	47.8667	,	47.8667	,	47.8667	,
47.8667	,	47.8667	,	47.8667	,	47.8667	,

51.9333	,	51.9333	,	51.9333	,	51.9333	,
51.5250	,	51.5250	,	51.5250	,	51.5250	,
48.9417	,	48.9417	,	48.9417	,	48.9417	,
46.3417	,	46.3417	,	46.3417	,	46.3417	,
46.3417	,	46.3417	,	46.3417	,	46.3417	,
46.3417	,	46.3417	,				
42.1750	,	42.1750	,	42.1750	,	42.1750	,
41.9333	,	41.9333	,	41.9333	,	41.9333	,
39.3333	,	39.3333	,	39.3333	,	39.3333	,
37.1000	,	37.1000	,	37.1000	,	37.1000	,
37.1000	,	37.1000	,	37.1000	,	37.1000	,
37.1000	,	37.1000	,				
55.4250	,	55.4250	,	55.4250	,	55.4250	,
54.7083	,	54.7083	,	54.7083	,	54.7083	,
50.4417	,	50.4417	,	50.4417	,	50.4417	,
47.5750	,	47.5750	,	47.5750	,	47.5750	,
47.5750	,	47.5750	,	47.5750	,	47.5750	,
47.5750	,	47.5750	,				
46.7167	,	46.7167	,	46.7167	,	46.7167	,
46.3750	,	46.3750	,	46.3750	,	46.3750	,
42.2917	,	42.2917	,	42.2917	,	42.2917	,
40.3917	,	40.3917	,	40.3917	,	40.3917	,
40.3917	,	40.3917	,	40.3917	,	40.3917	,
40.3917	,	40.3917	,				
43.7667	,	43.7667	,	43.7667	,	43.7667	,
43.2500	,	43.2500	,	43.2500	,	43.2500	,
40.0583	,	40.0583	,	40.0583	,	40.0583	,
38.7917	,	38.7917	,	38.7917	,	38.7917	,
38.7917	,	38.7917	,	38.7917	,	38.7917	,
38.7917	,	38.7917	;				

ENDDATA

End

## Annexure E: Team Selection of the Earthquake and Hurricane Scenarios

Position allocated to with regard to Disaster Scenario		
	Earthquake	Hurricane
<b>Andrew Murray Louis Faure</b>	J6	J14
<b>Chris Coetzee</b>	J22	J15
<b>Derek Gavin Bower</b>	J5	J05
<b>Eric Gerhardus Bothma</b>	J2	J10
<b>Gerald Moswathupa</b>	J4	J4
<b>Johannes Hendrik Malan</b>	J13	J11
<b>Jurgens Johannes Vorster</b>	J14	J2
<b>Kwena George Moabelo</b>	J10	J17
<b>Lindsay Zwelithini Mnguni</b>	J19	J9
<b>Lucas Masalesa Kekana</b>	J8	J1
<b>Ludwig Goldschagg</b>	J11	J20
<b>Mfanukhona Thomas Zulu</b>	J1	J8
<b>Pat Cass</b>	J18	J22
<b>Paul Gershin Chetty</b>	J12	J7
<b>Refilwe Sabina Kgokane</b>	J9	J6
<b>Robin Lester Charles</b>	J3	J3
<b>Rona Livanos</b>	J7	J21
<b>Rudy Nell</b>	J17	J13
<b>Sylvia Mannyana Maimane</b>	J21	J19
<b>Thabo Charles Mabaso</b>	J20	J18
<b>Wayne Martin Harvey</b>	J15	J12
<b>William Mogale Ntladi</b>	J16	J16

## References

- Aguilar-Savén, R. S., 2004. Business process modelling: Review and framework. *International Journal of Production Economics*, Volume 90, pp. 129-149.
- Altay & Green, 2006. OR/MS research in disaster operations management. *European Journal of Operational Research*, 175(1), pp. 473-493.
- Baykasoglua, A., Derelia, T. & Das, S., 2007. Project team selection using fuzzy optimization approach. *Cybernetics and Systems: An International Journal*, 38(2), pp. 155-185.
- Boon, B. H. & Sierksma, G., 2003. Team formation: Matching quality supply and quality demand. *European Journal of Operational Research*, 148(2), pp. 277-292.
- Chang, Y., Wilkinson, S., Potangaroa, R. & Seville, E., 2012. Managing resources in disaster recovery projects. *Engineering, Construction and Architectural Management*, 19(5), pp. 557-580.
- Ciottone, G. R., 2006. *Disaster Medicine*. 3rd ed. Philadelphia: Mosby Elsevier.
- Deas, S., 2009. *SlideShare: Why Process Mapping?*. [Online]  
Available at: <http://www.slideshare.net/SDeas/simple-process-mapping-techniques>  
[Accessed 18 May 2014].
- Emergency Management Australia, 2004. *Emergency Planning. Manual 43*, Dickson: Commonwealth of Australia.
- Flemming, J., 2014. *Pounds of Prevention - Focus on Peru*. [Online]  
Available at: <http://blog.usaid.gov/2014/02/pounds-of-prevention-focus-on-peru/>  
[Accessed 1 April 2014].
- Green, W., 2002. *Four phases of emergency management. Electronic Encyclopedia of Civil Defense and Emergency Management.*. [Online]  
Available at: <http://0-www.richmond.edu.innopac.up.ac.za/~wgreen/encyclopedia.htm>  
[Accessed 24 March 2014].
- IDEF, 2010. *Integrated DEFinition Methods*. [Online]  
Available at: <http://www.idef.com/IDEF0.htm>  
[Accessed 18 May 2014].
- INSARAG, 2012. *Guidelines and Methodology*, New York: United Nations Office for the Coordination of Humanitarian Affairs.
- INSARAG, 2014. *IER/IER Handbook*. [Online]  
Available at: <http://www.insarag.org/en/iec/process-a-guidelines.html>  
[Accessed 2 May 2014].
- INSARAG, 2014. *Mandate of INSARAG*. [Online]  
Available at: <http://www.insarag.org/en/about/mandate-of-insarag-leftmenu.html>  
[Accessed 25 March 2014].
- Kelly, C., 1995. A framework for improving operational effectiveness and cost efficiency in emergency planning and response. *Disaster Prevention and Management*, 4(3), pp. 25-31.

- Ko, R. K., Lee, S. S. & Lee, e. W., 2009. Business process management (BPM) standards: a survey. *Business Process Management Journal*, 15(5), pp. 744-791.
- Kovács, G. & Spens, K. M., 2007. Humanitarian logistics in disaster relief operations. *International Journal of Physical Distribution & Logistics Management*, 37(2), pp. 99-144.
- Maine Emergency Management Agency, 2008. *What is Emergency Management?*. [Online] Available at: [https://www.maine.gov/mema/about/mema\\_emdef.shtml](https://www.maine.gov/mema/about/mema_emdef.shtml) [Accessed 24 March 2014].
- Markov, I. & Varone, S., 2013. *Management of Emergency Response Teams under Stochastic Demands*. Barcelona, International Conference on Operations Research and Enterprise Systems.
- Mete, H. O. & Zabinsky, Z. B., 2010. Stochastic optimization of medical supply location and distribution in disaster management. *International Journal of Production Economics*, 126(1), pp. 76-84.
- MI-TF1, 2008. *Michigan Urban Search and Rescue Task Force 1 Mobilisation Manual*, Lansing: s.n.
- National Geographic News, 2005. *Hurricane Katrina: Complete Coverage*. [Online] Available at: [http://news.nationalgeographic.com/news/2005/09/0902\\_050902\\_katrina\\_coverage.html](http://news.nationalgeographic.com/news/2005/09/0902_050902_katrina_coverage.html) [Accessed 1 April 2014].
- National Geographic News, 2005. *The Deadliest Tsunami in History?*. [Online] Available at: [http://news.nationalgeographic.com/news/2004/12/1227\\_041226\\_tsunami.html](http://news.nationalgeographic.com/news/2004/12/1227_041226_tsunami.html) [Accessed 1 April 2014].
- National Geographic News, 2010. *Haiti Earthquake "Strange," Strongest in 200 Years*. [Online] Available at: <http://news.nationalgeographic.com/news/2010/01/100113-haiti-earthquake-red-cross/> [Accessed 1 April 2014].
- National Geographic News, 2013. *The 2011 Japan Tsunami Was Caused By Largest Fault Slip Ever Recorded*. [Online] Available at: <http://news.nationalgeographic.com/news/the-2011-japan-tsunami-was-caused-by-largest-fault-slip-ever-recorded/> [Accessed 1 April 2014].
- OMG, 2011. *Object Management Group*. [Online] Available at: <http://www.omg.org/spec/BPMN/2.0/> [Accessed 19 May 2014].
- Pang, S.-W., 2011. *Process Excellence Network*. [Online] Available at: <http://www.processexcellencenetwork.com/business-process-management-bpm/articles/4-common-process-mapping-mistakes-and-how-to-avoid/> [Accessed 18 May 2014].
- Paton, D., 2003. Stress in disaster response: a risk management approach. *Disaster Prevention and Management*, 12(3), pp. 203-209.
- Rescue South Africa, 2012. Urban Search and Rescue... What's the story on training?. *FIRE Africa*, October.



- Rescue South Africa, 2013. Urban Search and Rescue: Foreign Disaster Response. *FIRE Africa*, May.
- Rescue South Africa, 2014. *Disaster Response Urban Search and Rescue*. [Online]  
Available at: <http://www.rescue-sa.co.za/>  
[Accessed 25 February 2014].
- Rescue South Africa, 2014. *Rescue South Africa Fact Sheet*. [Online]  
Available at: <http://www.rescue-sa.co.za/about-us.html>  
[Accessed 25 February 2014].
- Rescue South Africa, 2014. *Training*. [Online]  
Available at: <http://www.rescue-sa.co.za/training.html>  
[Accessed 29 April 2014].
- Scher, I., 2014. *Introduction to Rescue South Africa* [Interview] (2014 February 2014).
- Schneider, S. K., 2005. *Administrative Breakdowns in the Governmental Response to Hurricane Katrina*, Michigan: Michigan State University.
- Sessions, R., 1950. How a 'Difficult' Composer Gets That Way. *New York Times*, 8 January.
- UN ISDR, 2009. *Terminology on Disaster Risk Reduction*, Geneva: United Nations International Strategy for Disaster Reduction.
- UN ISDR, 2013. *ReliefWeb*. [Online]  
Available at: <http://reliefweb.int/map/world/world-humanitarian-and-country-icons-2012>  
[Accessed 18 May 2014].
- UN OCHA, 2006. *The Use of Foreign Military and Civil Defence Assets In Disaster Relief - "Oslo Guidelines"*, Geneva: United Nations Office for the Coordination of Humanitarian Affairs.
- UN OCHA, 2012. *INSARAG: Structure*. [Online]  
Available at: <http://www.unocha.org/what-we-do/coordination-tools/insarag/structure>  
[Accessed 28 April 2014].
- United Nations, 2003. *Resolution 57/150 of 16 December 2002 "Strengthening the Effectiveness and Coordination of international USAR assistance"*, Geneva: United Nations.
- van Hoving, D. J. et al., 2010. Haiti: The South African perspective. *South African Medical Journal*, 100(8), pp. 513-515.
- VA-TF1, 2008. *Fairfax County Urban Search and Rescue Task Force One Mobilisation Manual*, Fairfax: s.n.
- White, S. A., 2004. *BPTrends*. [Online]  
Available at: <http://www.bptrends.com/bpt/wp-content/publicationfiles/07-04%20WP%20Intro%20to%20BPMN%20-%20White.pdf>  
[Accessed 18 May 2014].
- Zakarian, A. & Kusiak, A., 1999. Forming teams: an analytical approach. *IIE Transactions*, 31(1), pp. 85-97.