DEVELOPING AN ASSESSMENT FRAMEWORK TO ENHANCE COMMUNITY RESILIENCE TO PLUVIAL FLOODS IN THE UAE

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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I would like to give praise and thanks to Allah for granting me health, strength and knowledge to complete this work.

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DEDICATION

This research is dedicated to my late daughter Salama, my mother, father, wife, lovely children Mariam and Ahmed, brothers, sisters, and my late uncle Mr Ahmed Alkuwaiti.

DECLARATION

This thesis is submitted in partial fulfilment of the University of Salford requirements for the award of a PhD degree. While the research was in progress, some research findings were published in conference paper prior to the thesis submission.

The researcher declares that no portion of the work referred to in the thesis has been submitted in support of another qualification or degree programme at any other university or learning institution, either in the UK or another country.

MUSABBEH ALNUAIMI

LIST OF ABBREVIATIONS

WB	World Bank
DRR	Disaster Risk Reduction
UAE	United Arab Emirates
CRPF	Community Resilience to Pluvial Flood
UNISDR	United Nations International Strategy for Disaster Reduction
MENA	Middle East and North Africa
WCDRR	World Congress on Disaster Risk Reduction
UNEP	Global Risk Data Platform
CRED	Centre for Research on the Epidemiology of Disasters
DRM	Disaster Risk Management
FRM	Flood Risk Management
EM-DAT	OFDA/CRED International Disaster Database
NCEMA	National Emergency Crisis and Disaster Management
NGOs	Non-governmental organisations
HFA	Hyogo Framework for Action
SFDRR	Sendai Framework for Disaster Risk Reduction
CDRF	Community Disaster Resilience Framework
DROP	Disaster Resilience of Place
SLF	Sustainable livelihood framework
AHP	Analytic Hierarchy Process
SPSS	Statistical Package for the Social Sciences

PUBLICATIONS

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ABSTRACT

Over the last two decades, the increase in natural disasters has affected communities around the world through significant loss of life and negative environmental and economic impacts. Although communities cannot always prevent these disasters, they can mitigate their consequences by adopting several disaster management strategies, including improving community resilience, which refers to a community's capacity to withstand and cope with disasters. In recent years, enhancing community resilience to disasters becoming one of the most supported approaches to disaster risk management. Due to its geographical location and environmental conditions, the United Arab Emirates (UAE) has experienced an increase in natural hazards, including pluvial floods. In fact, pluvial floods have become a global concern as they cause a serious threat to lives and livelihoods. They are difficult to predict, less well known by communities, and happen due to heavy rains in a short time, resulting in difficulties in managing them effectively. The UAE has recognised the importance of implementing and adopting appropriate measures to mitigate the potential effects of these hazards. Therefore, due to the lack of assessment tools and published evidence on community flood resilience, this research aims to develop an assessment framework to enhance community resilience to pluvial floods in the UAE.

To achieve this aim, the research adopts a case study strategy with an exploratory sequential mixed-methods approach, and it is structured into four phases for data collection and analysis. In the first phase, qualitative semi-structured interviews were conducted with senior managers (n=12) from related government organisations with rich knowledge and experience in the field of emergency management to investigate and identify key factors that influence community flood resilience through using content analysis based on four main dimensions of resilience: physical, institutional, social and economic. The second phase was employed the questionnaire survey completed by government officials (n=82) at different management levels to analyse the identified factors and obtain respondents' consensus on their relevance to assess community resilience to pluvial floods. In the third phase, the proposed framework was developed by using an analytic hierarchy process (AHP) to determine each factor's level of importance based on experts' opinions (n=10) by using pair-wise comparisons as the method of judgement, so that weights of factors were determined and organised into the developed framework. The last phase included the validation stage of the Community Resilience to Pluvial Floods (CRPF)

framework by employing a focus group method with seven senior managers to verify its relevance, implementation and adaptation in the UAE context. The findings of this research indicate that the CRPF framework, which consists of four resilience dimensions and 20 key factors, can be used as an assessment tool for stakeholders, particularly for government organisations, helping to enhance community resilience to pluvial floods. This framework provides an important step towards building more resilient communities through the development of measures, policies and regulations for effective management of pluvial floods hazards in the UAE and surrounding regions.

CHAPTER 1: INTRODUCTION

1.1 Introduction

The purpose of this chapter is to give a comprehensive introduction to this research study. Particularly, this chapter will first start by giving a general background of the research topic highlighting the importance of this research. Then, the research justifications are explained through exploring the current gaps in knowledge related to the research topic. Moving forward, it clarifies the research questions and the aim and objectives of this research. This chapter underlines the conducted research's original contribution to the knowledge in the areas of disaster management and community flood resilience. Finally, the proposed methodology adopted in this research is clarified with the research process and the thesis structure.

1.2 Research Background

In recent decades, our planet has experienced an unprecedented increase in earth's temperatures and changing in climate patterns. The changing in the hydrological cycle can be observed as the main environmental changes which is composed of many elements such as higher water evaporation and precipitation (Ye et al., 2014). These changes, combined with a greater degree of urbanisation have resulted in an increase in both the frequency and severity of natural disasters (Field, 2014; EM-DAT, 2015). Natural disasters frequently affect communities globally and cause large damages and losses, which in turn badly affect people's lives from all corners, indirectly and directly. According to a World Bank (2010) report, there were more than 82,500 deaths every year as a result of these natural disasters from the period 1970 to 2010, and the economic loss was US$3.8 trillions from 1980 to 2012 (World Bank, 2014). Other reports have disclosed that disasters related to economic losses are now raising new warnings since they are touching US$300 billion on a yearly basis, and they had affected more than 141 million people globally in 2014 (UNISDR, 2015; Guha-Sapir et al., 2016).

Hydrological disasters are the most recurrent type of natural disaster. They caused negative impacts in different parts of the world including loss of lives and substantial damages to properties and environments, which has forced policymakers to take appropriate measures to minimize these impacts. According to Guha-Sapir et al. (2016), there are various types of hydrological disasters such tsunami, landslide and floods. Form all these, floods are the most severe one as they represent 35% of the overall global natural disasters (Le Polain de Waroux, 2011). Flood disasters tend to have severe negative impacts on human lives, the economy, society and the environment (Jha et al., 2012). For example, from the year 1900 to 2004, flood disasters left almost 7 million people dead and led to almost $323 billion in damage all over the world (Merabtene & Yoshitani, 2005). Specifically, the total number of people affected by flooding in 2010 was 178 million; this represented over 56% of all disasters (Renaud, 2013). Figure 1.1 demonstrates the trend in number of flood disasters in each five years for the period 1980 to 2006 (Adikari & Yoshitani, 2009).

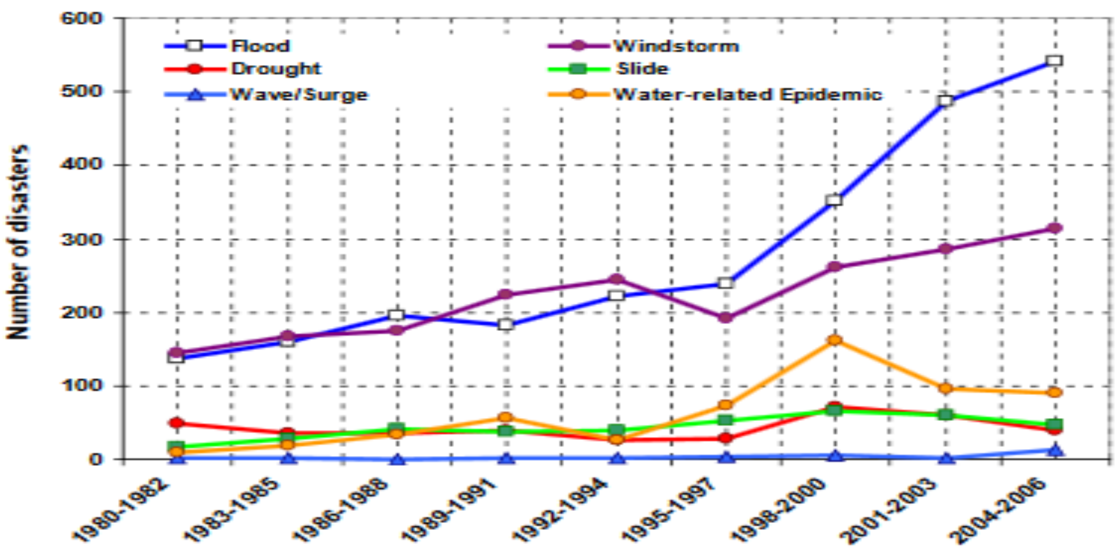

Figure 1.1: Global trend in number of flood disasters from 1980 to 2006 (Adikari & Yoshitani, 2009).

Over the last three decades, there has been substantial increase in the frequency of floods worldwide. It has been observed that there were 2,750 flood disaster events during the years 2000 to 2016 and they occurred in many continents. The highest rate was recorded in Asia at 40%, Africa at 23.6%, then the United States at 20.4%, and finally Europe at 13.4% (Guha-Sapir et al., 2014). Floods fall into various categories such as groundwater floods, river floods, coastal floods and pluvial floods (Ingirige & Amaratunga, 2013; Jha et al., 2012). According to UKELA (2014), pluvial floods are typically unpredictable, and they occur suddenly (mostly without early warning) as a result of steady and extreme rainstorms. Due to the lack of soil permeability (low rainfall absorption), urban areas are the most vulnerable to these hazards (Jha et al., 2012). Many scholars highlighted that climate change phenomenon significantly influences the frequency and intensity of pluvial floods (Houston et al., 2011; Abdulkareem, 2018; Tabari, 2020). This brings a real challenge in managing them and provide enough warning time. Houston et al. (2011) and Abdulkareem (2018) clarified that this type of flood is less well known and understood by the public, and happens because of heavy rainfall in a short amount of time, so that they cannot be effectively managed through rainwater drainage system or ground infiltration.

Recent studies have stated that the stability and growth in the Middle East and North Africa (MENA) region is badly hindered by the floods related serious challenges (World Bank, 2014). Pluvial floods in a wide range of areas across the MENA region have caused social disruption in terms of livelihood and business, loss of life and huge economic damage to public and private resources. The incremental frequency of surges and floods in the area is an obvious indicator that the management of urban floods will have possible significance for the sustainable development of present and future infrastructures in the MENA region (Evans, 2008; Evans, Smith & Oglesby, 2004). Merabtene and Gokhan (2011) stated that, in recent years, many Middle Eastern countries such as Lebanon, Iraq and Jordan have suffered from the increasing frequency of pluvial floods. For instance, in the period from the year 2000 to 2006, there were 60 reported flood disasters in the Middle East and North Africa region, killing over 2,000 people and causing damage of over $400 million.

The United Arab Emirates (UAE) has also experienced several natural hazards such as Al Qurayah flood in 1995, Masafi Earthquake in 2002 and 2007, and Alghail flood in Sharjah in April 2013, due to atmospheric, hydrologic, geological or anthropogenic factors (Al Ghasyah Dhanhani, 2010; Al Khaili & Pathirage, 2014; Almarzooqi, 2017). These factors can lead to increase number of natural hazards in future, with drought, water shortage and flooding being the most recurrent. Consequently, the UAE have suffered negative impacts as result of these hazards in terms of economic, environmental and social losses. In fact, being part of the Middle East, which is mostly an arid to semi-arid region where fresh water is scarce and high temperatures are the norm, tends to magnify the magnitude of such disasters in the event of their occurrence. The UAE has been affected badly by climate change, through various means.

Although flood risk in the UAE is not that high, it has spread to new areas that have become more impermeable due to many factors such as low absorption, less infiltration, less vegetation, and more runoff (Yagoub et al., 2020). Pluvial floods caused by heavy rainfall have increasingly become a more common cause of flooding in the UAE and Abu Dhabi city in recent years (Abdouli et al., 2019; Sanderson, 2020) (See Figure 1.2 below). It leads to chaos on roads, damaging homes and forcing schools to close. This situation has been influenced by rapid population growth and decades of development which caused a dense urban and built environment. However, little attention has previously paid to flood measures in the UAE to protect communities from these hazards due to weather condition (Almarzouqi, 2017; Shanableh et al., 2018).

Figure 1.2: Flooding in Abu Dhabi city caused by heavy rain in 2016 (Perring, 2016).

As a result, it is important that local governments implement disaster management strategies to mitigate the effects of flooding. According to Mikulsen and Diduck (2016), disaster risk management can be explained as organising and implementing of all activities and measures to deal with any possible risks and their impacts. One essential disaster risk management strategy is the improvement in community resilience and a reduction in its vulnerability. Thus, it is important to obtain a deep understanding of this concept in order to enhance and implement resilience into disaster risk management strategies. Researchers such as Manyena (2006) and Sherrieb et al. (2012) indicated that after the Hyogo Framework for Action (HFA) was adopted in 2005, the term disaster resilience is considered a common concept used in disaster management. Therefore, to achieve disaster-resilient communities, all disaster risk management practices, policies and strategies need to be integrated (Chang and Shinozuka, 2004).

The concept of resilience comes from the Latin word '*resilire*', meaning 'rebounding back' (Klein et al., 2003). According to Lopez-Marrero and Tzchakert (2011) "resilience emphasises the multiple ways a system can respond to hazard occurrence, including its ability to absorb hazard impacts, to learn from, adapt to and recover from them, and to reorganise after impacts" (P.230). Thus, several studies have stated that resilience is becoming an essential concept for assessing environment adaptation policies for the architecture, engineering and construction industries (Keessen et al., 2013). Moreover, it was observed that the concept of resilience is still relatively new and is being used for the observation of the systems' dynamics in many specialist areas like business and management, engineering and economics (Madni & Jackson, 2009). Nevertheless, resilience is not seen by all researchers as a useable term (Vale, 2014), where this may be considered as weak argument since it is easy to use this concept through having an appropriate understanding of the specific situation for which resilience needs to develop.

Accordingly, there is currently an increase in efforts and recognition to consider comprehensive frameworks for supporting the development of a resilient system. In fact, the ability of governments to handle hazards and their consequences is considered a challenging task (Perrow, 2011). This is because insufficient planning for any hazard may cause significant environmental and human impacts (Haddow & Haddow, 2013). Steigenberger (2016) stated that the severity of damage caused by disasters in developing countries is usually larger due to less capacity to build and maintain response capabilities. Thus, modern communities have recognised the importance of being resilient to disasters as it is quite hard to avoid them; rather, they should learn how to manage and adapt to these disasters in order to reduce their impacts (Renschler et al., 2010).

When it comes to describing community resilience, it represents a community 's capacity to establish emergency plans and prepare for any unexpected incident, while maintaining the capacity to stay reactive and flexible to the current situation (Wickes et al., 2010). Particularly, a community is described as an entity which is enclosed in physically marked topographical borders (for instance, a specific village boundary) where groups of people share identical attributes, which are associated with each other in shape of a community (Norris et al., 2008). Kumar (2005) furthered this point as a community shares a common set of characteristics such as social, political, relational, economic, environmental and physical characteristics.

In disaster conditions, communities are unique in the sense that they do have their own ideas, resources, experiences and requirements regarding the recovery from diverse types of disasters, their response to those disasters, the way they protect themselves from the disasters, and about their prevention strategies. Every community has particular resources as well as the capability of influence and decision-making. Hence, broad ranges of local institutions are involved in disaster planning situations and they should immediately respond to unexpected disasters (Bruneau et al., 2003; Norris et al., 2008). This has led to the concept of community resilience actively gaining worldwide attention for being a framework for enhancing the response capability and disaster readiness (Sherrieb et al., 2012). Many scholars have observed that there are varying levels of resilience in communities, and there are established indicators when it comes to measuring a community's resilience (Cutter et al., 2010; Alshehri, 2016; Almutairi, 2019). Kirmayer et al. (2009) pointed out it is crucial to assess resilience over time in order to ensure that the resilience measurements are always suitable and updated. However, measuring community disasters resilience is still difficult in terms of developing dependable indicators and assessment approaches (Norris et al. 2008; Cimellaro et al., 2010). Thus, it is important that any expected disaster be managed appropriately in order to reduce its impacts and protect communities as building community disaster resilience is essential part of disaster risk management. This research particularly focuses on pluvial floods that have frequently occurred in the UAE, and how to enhance community resilience to cope with their related consequences through developing an assessment framework.

1.3 Justification for the Research

Floods influence communities differently and lead to direct and indirect impacts to the area, and communities react differently in terms of building their environment. There are many factors that influence pluvial floods including: existence of underground structures, rainwater drainage maintenance, and type and extent of impervious surfaces (Dawson et al., 2008). Thus, one of the main challenges of flood risk management is to mitigate and cope with floods caused by extreme rainfall. It is important to note that sustainable development is increasingly being influenced by natural disasters. The rate of flood disasters is rising much faster as compared to the capacity level of affected communities (EM-DAT, 2013). Consequently, there is a great need to take necessary measures to lessen flood impact at the community level so that local communities are well prepared to protect their properties and lives, and the risks of flooding in specific areas could be avoided as well (Ingirige et al., 2008; Ingirige and Wedawatta, 2011).

In addition, population growth and the movement of people to cities causing expansion of urban areas, where rapid urbanisation has led to many environmental challenges including: change in water resources and hydrological characteristics, urban heat island effect and contribution to climate change (Du et al., 2015). Urbanisation causes changes in hydrological processes by changing the characteristics of the surface infiltration due to an increasingly impermeable surface. An increase in built area leads to a reduction in infiltration, baseflow and lag times, as well as an increase in peak discharge, flood frequency and runoff volumes (Ogden et al., 2011; Suriya & Mudgal, 2012)

The significance of flood risk management revolves around achieving better results in the areas of health and safety, emergency relief and recovery, and sustainable construction and development. Including lessons learned in a systematic way is considered a necessary step to mitigate the risks of future flood incidents, especially with unpreventable risks such as natural disasters. This can be achieved by documenting the common practices and using them to improve the flood resilience of communities (Meyers, 2011). As people and communities are increasingly being affected by natural disasters, enhancing community disaster resilience has become a necessity (Mayunaga, 2007; ACCCRN, 2009; Shaw & Sharma, 2011; and Wilson, 2012). The researchers Bosher and Dainty (2011) also confirmed that more importance is being given to developing the resilience capacity of the communities affected by the disasters so that they can stand on their own feet and recover from the disaster-related effects.

However, despite that, many countries lack the right disaster preparedness and recovery measures in many resilience aspects such as physical, institutional and social. The reasons for this are: lack of sufficient flood emergency vision, planning and subsequent measures. Further, it can be considered that the main foundation for resilience lies in the physical infrastructure of the country, where appropriate systems and tools can be provided as per people, government and business needs, in terms of restoring the economy and neighbourhoods, and providing appropriate facilities and care to the population at risk. For instance, Bosher (2014) and Malalgoda et al. (2014) argued that poor building codes as well as bad planning of urban areas make communities more vulnerable to flood hazards, and similarly Ireni-Saban (2012) emphasised the importance of reliable construction practices, usage of the latest technology and building codes so that these structures are able to resist and survive these hazards.

Efforts to lessen the effects of natural disasters through post-disaster rehabilitation and relief coupled with preparedness measures have not served the true purpose of long-term resilience and recovery. Haque and Etkin (2005) provided the reason that both local- and national-level institutions gave key attention to the physical and geological events without focusing much importance on awareness of the vulnerability related to societal and human factors. In this regard, Maskrev (1999), Tobin (1999) and Wisner et al. (2004) also favoured the same viewpoint that there is a great need to deeply investigate the social dimension to build communities with better resiliencies and strong sustainable development. Furthermore, there is no denying the critical importance of identifying the main issues related to institutional dimensions like staff training and education, which could serve as the foundation for improving employees' competency levels in organisations and in terms of enhancing their capabilities to deal with disasters (Nazli et al., 2014).

Regarding the UAE context, many studies have predicted that there could be an increase in temperatures of up to 2°C and a 10% rise in humidity by 2050 in the United Arab Emirates (EWS-WWF & Acclimatise, 2017). The country's geography plays an important role in increasing the potential negative impacts of these disasters on both the environment and people. The UAE's geomorphologic features include sand dunes, mountains, costal zones, gravel plains and drainage basins, and more than 75% of the area is covered by desert (Böer, 1997). The geographical nature of a mountainous zone increases the probability of occurrence of flooding events as extreme rainfall in the mountains, coupled with the mountain stream network, tends to runoff, through the wadis, to the urbanised coastal region, especially from December to March (Elhakeem, 2017). However, lower-lying flat coastal zones such as Abu Dhabi and Dubai cities can also be influenced, where many incidents of flooding in urban areas have occurred after heavy rain events due to inefficient rainwater drainage systems (EWS-WWF & Acclimatise, 2017). In particular, the country has been confronted with rapid urbanisation during the last 10 years, which modified the land coverage and substantially altered the area, leading to an increased incidence and severity of pluvial floods (Shanableh et al., 2018).

The UAE has hot and warm weather, and rainfall is typically rare (less than 120 mm per year). However, extreme rainfall creates an inundation problem in the urban area of UAE which is exacerbated by sand clogging of storm drainage systems (Chowdhury et al., 2016). The amount of rainwater caused by the 2016 storm which hit the UAE in March was up 295 mm, and this shows that flooding can be a serious risk to communities across the country (Webster, 2016; Perring, 2016). During this event, heavy rains led to traffic accidents, closures of businesses and airports, property damages and an overall economic loss of almost $140 million (AON, 2016). Similarly, in 2020, the UAE broke the record for the most rainfall to hit the country since 1996 (Al Serkal, 2020). The UAE government should be better prepared to protect people and assets against any natural disaster. Thus, there is a great need to explore the concept of disaster resilience for better future planning in urban development to reduce flood impacts.

Furthermore, existing emergency response measures in the UAE showed that successful coordination is impeded by the lack of adequate regulations, policies, and understanding of how to enhance communication and coordination between different stakeholders (Alteneiji, 2015). This was supported by Almarzooqi's (2017) study, which indicated that there were key issues related to emergency management in the UAE, such as duplication of roles, communication gaps, and speed of response. Other studies also revealed a lack of contingency planning and lack of knowledge among stakeholders about an early warning system, and the community is unaware and uninformed about Federal Plans (Alshamsi, 2017; Alhamoudi and Aziz, 2015). Moreover, the UAE context presents challenges in managing disaster risk in terms of cultural and language barriers to education and communication. There is considerable population diversity, as many of the large numbers of expatriates do not speak Arabic, which creates significant communication challenges (Alteneiji, 2015; Alhmoudi, 2017). The UAE should consider emergency protective measures and long-term preventative plans to meet flood hazards' challenges (NCEMA, 2018). Therefore, taking all viewpoints into account, there is a critical need to develop an assessment framework based on different resilience dimensions that help enhance community resilience to pluvial floods in the UAE.

1.3.1 General Theoretical and Practical Gap of Knowledge

Disaster risk management approach is crucial since any individual or community around the world may vulnerable to natural disasters. Approximately 2.5 billion people have been affected by these disasters, while it is claimed that approximately 900,000 died in the wake of these disasters. Hence, there should be a great focus on natural disasters as the factor of global warming has also increased the impact and intensity of Hydrological disasters all around the globe (UNISDR, 2015; Guha-Sapir et al., 2016). From theses disasters, flooding is a global concern affecting all countries as the severity and length of floods events is expected to worsen due to changing climatic conditions (Ingirige & Amaratunga, 2013). Particularly, there is less well understood by the general public about pluvial floods as they are typically unpredictable, and they occur mostly without early warning as a result of steady and extreme rainstorms (Houston et al., 2011; Rözer et al., 2016; Abdulkareem, 2018).

The Disaster Risk Reduction (DRR) strategies work to improve infrastructure and community disaster resilience. In fact, many frameworks have been established, such as the Sendai Framework and Hyogo Frameworks, which significantly focus on improving communities' resilience to disasters (UNISDR, 2015). Weichselgartner and Pigeon (2015) stated that the Sendai Framework give suggestions with regard to knowledge creation and subsequent dissemination. The framework recommends developing the knowledge of government officials and communities through good measures and practices, training, lessons learned, sharing experiences and education on disaster risk reduction.

In particular, the concept of resilience requires serious attention and understanding before building community's resilience. Zutshi & Ahmad (2019) viewed that the focus of disaster risk reduction should be based on building a resilient community instead of just acting against natural disasters when they occur. He argued that the causes and triggers of vulnerability should be addressed, and an investment made for building more resilient communities through the appropriate capability to cope with disasters in future. Moreover, recent models have shifted away from vulnerability reduction models to more comprehensive models of building community resilience. Hence, the paradigm of resilience perceives communities as the main focal point when dealing with and facing the challenges related to the shocks and consequences of natural hazards. However, its application has been influenced by the lack of assessment tools (Rolfe, 2006; Ahmad et al., 2016; Almutairi et al., 2020). According to Wilkinson (2012) "There are surprisingly few publications that addresses how resilience approach to planning might be pursued in practice" (P.320).

There is lack of understanding among most stakeholders about community disaster resilience which help to improve the response capability and disaster readiness (Sherrieb et al., 2012). Moreover, according to many studies, there is a considerable knowledge gap and lack of published evidences related to flood mitigation measures, which gives credence to the fact that they were insufficient to protect communities by addressing flood risks (López-Marrero & Tschakert, 2011; Oladokun et al., 2017). Different studies have also affirmed that, in order to cope with natural disasters, communities and cities need to be more resilient to natural disaster through overcoming the faced challenges (Cutter et al., 2010: Albrito, 2012; UNISDR, 2015). It is crucial to assess community resilience over time in order to ensure that the resilience measures are always updated (Ahmad et al., 2016; Almutairi et al., 2020).

For the UAE context, due to the rising risk of pluvial floods, it is crucial for the country to have comprehensive disaster resilience measures and practices through using assessment framework (Almarzouqi, 2017; EWS-WWF & Acclimatise., 2017). There is currently no research that has conducted in the UAE on developing an assessment framework to measure community flood resilience. Moreover, despite there is a lack published empirical studies into community resilience and pluvial floods, a few academic studies such as Alkhaili (2015), Alhmoudi (2016) Alshamsi (2017) and Almarzouqi (2017) have indicated that the need for further research into disaster management and community resilience within the UAE context. Therefore, this research will seek to fill this gap through developing an assessment framework helping to build resilient communities to pluvial flood hazards in the UAE.

1.4 Research Aim and Objectives

The aim of this research is to develop an assessment framework to enhance the community resilience to pluvial floods in the UAE. To reach this aim, the following research objectives are identified:

1. To critically review the relevant literature on pluvial flood, and the concept of community disaster resilience.
2. To examine the current flood measures adopted by developed countries and the UAE.
3. To investigate and analyse key factors that influence community resilience to pluvial flood in the UAE through using sequential mixed methods approach.
4. To develop and validate CRPF framework with related stakeholders in the UAE for effective evaluation of community resilience to pluvial flood.

1.5 Research Questions

The following research questions are shown to meet the research objectives:

1. What are the current measures to manage pluvial floods in developed countries and in the UAE?
2. What are the key factors that influence community resilience to pluvial flood in the UAE?
3. What is the most applicable weighting system of identified factors for appropriate assessment of community resilience to pluvial floods in the UAE?
4. How can CRPF framework determine measurable outcomes of community resilience to pluvial flood?

1.6 Research Scope

The scope of this research is limited to community resilience to pluvial floods in the UAE. Thus, a critical review of flood measures in developed countries and the UAE context was conducted. From the relevant literature, the researcher built a conceptual framework to improve community resilience concerning physical, institutional, social and economic dimensions of resilience. The analysis in this study was conducted with both primary data collected from government organisations through one case study in Abu Dhabi city and secondary data from the literature review. This analysis covered the key factors that influence community resilience to pluvial floods. The reason behind choosing the UAE and Abu Dhabi city as the case study is that there is a lack of assessment tools and published evidence on community flood resilience and emergency management in general, where Abu Dhabi city is the capital of the UAE and all federal governmental authorities and most of critical infrastructure and properties are located, which is advantageous in that it allows close contact with decision makers. The city is also experiencing significant growth in population and expansion in the field of construction. The city urbanisation rate has recently increased with a large number of facilities and buildings, which puts the city at risk of climate change consequences. Moreover, the city is constantly affected by several natural hazards, especially pluvial floods, which cause negative impacts on lives and livelihoods, as shown in Figure 1.2 (Perring, 2016; Haza, 2020).

1.7 Research Contribution

This research benefits the local organisations or implementing agencies through developing an assessment framework for measuring community resilience to pluvial floods in the UAE. It provides the basic milestone towards building resilient communities to pluvial floods. The research recommendations will encourage decision makers to take the necessary steps to enhance community flood resilience in the country. Moreover, this research also contributes to the knowledge through providing in-depth understanding about the pluvial flood hazards, community resilience and disaster management. To do this, this study fills the knowledge gap in the context of disaster management by critical reviewing pluvial floods, flood measures and the concept of community resilience. It also investigates and analyse the key factors that influence community flood resilience in the UAE by conducting semi structure interviews and questionnaire. Moreover, the study contributes to practice through developing CRPF framework for stakeholders, particularly for government agencies, which benefit to enhance community resilience and ensure the successful mitigation of pluvial flood hazards in the UAE and surrounded regions that share the same features. The above contributions represent the novelty of this research.

1.8 Research Process

To achieve this research's aim and objectives, an appropriate research methodology has been chosen, which is a sequential mixed-methods approach. The research adapted Saunders' model, also known as the 'Research Onion', which is one of the most effective and comprehensive approaches towards conducting a piece of research; and in which the research will be conducted in layers, starting by selecting the research philosophy till reaching the data collection and analysis phase (Saunders et al., 2016). Overall, the research design has been divided into four main stages. Firstly, after reviewing the existing literature, the researcher used semi-structured interviews with senior managers from related stakeholders to investigate the key factors that can help to improve community flood resilience in the UAE context. This step is used as the platform for the other stages in this research. Secondly, the researcher employed a questionnaire survey to further examine and analyse the identified key factors. The third stage was the development of the proposed framework through weighing the identified factors by using the analytic hierarchy process (AHP). This weighting scale helped to prioritise key factors in terms of their importance to build community flood resilience. The last research phase was the validation of the assessment framework by conducting a focus group with senior managers to verify the simplicity, completeness, flexibility, understanding, acceptance, usefulness and implementation ability of the framework in the UAE. The research methodology is justified and discussed in detail in Chapter 4.

1.9 Structure of the Thesis

The entire research study is organised into eight main chapters and each of them contributes to the aim and objectives of this study as shown in Figure 1.3:

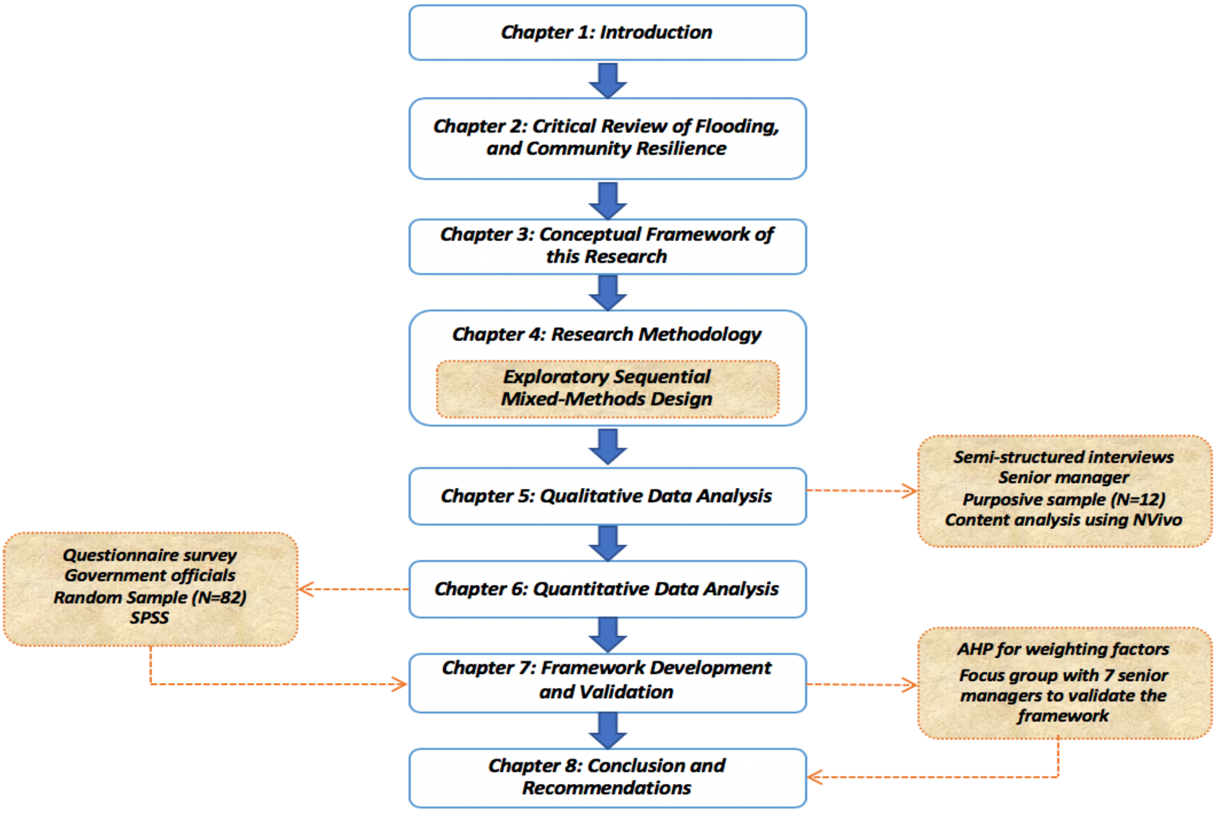

Figure 1.3: Research process.

Chapter 1: Introduction

This chapter presents a background on natural disasters with a specific focus on flood disasters. It also includes an overview on pluvial floods globally and in the UAE specifically, and the importance of enhancing community resilience to pluvial floods. Moreover, this chapter involves research justification, theoretical gaps within the field of study, research questions, the aim and objectives of this research, research scope, research's contribution to the knowledge and research process.

Chapter 2: Critical Review of Flooding and Community Resilience

This chapter provides a critical review of the existing literature concerned with the scope of this research. It reviews the literature concerned with flooding, resilience, community resilience, and the existing measures in flood risk management in developed countries and in the UAE.

Chapter 3: Research Conceptual Framework

This chapter explains the conceptual framework adopted by the researcher. It conceptualises the phenomenon being taken into consideration through developing an assessment framework to improve community resilience to pluvial floods which explains the important areas identified in the literature and presents the topics on which the study will concentrate.

Chapter 4: Research Methodology

This chapter illustrates the research methodology adopted in this research study to achieve the research aim and objectives. It provides proper justification and explanation of the methods employed in the current research study as well as their prime significance in terms of gathering reliable and valid data in order to accomplish the desired outcome.

Chapter 5: Qualitative Data Analysis

This chapter analyses the data collected through semi-structured interviews with senior managers using a content analysis method and interprets the meanings based on the research objectives and the literature gaps under investigation, thereby exploring the further explanations accordingly.

Chapter 6: Quantitative Data Analysis

This chapter provides the quantitative results of the questionnaire survey to examine and analyse the identified factors from the previous qualitative data analysis chapter. The questionnaires were distributed to government officials from different management levels from local organisations in Abu Dhabi city.

Chapter 7: Framework Development and Validation

This chapter illustrates the discussion of the study's findings and their connection with findings obtained from existing literature. Moreover, the chapter employs a focus group method to develop CRPF framework by using AHP as an effective technique to assess community flood resilience in the UAE. The last section demonstrates the validation of the developed framework.

Chapter 8: Conclusion and Recommendations

In this chapter, conclusions are drawn to achieve the aim and objectives of the study on the basis of empirical findings. Further, the chapter describes the contributions of the conducted research to both knowledge and practice, as well as the research limitations. Finally, it suggests recommendations for practice and future research.

CHAPTER 2: CRITICAL REVIEW OF FLOODING AND COMMUNITY RESILIENCE

2.1 Introduction

This chapter reviews the associated literature and provides investigations such as: the past discussions on the research subject, the development of theories relevant to the subject at hand, and the associated relevant questions that have been raised in the past and those for future researchers. To achieve the first and second research objectives, this chapter starts firstly with an overview of the climate change phenomenon and the influence it has in increasing rainfall frequency. It also reviews pluvial floods, and their impacts on communities. Moreover, it provides an outline of the disaster risk management, flood measures in developed countries and in the UAE, and it defines and explains resilience and community disaster resilience as important concepts to cope with natural disasters.

There are five main sections in this chapter. The first section revolves around the phenomenon of climate change and its association with natural disasters. The second section provides an overview of natural disasters, and the third section particularly focuses on flood disasters and their impacts. The fourth section investigates the process of disaster risk management globally and in the UAE specifically, which includes flood risk management and measures taken to mitigate the impacts of floods. The resilience and community resilience concepts are reviewed in the fifth section with regard to their definition and association with vulnerability. Finally, the chapter concludes with the chapter summary. The purpose of this chapter is to provide a better understanding and help to develop a conceptual framework for assessing community resilience to pluvial floods. Figure 2.1 illustrates the main sections of this chapter.

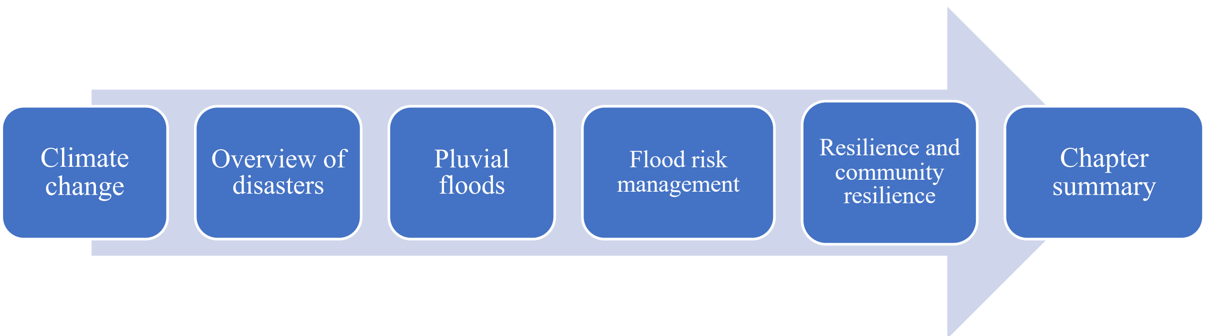

Figure 2.1: Structure of the chapter.

2.2 Climate Change

The term 'climate change' is used to describe seasonal changes over a long time period with reference to the continuous increase of the greenhouse gases (GHG) in the environment (Beeatna, 2018). Hulme et al. (2002) said that it is extremely important to deal with this phenomenon considering the main role of climate in the process of forming natural ecosystems that are based on human civilisations and economies alike. Many regions in the world have previously experienced the increased frequency and intensity of storms, a considerable change in rainfall patterns, markedly high temperatures, and issues related to the warming of coastal waters. It is expected that sea levels will continue to rise alongside rising temperatures in the time to come. Moreover, there is a great potential for irrevocable and severe environmental and climate change, which includes the continuous trend of polar ice layers melting, as seen in the cases of West Antarctica and Greenland, which might trigger the sea levels to rise more than 10 metres, increase emissions of methane, and might contribute to forming dangerous variations in the ocean currents as well (IPCC, 2013; Beeatna, 2018).

The term 'climate change' refers to the change observed in the average climate condition alongside the fluctuations in its attributes, such as the changing patterns of seasons and storms, wind, humidity, rains and temperature. Adelsman and Ekrem (2012) argued that climate change is not merely a change of weather; the climate change phenomenon is beyond this, as it spans a long time period, for instance, seasonal changes. The term climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural variability observed over comparable time periods" (Mustafa et al, 2009, P.134).

As a key cause behind climate change, global warming comes in the top slot. According to Adelsman and Ekrem (2012), the global warming phenomenon is associated with an increase in temperatures around the globe, whereas climate change is more about other particular kinds of patterns and changes. Based on the facts presented by Gore (2006) and IPCC (2013), human activities are considered as the main causes of global warming since the beginning of the Industrial Revolution, which could be seen as: power generation related to fossil fuel consumption, agriculture-related land deforestation, and urban expansion, which caused an increase in carbon dioxide concentrations in the environment by as much as 40%. Although global warming is documented as a serious problem in the entire world, many areas of the world are susceptible to specific climate changes, which not only endangers the world ecosystem but also puts human survival at risk. Therefore, climate change is now one of the most challenging subjects and is the focus of various political and economic programmes (Adelsman & Ekram, 2012).

2.2.1 Causes of Climate Change

As indicated by Woodward (2008) and the UNEP (2009), the causes of climate change before the industrial revolution can be referred back to natural causes only, such as volcanic eruptions, sun heat radiations and other natural causes that affect the concentrations of ozone-depleting substances (GHG). Moreover, Hulme et al. (2002) highlighted that the climate change on earth is a natural phenomenon resulting from many natural causes including volcanic eruptions gasses, ocean and atmosphere interactions as well as changes in the earth's orbit around the sun. However, the argument over the fundamental reasons behind the increment in carbon dioxide (CO2), as one of the primary GHG, is still going on. The debate among scholars concerns whether climate change is caused by natural changes or by human intervention in the ecosystem, and whether this increment is certainly the main reason behind the climate change or not. However, the current climate change phenomenon can be referred to as natural causes or human activities, where those natural causes were unable to show most detected warming, particularly warming that has occurred since the middle of the 20th century. Relatively, it is very likely that human activities have been the predominant cause for climate change and that warming (Changnon, 1995; Karl et al., 2009). Hence, the main causes of climate change can be linked to natural causes and human activities.

In particular, there are three factors based on which climate change could occur, as shown below (EPA, 2009):

- Due to natural factors such as if there are changes in Earth's orbit around the sun, or if the intensity of the sun changes.
- Due to the natural processes which occur inside the climate system, like the interaction between the atmosphere and the oceans, and the quantity of gas emissions which result from volcanic eruptions.
- Due to human activities, which are sub-divided further into two key types:
    - Those human activities which contribute to making changes in the atmospheric climate, for example, increasing the greenhouse gas emissions and when humans burn fossil fuels.

- When humans are involved in procuring too much of the land's surface, for example, in the development of suburbs and cities by building infrastructures and roads (urban development, or through related activity of cutting down forests.

The following Figure 2.2 shows that, because of human-induced changes that increase the amount of greenhouse and ozone-depleting gases in the atmosphere, the Earth and the open surfaces of the oceans and seas are heated more rapidly, accelerating the evaporation process, thereby increasing the water vapour (H2O) in the environment and increasing rainfall frequency (Climate Commission, 2013).

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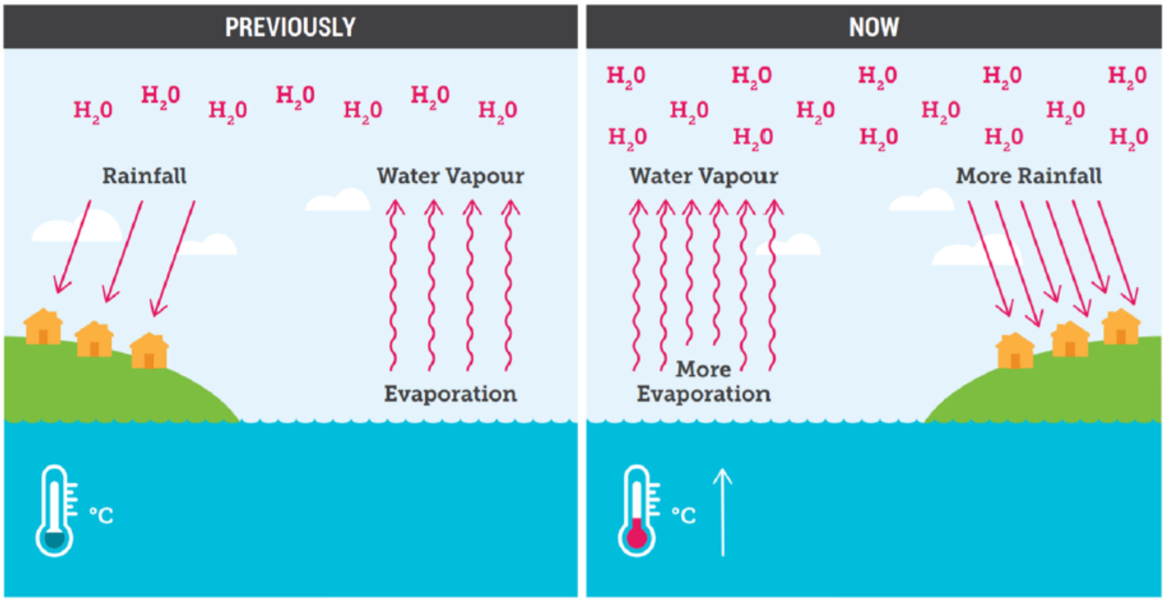

Figure 2.2: Climate change impact on the water cycle (Climate Commission, 2013).

Based on the 5th assessment report of the Intergovernmental Panel on Climate Change (IPCC), global climate warming is a certain thing, it exists, and is referred to as 'virtually certain'. The NOAA (2016) underlined that one of the hottest years all around the globe was recognised as the year of 2016, with records going back to 1880, wherein the current era is 0.99°C higher when compared with the pre-industrial period. Apart from the temperature changes, the global water cycle also happened to undergo recorded changes as well. For instance, some locations on planet Earth such as mid-latitude Northern Hemisphere have experienced an increase in rainfall whereas the other parts of the world experienced a decrease. Hence, it has become unclear how the rainfall trends have changed due to the temperature.

In the same context, Bronstert (2003) found that the mean worldwide temperature has increased by 0.3–0.6°C since the 19th century, and 0.2–0.3°C of this expansion happened over the past 40 years of the 20th century. However, this increased temperature of the recent years can be credited as 95% due to anthropogenic (human activities) causes instead of natural climatic variability. Therefore, this recent climatic change and increased temperature play a significant role in increasing the occurrence of flood events as a result of increases in the quantities of precipitation. Accordingly, and due to the changes of climatic zones and an expanding intensity of convective procedures, Hirabayash et al. (2013) emphasised a future increment in the severity and recurrence of natural disasters such as windstorms, surges and tempest floods all around the world. Hence, this section gives an overview of the main causes of pluvial floods which related to the climate change phenomenon. The next section highlights the disaster definition and the difference between disaster and emergency evets to develop more effective measures to prevent or mitigate pluvial flood impacts. This helps to achieve the first research objective "To critically review relative literature on flooding, and the concept of community resilience".

2.3 Definition of Disaster

When it comes to defining the word 'disaster', it refers to any disastrous or catastrophic event that happens suddenly and which stems from other events like explosions, fires, disastrous accidents, floods and earthquakes. A disaster is a phenomenon which has the capability to damage property and life, and it can also have a negative impact on people's cultural and social lives, as well as the economy (Oliver-Smith, 2005; IFRC, 2018). As defined by the United Nations International Strategy for Disaster Reduction, a disaster is: "A serious disruption of the functioning of a community or society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of affected community or society to cope using its own resources" (UNISDR, 2009, P. 9). Previously, a disaster was considered as an event that occurs when hazards are 'realised'. Nevertheless, Smith (1996, P.22) claimed that the definition of disaster includes the human aspect by observing that: "A disaster generally results from the interaction, in time and space, between the physical exposure to a hazardous process and a vulnerable human population".

It is essential to be aware of the proper semantic construction while defining the term 'disaster' to characterise an event. Natural events such as seismic tremor, wind or water-related anomalies cannot be characterised as a disaster. By definition, an event or a potential disaster can be classified and entered into the emergency events database (EM-DAT) only when at least 10 or more people are reported killed, 100 people directly affected, when there is a call for international assistance, or a state of emergency has been declared (CRED, 2013).

Andersson et al. (2007) asserted that the classification of disaster is largely contextual and subjective. For example, floods, which effect the same number of people in topologically similar countries, are likely to be viewed differently and the international response to the event will, in all likelihood, be different. This depend on the capabilities of these countries to prepare, response and quick recover from these disasters.

It can be noted that the measurable effect of the event on those experiencing it does not entirely dictate whether or not an event is viewed as a disaster (Andersson et al., 2007). Different schools of thought view disasters as inevitable events that are the necessary price for identifying inadequacies in societies, thereby providing opportunities to identify and repair protective risk-aversion mechanisms. In essence, according to such definitions, while a disaster may manifest as physical destruction or loss of life and property, the underlying constructs are social (Mileti, 1999). In fact, defining the term 'disaster' requires a multi-dimensional approach involving different, often competing, disciplines and stakeholder views. Discussion around this paradigm started in the 1970s, when it became necessary to study the effect of human environmental interactions. Primarily, there is an argument to be had regarding the hazards posed to humans by the environment, and, conversely, an opposing perspective involving how humans affect the environment. This hazard paradigm makes up the core of the dispute involving defining disaster. This argument regarding the definition of disaster continues to this day, with academia trying to define a disaster, its causes, and its effects as independent entities (Oliver-Smith et al., 1999).

Furthermore, it is important to have an appropriate understanding about the difference between disaster and emergency, which may help to develop more effective strategies to prevent or mitigate the severity of their impacts on communities. An emergency can be defined as “an imminent or actual event that threatens people, property or the environment and which requires a coordinated and rapid response” (Alexander, 2005b, P.159). Similarly, Eshghi and Larson (2008) emphasised that an emergency is “an event that may be managed locally without the need for added response measures or changes to procedure” (P.63). Moreover, according to Jorgustin (2012), an emergency is a situation that could lead to disaster if left unchecked or unattended, but not all disasters are preceded by an emergency. Thus, a disaster happens more quickly and without warning, usually requires external support, and it influences more people and causes more devastating impacts compared to an emergency.

There is a tendency to base the classification of disasters on an understanding of disaster taxonomy rooted in disaster theory. However, many disasters are complex enough to not fall within the simplistic classification framework. In such cases, it becomes essential to develop a deeper understanding of the epistemology of disaster theory (Perry, 2018). Laframboise and Loko (2012) insisted that the Emergency Events Data Base (EM-DAT) is considered to be the most reliable and responsible source of data on natural disasters; it is maintained and provided by the Collaborating Centre for Research on the Epidemiology of Disasters (CRED). According to CRED (2013), disasters can be classified broadly into manmade and natural. Natural disasters are further classified into five sub-groups (geophysical, meteorological, hydrological, climatological and biological), which can further be categorised into 14 types of disaster and more than 30 subtypes. These are listed in Table 2.1 and Figure 2.3. This study focuses on pluvial floods, which are under the hydrological disaster group.

Table 2.1: Definition and Classification of Natural Disaster Sub-groups (CRED, 2013).

Disaster Subgroup	Definition	Disaster Main Types
Geophysical	Events originating from solid earth	Earthquake, Volcano, Mass Movement (dry)
Meteorological	Events caused by short-lived/small to meso scale atmospheric processes (in the spectrum from minutes to days)	Storm
Hydrological	Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up	Flood, Mass Movement (wet)
Climatological	Events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)	Extreme Temperature, Drought, Wildfire
Biological[4]	Disaster caused by the exposure of living organisms to germs and toxic substances	Epidemic, Insect Infestation, Animal Stampede

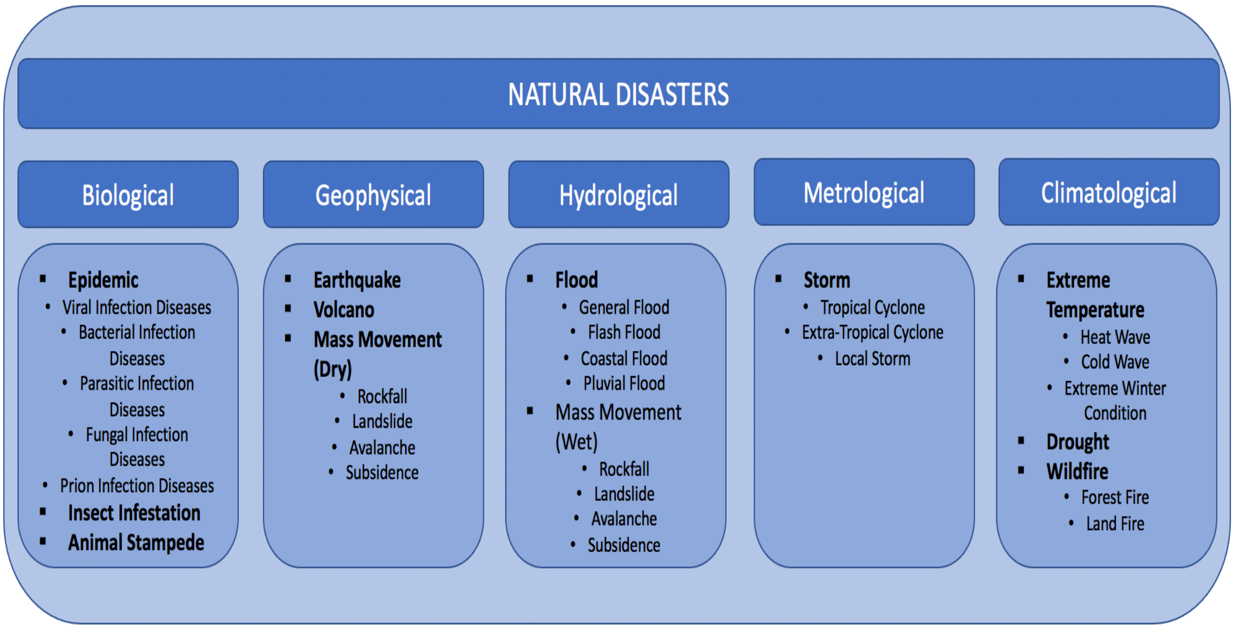

Figure 2.3: Natural disaster classification (CRED, 2013).

2.4 Floods

Recently, floods have caused large-scale human, environmental and economic consequences as they have become one of the most damaging weather-related hazards. A flood is defined as an event which involves land (which is not normally covered in water) being subject to such a situation for a certain span of time. This usually happens along rivers, lakes, estuaries and coastal regions (Floodsite-Consortium, 2005). Moreover, the European Commission (2007) shared the same view, and they defined a flood as land that is covered by water that is normally not water covered. This implies that the word flood relates to too much water in the wrong place, or on land which is normally dry. There are many of factors which contribute to the flooding phenomenon, such as when there is a high-intensity or long duration heavy rainfall which contributes to the building up of surface water in low relief areas as well as creating extra overflow of water in the rivers. Additionally, topographic features, soil conditions, pre-existing levels of groundwater and other such factors also play a part in determining the likelihood of floods. Other weather events like storms and cyclones may in turn increase water runoff, causing flash floods. Similarly, melting ice or release of a debris jam can cause a sudden increase in available water, causing floods (Few & Matthies, 2013; Alhasanat, 2017).

Floods are classified as the most frequent and economically debilitating of natural disasters by the US National Weather Service (Dingman, 2009). The last three decades have seen a marked rise in the number of flood-related events globally. Like other natural hazards, floods have had a significant impact in shaping the course of human history (Parker et al., 2007). From destroying infrastructure and life, causing landslides, and destroying agriculture and livestock, floods can have a deeply adverse effect on human populations (Norbiato et al., 2008; Few & Matthies, 2013). Causing over 6.8 million causalities in the last century, floods have resulted in more loss of life worldwide than any other natural calamity (Jonkman & Kelman, 2005). Risk from flooding can be conceptualised into four stages, as shown in Figure 2.4, where the process of flooding is illustrated, which include the source of the floodwater, the pathway, and the receptor of the flood risk, which may involve the human settlement, structure, building, or environment that is exposed to flood consequences (Jha et al., 2012).

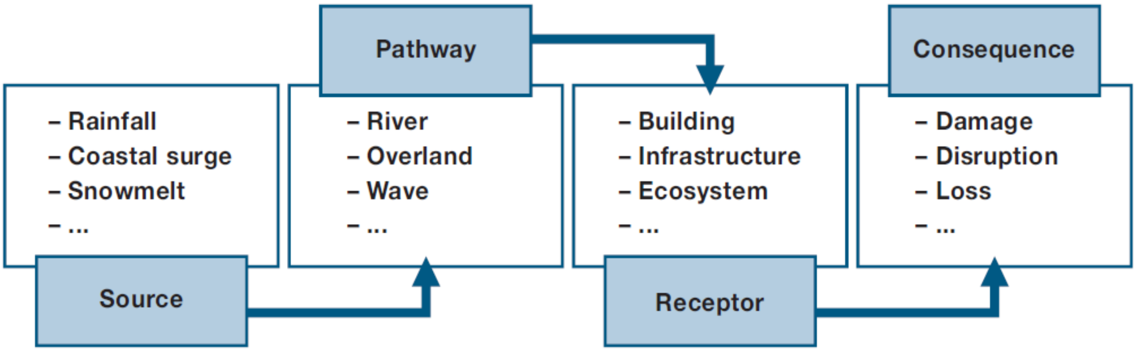

Figure 2.4: The source, pathway, and receptor of flood risk Model (Jha et al., 2012).

It is also important to differentiate between the possibility of a weather event occurring and the likelihood of a flood event. Flooding is mainly caused by weather events that are difficult to predict because of what is considered to be their unpredictable existence. In particular, it is hard to determine the exact time and location of rain falling or storms forming, despite the availability of advance weather forecasting software and equipment. Moreover, it is still difficult to estimate the occurrence of flood events even with the availability of historical data. This is because of floods that happened as a combination of a hydrological event such as heavy rainfall and other important issues such as inadequate infrastructure, drainage capacity, and other human factors (Jha et al., 2012).

While floods are natural events, the increase in flood risk has been attributed to many causes such as: climate change, unscientific land-use patterns, and other anthropogenic interventions such as construction, which results in reduced soil infiltration, causing excess runoff. Moreover, the increase in population and urbanisation in flood-prone areas further increases the damage caused by floods, making them more destructive (Green et al., 2000). According to the ISDR (2009b), unscientific urban planning, lack of investment and interest in water drainage systems, affordable social housing projects built on low-lying flood-prone areas, and improper water management all contribute to flood damage. For example, Yuen and Kumssa (2011) highlighted that, when the population and large-scale urbanisation rises, such as in Mumbai city in India, it leads to the gathering and settling of a large number of people, particularly those who are poor, alongside urban areas associated with floodplains. Therefore, in urban areas, the flood phenomenon is not only associated with high-intensity precipitation and the events related to extreme climate alone, it is also linked with the built-up changes in the areas as well.

There has been a marked increase in the number of floods happening annually. While the numbers of fatalities were constant between 1980 and 1990, there has been a reduction in casualties in the developed world since then. This can be attributed to effective mitigation measures and disaster preparedness (Drobot & Parker. 2007). However, Gencer (2013) stated that, when such measures are absent or inadequate (as is often the case in many countries), the numbers of casualties increase. A notable example is the tsunami flooding which caused maximum casualties in India.

Nevertheless, the severe impact of floods on life and the economy cannot be overstated. Between 2015 and 2016, 2,945 floods affected 1.4 billion people and caused damage estimated at $403 billion (CRED, 2013). The effect was similar in 2014, where floods accounted for 47.2% of natural disasters affecting 42.3 million people, which was 30% of natural disaster victims in that year. Moreover, the largest flood in recent times had 15 million victims and occurred in China in 2014, while the most expensive ($16 billion) flood was in Kashmir, India (CRED, 2014). Although flood mitigation measures have taken place in developed countries, floods cause an average annual loss of US$104 billion, which is more than 200% of the entire public health spending in the Middle East and North America (UNISDR, 2015).

The situation does not seem to be that different with respect to the UK. For instance, in 2007 the impacts of summer floods cost the country around £3.2 billion (Chatterton et al., 2010), and, according to Pitt (2008), about 7,300 businesses and 48,000 houses had flooded. In fact, based on data from the Environment Agency (2009a), one out of six properties was at risk of flooding in England alone, which represents around 5.2 million properties. Flood risk in the UK is expected to increase further in the future, especially as a result of climate change (Pitt, 2008; Reynard et al., 2017). Evans et al. (2004) described key drivers for increased potential flood risk in the UK such as: urbanisation, climate change, rural land management, environmental regulations, growing national wealth and social impacts.

There are several types of flood such as; groundwater floods, river floods, coastal floods, artificial water system failure and pluvial floods, and each type causes a distinctive effect regarding how it happens, the harm it causes, and how it is estimated and predicted (Jha et al., 2012; Ingirige & Amaratunga, 2013). Moreover, floods can be categorised in terms of their speed into slow-rise floods, semi-permanent floods, urban floods and pluvial floods. This research will focus on pluvial floods. Therefore, this section demonstrates floods as natural hazards, flood types, and the causes that contribute to floods, helping to reach the first research objective. The next section reviews relevant literature on pluvial flood events.

2.5 Pluvial Floods

As a result of the current climate change phenomenon, pluvial floods have been considered as the flood type most likely to increase in severity. Rosenzweig et al. (2018) pointed out that the pluvial flood definition is not simply interpretable in terms of the rainfall rate, but also the condition of the catchment area on which the rain falls. Thus, combined with the social and physical contexts of the area, a high rainfall rate could cause pluvial floods in an urban area. Pluvial floods occur only when the rainfall rate exceeds the capacity of rainwater drainage or ability of the ground to absorb the rainwater (Houston et al., 2011). This is generally linked to short storms (up to three hours) and rainfall > 20–25 mm / hour. However, they can occur during longer periods after lower-intensity rainfall (~ 10 mm / hour), particularly if the ground surface is impermeable, where the water absorption rate is too low. Moreover, they occur in impermeable basins or poorly drained areas as they are affected by the degree of urbanisation, the distribution and dimension of buildings that influence the runoff-damming ratio, and the remaining percentage of the natural surface (Zevenbergen et al., 2011)

Pluvial floods are difficult to predict and plan because they do not have an easily defined 'floodplain', unlike seas and rivers. Buildings, roads and drainage capability all affect surface water flow, making it difficult to monitor and control (Houston et al., 2011; Abdulkareem, 2018). Norbiato et al. (2008) correctly observed that convective storms with extreme rainfall create the ideal conditions for a pluvial flood. These usually happen suddenly, giving very little response time as the water level rises quickly. They account for almost one-third of flood risk from all sources in the UK. In 2050, 3.2 million people who live in urban areas might be vulnerable to pluvial floods, and that represents an increase of 1.2 million. This increase is as the result of a combination of climate change and population growth (Houston et al., 2011). This estimation results from data and process variations rather than real regional differences in pluvial flood, demonstrating the complexity and uncertainty involved in estimating pluvial floods.

Despite being the most lethal natural hazard, pluvial floods rarely generate much interest or attention, although they generate the maximum number of fatalities (as a fraction of affected people) and account for millions of dollars of fiscal damages (CRED, 2013). According to the Global Risk Assessment Report (2015), pluvial floods are regarded as the most wide-ranging risk layers which contribute to forming the recurrent and localised hazard events since the attributes related to these floods are high frequency but with low-severity losses (UNISDR, 2015; GAR, 2015). However, the lack of interest around such events is due to multiple factors. Pluvial floods are small-scale events that that are occurring more frequently nowadays.

Additionally, when they occur, they are likely to affect more poor communities that are not easily accessible. Thus, they may not garner as much attention as individual events (WMO, 2007). The risk of pluvial flood is increased due to growth in population and urbanisation as flood-prone zones normally have more infrastructures and people. Furthermore, Davis (2001) stated that urban development could cause a rapid flood as it creates water impervious surfaces. The challenging aspect is that pluvial floods develop immediately after a heavy rainstorm with little or no reaction time, which makes evacuation and other protective steps difficult (Alfieri et al., 2016).

Floods with large numbers of fatalities happened in Afghanistan and Congo in April and October of 2014 (CRED, 2014). These killed 431 and 154 people respectively and qualified to be among the top 10 natural disasters that year. Moreover, in 2007, a total of 98.3 mm of rain fell in one hour in the east and south Belfast catchments. This occurred as a result of both pluvial and fluvial flooding, which caused a major disturbance in Belfast with more than 400 properties affected. The EM-DAT international disaster database reported that, during the 2000-2015 period, 2,495 floods directly influenced 1.4 billion people and had a causality count of 85,773 people, resulting in damage totalling a cost of $403 billion. Specifically, there were 382 flood events that caused 15,352 deaths with total damages of $38.9 billion (CRED, 2014).

In the same context, the MENA (Middle East & North Africa) region is regarded as a region with rapid urbanisation, which puts more pressure on economic assets, infrastructure and people in terms of disasters. The Global Assessment Report on Disaster Risk Reduction report published by UNISDR (2011) explained that there had been an increase in the flood mortality risk in the MENA region, although the said risk had been decreasing since the year 2000. It was observed that floods are one of the toughest challenges to stability and growth in the MENA region. The World Bank (2014) also revealed that the mortality rate as well as the number of people affected by floods had doubled during the period between 2000 to 2009.

More specially, flood disasters were recorded in the Middle East region which were caused by storms and torrential rains, and which inflicted massive economic losses to both public and private property, massive livelihood and social disturbances, and deaths. For instance, the city of Jeddah (Saudi Arabia) witnessed floods as a result of heavy rainfall in November 2009 wherein more than 90 mm of rain fell in just four hours, which was recorded as the greatest rainfall in the previous 10 years, and which equates to approximately two times the yearly average. The death toll was more than 100 and the business losses were of approximately US$270 million (Lopez, 2012). Similarly, when the low-pressure systems passed across the region of Abu Dhabi City in the year 2016, the city experienced massive floods and hailstorms which brought heavy rains to not only the UAE, but also to the nearby regions of Qatar and Oman (Perring, 2016). The EM-DAT (2006) database showed the flood disaster trend between the years 1927 and 2006 in the North Africa and Middle East region, which is also depicted in Figure 2.5 below. Hence, to accomplish the first research objective, this section explains pluvial floods and their impact in different countries globally. The following sections demonstrate different types of flood impacts on the built environment.

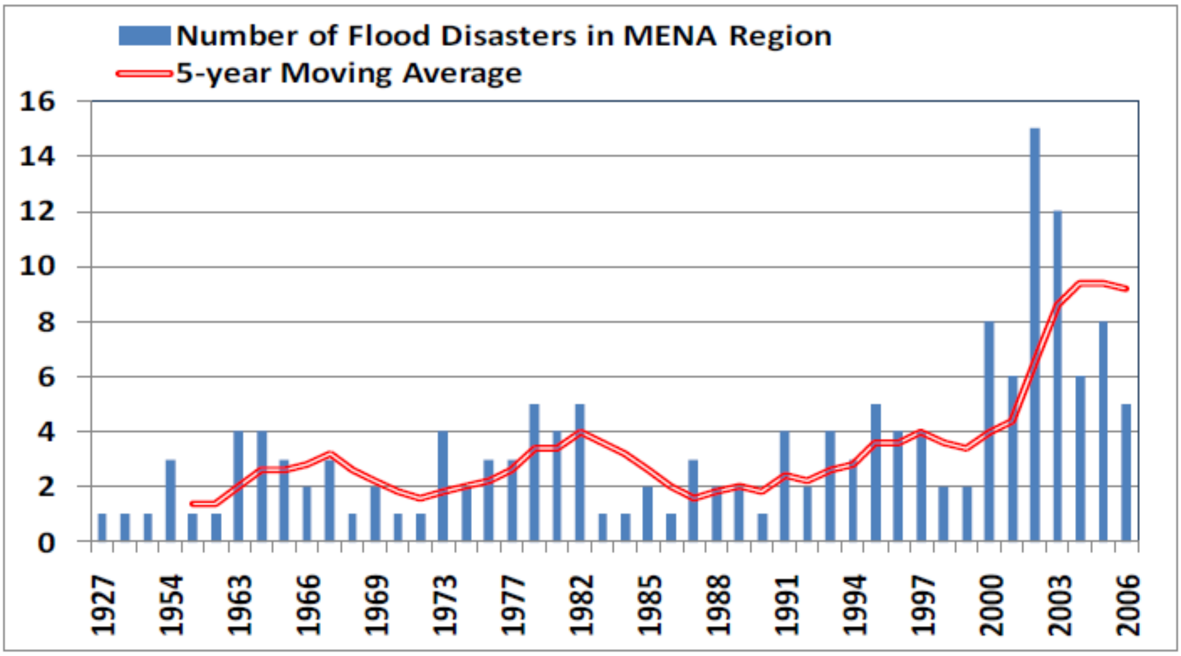

Figure 2.5: Number of flood disasters in the MENA region between 1927 and 2006 (EM-DAT, 2006).

2.6 Impacts of Flooding on the Built Environment

The ways in which a disaster such as a flood is assessed can be divided into tangible damage and intangible damage (Smith & Ward, 1998). Tangible damage is defined as damage that can be readily measured in monetary terms, such as damage to buildings and assets. Intangible damage is defined as damage to environmental goods and services that are difficult to quantify in monetary terms (Markantonis et al., 2012). Similarly, Jha et al. (2012) classified the effects of floods into two basic types, direct impacts and indirect impacts. Direct impacts include damages to buildings or houses. While, indirect impacts include the impacts of floods on the natural environment, human and social impacts (including demographic changes, health impacts, human development impacts), economic and financial impacts (including impact on long-term economic growth, impact on development goals, impact on livelihoods, business interruption and property values impact), and political impacts.

2.7 Flood Direct Impacts

Floods directly affect buildings, as the nature of the building and the nature of the flood play a key role in determining the magnitude of this impact. All components of buildings are exposed to direct damage caused by floods, including basements, ground floor and others. Jha et al. (2012) stressed that the impact of flooding on residential buildings would be very harmful and, in some cases, could result in their complete destruction. In the most fortunate cases, the building may suffer considerable damage, which requires many repairs and renovations. The characteristics of the flood, such as its speed, duration and cause, contribute to determining the impact it will have on the building. Rapid flooding such as flash floods may result in damaging the building completely or cause irreparable damage to building structures. A slow flood can damage the building in following ways (Jha et al., 2012):

1. Water leaks into the lower layers of the building, which in many cases leads to the building lifting up and thus breaks or cracks in the building, and, in other cases, may lead to the destruction of certain elements within the building.
2. The pressure inside the building due to the flow of large quantities of water, which leads to a complete collapse inside the building.
3. Floodwater may be subject to chemicals and may interact with building elements and components, causing damage to the structure of the building.
4. The flow of water into the building may damage the electrical systems and cause burning in the entire building and thus damage the building completely.
5. The presence of water around the building may contribute to the erosion of the building and thus may lead to collapse.

Although water depth and flow velocity are critical factors in estimating flood damage to buildings, Kreibich et al. (2009) concluded that flow velocity has a direct and significant impact on building structures, but has little or no impact on the streets, for example. Thus, if the water depth is less than 2 metres, the flow rate cannot be relied upon as a primary factor in estimating the damage resulting from the flood. In addition, the nature of the materials used in the building affects the amount of damage from the flood. Some materials have a higher porosity and therefore are more prone to erosion and collapse. Moreover, according to the DTLR (2002), the interim guidance on flood preparedness explains that flood depth is the most significant factor for identifying the building damage, as shown in Table 2.2.

Table 2.2: The types of flood damages for a typical residential property (DTLR, 2002).

Depth of Flood	Damage to Building	Damage to Services and Fittings	Damage to Personal Possessions
Below ground floor	• Minimal damage to main building • Water may enter basements, cellars and floor voids • Possible erosion beneath foundations	• Damage to electrical sockets and services in basements and cellars • Carpets in basements and cellars may need replacement	• Possessions and furniture in basements and cellars damaged
Up to half a metre above ground floor	• Damage to internal finishes such as wall finishes and plaster linings • Floors and walls becomes saturated and will require drying out Chipboard flooring likely to require replacement • Damage to internal and external doors and skirting	• Damage to downstairs electricity meter and consumer unit • Damage to gas meters, low level boilers and telephone services • Carpets and floor coverings may need replacement Chipboard kitchen units likely to need replacement • White goods may need replacing	• Damage to sofas, furniture and electrical goods. • Damage to small personal possessions. • Food in low cupboards may be contaminated
More than half a metre above ground floor	• Increased damage to walls and possible structural damage	• Damage to higher units, electrical services and appliances	• Damage to possessions on higher shelves

Damage to critical buildings such as educational institutions and hospitals may be greater than damage to other buildings. Deshmukh et al. (2011) stressed that the destruction of these buildings leads to the disruption of education and health services and the disruption of movement in general, and it may last for a relatively long period. Damage to buildings is not confined to residential or educational buildings; it also affects airports, railways and businesses. These buildings are heavily linked to the lives of individuals, and their destruction adversely affects all individuals. In addition, electrical systems may collapse and be completely destroyed as a result of a large flow of water and result in a complete disruption to work.

2.8 Flood Indirect Impacts

The impact of flooding is not only confined to buildings and their destruction; floods have an indirect impact on the natural environment and various resources. Although Akeh and Mshelia (2016) argued that it was difficult to identify and quantify these indirect effects, they can be divided into four main sections:

2.8.1 Natural Environment

Gupta and Uniyal (2012) stated that high-altitude flooding can cause landslides of varying degrees depending on the nature of the terrain. These collapses lead to massive damage to the infrastructure, which may be partially or completely eliminated. Such flooding can cause severe damage to roads and thus impede the movement of people and move them from place to place for a certain period of time. The collapse of buildings contributes to the accumulation and deposition of debris in different places. Andjelkovic (2001) pointed out that disposal and removal of these sediments is costly and requires special equipment, which would be an additional obstacle. In many cases, it may be difficult for individuals to remain in the area where the flood occurred, so they may have to move to other places, and this will put pressure on these other areas or agricultural land may have to be repurposed to establish the proper habitats for individuals. In agricultural areas, in particular, sediments may adversely affect agricultural crops, and large parts of them may be damaged (Akeh & Mshelia, 2016).

Floods resulted from tsunamis cause a great deal of damage to coasts and marine organisms (Lopez, 2012). These floods will cause damage to coral reefs and thus reduce the reefs' ability to dissipate wave energy. Oyediran et al. (2015) noted that if the sea-level rises more than the coral growth rate, this will cause more vital flooding. Floods also contribute to increased water salinity, affecting agricultural land and making it unsuitable for cultivation and use. Akeh and Mshelia (2016) clarified that the disposal of water salinity needs a great deal of time, and in many cases, it may be difficult to get rid of. However, such agricultural lands could be transformed into aquaculture, which requires many measures, which could result in many difficult land ownership issues.

2.8.2 Human and Social Impacts

The people who survive flood disasters have many requirements after the flood has finished, such as clean drinking water, food and safe housing. Certain pressures increase after a flood event, to cope with the consequences of the flood. Many survivors are shocked and overwhelmed after the flood, which means they need more care and attention. Therefore, floods produce many human and social impacts (Mwape, 2009). These impacts include:

A. Demographic Changes

Floods cause the elimination of balance between age groups as a result of the death of certain age groups more than others. Statistics on the devastated areas hit by floods in Bangladesh in 1991 showed that the mortality rate of children under the age of 10 years was clearly significant, and the mortality rate of males over the age of 10 years was lower, while that the rate of mortality for women over the age of 60 was about 40% of total deaths (Bern et al., 1993). Flood affected communities have high mortality rates for older people, as well as young children, who are unable to run very quickly to a safe place. The number of women who die is higher than that of men, mainly because men are often more physically stronger than women (Lopez, 2012). Further, in many cases, women have preferred to protect their children and ensure their safety, putting their own lives at risk, which has contributed to increased mortality rates for women (Shultz, 2017).

B. Health Impacts

Riggs et al. (2008) clarified that the health effects of floods can be divided into two types. The first are those resulting from exposure to water, resulting in drowning, debris injuries, and chemical contamination. The second effects are those resulting from the negative effects of water on the natural environment, including the spread of diseases and epidemics, lack of nutrients, malnutrition, displacement and inadequate shelter. Du et al. (2010) also explained that the health effects of floods can be divided into three basic periods, which are immediate, medium term (secondary health effects) and long term. The effects in the immediate term coincide with the occurrence of flooding, such as drowning, injuries, electrical injuries, hypothermia and disruption of health services. The medium-term effects arise after the occurrence of the flood and take days or weeks to be processed, such as chemical contamination, carbon monoxide poisoning, water contamination, communicable diseases and respirational illness. Long-term effects are those that require a long treatment period ranging from months to years, such as mental health problems, social disruption and related health issues (Schwab et al., 2007).

Floods have caused the deaths of large numbers of people due to the spread of diseases and epidemics or as a result of heavy water-borne aggregates. Alirol et al. (2010) pointed out that the 2007 monsoon floods in Bangladesh indicate that diarrhoea and respiratory diseases are the leading cause of death, followed by deaths from snake bites. The seriousness of floods for human health is closely linked to the impacts and changes that floods cause to the environment and nature in general. Flooding is accompanied by storms that carry diseases such as cholera and malaria. Noji (2005) indicated that the risk of epidemic transmission and spread among individuals surviving after a flood depends on population density. An increase in population is associated with an increased probability of disease spread. Jha et al. (2012) also showed that malaria, cholera and diarrhoea are mainly caused by the lack of fuel to boil water and eliminate contaminants. In 2009, a Leptospirosis disease outbreak in the Philippines resulted in 1,000 deaths; the disease is mainly caused by floods and is considered a killer (IRIN, 2009).

Floodwater may mix with potable water and thus the risk of disease is increased due to floodwater pollution. Some chemicals may also interact with floodwaters and this may lead to many health risks.

C. Human Development Impacts

At the level of development and keeping abreast of modern requirements, floods have a significant impact. Deshmukh et al. (2011) clarified that post-flood births are directly related to an increase in child mortality or birth rates with congenital defects. Families who lose a parent are also significantly affected. Children are displaced and lost may not stay in education in order to meet their needs and requirements. Students' education levels may also be affected, because of the disruption to schools and the need for reform (Oyediran et al., 2015). On the other hand, the impact of floods in rich places is lower than in poor ones. More specially, the effects of flooding in rich areas can be overcome rapidly compared with other areas. In many cases, floods contribute to increased poverty in poor areas, as observed by Jha et al. (2012).

2.8.3 Economic and Financial Impacts

A. Impact on Long-Term Economic Growth

According to Jha et al. (2012), the impact of disaster on individuals is greater than the impact of floods on the local economy, where Kim (2010) stated that the flood impact is often limited or may have no impact in the case of small or medium floods. However, floods may have an impact on tourism, where the level of tourism activity in the country will decline. At the national level, many studies have indicated that the impact of disasters on economic growth is variable and depends mainly on the economic level of the country (Skidmore and Toya, 2002; Kim, 2010). Kim (2010) confirmed that some natural disasters may have a positive impact on a state's economy. The reason for this is that the reconstruction of the affected areas requires a large labour force. Skidmore and Toya (2002) in their study of 89 countries affected by natural disasters concluded that these disasters positively affected human capital and increased GDP growth for individuals. On the other hand, the frequency of natural disasters in developing countries has a negative impact on the economy because of the need of these countries for many resources for reconstruction (Fomby et al., 2009).

B. Impact on Development Goals

Some economies face economic constraints as a result of natural disasters, and this is especially true for low-income countries. Many governments face liquidity problems in dealing with natural disasters and seek international assistance or credit funds to control the situation, which puts their country at a greater economic burden. Gurenko and Lester (2004) indicated that

India's direct costs of dealing with natural disasters are high, accounting for about 12% of the central government's revenue. Jha et al. (2012) added that one of the most negative effects faced by governments in coping with natural disasters is indebtedness, which represents another burden on the national economy. This underscores the importance of cooperation between different sectors in order to deal effectively with these impacts and with minimal losses.

C. Impact on Livelihoods

Livelihoods are expected to be greatly affected by floods, affecting the level of employment, especially for families who have lost their main breadwinner (Kim, 2010). Women-headed households will also find it more difficult to provide an adequate livelihood as a result of the difficulties women face in general and the obstacles they face at work (Jha et al., 2012).

D. Business Interruption

Haraguchi and Lall (2015) stated that the impact of floods extends to many aspects of life. Floods have a significant impact on business activity as a result of the direct effects on property and shops. In many cases, work in factories or shops may be completely halted due to the lack of access to water, or lack of electricity to these factories and shops. In 2011, Japan was exposed to a massive tsunami that greatly affected the national and global economy. At the global level, Japan stopped supplying the world with vehicle parts, although the country was considered to be one of the main suppliers of cars to the world, where this disaster took long time to recover. Flooding can lead to loss of staff, loss of official documents, loss of insurance policies, loss of licensing documents and a decline in the productivity of companies. A study conducted by Wenk (2004) found that 43% of companies affected by natural disasters were unable to recover and work again, and that 29% of companies needed two years or more to be able to work again.

E. Property Values Impact

Many researchers have studied the impact of floods on property values in different regions. Studies in the United States of America have found that house prices decline markedly after a flood (Harrison et al., 2001; Hallstrom and Smith, 2005; Bin and Polasky, 2004; Ismail et al., 2014). Montz and Tobin (1988) conducted a study at Yuba County, California, and concluded that, immediately after the flooding, the flood-hit houses were not sold, as there was no real estate market, but a few months later the houses were sold at low prices. Montz and Tobin (1988) concluded that there were no negative effects of flooding on property values. In the same approach, Montz (1992) compared the property values in three regions in New Zealand: Te Paeroa, Te Aroha and Thames. In the Te Paeroa region, there was a noticeable rise in property prices. In Te Aroha, property values declined significantly, and in the Thames region, property prices did not decline.

The differing findings of the studies can be clarified by a combination of factors. The first reason may be due to the different social and economic contexts of the participants, which contribute to their differing understanding of the flood risk, and hence their different treatment of house prices. Jha et al. (2012) clarified that the repeated flooding in some areas contributes to the decrease of property values for a long period of time. The second reason may be due to the size of the sample selected in the studies, as some studies have used a relatively small sample, and this has an impact on reaching strong conclusions.

2.8.4 Political Impacts

The occurrence of natural disasters affects many aspects, including the political aspect. Some governments are not able to cope with the effects of floods and this may lead to political instability. In these cases, these governments must be able to identify the roles and responsibilities of different stakeholders to deal with any crisis in the appropriate manner (Jha et al., 2012). The problem of the state's ability to maintain property security may also arise, especially after individuals have been forced to leave it for a period of time. The poor sections within communities fall into the category who are least able to help themselves, but, on the flip side, they do not have many assets to lose either. This might also include social dimension which form the basis of community division, thereby resulting in political instability (Kim, 2010).

2.9 Disaster Risk Management

This section highlights disaster risk management to achieve the second research objective. The term disaster management describes a process in which the disaster risk impact is reduced in the first place by adopting various emergency response measures, not only subsequent relief and aid work after disasters (Ahrens & Rudolph, 2006). Vasilescu et al. (2008) said that different communities recognise disaster management as a cycle of activities which come from the negative effects of disasters within those societies. UNISDR (2009, P.10) defined Disaster Risk Management (DRM) as "The systematic process of using administrative directives, organisations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster".

DRM contains three stages, which are: the disaster stage, which is preceded by the pre-disaster stage and followed by the post-disaster stage. There are different priorities in each stage. The pre-disaster stage usually deals with preventive and mitigative measures, the disaster stage handles the emergency response needed during the event, and the post-disaster stage concentrates on rebuilding, recovering and reconstructing what was lost during the disaster (Freeman et al., 2003; Tingsanchali, 2012). These stages come with specific needs, tools, resources and strategy requirements along with unique challenges. Shaluf (2007) and Vasilescu et al. (2008) opined that the key goals of disaster management revolve around reducing the effects of a disaster's risk, helping out the victims, and returning to the normal condition before the disaster in the quickest time possible. Hence, many studies have shown that the cycle of disaster management is composed of four phases, called mitigation, preparedness, response and recovery as shown in Figure 2.6 (Kusumasari et al., 2010; Vasilescu et al., 2008).

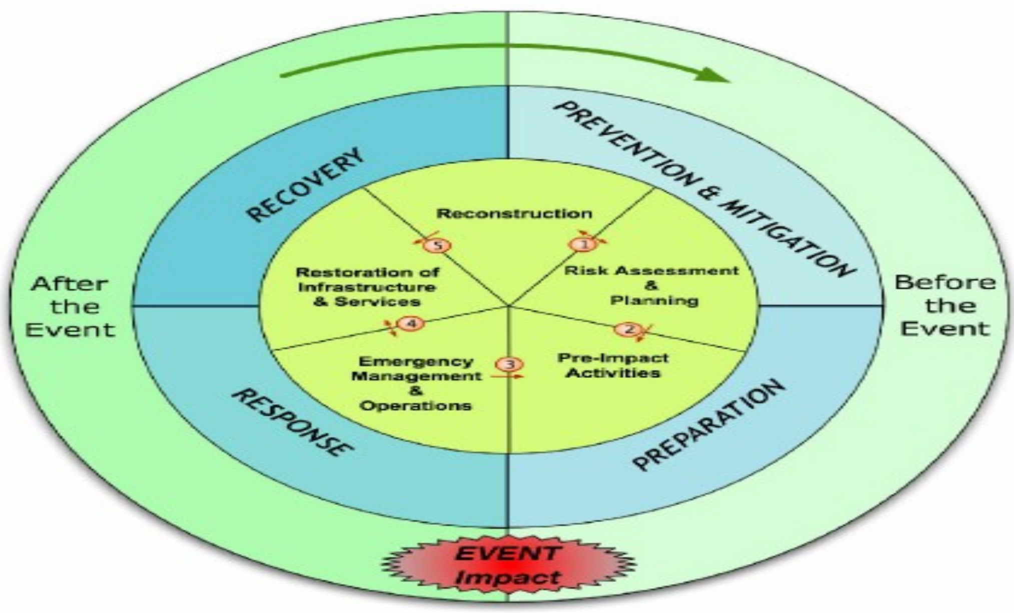

Figure 2.6: The phases of the disaster risk management cycle (Vanneuville et al., 2011).

2.9.1 Prevention and Mitigation

Prevention and mitigation are usually described as sustained actions or measures taken in order to minimise or avoid material losses and loss of life caused by sudden hazardous events. This step deals with sustained and long-term solutions implemented to reduce risk (Sylves, 2014). The usual first stage of emergency management occurs before a disaster strikes and it may combine activities and characteristics from all stages (Shaluf, 2008; Ophiyandri et al., 2010). The activity aims at preventing, or at least reducing, the damages caused by the disaster. ADRC (2005) listed methods such as dam construction and proper land zoning etc., which mitigate disasters such as floods, thereby reducing the chances of loss of life and property. Such approaches strengthen local infrastructure to make it more resilient to natural disasters, making the community less likely to be affected by drastic events (Sylves, 2014). In essence, the aim of mitigation is to improve the chances of economic security and stability and improve environmental conditions. This is commonly used for risk reduction, and includes steps to identify and map hazards, plan land use based on risk assessment, incentivise people to follow these guidelines, provide insurance, develop design and construction applications, and enforce structural controls (Said et al., 2011).

Furthermore, the mitigation principles are mainly based on community participation combined with other mitigation measures. The community participation includes various phases to assess the community's vulnerability and capacity to handle and cope with floods; the community's participation is primarily needed in order to ensure the efficient and sufficient priority identification of actions and to give legitimacy to the actions. In particular, a flood mitigation plan should include one or more practical measures (structural and non-structural measures) to reduce the flood damage. Heidari (2009) stated that the flood mitigation plan has to address the following main issues:

- The optimal implementation approaches to control the flood.

- The optimal location for facilities installation.

- Identify the best size of the facilities.

- The optimal operation and maintenance approach of the facilities.

- Identify alternatives for mitigation (location, size of the structures) and the operating conditions of these alternatives.

2.9.2 Preparedness

Disaster preparedness is defined as the extent to which a society is ready to face disasters. It involves steps such as leadership, training, preparedness and exercises carried out to improve a community's response to a disastrous event. It also involves providing technical support and assistance to various public, government and non-government organisations and workers to help them be prepared for disaster. Kapucu and Özerdem (2011) theorised that these steps will in turn help with response and recovery. In essence, the 'preparedness' phase deals with emergency drills and public awareness programmes which will allow the community and governing mechanisms to respond effectively to a crisis (Kapucu, 2012).

The objective here is to minimise the vulnerability of a community to loss of life and property in the event of a disaster. This stage concentrates on involving local bodies (individuals, businesses and governing organisations) in activities related to preparing for and responding to disasters. This may require governance decisions such as developing operating protocols for dams and other water storages, protecting flood plains from development, and ensuring that zoning and land use are carried out with disaster prevention taken into consideration (ADRC, 2005). According to the IEDC (2016), this may involve engaging warning systems and developing evacuation routes, stocking up for emergency needs, and preparing safe shelters in case of an emergency. The people should also be familiarised with the measures and trained to respond appropriately. Similarly, Allen (2006) stated that communities should have a plan and be trained in that plan, as then exercising that plan can in turn help to mitigate damages due to disasters and build communities that are disaster resilient.

2.9.3 Response

Disaster response consists of actions that are taken in the immediate wake of a disaster as instant responses. This response may be anticipatory action before a disaster actually hits an area or measures taken immediately after the disaster occurs (McEntire, 2014). This stage was established in order to be able to reduce the impact of disasters in the affected community through organisational, tactical and strategically coordinated actions between all concerned stakeholders (Dillon et al., 2009). Actions taken in this phase may include evacuation, giving first-aid, medical treatment, setting up of temporary housing or camps and monitoring the disaster situation. The response to a disaster starts as soon as officials with the authority to commence the response effort recognise the imminence of a hazard event. Responses are directed towards saving lives, providing basic needs like food and water, and resource distribution to minimise the impact of disasters on people and environment (Hidayat and Egbu, 2010; Kapucu & Özerdem, 2011). By using knowledge from past events, decisions made during emergencies can be improved to make current and future response procedures (Turoff, 2002).

2.9.4 Rehabilitation/Reconstruction/Recovery

The fourth phase of an effective disaster management cycle is reconstruction/recovery, which is the process of bringing back as much normalcy as possible to the lives of people and the economy of the region where the disaster has hit (Moatty et al., 2017). The main aim of this reconstruction phase is to support people to quickly get back to as normal a life as possible, both immediately and on a long-term basis (McEntire, 2014). This reconstruction/recovery phase of disaster management has two phases. In the first phase, which lasts for six to 12 months, people's immediate needs like shelter, food, water and clothing are met and the rehabilitation process begins. The objective here is to establish basic functionality, ensuring that all services are back in operation. The second phase is a long-term phase that may last over 10 years and here careful strategies are undertaken to bring the entire disaster-hit area and its people to completely normal life and to aid the recovery of the negatively impacted economy (Tagliacozzo & Magni, 2016). The IEDC (2016) highlighted the importance of disaster-affected communities concentrating on building up the society using both private and public resources. It is essential that communities can mobilise both private and public resources at this stage so that the severe effects of a disaster can be overcome.

The ADRC (2005) ascertained that overall disaster risk can be reduced by following appropriate steps through all the phases of disaster risk management (DRM). Applying a combination of these steps constituting of policies, strategies and practices can minimise the disaster risk for a society. In essence, DRM helps to avoid or at least to hedge the impact of hazards, specifically when sustainable development is also one of the objectives (Freeman et al., 2003). On the other hand, disaster risk reduction (DRR) is systematic development consisting of implementing policies and strategies so that the vulnerability of an area or communities to disasters is avoided or reduced and their resilience is increased (UNISDR, 2015). Moreover, through the effective adoption of the disaster risk reduction strategies the impact of disasters can be prevented or mitigated. Deciding on suitable measures built on disaster risk management in every phase of the cycle can lessen the total disaster risk. In short, Table 2.3 demonstrates measures taken in each phase to prevent or mitigate flood disaster impacts (ADRC, 2005).

Table 2.3: An example of measures taken in every phase of DRM.

Disaster / Phase	Flood
Prevention/ Mitigation	Construction of dike Building of dam Forestation Construction of flood control basins/reservoirs
Preparedness	Construction and operation of meteorological observation systems Preparation of hazard maps Food & material stockpiling Emergency drills Construction of early warning systems Preparation of emergency kits
Response	Rescue efforts First aid treatment Monitoring of secondary disaster Construction of temporary housing Establishment of tent villages
Rehabilitation/ Reconstruction	Disaster resistant reconstruction Appropriate land use planning Livelihood support Industrial rehabilitation planning

2.10 Flood Risk Management

Flood risk is described as a product of vulnerability and hazard associated with floods. It is a function of the likelihood of adverse effects caused by a flood and varies with the exposure of assets and people who are likely to face the hazard (ISDR, 2004). This was supported by Hooijer et al. (2004, P.345), as they defined flood risk as: “a function of probability (of flooding) and potential damage (due to flooding). It is increasing not only due to climate change phenomenon but also due to large investments in flood risk areas causing an increase in potential damage. Hence, flood hazard is described as the probability of the occurrence of flood damages. This in turn implies that, when elements are exposed to a flood event, there is a probability, but not a necessity, of these elements being damaged. Schanze et al. (2007) rightly observed that the damage caused by a flood depends on the characteristics and vulnerability of the elements being placed in the path of the flood.

Accordingly, flood risk management (FRM) is a major approach to mitigate and deal with flood risk. Alternatively, Hutter (2006) stated that flood risk management should be a continuous process where a society is considered as a single holistic unit, and the risk of flood events is analysed, and mitigation options developed in order to minimise the effect from future events. This means that flood risk management involves all the processes carried out to analyse and assess flood risk, and all the decisions taken based on this data to mitigate and minimise damage in the future. Schanze et al. (2007) presented their viewpoint that there are a wide variety of tasks and issues associated with flood risk management, which range from the process of flood prediction to their societal effects and measures for disaster risk reduction (DRR). Thus, FRM aims to prevent loss of assets, property and, most importantly, human lives (Hartmann & Driessen, 2017).

In fact, minimising the negative effects of floods can be achieved by two key approaches. The first approach is to prevent flooding itself by various measures. The second one is to ensure that people or property are not in the path of floods and to reduce the impacts of them. Using either of these approaches, it is possible to minimise the harm to people and damage to property due to flood events. However, it should be noted that these approaches concentrate heavily on decreasing the flood hazard. The alternative of reducing damage by managing the vulnerability of exposed assets is not given sufficient importance (Klijn, 2009; Vis et al., 2003). Moreover, according to Raadgever et al. (2018), there are some particular strategies of FRM that highlight easier ways to manage a flood or the entire disaster. Short-term strategies are used to rescue people from the hazardous situation in order to save their lives. In contrast, long-term strategies help to balance the needs of the present time with the requirements for a sustainable future. In particular, Kourgialas and Karatzas (2011) highlighted that the strategy of flood management comprises: a) pre-flood measures, b) flood forecasting and c) post-flood measures.

The pre-flood stage essentially deals with measures and policies implemented (technical and policy based) to reduce the effects of floods. Technical measures involve constructing dykes and dams, or desilting rivers for proper drainage. Policy interventions can involve proper zoning of land and enforcement of appropriate building regulations, appropriate settlement planning, and economic interventions like insurance requirements (Hutter, 2007). This step depends on sufficient resources and time being available to institutes, governing agencies and local institutions (Faisal et al., 1999; Schanze et al., 2007). The purpose of flood forecasting is to provide the appropriate warning with as much time as possible. Any amount of time given before a hazard can help to minimise the damage caused by it (Parker & Fordham, 1996). A flood forecasting warning system (FFWS) consists of setting up a network of telemetric units that can monitor and record precipitation, meteorological parameters and flow values for rivers (Green et al., 2000). According to Sayers et al. (2013), flood forecasting is a key part of emergency planning, as such a plan will be initialised by a flood warning. The final flood management strategy is post-flood measures, which includes steps to promote rapid reestablishment of infrastructure and services lost to floods. It also includes steps to reassess the flood prevention protocols and mechanisms in place before the flood so that future events can be dealt with more effectively. Kourgialas and Karatzas (2011) noted that societies with appropriate flood prevention plans and readiness measures can respond much more effectively to such events. In essence, these measures aim at post-flood recovery and mitigation of any similar future events (Raadgever et al., 2018).

On the other hand, Abhas et al. (2012) observed that meaningful flood risk management needs to be an ongoing process with multiple iterations of the same set of activities. These activities involve analysing the risk of flood events, studying and identifying measures and policy interventions that may help reduce this risk, adopting and implementing these measures and then continuously observing their effects (Klijn, 2009). Ultimately, flood risk management can be carried out after identifying areas where the potential for a flood is high. This process of identifying probable areas is also helpful to stakeholders and decision makers as it allows the community to enhance resilience to reduce the risk of losses due to flood events (Hall et al., 2003; Klijn, 2009). According to Schanze (2006), there are three main areas under which flood management activities can be classified. These areas involve the analysis, assessment and reduction of risks. The risk analysis stage uses information available to generate a rational foundation for decision making related to floods on a local and national level. This also involves the analysis of past floods and risks associated with them in addition to ongoing or likely events. Developing an appropriate flood management policy is largely based on assessment of risk data generated from analysis. Hall et al. (2003) discussed how appropriate resource allocation, evaluation and monitoring of activities performed for flood mitigation, and flood management policy in general, is based on risk assessment.

Risk reduction alternatively tries to minimise the risk of flooding using a number of structural and non-structural interventions (Schanze et al., 2007). The Sendai Framework for Disaster Risk Reduction (SFDRR) agreed with this approach. In fact, the first priority of the SFDRR insists that DRM can only be carried out after developing an in-depth understanding of disaster risk, which is a multifaceted construct involving factors such as capacity, exposure of people and property, environmental and hazard features, and vulnerability. Flood risk can be described and represented in several ways, but the three most important elements are as follows: a) hazard, b) exposure and c) vulnerability, a concept which is expressed as a 'risk triangle' by Crichton (1999). The researchers Peduzzi et al. (2002) and Granger (2003) also confirmed that this concept has been broadly acknowledged and used in research on natural disasters. Figure 2.7 explains the risk triangle (Crichton, 1999).

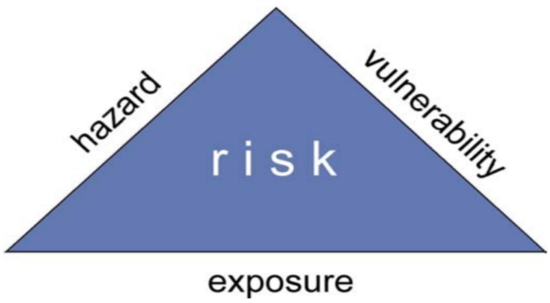

Figure 2.7: The risk triangle (Crichton, 1999).

Therefore, flood risk is comprised of three parameters, namely exposure (or the worth of materials that may be affected), hazard (or the likelihood and intensity of the event), and vulnerability (or the predisposition of a building or material to suffer damage). Kron (2005) combines these to give the value of risk as per the following equation:

$$Risk\ (R) = Hazard\ (H) \times Vulnerability\ (V) \times Exposure\ (E)$$

It is worth noting that if any one of the three components - hazard, exposure or vulnerability - turn to zero, then the corresponding risk of flood would also equate to zero. More specially, there would be zero risk if a) there is no chance, probability or likelihood of flood occurrence, and/or b) there is no population in the flood-affected area and/or c) there is no vulnerability in the population, such as if there is a built-in flood security in place for all the constructed houses.

2.10.1 Hazard

The UNISDR (2009) defined a hazard as: "A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage" (P.17). A hazard can include all probable events that may happen at any point in the future. It can be natural or anthropogenic and is likely to damage exposed elements if they are vulnerable. Natural hazards are defined as extreme events that create in the hydrosphere, lithosphere biosphere or atmosphere. Of these, natural hazards may be hydrological, meteorological or geological occurrences that can cause disruption to livelihoods, affect social and economic conditions adversely, destroy or damage property, or cause loss of life or adversely affect health (Alexander, 2000; Scheidegger, 1994).

Man-made or technological hazards are usually caused through industrial or technological events and result in similar social or economic disruptions, environmental degradation, loss of services, injury or ill health, or loss of life or livelihood. It can be argued that natural hazards often cause, directly or indirectly, technological hazards (ISDR, 2009a). The location of a natural hazard mainly relies on natural processes which include movement of tectonic plates, impact of weather systems, and the presence of slopes and waterways (such as they might contribute to a landslide). On the other hand, UNISDR (2011) reported that the natural hazards' intensity, their frequency of occurrence and their location could also be influenced by processes such as change in climate, environmental degradation and urbanisation.

There are several countries which have been exposed to more than one hazard. Hence, it is essential to take a holistic view of all those risks which are associated with the broad range of hazards which have the capacity to impact assets or people. Unfortunately, there are many cases on record wherein the full consideration of the hazard was not taken; for example, the case of the Indian Ocean tsunami in the year 2004, where housing in Aceh in Indonesia was built in highly vulnerable areas, putting families at risk from flooding (Benson et al., 2007).

2.10.2 Vulnerability

Recently, vulnerability has received major attention from researchers, especially in disaster and emergency management studies (Birkmann, 2006). The concept of vulnerability has its roots in geography and natural hazard research, but the term is used in a variety of other research contexts (Füssel, 2007). Hence, the notion of vulnerability has been discussed in various fields like environmental change, development, emergency and disaster management studies (Birkmann, 2006). It has become a basic concept in hazard and disaster risk reduction (DRR) studies (Burton et al., 1978; Hewitt & Dyck, 1986; Wisner et al., 2004). Moreover, Blaikie et al. (1994) rightly observed that managing vulnerability can naturally lead to disaster mitigation.

The IPCC (2012) characterised vulnerability as the propensity of people, their sources of livelihood, or material assets to suffer damages or losses when faced with a hazard event. In the same context, Turner et al. (2003) described vulnerability as the tendency to bear some loss due to hazardous events. It is reported that vulnerability assessment is taken as a tool to measure risk assessment (UNISDR, 2005). There are two well-known aspects of vulnerability: exposure and sensitivity (Miller et al., 2010). These two aspects are different in term of the change in function of system experienced by natural hazards. The two aspects of vulnerability highlight what and who is at risk (exposure) and the tendency to which infrastructure and people may be negatively affected (sensitivity) (Cutter et al., 2008).

Since the 1990s, researchers in many fields have studied the factors of vulnerability, which include development studies, the areas of global change and environment, mitigation of disasters, and the hazards and risks (Weichselgartner, 2001). The meaning of 'vulnerability' differs based on the context in which it is and type of discipline using it (Füssel, 2007; Vatsa, 2004). Schroeder and Gefenas (2009) highlighted that several studies have pointed out the source of 'vulnerability' is from the Latin verb 'vulnerare', which means 'to wound'. The term 'vulnerability' had two uses in particular which resemble military and medical interpretations. When it comes to observing it in the context of the medical field, it is used in pathology, where it is referred to as the susceptibility to disease and injury and the capability to be hurt. TenHave (2016) said that the third use of the term is connected to several other concepts such as being hurt, harm, or damage.

In the view of Schanze et al. (2007), vulnerability is defined as the characteristics of a system that describe its potential to be harmed. This can be reflected in the functional relationship between potential harm to all at-risk components and the susceptibilities and exposure characteristics of the structure affected, relating to all possible flood hazards. Many studies have presented definitions of vulnerability but there is no consensus or agreement on these definitions. Table 2.4 presents a list of definitions of vulnerability to natural hazards.

Table 2.4: Selected definitions by various authors on the concept of vulnerability.

Author and Year	Vulnerability Definitions
Hewitt and Burton (1971)	Vulnerability can be described as a function of social response and biophysical risk as well as how this apparent hazardousness of place or itself locally.
Pelling and Uitto (2001)	Vulnerability can be explained as an outcome of 'physical exposure' to natural danger, and the ability of human to get ready or cope with the detrimental impact of disaster.
Blaikie et al. (2004)	Vulnerability is not only related to the likelihood of human being killed or injured due to any uncontrollable hazard, it also includes the level of influence of various hazards on people or groups.
Turner et al. (2003) p. 8074	Vulnerability is not only focused to highlight weakness and coping capacity but also identify exposure, interaction with stresses and external shocks, and adaptive capacity.
UNISDR (2005)	Vulnerability represents the social, environment, physical, and economic processes which can enhance the susceptibility of a society to the influence of danger.
Cutter and Emrich (2006)	Vulnerability is an outcome of social inequalities and it also represents susceptibility of groups to influence of danger. Further, vulnerability also shows the capability to manage the impact of external shocks.
O'Brien et al. (2006)	Vulnerability is a feature of a group or person and their condition that impact their ability to anticipate, resist, and bounce back from extreme natural hazard.
ISDR (2009a)	It refers to the feature and situation of an asset, system, society, group, system, or community that build it inclined to the detrimental effects of natural hazard.
Scheuer et al. (2011)	Vulnerability is a feature of a system that can explain its strength to be damaged. It may be shown in terms of connection between susceptibility and exposure feature of the influence system and expected losses about all elements at risk.
IPCC, (2012)	Vulnerability is a susceptibility of elements like assets, systems, or human beings to experience adverse influences when affected by natural hazard.

It can be noted that vulnerability is therefore a characteristic of the system, community or physical asset that is to be protected, and is not dependent on the hazard event itself. However, the vulnerability is focused on system's condition before an event which help in coping with future hazards (Scheuer et al., 2011). Lewis and Kelman (2010) opined that a combination of diverse factors such as economic, social and political determines the 'vulnerability' of a community instead of the intensity of only one, and also that the effects of a hazard will influence people and communities differently based on their level of vulnerability. Hence, there are many factors that influence vulnerability such as age, health, gender, resources, lack of preparedness, certain beliefs and customs, weak building infrastructure, and lack of local and national institutional structures (As shown in Figure 2.8) (Cutter et al., 2003; Lemonick, 2011; Birkmann, 2006; Kusumasari et al., 2010).

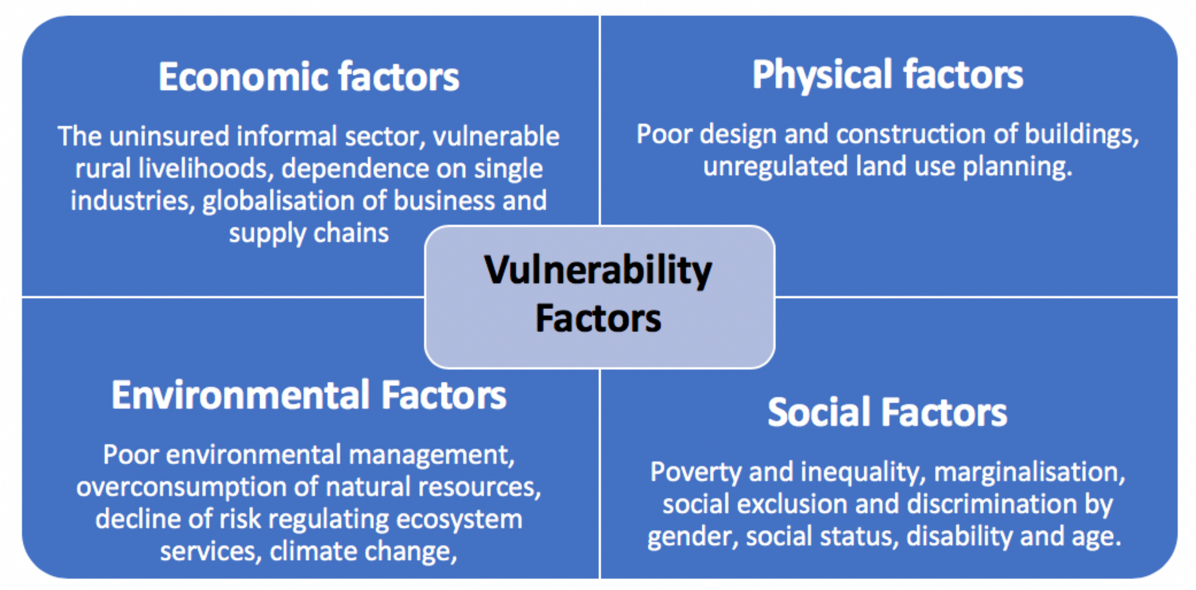

Figure 2.8: Example of vulnerability factors in different disciplines (Preventionweb, 2015).

2.10.3 Exposure

The term 'exposure' reflects a broad range of elements inventory such as systems, property and people which exist in the hazard zones, and are thereby susceptible to potential damages or losses. This implies that, if the economic resources and the population are not situated in potentially hazardous locations, there would be zero risk of disaster. When it comes to defining the term 'exposure', research defines it as a system's propensity to be disturbed or disrupted due to a hazard event, for instance, flooding, when it is located in a flood-prone area (Balica, 2007). Exposure can also be described in terms of values which exist in an area that is vulnerable to flooding. These values could be people, agricultural fields, infrastructure or properties. The degree to which a property is located in an area that is vulnerable to flooding is also termed exposure, which is normally illustrated through the processes and patterns by which the duration and intensity of floods are estimated. Researchers also define it as the several elements that are at risk (Messner & Meyer, 2006), and it is also defined as the association of elements to the hazard risk (Fuchs et al., 2011).

According to ISDR (2009a), it is possible to estimate the risk of any hazard if the particular vulnerability related to people and exposed elements are known. However, Cardona (2013) stated that vulnerability and hazard cannot occur independently of one another. According to UNISDR (2012), the degree to which the economic assets or people are normally at risk depends on their level of vulnerability. The IPCC (2012) reported that it is also worth noting that the hazard factor cannot be changed, and it is necessary to manage vulnerability of ecosystems and communities to reduce the impacts of hazards. Exposure measures can involve the numbers of people or assets in a particular area that are exposed to any specific hazard to determine the quantitative risks related to that hazard in the area (UNISDR, 2015).

2.11 Flood Measures

Flood risk management (FRM) includes several measures to address and deal with floods that are occurring or likely to occur soon. Abhas et al. (2012) and Hall et al. (2003) rightly stated that the measures taken for flood risk management should include both structural and non-structural approaches as the aim is to develop an integrated, long-term strategy for FRM to reduce flood hazard. Thus, a range of flood measures were adapted by developed countries to prevent and mitigate flood impacts. Through structural measures, the impact of floods can be prevented or reduced through constructing flood defences, dams, basins and dikes, which can help to protect people and properties from the negative impacts of floods. On the other hand, insurance, flood forecasting and warning the people are common non-structural measures. Moreover, according to many studies, relocation and insurance investments have been identified as non-structural measures of flood risk management for a long time in the UK (Van den Hurk et al., 2014). These strategies have different degrees of usefulness, and some structural measures depend on non-structural measures.

Furthermore, the non-structural approach is more diverse, and involves steps taken to share the losses incurred such as insurance and financial aid during disaster (Hsu et al., 2011). Smith and Ward (1998) highlighted non-structural measures involving training staff for preparedness, better forecasting and warning systems, and appropriate land use, which can minimise the damages due to flood events. However, structural measures are most effective when combined with non-structural approaches (Parker & Priest, 2012). Moreover, international and regional treaties such as the Aarhus Convention in 1998, which encourages public participation in decision making on environmental issues, have recognised the importance of the stakeholders' role in decision making in flood risk management.

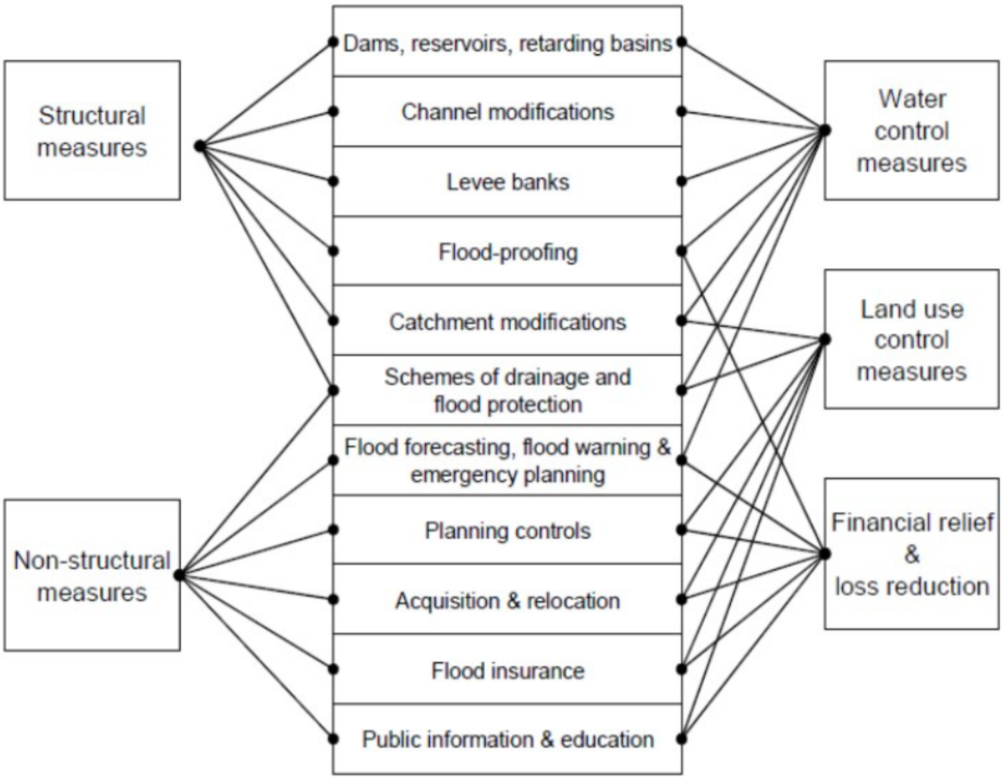

Figure 2.9: Structural and non-structural flood measures (Penning-Rowsell & Peerbolte, 1994).

The European Union (EU) has a plan for flood risk management which is based on five main elements: prevention, protection, preparedness, emergency response and recovery (European Commission, 2007). It is important to note that producing flood risk maps and risk management plans help to mitigate flood risk, but these do not stop the occurrence of floods by themselves. Figure 2.10 outlines the measures for the five elements of flood risk management.

Figure 2.10: Measures for five element of flood risk management (European Commission, 2007).

Similarly, many other developed countries have adopted the necessary flood measures and practices, and they are beginning to promote adaptive and integrated systems of FRM towards the management of flood events. For instance, the US government assumed primary responsibility for flood control in 1936, where most efforts at the beginning included flood structural measures such as construction of dams, levees and floodways. Then, interest in non-structural flood measures increased as the concept of flood management slowly developed. A good example of a non-structural flood measure adopted by the US government is the presence of an insurance programme known as the National Flood Insurance Program (NFIP). This insurance programme offers protection of property in areas considered to be at a high risk of flooding. The programme is accessible to communities that agree to implement flood management measures in order to minimise future risks in flood-prone areas (Galloway, 2008; Huber, 2012).

In the same regard, the UK government introduced better flood resilience measures as the Department of Environment and Rural Affairs developed particular action schemes like the Property Flood Resilience Action Plan which help the country to have the appropriate preparedness at a national and individual level for flood events through making communities and properties more resilient to flood events by initiating flood management measures (DTLR, 2002). Organisations and individuals in the UK share in the responsibility for risk management actions in order to control and adapt to the impacts of floods (Hall et al., 2003). There is an increased emphasis by the UK government on public flood awareness raising, land-use planning and development control to manage flood risks. Table 2.5 illustrates the different flood risk management actions, and roles of related stakeholders in the UK with the most capacity to implement change (Hall et al., 2003). Therefore, this section examines the current flood measures adopted by developed countries, which benefits from answering the first research question and achieving the second research objective.

Table 2.5: Flood risk management actions and roles with control over those actions (Hall et al., 2003).

Risk management action	Effect of action	Role
Development control in floodplains	Limit to construction of buildings and infrastructure in the floodplains, hence controlled increase in vulnerability	Planning authorities
Improving flood resistance of the buildings	Reduced flood damage	Property developers and building owners
Increasing public awareness of temporary measures to reduce flood impact on building contents.	More effective public action to reduce flood damage to building contents	Building occupants
Flood insurance	Redistribution of the cost of damage across the population and through time	Insurance companies
Increasing storage in catchment and reducing the rate of runoff (source control)	Reduced flood severity	Property and infrastructure developers, planning authorities, farmers
Urban drainage	Reduced probability of flooding	Water authorities, local authorities, highway authorities
Flood defence planning, design, construction, operation, and maintenance	Reduced probability of flooding (up to events that overtop the defences)	Environmental agency, local authorities
Real time flood forecasting and warning	Reduced flood impact (if followed by appropriate action by the public)	Environmental agency, Metrological office
Emergency repair of flood defences	Reduced probability of flooding	Environment Agency, emergency services
Evacuation of people in flood events	Reduced public safety and health impacts of flooding	Emergency services

2.12 Flood Management Within the UAE Context

2.12.1 The United Arab Emirates

The United Arab Emirates (UAE) area is around 83,600 km^2 and its coastline is on both the Arabian Gulf and Gulf of Oman. Politically speaking, a federation of seven individual emirates forms the UAE: Fujairah, Ras Al Khaimah, Ajman, Umm al-Quwain, Sharjah, Dubai and Abu Dhabi, and there is a significant degree of autonomy enjoyed by each federation (Zayed

University, 2018). According to the report of the Ministry of Energy (2006), the UAE borders Saudi Arabia and Oman, and situated in South West Asia between latitudes 51° and 56.5° E and between 22.0° and 26.5° N. The UAE has an important strategic location along the southern approaches to the Strait of Hormuz, which is a major transit point for world crude oil. As reported by Dougherty (2009), the EAAD (2009) and Sherif et al. (2009), the coastline of the UAE spans an area of 1,300 kilometres, as shown in Figure 2.11.

Figure 2.11: The UAE map (Sherif et al., 2009).

The UAE area is divided into three main ecological areas: coastal areas, mountainous areas such as the Hajar Mountain range, and desert areas. Approximately four-fifths of the UAE area is classified as desert, especially the western parts of the country. The landscape of the country also includes continental shelfs that slope into the Gulf of Arabia and a number of islands, reefs and salt marshes. Dougherty (2009) noted that the littoral zone of the country has a number of active salt flats (also known as sabkhas). In general, winter, which ranges from November to March, and summer, which covers the rest of the months, are the two distinct seasons. While winters are generally mild, with temperatures rarely dipping below 6ºC, summers are harsh, with humidity levels as high as 90% and temperatures hovering around 48ºC. The inlands are spared the high humidity, though they regularly experience temperatures as high as 50ºC (Ministry of Energy, 2006).

Given the arid climate, it is not surprising that rainfall is a relatively rare event. However, when high rainfalls occur in association with northern winds in the winter or local atmospheric depressions, they become newsworthy events, causing sudden flood events. An example of such a hazard occurred in November 2013, when a flood caused a number of injuries and one death when a vehicle was swept away by floodwater. Similarly, in 2014 February, unstable weather and heavy precipitation made it necessary for drivers to be cautious as significant traffic disturbances occurred (Kazmi & Chief, 2014). Areas of high altitude receive 140-200 mm/yr summer rainfall while the rest of the country receives little rain even in the rainy season, which is between February and March. Evaporation, however, is significant, as per the Ministry of Energy (2006), and has a mean value of 8 mm per day.

On the other hand, it was the middle of the 20th century when oil and gas were discovered and explored in the UAE. At that point of time, the UAE population was small and people's economic impact on the natural environment was very low as well. Since then, economic development in conjunction with the invasion of massive wealth has dramatically changed this situation altogether (Gardner & Howarth, 2009). The UAE witnessed a dramatic growth in its population, which was only 1 million in 1980 but touched 8.4 million three decades late, in 2010. It is also predicted that, by the year 2050, the UAE population might reach 15.5 million (DeSA, 2013). The reason is that most of the population in the UAE consists of immigrant workforces, which are estimated as 7.8 million people or roughly 84% of the total population, thereby giving the UAE the 5th-highest immigrant population in the world.

However, populations are largely concentrated in urban settlements along the coast, making them susceptible to a number of natural and anthropogenic hazards (Ministry of Energy, 2006). Shihab (2001) said that the economic factors were behind this rapid surge in the UAE's population. The UAE also witnessed an associated increase in people's living standards in urban developments such as commercial, industrial and residential development.

2.12.2 Climate Change in the UAE

The UAE falls into the category of countries with the top-most vulnerability rate due to the change in climatic conditions around the world (Sanderson, 2020). As a consequence, the weather is likely to turn warmer alongside droughts and lack of adequate rainfall, and the UAE is likely to face more storms and higher sea levels as well. These conditions put negative impacts on environment and health, socioeconomic conditions, policies and development sectors, natural health and human health, and infrastructure. Moreover, due to global warming, it is highly likely that both the coastal and oceanic, anthropogenic and natural hazards will continue to rise (IPCC, 2007).

The UAE is seriously concerned about the global warming and climate change conditions, which is why the country has commissioned international research studies in order to gauge the weather change patterns by measuring the effects of higher concentrations of CO_2 in the environment. A complete report for Abu Dhabi was presented by the Stockholm Environment Institute's US Centre in 2010 which purely focused on how the changing weather patterns would influence the economy, infrastructure and ecosystems, and how it would influence the health of the UAE's residents. The report presented the finding that it is quite possible by the end of the century that the rising sea levels will claim up to 6% of the country's developed and populated coastline (OPUG, 2018).

According to Kumar (2013), the UAE could suffer critical damage to the coastlines that are near or at sea level due to the 5 mm/year predicted sea level rise. Tolba and Saab (2009) observed that, even when the sea level undergoes a rise of a single meter, it is likely to affect 33% of the available land, and more storm surges would be formed due to the rising sea level. Researchers noted that, between the years 1979 and 2007, there has been a 2.2 mm (± 0.5 mm) rise in sea level every year (Alothman et al., 2014). Moreover, Hassanzadeh et al. (2007) pointed out that there also has been a reported rise of 2.8 mm every year between 1990 and 1999 from tide gauges at two stations beside the Arabian Gulf north coast, i.e. Bushehr and Bandar Abbas in Iran. These rises will in turn affect the erosion patterns, causing heavy damage to offshore reclaimed townships and islands. In addition to the rise in seal levels, global warming also increases the incidence and intensity of heat waves. Such events are expected to happen more often, with higher temperatures than before. Heat waves are hazardous to human life, and such events are regularly linked to loss of life. Furthermore, the seasonal accumulation of allergens is also on the rise. The temperature is projected to increase between 2 and 3° C during the summer by 2060-2079. Moreover, within the same period, the humidity is also projected to increase by about 10% over Arabian Gulf (EWS-WWF & Acclimatise, 2017).

As a matter of fact, the water demand and supply will change due to the global warming phenomenon and, according to the IPCC (2007), this could raise the water availability gap around the globe. As a consequence, due to climate change phenomenon, the UAE would witness hydrological changes include frequent floods and water shortage. The situation would be worse in those areas that are already associated with water shortages and similar issues would be faced by other regions (OPUG, 2018). The UAE is vulnerable to the climate change risk, which also threatens society, businesses and the country's economy at large. Moreover, the effective development and implementation of adaptation measures and actions will only be possible if the capacities and knowledge on climate change impacts and the associated risks are strengthened, and there is considerable improvement in climate information and data sharing as well (EWS-WWF & Acclimatise, 2017).

In recent years, the UAE has made steps forward on green development and to mitigate the impacts of climate change. The most prominent example perhaps is the city of Masdar in Abu Dhabi, which is a zero-carbon city (the first of its kind globally) emphasising clean technology. The technology transfer from this city makes it a leader in the area of green development, aggregating measures such as solar power generation, geothermal harvesting, water management, various cooling measures, recycling of grey water waste to energy conversion units, logistical platforms and light rail. Moreover, Dubai Council of Energy plans to take solar energy in the energy mix to 7% by 2020, 25% by 2030 and 75% by 2050 (Beeatna, 2018).

The UAE's National Climate Change Plan 2017-2050 is one of the most in-depth and detailed frameworks to address the triggers and influences of climate change; it provides a planned shift and conversion into a green economy tagged with climate resiliency to achieve a better-quality life in response (MOCCAE, 2017). Although there is still no effective assessment available for this plan, it addresses key goals as follows:

1) The UAE should manage and control the emissions of greenhouse gases (GHG) and also maintain its economic growth.
2) Reducing the risk of climate change and enhancing the adaptation capacity.
3) Improving the economic variation of the UAE by providing feasible and practical solutions.

2.12.3 Flood Events in the UAE

The UAE and its neighbouring countries such as Qatar and Oman have been less experiencing natural calamities compared to other nations globally. However, it has been identified that the country has been battling unstable weather conditions, particularly with respect to pluvial floods that have seen authorities caution residents during incidents of heavy rains. For instance, the heavy precipitation experienced in February and March 2016 saw significant interruption because of a progression of extraordinary thunderstorms in the nation which brought about broad flash flooding (EWS-WWF & Acclimatise, 2017). The surge hazard map in Figure 2.12 shows the depth and extent of the 1 out of 100-year event (because of heavy precipitation) across the nation, where the greater depth of flood is indicated by blue shading (UNEP, 2016).

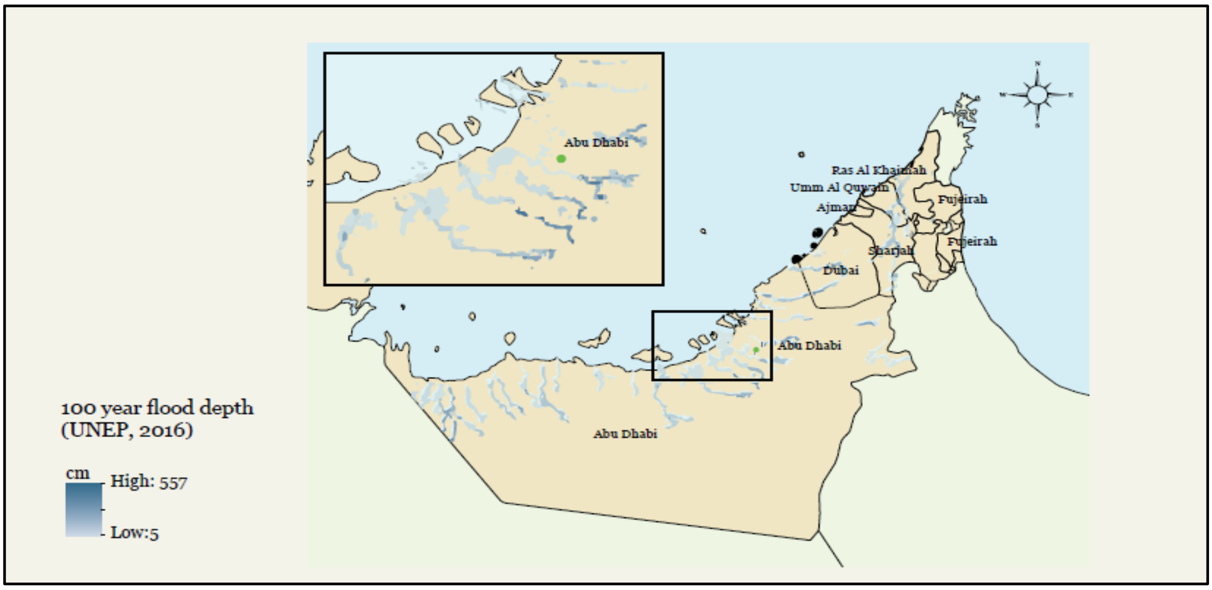

Figure 2.12: Water Depth over 100 years due to heavy flooding in the UAE (UNEP, 2016).

According to Elhakeem (2017), floods in the UAE are common in the frontal area of the coastal valley due to the surrounding mountain watercourse network, which is characterised by sudden flooding of high rainfall amounts between December and March. Most of the flows in this region do not have hydraulic control structures in the outlets to direct their currents. However, lower-lying coastal zones across the coastline, such as Abu Dhabi city, can likewise be influenced. There have been reports of sudden flooding in urban areas where heavy rains are increasing due to the lack of leakage and drainage associated with streets and structures (EWS-WWF & Acclimatise, 2017).

It is more usual that pluvial floods occur in the urban areas of the UAE, causing a great deal of damage to streets and structures, and making these regions highly vulnerable, as indicated by Alsenaani (2013). One of the most famous flood events in the UAE was the Alghail flood in Sharjah in April 2013. Almarzouqi (2017) investigated this region and its propensity to flood events through interviews conducted with its citizens. He stated that the locale is encompassed by a series of mountains that have various valleys. Citizens have lived in the region since 1982 but they are in danger as the territory is surge inclined and wadis are unsafe as they are inclined to flash surges. Levees have been built in a few channels, yet there was a hazard that they could crumple amid an extensive surge. Alghail endured two extreme flood events, in 1980 and 1998. However, in 2013 the flood event was believed to be a result of new development and improvement of construction projects, for example, houses and streets in the valley-way which is the path taken by floodwater. The citizens of Alghail believed that the fundamental driver of the last surge was the modification of the valley-way by a portion of the stone-mining organisations in Fujairah city, which these organisations do for their own advantage and give no thought to the disturbance to properties, resources, domesticated animals and ranches that such exercises could cause (Almarzouqi, 2017).

This was not the first time that development works had taken place in UAE districts and been the main cause behind the country's flooding events. Almarzouqi (2017) also investigated the reason behind the flood that occurred in the Suhailah region of Kalba city, which is located in the eastern region of the UAE and found that development was also the main cause behind the flood. Suhailah citizens also believed that the flood was caused by careless companies that dig rocks for trade. They did not regard how the mining changed the surge-ways, leading to the formulation of severe flood paths in the region. Thus, floods in the UAE are accompanied by various negative impacts on communities, infrastructure, and the country’s economy. Figure 2.13 shows that heavy rain caused blackouts in Khorfakan, and floodwater entered a shopping mall in Dubai (Rai, 2016; Emirates 247 News, 2016).

Figure 2.13: The impacts of flood in Khorfakan and Dubai cities (Rai, 2016; Emirates 247 News, 2016).

2.12.4 Flood Measures in the UAE

The UAE is vulnerable to several natural hazards which include the anthropogenic, geological and atmospheric situations. The researcher Al Ghasyah Dhanhani (2010) said that, as the nation continues various developments, the people and the country itself become prone and susceptible to those hazardous effects. According to EMA (1998), the unsettling and disruptive events can be described through various terms like crisis, accidents, disasters, emergencies and incidents based on coping capacities, number of involved organisations and each country's preferred terms. For instance, NCEMA (2018) stated that terms like disaster, emergency and crisis are selected by the UAE to explain those events which can trigger considerable disruption to the community.

The National Crisis and Emergency Management Authority (NCEMA), a government agency of significant authority, was set up in 2007 to tackle any hazards such as floods within the UAE. Falling under the jurisdiction of the Higher National Security Council, the body aims to keep the citizens and residents of the country safe in the event of an emergency. It also hopes to preserve material assets within the country during such events (NCEMA, 2018). This authority develops the national plan for emergency response and coordinate coordinates and regulates every aspect of crisis management within the UAE. Its mission statement is as follows:

"To enhance the capabilities of the United Arab Emirates (UAE) in dealing with and managing emergencies, crises and disasters, and to set the requirements that ensure work continuity and rapid recovery. This will be through mutual planning and preparation, and by using all means of coordination and communication at the federal, local and private levels, with a view to saving lives and property". (NCEMA, 2018, P.2).

On a global scale, when it comes to the disaster management context, the undeniable role of social media has gained considerable attention. Alexander (2014) observed that social media is speedily growing as a global phenomenon which is tagged with high-speed information transferring and sharing to a broad number of people, which can also be utilised to exploit disaster management situations. The MCEMA has highlighted the need to keep an eye on social media-related information sharing. There should be a continuous and strong online presence as the social media has its appearance in these current days. Social media operates through various social networking platforms like Twitter, Facebook and YouTube, and it ensures the passing of verified and good advice to the public during any hazardous situation including floods (NCEMA, 2007).

The organisation has worked effectively in terms of building collaborations among other local authorities, scientific, professional and academic stakeholders, so that they join hands on disaster management. These collaborations should be based on the exchange of expertise between foreign and local governments as well. The emergency management-related information is made available through the outlets of conferences, discussions and workshops which benefit professionals on a global scale. In a bid to manage any emergency such as floods in the UAE, the country has adopted the national guidance from the United Kingdom. Apart from this, many international emergency management agreements have been signed by the NCEMA with other countries like the USA and the United Kingdom. The main goals of these agreements are to enable the NCEMA and the UAE to benefit from the global expertise and to allow effective coordination between human, technical and scientific efforts in terms of managing and controlling emergency situations (NCEMA, 2007).

Additionally, with the aim of supporting the UAE's plans to be prepared for emergencies, in 2013, the Abu Dhabi Environment Agency (EAD) started a centre named the EOC or Emergency Operations Centre. The EOC further strengthens and adds additional expertise to the NCEMA through its collaboration. This includes steps such as providing appropriate advice to emergency management executive bodies, inspecting and reporting on crisis potential at given locations, analysing risk, planning for various adverse events, and communicating directly with various important stakeholders. The key function of the EOC, however, is to address crisis within Abu Dhabi, and provide training to EAD employees so that they are prepared to provide an emergency response (EAD, 2017).

Therefore, to handle flood hazards, the UAE also has an emergency model, just like other international emergency models around the globe. The framework of emergency and crisis management shows the flow process to handle such emergency incidents. Figure 2.14 clarifies the crisis phases and the corresponding practice of emergency management in the UAE which are referred to as the crisis and the emergency management pillars (NCEMA, 2007).

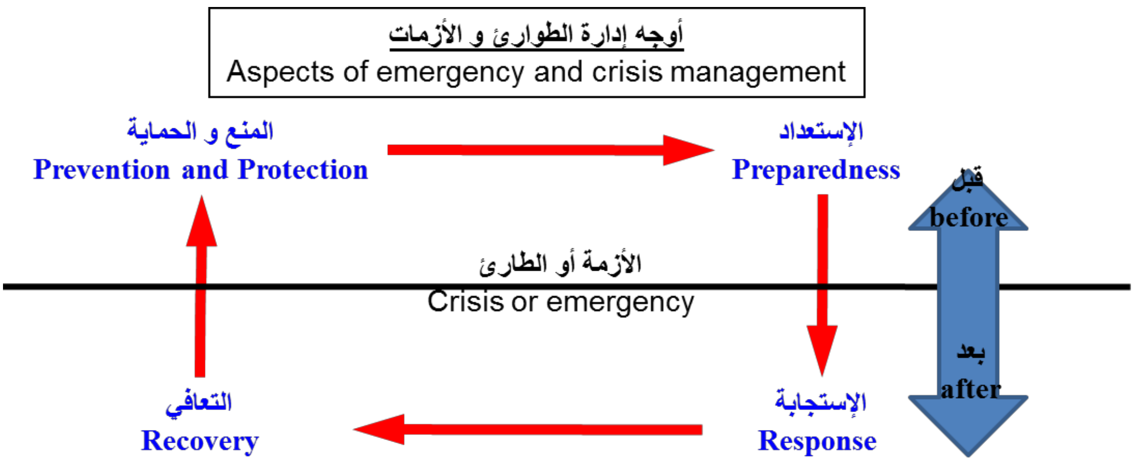

Figure 2.14: The main crisis and emergency management pillars (NCEMA, 2007).

The framework's phases are divided into two key sectors: the first refers to prevention, protection and preparedness before the crisis or emergency occurs, whilst the second covers the processes associated with the response and recovery after the emergency period. Basically, the phases remain similar and the activities in every phase follow the international standards for coping with emergency situations and disaster management practices. The following table illustrates the phases of crisis and emergency management in the context of the UAE (NCEMA, 2007).

Table 2.6: The UAE's crisis management and flood measures and phases (NCEMA, 2007).

Phases	Measures and Activities
Prevention and Protection	Those activities and actions that are focused on removing the triggers of disaster, crisis or emergency and reducing their chance of occurrence. For flood hazards, this includes many structural and non-structural measures like availability of effective infrastructure such as rainwater drainage system, formulating essential legislation, flood risk assessment and the holding of responsibility for all the preventive and security measures by the authorities involved.
Preparedness	It involves preparing for the procedures associated with the abilities and resources so as to cope with the emergency situations alongside dealing with flooding which might happen in the future. This stage involves the development of planning, coordination and training relating to the National Response Plan.
Response	It includes all those procedures and actions that have been executed due to flooding or emergency situation to reduce its impact and offer a helping hand and assistance to the community.
Recovery	All those procedures and actions that are executed after the emergency situation or floods. It focuses on the process of building the affected infrastructure again so as to return life to a normal state just as before the emergency situation. This stage includes the short-term, medium-term and the long-term actions and procedures.

In addition to the NCEMA authority, the UAE also has many other organisations which hold responsibility for managing the emergency situations; these are: Police (the first contact point for any situation), the municipality, Civil Defence, and the Ministry of Health. These organisations and agencies are considered as the main ones for emergency response. Additionally, other organisations are included in this category and provide assistance and facilities during response: Department of Environment, Department of Immigration, Department of Public Relations, and Community Development Authority (CDA) (NCEMA, 2014, 2018).

Based on the UAE's Vision 2021, the UAE government has large development plans for sustainability and to efficiently extend or upgrade their water infrastructure, enhance urban drainage and reduce the flooding risk. To do this, the local agencies in the UAE have adopted many flood measures over the years to mitigate the impacts of pluvial flood, such as adoption of rainwater drainage networks as one of the essential elements of infrastructure for new development areas. For example, in 2016 Abu Dhabi Municipality launched a rainwater drainage project; this includes work needed to improve the operational conditions of the existing system in order to make it more efficient and to increase its capacity to prevent floods, to protect local citizens and properties, and fulfil development needs until 2030, as the project covers the whole peripheries of Abu Dhabi Island. The scope of the project's activities covers building rainwater drainage systems along with the necessary pumping plants in various parts of Abu Dhabi, including Al Maqtaa, Al Mussaffah, Shakhbout City, Mohammed bin Zayed City and Baniyas (The National, 2016). However, there is a need for continuous and sustainable development in flood measures, including both structural and non-structural measures such as staff training, early warning system, emergency planning and public awareness, to build a community that is resilient to pluvial floods (Alhmoudi, 2016; Alshamsi, 2017; Almarzouqi, 2017). Hence, this section reviews the current pluvial flood measures in the UAE, helping to reach the first research question and the second research objective.

2.13 The Concept of Resilience

The term resilience derives from the Latin word 'resilio', which means to jump or bounce back (Klein et al., 2003). The word resilience has its roots in mathematics and physics. Based on Norris et al. (2008), the term 'resilience' was originally used to highlight the ability of a system to bounce back after a displacement. It is a multi-dimensional concept but there are several challenges with respect to the succinct, quantifiable and diverse meanings of resilience. The concept of resilience was firstly applied by Holling (1973) to describe system's measures and its ability to absorb disturbance or change, and still keep the same relationships between populations or variables. It was originally extracted from an ecological term (Holling, 1973) extensively used within human and environmental systems (Carpenter et al., 2001; Folke, 2006), and social systems (Adger, 1997). However, there are some challenges related to the term, in that it can be used in several research fields and in many ways. Therefore, it is hard to reach to a common resilience-based definition (Mayunga, 2007).

From disaster perspective, the term resilience was being used in the 1980s, and was associated with the notion of the capability to absorb and recover from a dangerous event with minimum damage or impact (CARRI, 2013). After the adoption of the Hyogo Framework for Action 2005-2015, the concept of disaster resilience has become more common. The Hyogo Framework for Action (HFA) is the main tool to implement disaster risk reduction strategies (UNISDR, 2005). There are two qualities for resilience: inherent, which is "functions well during non-crisis periods", and adaptive, which is "flexibility in response during disasters". They can be applied to many resilience dimensions such as institutional, infrastructure, economic and social (Cutter et al., 2008).

The main strategy of resilience is to avoid or minimise disaster consequences with minimum social disruptions (Tierney & Bruneau, 2007; Manyena, 2006). The objective of resilience is not only to focus on the ecosystems of a society; it also attempts to integrate the social-ecological system (Folke et al., 2003). The Department for International Development (DFID) defines disaster resilience as "the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses – such as earthquakes, drought or violent conflict – without compromising their long-term prospects" (DFID, 2011, P.6). The focus of disaster resilience is to enhance the ability to bounce back from damage caused by severe natural hazards in a very limited time. Disaster resilience deals with in- and post-disaster situations where a system or community devises strategies to cope with natural hazards. It can enhance the system or human capacity to deal with unique natural disasters such as flood, earthquake and storm. Its strategies are based on the experience of various disasters within the same geographic setting (Manyena, 2006).

There are two key reasons to consider the importance of resilience (Godshalk, 2003):

a. Since the vulnerability of social, natural and technological systems cannot be forecasted, it is extremely critical and important to be able to get on with the change without disastrous failure during times of disaster.
b. When disasters happen, both property and people are better protected in cities that are resilient. This is because resilient cities are subject to less collapse of buildings, fewer

injuries and deaths, businesses are less susceptible to risk, and fewer power outages happen.

With the passage of time, the concept of resilience has been re-invented or adapted due to the nature of short- and long-term disasters as well as climate change (Bruneau et al., 2003; Dovers & Handmer, 1992; Rose, 2004). Many studies have applied resilience strategies during disaster situations in specific cities (Vale & Campanella, 2005), earthquakes (Whitman et al., 2013), coastal regions (Adger et al., 2005), hurricanes (Frazier et al., 2013), and wildfires (Paton & Tedim, 2012). However, despite scholars' efforts to elaborate on the concept of resilience, there is still ambiguity regarding its proper conceptualisation (Cutter et al., 2010). Table 2.7 shows several definitions of resilience.

Table 2.7: Definitions of resilience according to several authors.

Source	Definitions of Disaster Resilience
Holling (1973, P.14*)*	"Resilience is a measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables".
Timmerman (1981, P.23)	"The measure of a system's or part of the system's capacity to absorb and recover from hazardous event".
Pimm (1984)	"The speed with which a system returns to its original state after a disturbance".
Cardona (2003)	"The capacity of community to absorb negative impacts and recover from hazardous event".
Longstaff (2005)	"The ability by an individual, group, or organisation to continue its existence (or remain more or less stable) in the face of some sort of surprise. Resilience is found in systems that are highly adaptable (not locked into specific strategies) and have diverse resources".
(Cutter et al., 2008, P.599)	"The ability of a social system to respond to and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post- event, adaptive processes that facilitate the ability of the social system to re-organise, change, and learn in response to a threat".
UNISDR (2009, P.24)	"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely

	and efficient manner, including through the preservation and restoration of its essential basic structures and functions".
Zhou et al. (2010, P.22)	"Resilience, broadly defined as the capacity to resist and recover from loss, is an essential concept in natural hazards research and is central to the development of disaster reduction at the local, national and international levels".

It is obvious from the above table that there are varying definitions which show the complexity of the concept. However, Castleden et al. (2011) stated that a great commonality could be seen in the different notions of resilience even when they are used across diverse research fields. Moreover, according to Levina and Tirpak (2006), when it comes to the resilience definitions, there are two main differentiators in this regard. The first is the system's capability to survive a disturbance without being changed (be it through deterioration or improvement), inferring that no damage has occurred, whilst the second differentiator is the system's capability to recover after damage has occurred. With these previous definitions in mind, the concept of resilience can be defined as the capacity of a system or a community to absorb, cope with and recover from the impacts of hazards. The following are the key attributes of a resilient system (Bruneau et al., 2003):

- Minimised probabilities of failure.
- Minimised failure-related consequences such as: negative social and economic impacts, damages or loss of life.
- Decreasing the recovery time, i.e., restoring the particular system or set of systems so that they return to the normal conditions and performance levels as before.

In addition to that, Bruneau et al. (2003) classified resilience into four properties: robustness, rapidity, redundancy, and resourcefulness (4 Rs). Robustness refers to the ability of systems to cope with or withstand the stress level without loss of function or failure. Rapidity is the capacity to achieve goals in a timely manner to avoid any disruptions in the future. Redundancy is the extent to which existing systems are satisfactory or substitutable in the event of a disruption. Finally, resourcefulness is the capacity of an element or system to mobilise resources, establish priorities and identify problems when any disruptions exist.

It has been identified that resilience does not essentially reflect that the system is going to look as it was before the disaster or disturbance. It is quite possible that the system's functions would be maintained yet its individual parts might have adapted or changed based on the new environmental situations. Hence, Longstaff et al. (2010) pointed out that there is no guarantee of short-term stability in a resilience strategy, but the main functions of the system will survive and be sustained in the long run. On the other hand, the terms vulnerability and resilience are related but very different methods to know the reaction of actors to change or reaction of systems. These are two different approaches to respond to surprise, shocks, or unique events. The concept or term vulnerability is derived from social sciences that are based on natural hazards, climate change and environmental risks (Blaikie et al., 1994; Kasperson et al., 2005). Compared to vulnerability, resilience has been derived from the ecological sciences to tackle change in ecosystems (Gunderson, 2000; Carpenter et al., 2001). Vulnerability is an outcome of social inequalities and it also represents the susceptibility of groups to danger.

There are many arguments and contradictions regarding the conceptualisations of vulnerability and resilience within the context of natural hazards. Several studies have attempted to determine whether resilience is linked or opposite to the concept of vulnerability. A few studies have highlighted that resilience is opposite to vulnerability and they also indicated that a high level of resilience means a low level of vulnerability and vice-versa (Timmerman, 1981; Cannon, 1994; Adger, 2000). On the other hand, some studies have reported that vulnerability and resilience are not opposites; instead, they have a significant relationship with each other. For instance, according to Akter and Mallick (2013), poor household groups that have high vulnerability can be more resilient or can manage natural hazards efficiently and effectively. However, resilience is not just the absence of vulnerability, as argued by Buckle et al. (2000), as vulnerability aspects may include measures that enhance the capacity for adaptation (Sapountzaki, 2012). Therefore, both terms are a major feature of a system, changing over time and across space. However, a number of researchers, such as Arbon (2014), Ahmad et al. (2016) and Almutairi (2019) have stressed the importance of focusing on the resilience concept in facing disasters, rather than vulnerability.

2.14 Community Disaster Resilience

Throughout history, Communities in different parts of the world have sought to improve their integral life and prosperity (Steiner and Markantoni, 2013). Marsh and Buckle (2001) viewed that the term ‘community’ could be described to the people who are living in a specific region as it contains geographic and spatial dimension. According to MacQueen et al. (2001, P.1929), community is defined as “a group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings”. This is emphasised by Marsh and Buckle’s (2001) study as it indicated that, in the context of disaster management, the concept of community has a significant consideration. In contrast, the researchers MacQueen et al. (2001) and Jigyasu (2002) said that this concept is contested, and it has varying inferences and interpretations, which is also shown in many past definitions as well.

Over time, communities have faced many natural disasters, causing deaths and damages (Huppert and Sparks, 2006). With natural calamities taking thousands of lives and destroying the existence of people’s livelihoods, landscapes, etc., it has become indispensable for communities as they are first disaster responders to adopt protective measures against these disastrous situations or natural calamities so that they can build a better community resilience for future scenarios (Aldrich, 2012; Joerin, 2012). This community interest has brought the concept of resilience as a critical element so that suitable procedural measures could be formulated to take all necessary actions in the event of such disasters or hazardous situations. Many studies conducted on such societies around the globe favour the opinion that, in the wake of natural disasters, the community recovery only requires a minor change in ways of life so as to adjust to the new political, social, economic and environmental changes which result from the disasters (Aldrich, 2012). According to Cannon (1994), that concept of change is what brings resilience through the movement from vulnerable areas of those people who are influenced by the disasters to improving their resilience and coping capability to respond to them.

In fact, community resilience is considered to be a community’s characteristic, potential outcome and dynamic process. It is defined as “The sustained ability of a community to withstand and recover from adversity” (Chandra et al., 2011). It illustrates a community's capacity to create emergency plans and prepare for an unexpected event while preserving the capacity to be flexible and reactive during the current situation (Wickes et al., 2010). Most of scholars agreed that the term of community resilience reflects the capacity of community to absorb, withstand, and recover from hazards. Thus, according to USDHS (2010), the concept of community resilience has been recognised as main aspect of disaster management and homeland security.

It important to note that community resilience is clarified as a lifecycle, where the post-disaster process is characterised by a community's capacity to improve its ability to cope with its adaptive disaster capability (Cutter et al., 2008). This enables communities to increase their responsive ability (resilience) to adapt to any future disasters, as demonstrated in Figure 2.15.

All these theoretical aspects of resilience, however, depend on the actual context of a community. In fact, communities that are resilient to disaster have a higher capacity to cope with disasters, and they are also less vulnerable. Many scholars have observed that there are varying levels of resilience in communities, and there are established indicators when it comes to measuring a community's resilience (Cutter et al., 2010; Alshehri, 2016; Almutairi, 2019). Communities should work to reduce their vulnerability to disasters and strengthen their disaster response capacity in order to build community disaster resilience. Figure 2.15 clarifies the community disaster resilience framework (Joerin et al., 2012).

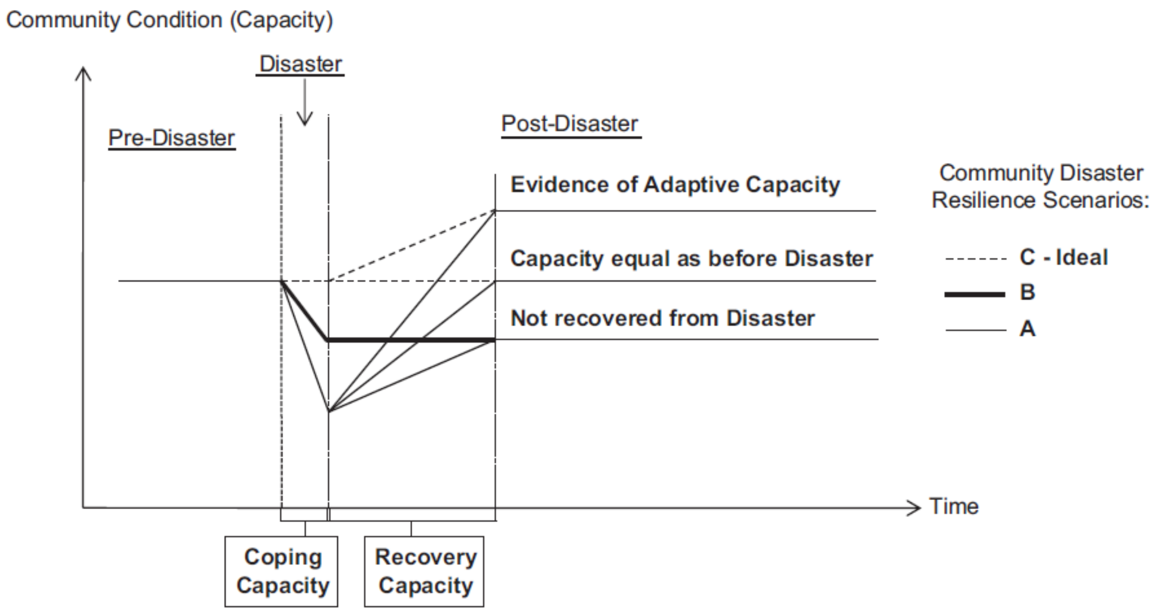

Figure 2.15: Community disaster resilience framework (Joerin et al., 2012).

In the same context, community disaster resilience could be improved by focusing on the knowledge of participants, emphasising the importance of developing an appropriate options of flood measures, and promoting active connections and collaborations between emergency managers and community members (López-Marrero and Tschakert, 2011). Zahari and Ariffin (2013) opined that people have the ability to build capacity to cope with their vulnerabilities to any hazards through knowledge sharing and communication about the risks with the community members alongside the appropriate guidance by credible government agencies. According to Berkes (2007), people in Bangladesh developed and built their resilience to frequent flooding through adapting to and living with these events by constructing their houses above ground level, which helped them to maintain their livelihood of catching fish. Therefore, community resilience has evolved out of actions taken by the various governmental and functioning bodies to make society safe from natural disasters (Steiner and Markantoni, 2013).

Many researchers have highlighted the benefits of resilient communities, such as reducing the loss of life and injury, preventing property loss to businesses and homes, minimising revenue loss and business interruption, enhancing quick response and lower level of recovery cost, attracting new residents and businesses, securing historical and cultural assets, preventing environmental losses, and building and enhancing the peace of mind and sense of place (Fekete et al., 2014; Paton & Johnston, 2017). The resilience level can be assessed in how the community returns to the pre-disaster situation. It is important to recognise that resilient communities return to function quicker, and stress is just a passing phenomenon. It does not mean that the community would not suffer from any disturbance or stress (Norris et al., 2008). It can be emphasised that resilient communities come up with certain advantages in many aspects such as: social, physical, organisational and economic. Therefore, this section defines and explains community disaster resilience as an essential concept to cope with and recover from natural disasters, which supports the first research objective.

2.15 Community Disaster Resilience Challenges

Communities around the world have faced an increase in the effects of natural disasters due to many factors or reasons. One of the key reasons for natural disaster-related widespread damage lies in the insufficient structural capacity of the built environment. Moreover, inaccurate assessment of hazardous events, lack of consideration of climate change, incompatibilities between hazard levels and structural designs, lack of risk consideration in town planning, neglected building codes and regulations, and illegal occupancy in lands considered to be high risk, such as flood-prone areas, have been identified as the main factors for the increasing risks related to disasters (Mannakkara and Wilkinson, 2013).

Malalgoda et al. (2014) observed that there are a number of challenges in building disaster resilience in Sri Lanka such as institutional arrangements. Several organisations in Sri Lanka are responsible for the development, operation, maintenance and design of the built environment. Each organisation holds a particular role and responsibility for building safer cities through initiating disaster risk reduction practices. However, it has been found that the current system in Sri Lanka demonstrates a number of challenges such as unauthorised building structures; lack of well-defined roles and responsibilities; responsibilities overlapping; lack of coordination between organisations; lack of regulatory frameworks; unplanned cities and urbanisation; and lack of teamwork, leadership, political will and commitment (Malalgoda et al., 2014). However, these challenges may not apply to many regions especially in developed countries. Furthermore, communities in most cases suffer from a shortage of funds needed to apply measures and instruments to enhance community resilience to disasters such as floods. These measures are considered to be more significant to protect people from hazard events (Kotzee and Reyers, 2016). Additionally, it is observed that many challenges are faced by government agencies such as mission statement directives, funding, human resources and time, which prevent them from comprehensively addressing the vulnerability issues, or addressing them at all (Chaney, 2012). Therefore, in order to enhance community resilience to disasters, the areas of vulnerability and the corresponding challenges must be included in the recent efforts.

From the UAE's perspective, one of the key challenges to building communities that are resilient to disasters is related to population demographics. For example, according to Zaki (2019), the UAE population data shows that there are four times as many non-nationals as nationals in the UAE and there are more than 200 nationalities in the country. Therefore, this multi-cultural community creates a challenge in terms of a lack of awareness for building community resilience to disasters. Moreover, the disaster preparation level and resilience could be influenced by the main attitude of entitlement instead of responsibility. During disaster events, many Emirati citizens seek the State's help to get them out of the disaster and many others do little proactively. Jones (2011) underline that people either complain that they cannot do anything in that situation, or they put the blame on someone else; this implies that, in the event of a hazard, they do not take personal responsibility.

Limited education causes negative impacts on disaster preparedness and management. As a matter of fact, only 16% of Emirati people have an awareness of global warming and climate change, and not many are seriously concerned about the issue (ACNielson, 2007). Similarly, a study conducted by (Almarzouqi, 2017) shows that most community members were not aware of any measures to mitigate climate change risk. On the other hand, according to Aw (2010), since most Middle Eastern people follow Islam as a religion, they have their faith in the concept that life events are termed as an individual's destiny which is written by GOD beforehand; this is also reflected in their common saying "Insha Allah", which means "if GOD wills". Loney et al. (2012) explain that certain religious and cultural sensitivities are associated with some communities in terms of taking precautions while working in occupations which required safety measures.

2.16 Chapter Summary

This chapter has reviewed the existing literature to gain a comprehensive understanding of the issues related to natural disasters, flooding, flood risk management and community disaster resilience. The chapter illustrated that floods, especially pluvial floods, have critically impacted infrastructure, properties and people's lives. These impacts are classified into two basic types: the direct effect and the indirect effect. They occur more in developing countries than in developed countries due to the better mitigation measures adopted by the developed countries to reduce these disasters' impacts. The chapter also reviewed and analysed literature about pluvial floods and their impacts in the UAE. Moreover, the chapter reviewed the existing measures in developed countries and the UAE to mitigate flood risk, involving structural and non-structural measures. The final section in this chapter identified resilience and community disaster resilience as important concepts which will help communities to adapt to and cope with disaster impacts happening in the future. The chapter also identified the main challenges to building communities resilient to disasters globally and in the UAE specifically. The next chapter discusses the conceptual framework for this study.

CHAPTER 3: RESEARCH CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter explains the conceptual framework for this study which will help to measure community resilience to pluvial floods in the UAE through using the information obtained from previous literature. It also examines the previous frameworks for measuring community resilience, and it discusses processes and constructs to develop a conceptual framework for this study, with justification of why this research proposed a conceptual framework. Factors drawn from literature that have an effect on community flood resilience have been extracted and collected. These key principles are highlighted, identified and included in the framework. Lastly, the conceptual framework of this research is discussed, and this includes the main themes and factors that influence community resilience to pluvial floods in the UAE.

3.2 Conceptual Framework for this Study

The conceptual framework is the key part which shows the actual beliefs and ideas surrounding the research topic at hand (Maxwell, 2013). Miles et al. (1994) described the conceptual framework as a product presented in writing or in a visual format which clarifies the key subjects to be examined, including their main principles, factors and supposed associations among them. This explains the whole research process in the context of a figurative way in which essential principles are correctly and adequately illustrated to show and clarify the entire study. Moreover, Bakharia et al. (2016) supported the same view as they indicated that a framework can give an overview of various actions and the links between them. In other words, it provides the main ground to the researcher through showing the study's key concepts, how they are related to each other, the interrelations among the concepts, and the boundaries in which the implementation of concepts and relationships take place (Yin, 2014). Therefore, the conceptual framework as explained by Maxwell (2013) provides great aid to the researcher in a) linking the research problem and b) planning facilities in the research moving forward.

In order to build and formulate a conceptual framework, there are four module-related sources, as indicated by Maxwell (2013), which are: a) the experiential knowledge of the researcher, b) the subsisting research and theory, c) the pilot exploratory research of the researcher and d) the experiments. According to Saunders et al. (2016), a conceptual framework helps to select key elements to identify issues that arise during the data collection process. Thus, a conceptual framework can be revised and finalised until the data collected has been analysed.

On the other hand, the local authorities in the UAE have the main responsibility to ensure, in accordance with the laws and regulations, the welfare of the country's citizens, and to warn and help its communities and residents to plan, respond to and recover from disasters. Thus, it is important to have a tool that supports local government to assess the community flood resilience level. Hence, there is a great need to build an assessment framework to improve community flood resilience in the UAE which would illustrate how the researcher is going to conceptualise this study in order to produce productive results all along the line. In light of the above facts, the researcher has built an assessment framework in a bid to investigate the research problem at hand.

3.3 Assessing Community Resilience

One of the most important steps to develop strategies and take actions to achieve community disaster resilience and to apply disaster risk reduction revolves around measuring the degree of community resilience (Yoon et al., 2016). According to Burton (2015), measuring the resilience of communities is recognised as a crucial step in helping to reduce disaster risk and to be better prepared, respond and adapt to a wide range of natural and human disasters. Resilience has recently been integrated as a main component of the United Nations International Strategy for Disaster Reduction (UNISDR) (Alshehri et al., 2015). Researchers have also opined that determining community resilience indicators is not only an important thing, but these indicators are also considered useful in terms of measuring the negative impacts and the community's shrinking capacity to respond to the disaster and then recover from it accordingly (Cutter et al., 2008). According to Hughes and Healey (2014), in order to develop a suitable approach to measure and improve the resilience, it is important to comprehend several dimensions of resilience.

Due to dynamic interactions between residents and their communities and environment, the process of community resilience assessment has become more difficult (Manyena, 2006). Cimellaro et al. (2016), Ahmad et al. (2016) and Almutairi (2019) observed the lack of any ubiquitous model or framework to assess community resilience in the face of disaster. There are arguments among many studies as they have estimated several different dimensions to assess community resilience, and there are challenges still in the development of regular elements that can be utilised to assess the community disaster resilience (Bruneau et al., 2003; Mayunga, 2007; Cutter et al., 2008; Peacock et al., 2010). A valid theoretical framework provides a way to assess community resilience to disaster and combines the underlying variables into an important compound index (Burton, 2015). Since resilience is a multi-dimensional notion, developing methods to measure resilience still a challenge (Chang & Shinozuka, 2004). For instance, Cutter et al. (2010) introduced a framework which consists of five dimensions of resilience; social, economic, infrastructural, environmental and community competence. Similarly, Norris et al. (2008) stated that community resilience can be assessed based on five main dimensions: social capital, economic development, information and communication, and community competence. However, several studies such as Ainuddin and Routray (2012) and Qasim et al. (2016) believed that resilience can be conceptualised through four main dimensions: physical, institutional, social and economic. Therefore, this research aims to develop an assessment framework to enhance community resilience to pluvial floods in the UAE.

3.4 Existing Community Resilience Theoretical Frameworks

The world has recognised the importance of developing instruments and methods for assessment of community resilience since there has been a continuous evolution in the community resilience concept (Cohen et al., 2013; Cutter, 2016). As a result of that, several models and frameworks have been developed with varying approaches to assess community disaster resilience (Norris et al., 2008; Cutter et al., 2010; Jordan and Javernick-Will, 2013). Buckle (2006) highlighted that measuring different components of resilience is of utmost importance to assess the community resilience. This has been further explained by other researchers who underline that the community resilience measurement is significant to identify and indicate the community's weakness (Kirmayer et al., 2011). Therefore, the development of a framework for measuring community disaster resilience is a basic step to assess and measure a community's clear and realistic resilience to disaster. The next sub-sections illustrate several frameworks and models which have been created to measure community disaster resilience.

3.5 Frameworks Established by the UNISDR

The UNISDR was established in 1999 and it is the global platform for disaster risk reduction organisations. It is considered to be guidance to implement frameworks regarded as disaster risk reduction DRR strategies, and to share experience and knowledge between stakeholders (UNISDR, 2012). There are several types of government agendas in which one of the most essential components is disaster management as a result of the increasing frequency of new risks and disasters like climate change (IPCC, 2012). There has been an overall acknowledgement of the need to build a safer world by recognising the need to increase community resilience to disasters. The Hyogo Framework for Action and the Sendai

Framework set out clear guidance to implement disaster management systems (ISDR, 2005; WCDRR, 2015).

3.5.1 The Hyogo Framework for Action (HFA)

The Hyogo Framework for Action (HFA) was introduced in the year 2005 for community resilience building. Their action plan 2005-2015, "Building the Resilience of Nations and Communities to Disasters", which is considered to be the very first global plan for building resilience, explains the work and details needed to lessen the losses from disasters from all sectors. Many governments and international agencies have agreed on the framework in order to lessen the disaster risk. Its main purpose was to significantly lessen the losses incurred from disasters by the year 2015 through enhancing community resilience to disasters. It was created and developed to make sure that the environmental, economic and social negative impacts on communities from disasters are reduced (UNISDR, 2005).

In order to achieve the aforementioned stated objective, the HFA has five priority areas for action which are: to make disaster risk reduction as local and national priority; to get an appropriate risk knowledge and take necessary measures and actions like monitoring, assessing, and identifying the disaster risks; to build resilience culture by using knowledge, education and innovation; to apply sufficient measures of risk management to reduce risk factors; and finally, to strengthen disaster preparedness by being ready to response effectively when it becomes necessary to act. In addition, the Hyogo Framework for Action (HFA) furthers the requirement to build resilient communities by: 1) the integration of disaster risk reduction into development policies; 2) the development and strengthening of local capacity (mechanisms and institutions) to enhance disaster resilience; and 3) the inclusion of risk reduction into the designing and applying of preparedness, response and recovery actions, and programmes of emergency (Innocenti and Albrito, 2011).

The UNDP (2004) pointed out that disaster risk management is an integrated model, which incorporates all previous strategies from the standpoint of having the potential to increase or reduce risks throughout development activities. It has been found that the HFA has partially changed the emphasis to building resilience instead of the vulnerability model. DRR strategies view the resilience concept as the main approach to achieve sustainable development. The HFA comprises five main themes to build resilient communities, as follows:

- Disaster preparedness
- Governance
- Education and knowledge

- Early warning and risk identification, assessment, and monitoring
- Minimising of main risk factors

Although the HFA mainly focused on disaster risk reduction policies in communities, there is a lack of tools within institutions used to assess the effectiveness of these policies. Moreover, many scholars have also mentioned that the systemic changes required to minimise disaster vulnerability were not included or discussed by the HFA (Scolobig et al., 2015). Over the decade of the HFA (2005-2015), disasters continued to lead to human, political, environmental and infrastructure losses worldwide, and especially in the more vulnerable and poorest countries (de la Poterie and Baudoin, 2015).

3.5.2 Sendai Framework

The United Nations developed the first global policy framework, the Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR). It serves the purpose of a directional step towards the coherence of global policy with clear and obvious reference to climate change, development and health. The framework was introduced as a result of a strong desire to ensure that the policy of DRR reflects the understanding of disaster risk complexity. It also represents dynamic global issues at the present time, where it includes increasing globalisation, rapid climate change, and new technology development in the area of early warning and risk prediction (de la Poterie and Baudoin, 2015). Moreover, it has been noted that, in order to prevent, prepare, respond to and recover from disasters which occur from our exposure to evolving highly interdependent risks, there is a strong need to develop and implement a close association and collaboration among all the sectors (Aitsi-Selmi et al., 2015; UNESCAP, 2012). Thus, according to WCDRR (2015), Sendai Framework for Disaster Risk Reduction (SFDRR) priorities are:

1. To understand the risk of disaster.
2. To strength the disaster risk governance so as to handle and manage the disaster risk.
3. To enhance resilience, and invest in disaster risk reduction.
4. To develop the disaster preparedness to ensure an efficient response, and to "Build Back Better" in the process of rehabilitation, reconstruction and recovery.

The Sendai Framework is a significant document which provides guidance for many countries that could follow and then implement the policies, priorities and measures contained in it. The gaps which were present in the Hyogo Framework for Action (HFA) were eliminated by the Sendai Framework and the problems highlighted in the mid-term review were improved, such as the deficiencies of early warning systems in economic and social vulnerabilities; the systematic multi-hazards risk assessments; the insufficient disaster risk reduction integration plans at national and international levels of sustainable development policies; and inadequate application of the framework at the local level (UNESCAP, 2012). Furthermore, there is a global concern about the efficiency and implementation of the previous frameworks related to DRR frameworks. It has been observed that more focus is given to the institutional resilience than the community resilience (Aitsi-Selmi et al., 2015). Communities around the world are facing new and high levels of vulnerabilities; this is due to the production of new hazards caused by people's environmental interactions, like urbanisation, and also the new risks, like the impact of global warming/accelerated climate change.

The framework emphasis that resilience against disasters is a significant issue which needs improvement between all stakeholders for the reason that statistics show considerable damage to property and huge loss of life. These statistics give credence to the fact that, if action is not taken, then further disruption and loss of life could occur. A vital role could be played by the framework and it can hugely impact the efforts of DRR, but, to make sure that the efficiency is secured, special consideration must be given by the stakeholders, institutions, organisations and government with regard to the underlined priorities. The main element is risk governance, through which sufficient implementation of the framework is ensured that permits the process of reviewing and monitoring (WCDRR, 2015). Therefore, putting investment in the DRR is a necessary step and strategy to lessen the disaster disruptions and losses in the future. Nevertheless, the Sendai Framework has been criticised for not introducing new disaster management strategies but only continuing the application of HFA methods and approaches that have not succeeded in minimising disasters worldwide (Glantz, 2015). While capacity building in these different fields poses significant challenges of coordination for policymakers, it provides opportunities for more development of policies and more effective application. The next sections highlight several existing community disaster resilience frameworks.

3.6 The Sustainable Livelihood Framework (SLF)

In the mid-1980s, Robert Chambers originally developed the sustainable livelihood framework (SLF). Since then, there has been an increasing in its use. It has been found that the livelihood concept has been adopted by a number of governments, non-governmental organisations (NGOs), development agencies and community-based organisations (CBOs) (Glavovic et al., 2002). Many researchers have stated that the SLF serves as a valuable framework to understand the situation of urban poverty and people living in cities, as well as an effective tool for analysing impacts on their lives and livelihoods. It is also used to analyse coping and adaptive policies of individuals and communities in responding to external stresses such as civil disputes, drought and anti-poor regulatory frameworks (Majale, 2001). In other words, the sustainability component indicates that these individuals and communities can face and resolve moments of stress or crisis and can return to their normal situation or even increase their current and future skills and assets without abusing the provision of natural resources. In a number of countries, particularly in developing countries, where poverty is high, the United Kingdom Department of International Development (DFID) was promoting and supporting the implementation of this framework. The purpose was to reduce poverty in rural communities and support disaster risk reduction programmes which help to improve community resilience to disasters (DFID, 1999).

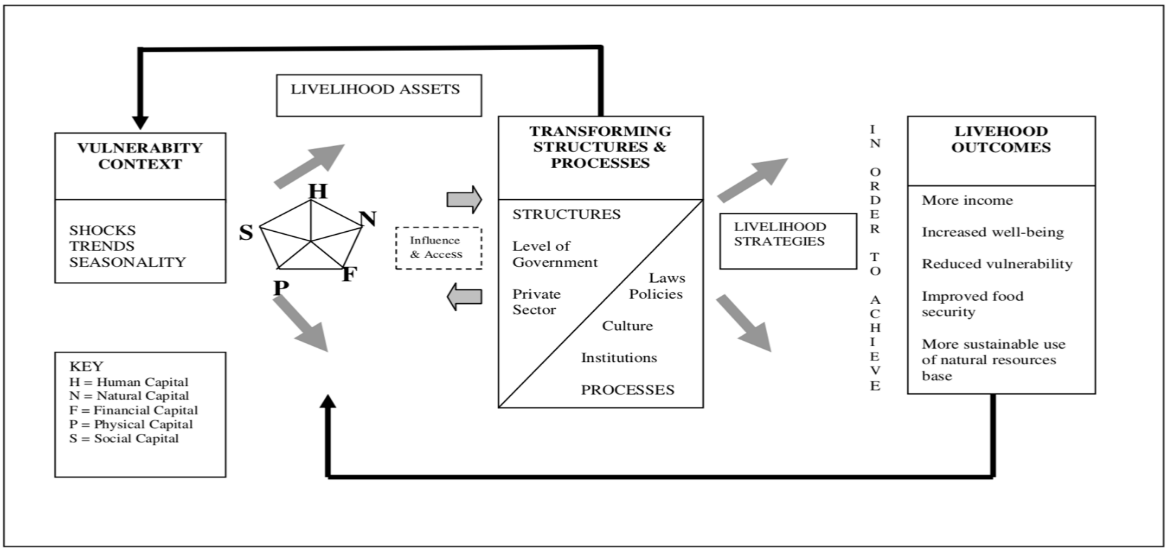

Figure 3.1: Sustainable livelihood framework (DFID, 1999).

Figure 3.1 illustrates the main dimensions of the SLF and the relationships between these dimensions. The framework arrows indicate a certain level of influence although they do not indicate causality. It is important to note that the concept of vulnerability refers to the influences of shocks or stresses on people's lives and livelihoods. Thus, in the sense of the SLF, the sustainability context relates to the capacity of individuals and communities to deal with and recover from shocks. According to the DFID (1999), the framework consists of five main capitals, which are: human, social, natural, physical and economic (see Figure 3.1). Theses capitals are described below:

1. **Human Capital:** It reflects the work skills, knowledge, experience and physical health that enable communities to participate in different strategies and achieve their own livelihood goals.
2. **Social Capital:** It relates to the social resources that communities depend on for achieving their livelihood objectives.

3. **Natural Capital:** It relates to natural resources (air, water, soil, genetic resources) that can be used as inputs to generate extra benefits, such as soil or coastal erosion protection, food chains, and different natural resources that can sustain livelihoods.
4. **Physical Capital:** It applies to basic infrastructure and resources for sustaining livelihoods.
5. **Financial Capital:** This applies to the financial resources used by communities to achieve their subsistence objectives.

Therefore, to build community disaster resilience, the sustainable livelihood framework (SLF) can be assessed according to these five capitals. However, even though, as stated by Mayunga (2009), the structure for sustainable livelihoods illustrates the key components needed to reduce vulnerability and poverty, it appears to be very broad and contains several variables. It can therefore be difficult to turn it into a practical tool to measure disaster risk reduction programmes and policy.

3.7 PEOPLES Framework

The PEOPLES framework is a holistic framework which defines and measures the community disaster resilience at several scales and dimensions. The framework consists of seven dimensions that reflect the various aspects of the community summed up under the term 'PEOPLES'. Resilience at the community level primarily relies on the actions of individuals and the system when a significant destructive incident happens. It also largely depends on processes and actions of governments and agencies to prepare and adapt to risk. Cimellaro et al. (2016) and Kammouh et al. (2017) indicated that the characteristics of PEOPLES were formulated at the Multidisciplinary Center of Earthquake Engineering Research (MCEER) with the purpose of measuring community resilience through connecting the resilience dimension with four resilience properties (robustness, redundancy, resourcefulness and rapidity). PEOPLES integrates MCEER's broadly accepted definitions with regard to service functionality, and its components such as demographics, services and assets along with the parameters that have an effect on the resilience (Renschler et al., 2010).

PEOPLES is mainly designed for communities on different geographical scales to improve community disaster resilience. Within this framework, disaster resilience is categorised into "technological units and social systems". The framework basically concentrates on community institutional units within the local level, such as neighbourhoods, towns and cities, and regional level such as states, regions and countries (Asadzadeh, 2016). PEOPLES allows the use of different community resilience indexes that integrate community functionality and resources in a landscape environment over time and space. Geographic Information Systems (GIS) is used in this model for measuring the system's resilience and providing a predictive resilience tool.

The framework needs to combine quantitative and qualitative sources of data at various time and space levels and therefore information needs to be consolidated or disaggregated to match resilience model scales and interest scales for model performance (Renschler et al., 2010). However, PEOPLES does not highlight a clear procedure that can compute resilience quantitatively; instead of that, there is a qualitative description and assessment of resilience. Thus, to assess community resilience, the framework is divided into seven components (dimensions) in which every dimension is further sub-divided into many sub-components. Below is the list of seven dimensions with a brief description of each:

1. **Population and demographics:** This component explains characterises of the community population so as to understand the society's capability to cope with adversative impacts, and for fast recovery after the disaster.
2. **Environmental and ecosystem:** It reflects the ecological system's capability to endure a disruption and then come back to the pre-event stage.
3. **Organised governmental services:** It shows to what degree the sectors of the community are prepared and ready to respond to a hazardous incident.
4. **Physical infrastructure:** This dimension concentrates on lifelines and facilities which need to be re-established to a working condition after the disaster.
5. **Lifestyle and community competence:** This dimension shows both the community's raw capabilities (such as skills to discover multiple solutions for a complex issue by political network engagements) and the community's perceptions (such as the perception that they possess the capability to bring a positive change by exercising mutual efforts).
6. **Economic development:** This component includes both the community's static state (present economy) and its dynamic development (future growth).
7. **Social-cultural capital:** It explains to what extent the people would be ready to remain at their position and be able to lend a helping hand to their community so that it bounces back after a hazardous incident.

Figure 3.2 describes the PEOPLES framework and associated geographical scales. In this framework, these potential indicators are combined with a community resilience index that represent community resilience for specific dimensions (Winderl, 2014). There are many advantages of this framework, such as it can be used and applied to various types of hazards on different scales. Thus, it conceptualises the disaster resilience term, and the framework's findings provide a comparative evaluation of the extent of disaster resilience in case study areas (Asadzadeh, 2016).

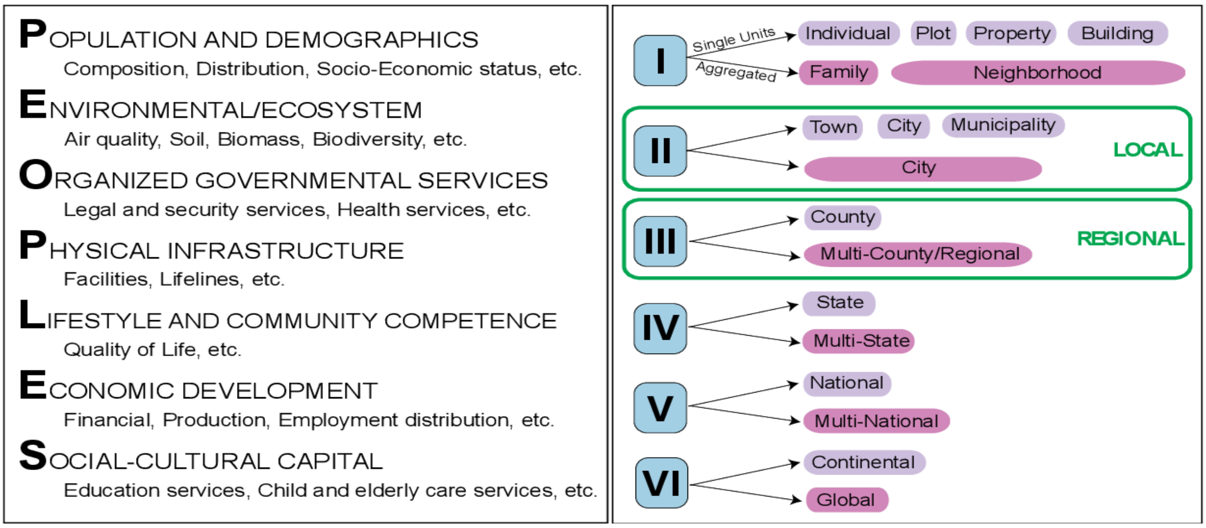

Figure 3.2: PEOPLES framework and associated geographic scales (Winderl, 2014).

3.8 Cutter's Model of Disaster Resilience of Place (DROP)

The DROP model is focused on presenting the association between resilience and vulnerability. It was formulated because the previous models had limitations with regard to vulnerability and resilience. It is mainly composed of vulnerability and resilience conditions which are built-in conditions that relate to hazards, thereby producing the post-hazard effect through the community's coping capabilities and response. This model was introduced to cope with natural hazards, but the model is also adjustable to other types of sudden events such as technological hazards, terrorism, or any natural hazards (Cutter et al., 2008). The model takes into consideration the political, environmental, physical and social factors which have an impact on resilience and vulnerability, although the key focus of this model is on the social resilience.

The DROP model represents the relation between natural environmental systems and social systems, which is the opposite of other models such as Norris et al.'s (2008) model. It obviously knows that disasters occur to communities who are living in a specific place (Boon et al., 2012; Cutter et al., 2008). Consequently, when considering disaster resilience, place issues as much as the people and communities involved. The integration of natural and social systems and the built environment allows for properly considered resilience components such as institutional, infrastructural and ecological (Adger, 2000; Bruneau et al., 2003).

In addition, this model was also considered in terms of a place-based model. Cutter et al. (2008) opined that the community-level resilience could be affected by the external factors, for instance, the national regulations and policies. However, the DROP model is still under the process and Mayunga (2009) said that it has not yet been thoroughly discussed as to how this model would be put into practice. It has been found that the models presented by Cutter et al. (2008) and Cutter, Burton and Emrich (2010) do not integrate the more subjective components of resilience such as communication and information. Nevertheless, based on the principle that publicly available data can be accessed, they offer policymakers a practical approach aimed at developing community resilience benchmarks.

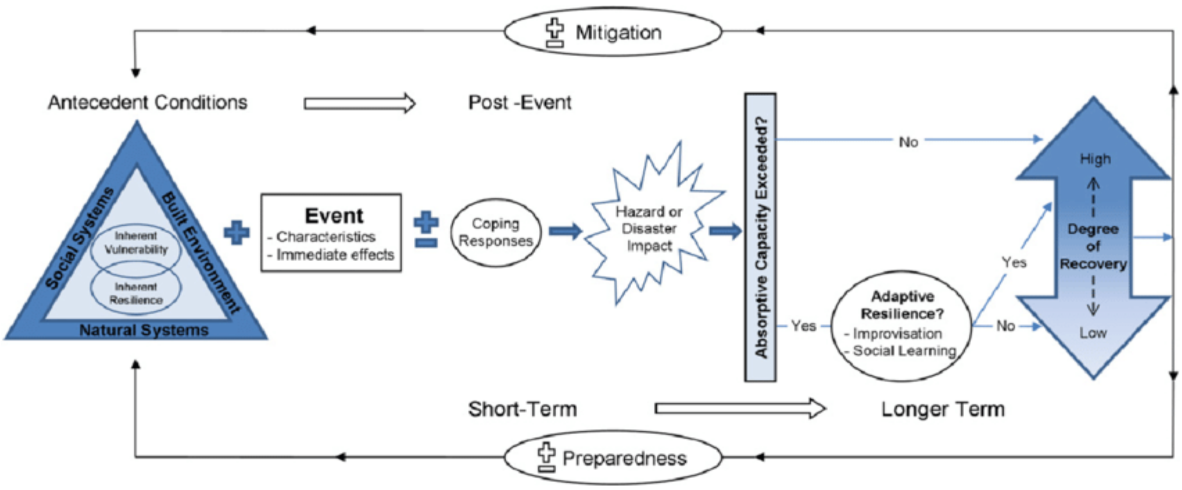

Figure 3.3: Cutter's model of the disaster resilience of place (DROP) (Cutter et al., 2008).

There is a built-in community resilience in this model as it is the result of past experiences and the available networks of economic, environmental and social resources. Therefore, there are six dimensions on which the model depends and there are many indicators associated with every dimension which can be used to assess community disaster resilience. These dimensions are: institutional, infrastructural, economic, social, ecological and community competence, as shown in Figure 3.3 (Cutter et al., 2008). The DROP model is still being developed and little discussion is currently taking place on how it will be implemented. Nevertheless, the DROP model stresses the disaster management phases' activities as the main elements for improving disaster resilience, similar to Tobin's (1999) and Maguire and Hagan's (2007) frameworks.

3.9 Community Disaster Resilience Framework (CDRF)

Mayunga (2009) developed the CDRF to stress in particular the importance of incorporation of the community capital and the activities of disaster management stages in order to create a forum for developing disaster resilience indicators. There are two main elements of the proposed CDRF: the phases of disaster management (preparedness, mitigation, response and recovery) and the capitals of community (physical, social, human and economic). The CDRF finds the four main forms of capital to be important aspects for the effectiveness of the four phases of disaster management activities that help to enhance community disaster resilience. Figure 3.4 further shows the association between the activities of disaster management phases' activities and community aspects (capitals). The framework demonstrates that the four community dimensions (physical, social, human and economic) have a major effect on the successful implementation of disaster management phases' activities. Such dimensions can be viewed as vital resources for socio-ecological systems that increase or decrease the degree of disaster resilience. Although natural capital was included in the original framework (Mayunga, 2007), it was not involved in this framework due to its focus on social structures rather than physical systems.

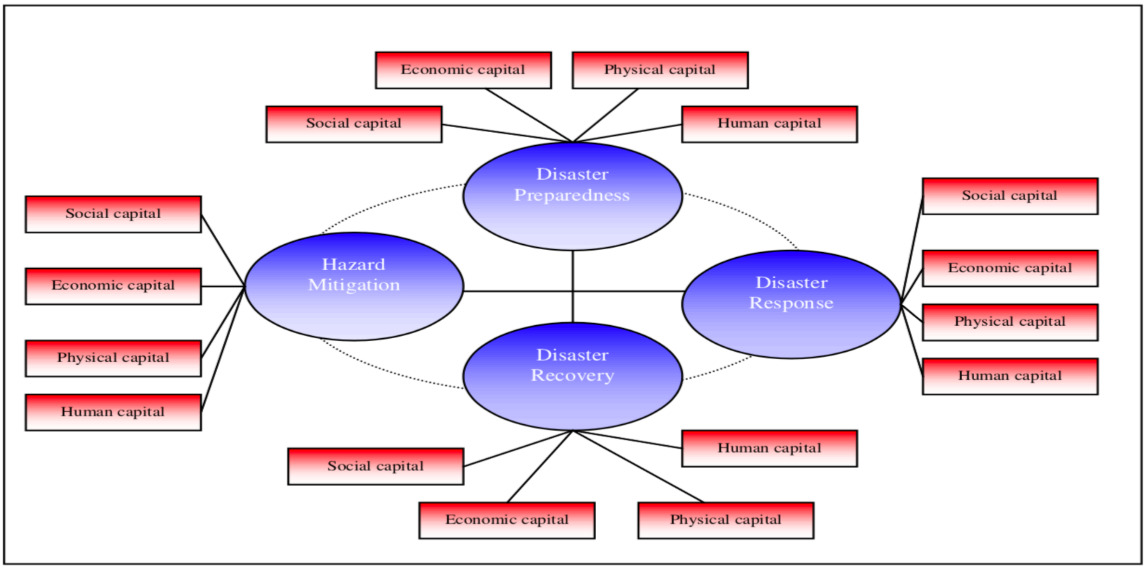

Figure 3.4: The CDRF framework (Mayunga, 2009).

According to Peacock (2010), the outcome of this model illustrates that disaster resilience level (the capacity of community) in the United States Gulf Coast region, which represents the study area, can: i) reduce the effect of disasters; ii) disasters quick recovery; and iii) eventually increase community resilience through quick and effective recovery process. In fact, the CDRF is known as a complete measuring approach among disaster resilience measurement approaches which emphasises readiness and response of disaster management phases that are largely ignored in other models. It also demonstrates effective application of disaster management phases' activities based on the four main community capitals (physical, social, human and economic) (Asadzadeh, 2016).

As mentioned before, different scholars have developed many frameworks for measuring community resilience despite there is no agreed framework among them about resilience aspects (Cutter et al., 2010; Norris et al., 2008; Jordan and Javernick-Will, 2013). For example, Cutter et al. (2014) used a geographically limited county-level in the US, where this level is typically less likely to change with the long-standing and most accurate data. In comparison, Yoon et al. (2016) used the Korean community-level to investigate community-based disaster resilience. To sum up the above frameworks, it has been widely shown that there are two important components for conceptualising community disaster resilience: (1) activities in the phases of disaster management (preparedness, mitigation, response and recovery) and (2) dimensions or capitals in the community (social, cultural, human and physical). Thus, frameworks created by Tobin (1999), Cutter et al. (2008), and Mayunga (2009) appear to have shared characteristics. All of them stress the importance of building disaster resilience through disaster management phases' activities. Table 3.1 illustrates other frameworks used to assess community disaster resilience.

Table 3.1: Several frameworks for measuring community resilience.

Framework	Dimensions	Reference
Measuring Improvements in the Disaster Resilience of Communities	Technological Organisational Social Economic	Chang & Shinozuka (2004)
Community disaster (CDRCBA) resilience: A capital-based approach	Social Capital Economic Human Physical Natural	Mayunga, J. S. (2007)
Coastal community resilience (CCR)	Governance Society and Economy Coastal recourses management Land use and structural design Risk knowledge Warning and evacuation	US/IOTWS /ADPC (2007)
Community resilience as a metaphor, theory, set of capacities, and strategy for disaster	Economic development Social capital Information and communication Community competence	Norris et al. (2008)
Climate and Disaster Resilience Index (CDRI)	Physical Social Economic Institutional Natural	Peacock et al. (2010)
Community resilience framework for an earthquake prone area in Baluchistan	Physical Social Economic Institutional	Ainuddin and Routray (2012)

Community recovery and resilience building in the aftermath of flood hazards in the small island developing state of Mauritius	Social Economic Infrastructure/Environmental Institutional Phycological Community Competence	Chacowry (2014)
A Measurement of Community Disaster Resilience in Korea	Human Social Economic Physical Environmental	Yoon et al. (2016)
Community resilience to flood hazards in Khyber Pukhthunkhwa province of Pakistan	Physical Institutional Social Economic	Qasim et al. (2016)

As shown in Table 3.1, different studies have proposed a broad range of theoretical frameworks for measuring the resilience of a community based on the resilience dimensions (Gunderson & Holling, 2001; Adger, 2000; Cutter et al., 2008). However, there is no agreed framework among many studies about resilience dimensions. Cutter et al. (2014) confirmed that many studies that are mainly focused on assessing community resilience are still in the early development stages. Twigg (2009) and Norris et al. (2008) supported that, despite many consolidating attempts concerning community resilience indicators, there is no accepted method, and there are still difficulties in terms of developing dependable indicators and assessment approaches.

3.10 Research Conceptual Framework

Recently, there has been mutual agreement about the multifaceted nature of resilience which can be accomplished by improving various community sectors such as institutional, economic, social, natural/ecological and infrastructural (Bruneau et al., 2003, Norris et al., 2008; Cutter et al., 2010). In the context of flood disasters, the current practices of DRR technically rely on warning response systems and on building structural measures such as drainage systems. For example, Bruneau et al. (2003) and Tierney and Bruneau (2007) pointed out that engineered systems such as infrastructure and buildings are included in some frameworks where the probability of failure is reduced by the properties of resilient infrastructure such as rapidity, resourcefulness, redundancy and robustness. Consequently, there has been a call for an integrated and holistic approach which is associated with the relationships and connections of many factors, such as institutional, social and economic, not just the building's structural integrity alone (Geis, 2000).

Based on explanations and justifications of this research in Chapter one, there is a need to develop an assessment framework for the UAE context to improve community resilience to pluvial floods. Since most of the existing framework focuses on four main dimensions of resilience which are physical, institutional, social, and economic, (Bruneau et al., 2003; Chang & Shinozuka, 2004; Peacock et al., 2010; Ainuddin & Routray, 2012; Alkhaili, 2015; Qasim et al., 2016). The UAE should give these dimensions a deep concentration to assess community flood resilience. Therefore, this research adapted these studies, and it will be based on four main dimensions of resilience: physical, institutional, social, and economic, with their variables/factors. Moreover, the conceptual framework of this study will emphasise the significance of activities of disaster management phases in improving community flood resilience. Figure 3.5 shows the conceptual framework for assessing community resilience to pluvial floods in the UAE.

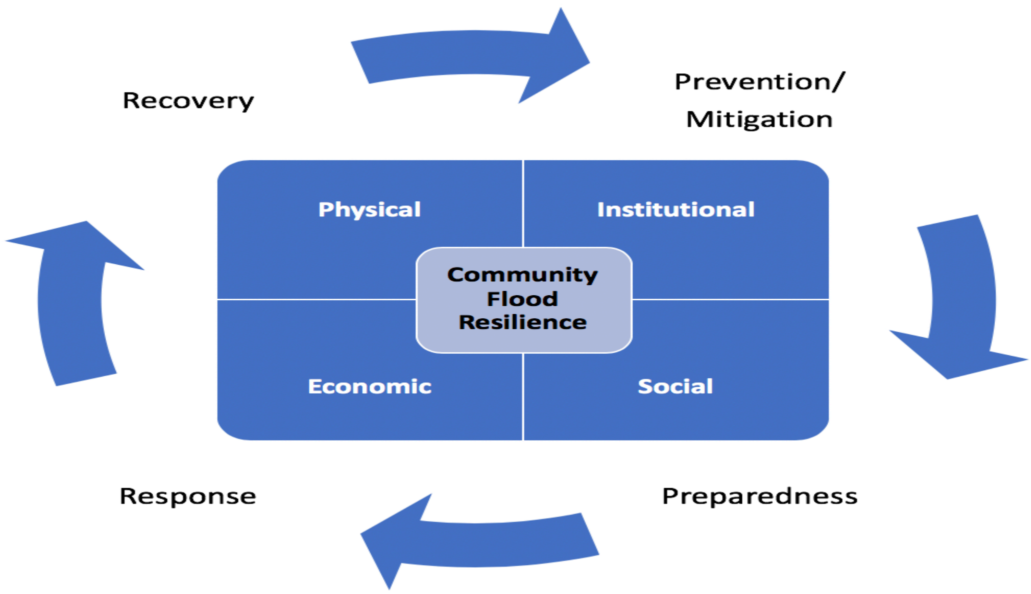

Figure 3.5: The development of the conceptual framework for this study.

3.11 Community Resilience Dimensions

As explained in the previous section, the proposed framework for this study depends on four main dimensions of resilience, namely physical, institutional, social and economic.

3.11.1 Physical Resilience Dimension

The physical resilience dimension is considered to be the most essential dimension in building communities that are resilient to natural disaster. It is known as one of the most significant community resources that helps to build the community's capacity for disaster management as it works at a level that provides households and communities with the means and measures to cope and also to recover in the post-disaster period (Longstaff et al., 2010; Pasteur, 2011). Longstaff et al. (2010) explained that there is a need to improve physical system flexibility in order to enhance physical resilience that can bend rather than breaking. Several studies have shown that physical resilience to potential hazards can be enhanced by implementing good measures and practices, which include proper maintenance, effective rainwater drainage systems, high-quality construction and the implementation of advanced engineering designs (UNESCAP, 2012).

According to Yoon et al. (2016) and Qasim et al. (2016), the physical resilience aspect refers to the location of the built environment and infrastructure such as lifeline services and critical facilities. The location of built environment plays an important role in maintaining and protecting the community's ecological environment from any actions that might reduce its resilience (Peacock et al., 2010). People who live near flood-prone zones may suffer more frequently from flooding, which can have negative effects (Cutter et al., 2010). Similarly, Mayunga (2007) and (Qasim et al., 2016) noted the importance of robust buildings and infrastructure for ensuring that people have resources and support in times of crisis. Good building condition and infrastructure can have a positive impact on reducing the impacts of flooding. Bowker (2007) stressed that an effective building design can significantly reduce flood effects through the necessary flood mitigation measures like building elevation by lifting up pillars, extended foundation walls, or raised ground structures or flotation.

Further, Change and Shinozuka (2004) mentioned that the physical tools or systems which can be vulnerable to disasters are composed of public lifelines and infrastructure such as roads, power, bridges and water. The reason for that is the financial burden on people will be increased due to the loss of infrastructure, and the ability of systems that are tagged with limited resources to bounce back from the disastrous circumstances. Carpenter et al. (2001) and Quinlan et al. (2016) claimed that physical durability identified areas where improvement in selected assets and facilities could be made to ensure that the assets and facilities are able to withstand specific threats. Dahlberg et al. (2015) explained that increasing the flexibility of system levels is necessary to build physical resilience that is able to bend rather than break. In the event of system failure, appropriate measures that can be used to improve system adaptation to potential hazards include increased monitoring and observability, system-level flexibility, and system boundaries that are less vulnerable in times of stresses, as well as measures that can assist rapid response and recovery (Schneider & Somers, 2006; Brown et al., 2012; Francis & Bekera, 2014; Panteli & Mancarella, 2015). For instance, flood defence and protection systems are the main functions of a flood disaster system.

Nevertheless, a community with a poor transport network is expected to struggle to evacuate its citizens, thereby showing a decrease in resilience level (Teo et al., 2015). Longstaff et al. (2010) further claimed that rural poor people cannot access the physical assets, whereas communities cannot always have the power to control the accessibility of physical assets such as hospitals and power systems. It is important to note that it is quite hard to predict the extent and duration of a flood event; however, O'Connell et al. (2015) argued that the likelihood of its potential occurrence could be estimated, which would give enough time to take structural mitigation measures. Therefore, the lack of critical facilities or physical infrastructure, ineffective building condition and design, and unsafe built environment location could have direct negative effects on the ability of communities to cope with and respond to such disasters.

3.11.2 Institutional Resilience Dimension

Institutional resilience is the capability of an organisation or institution to prepare for and respond to several emergency-related events to accomplish the required outcomes based on resilience (Bruneau et al., 2003). It refers in particular to enabling the role of governments and related institutions in the maintenance and development of community resilience. Gopalakrishnan and Okada (2007) indicated that the institutional aspect has been ignored through the history of DRR scholarship and research. In the current discussions within disaster theory and action, the simplistic definition of institutional resilience is a reflection of the lack of connections between institutional analysis and DRR. Yet there is growing interest in institutional systems which are designed to adapt, develop, respond to and withstand shocks and rapid environmental changes. Lee, Vargo and Seville (2013) observed that community resilience and institutional resilience are interconnected, which means that, without good functioning and resilient institutions, including the government and private sector, communities cannot remain resilient. Efficient institutional resilience allows the related organisations to respond to a sudden intervention and continuous change in order to succeed in emergency situations. According to Seville et al. (2006), a resilient institution is one that is still able to achieve its main objectives in the face of disaster. Therefore, institutional resilience is a long-term goal that helps institutions or authorities adapt their good skills and behaviours to boost enterprise by using the institution’s capacity and skill building (Ortiz-de-Mandojana, & Bansal, 2016).

To enhance institutional resilience, there are three main elements: a) decrease in crisis and hazard frequency and size (vulnerability), b) improve the ability of organisational speed to manage a crisis effectively (adaptive capacity), and c) increase risk perception and the ability to deal with strategic threats not only in an event but also in the context of the disaster management process (Seville et al., 2006). Similarly, as stated by Teo et al. (2015), there are two main areas for improving institutional resilience. The first one contains the robustness of the governmental frameworks to prepare for and mitigate the impact of natural disasters, through the consistent recognition and communication, policies, procedures, and adequate steps to support and empower communities to build community resilience. The second area deals with the capacity of the government to prepare communities for disasters.

Several studies have tried to analyse and assess institutional resilience particularly in the context of disaster (Ainuddin & Routray 2012; Yoon et al., 2016). For instance, it has been pointed out that the role of institutional resilience assesses the associated risk of hurricane displacement (Esnard et al., 2011). It consists of local and state disaster planning through taking effective steps to include geographical coverage and natural hazard elements in local planning, and also mandates the post-disaster recovery plan requirement. In fact, the total resilience of the organisation may essentially be assessed by the organisational capacity to respond effectively to natural disaster situations. Godschalk (2003) pointed out that the inevitability of change and the inclination to create a system that can adapt to new situations requires proactive risk mitigation planning. Klein et al. (2003) and Manyena et al. (2011) have expressed the view that such actions strengthen the system's resilience by improving the current status quo. Through efficient government legislation, it has been found that an organisation can build on a productive organisational structure, risk-free contact between employees and, most significantly, act promptly in emergencies (Ortiz-de-Mandojana & Bansal 2016). Likewise, adaptive regulations and policies can play a significant role in supporting communities through disaster prevention and recovery by using the organisations' ability to predict and learn (Adger, 2000). Bullough et al. (2014) noted that creating situational awareness among employees helps them to be more vigilant regarding their ability and performance to deal with potential hazards. This can be achieved by providing the necessary training and education on several capabilities for monitoring and preventing disasters.

It has been found that a resilient community has an appropriate roles and responsibilities of local emergency planning and response agencies in terms of disaster preparedness. Coordination and decision-making processes can also be developed between local authorities and community organisations if a community has a high level of resilience to disasters. The availability of institutional frameworks and local and national policies that value and consider local communities as part of the DRR's national system is likely to improve and maintain resilience (Manyena, 2009). Adamolekun (1990) argued that it is important to take into account the principles that support institutions' improvement and strengthening in order to build effective institutional capabilities. Maintaining local values and acknowledging them as crucial components of the related community could provide the foundation for building resilience to disasters.

In addition, the related stakeholders need to take into account other key factors to enhance institutional resilience. For example, to establish regional best practices and coping strategies, the collaboration between all disaster management organisations and stakeholders must be improved. Coordination at all levels should be considered in a case of potential hazards, and this includes local, national, regional and international levels for quick response and recovery (Moe and Pathranarakul, 2006). However, communities' capacity to reduce risk is impacted by their ability to engage local residents in the risk mitigation process, to develop connections with institutions to maintain the social system and establish a resilient community. Local community skills should be used, and local groups should get opportunities to be engaged in the decision-making process (Oloruntoba, 2015). Moreover, as discussed by Kirby et al. (2014) and Malalgoda et al. (2014), local organisations need to standardise stakeholder roles to prevent duplication and misunderstanding. Blurring roles may lead to duplication of certain tasks that waste resources and could cost lives, whereas other essential stakeholder activities may be overlooked or neglected as a result of blurring stakeholder roles and responsibilities.

3.11.3 Social Resilience Dimension

Bruneau et al. (2003) stated that the term 'social resilience' equates to those efforts that are focused on lessening the negative/harmful societal results of a failure of critical services during a time of disaster. It refers to the features that underpin a community's physical, social and cultural composition and the relationship with the development of resilient communities (Teo et al., 2015). Similarly, Frankenberger and Garrett (1998) noted that social capital shows the quality and quantity of resources in social settings (such as access to the community's wider institutions, social relations, and membership in groups), based on which the people engage in chasing their livelihoods, where most disaster risk management research has focused on outcomes at the individual level (Norris et al., 2008). On the scale of social resilience, there are three kinds of social capital that are in place which help communities to prepare for, cope with and recover from frequent stresses and shocks such as natural disasters (Aldrich, 2012):

1. **Bonding social capital:** It is displayed in the bonds between community members. It contains norms and principles such as reciprocity, trust and cooperation.
2. **Bridging social capital:** It links members of one community to other communities.

3. **Linking social capital:** It is noticed in those social networks that are trusted among the groups and individuals wherein these social networks interact across institutionalised, explicit and formal boundaries within the societal framework.

Communities with a higher level of ties, bridges and bonds have been found to be more resilient than those with none or only one kind of social capital (Woolcock & Narayan, 2000; Elliott et al., 2010; Aldrich, 2012). Green and Haines (2002) indicated that, while social capital is characterised in different ways, the elements of social structure, trust, norms and social networks that promote collective activities are commonly emphasised. Hence, it is also important to enhance social capital to build resilience at the community level. Aldrich (2012) clarified that social capital provides community members with access to knowledge and information before a disaster event. This knowledge and information enhances the capabilities of humans in terms of managing future disasters. Similarly, in order to build community disaster resilience, social networks such as relatives, friends and co-workers are essential since they provide necessary resources that can assist households to respond to and recover from disasters (Dynes, 2002).

In the context of other social resilience factors, awareness of disaster impact is important to integrate disaster preparedness, prevention and mitigation into community culture. As knowledge deficiency increases people's vulnerability to disasters, it is productive to reinforce communities against disasters to reduce any potential damage (Shiwaku and Shaw, 2008). In fact, communities that are resilient to disaster have higher levels of community awareness, which leads them to be more likely to be better prepared for and respond to emergencies and more capable of returning to the normal situation. Education and training sessions can raise citizens' awareness level regarding how flood risks can be minimised by taking all the necessary mitigation measures (Izadkhah and Hosseini, 2005). Moreover, the role of community demographics is an important factor in building community resilience. It has been indicated that local communities with higher proportions of female and elderly population, low levels of education, or high levels of unemployed individuals would be more prone to disasters and less resilient than communities with different characteristics (Cutter et al., 2010; Ludin et al., 2019).

3.11.4 Economic Resilience Dimension

The term 'economic resilience' reflects the capability to lessen both the direct and indirect losses which can happen because of several natural disasters (Chang & Shinozuka, 2004). Through enhancing economic resilience, the community, system, organisation and people can formulate plans and strategies to decrease the economic disruption. Economic resilience can also be described as adaptive reactions to natural hazards which build capacities in societies and people in terms of avoiding and recovering from the potential damages. Specifically, it reveals the capability to lessen both indirect and direct losses in the economy which occur due to a disaster. According to Martin and Sunley (2015), application of policies strengthens the economic resilience because it mitigates both the consequences and potential risks of severe crises. The examination of economic resilience has been conducted in terms of the inherent properties of local economies such as the firm's capability to adapt and adjust during times with no disasters, and also in terms of their capability for resource substitution, innovation and disaster improvisation. Generally, the capability of identifying and accessing a broad range of possibilities to cope with disasters is associated with social and economic resilience. The role of economic resilience in minimising financial losses in disasters can be accomplished by implementing mitigation strategies aimed at decreasing the likelihood of failure (Rose, 2004; Rose & Liao, 2005).

It has been found that economic capital generally enhances resilience among the people in a country while the impact of disastrous conditions can be increased in the presence of unhealthy economic capital (Buckle et al., 2001). Briguglio et al. (2009) noted that both the economic capital and resilience can be measured through the retrofitting house designs and the insurance-related household investments. Furthermore, economic resilience is crucial, and communities need to make sure their job interests are protected by the legislation in place (Masozera et al., 2007). This would make them able to bounce back from any situation that influenced their job opportunities, and ensure that they have an appropriate job to sustain themselves by securing minimum wages. In fact, people with an adequate income and access to the main economic resources recover more rapidly from disasters (Walter, 2004; Qasim et al., 2016). In other words, a community with high-income residents has enough money and required resources to use on absorbing, coping with and recovering from disasters.

Furthermore, it has been indicated that countries with a good economy can have an appropriate level of flood preparedness, effective flood measures to prevent or mitigate flood impacts, and a quick flood recovery process. In comparison, developing (poor) countries are more vulnerable to disasters due to many reasons, including: their primary export dependency, colonial history, extreme deprivation and inequities, improper land use, inadequate physical and social infrastructure, and weaknesses in public administration and governance (Pelling & Uitto, 2001). Moreover, countries with economic diversity can deal with and adapt more to the consequences of disasters through weathering the downturn following disasters and improving income growth levels (Xiao & Drucker, 2013). In contrast, communities with less diverse sources of revenue cannot easily recover from the impact of risk. The degree and diversity of economic resources can be used as a vulnerability measure where it is assumed that the higher economic diversity can lead to communities that are more resilient to disasters (Adger, 2000).

Furthermore, flood insurance is another economic resilience key factor that improves communities' resilience by both speeding-up recovery and reducing the extent of shock. It can enhance the preparedness level and recovery activity of a community in the aftermath of flood or disaster by providing the required funds and resources. This actually helps households to recover quickly, but, with more businesses and households having insurance, the whole community can recover more easily. However, self-insurance can also be preferable, especially for families with low and moderate incomes, which may not be enough to recover from major damages, while failure to get insurance may impose costs on their communities (FEMA, 2011; Kousky & Shabman, 2015). Table 3.2 highlights some community disaster resilience factors with related dimensions.

Table 3.2: An example of common factors to measure community disaster resilience.

Resilience Dimensions	Variables (Factors)	Reference
Physical	Infrastructure	Brouwer et al. (2007), Cutter et al. (2010)
	Building materials	Bosher et al. (2009), Elena-Ana et al.(2013)
	Location of built environment	Cutter et, al. (2010), Mishra et al. (2010)
	Building design	Cutter et al. (2010)
	Urban planning	Sharifi (2016)
	Transportation system	Sharifi (2016)
Institutional	Flood warning	Bohensky & Leitch (2014)
	Standards & regulations	Cutter et al (2008), Sharifi (2016)
	Education and training	Sharifi (2016)
	Institutional responsibility	Cutter et al (2008)
	Coordination and collaboration	Cutter et al (2008), Sharifi (2016)
	Leadership	Southwick et al. (2017)
	Emergency and recovery planning	Bohensky & Leitch (2014)
	Management of resources	Sharifi (2016)
	Social capital	Adger, (2000), Cutter et al. (2010), Apan et al. (2010)
	Religious belief (Faith)	Schmuck (2000), Almarzouqi (2017)

Social	Education status	Norris et al. (2008), Morrow (2008), Cutter et al. (2010), Alshehri et al. (2013), Qasim et al. (2016)
	Community bond	Cutter et al. (2008), Sharifi (2016)
	Safety & wellbeing	Sharifi (2016)
	Age	Cutter et al. (2010), Elena-Ana et al. (2013), Alshehri et al. (2013)
	Local culture	Cutter et al. (2008), Sharifi (2016)
	Awareness	Cutter et al. (2008)
	Disability	Cutter et al. (2010), Elena-Ana et al. (2013), Qasim et al. (2016)
Economic	Income	Ravallion et al. (2009), Hewitt (2014), Poussin et al. (2014)
	Employment	Cutter et al. (2010), Qasim et al. (2016)
	Multi-livelihood sources	Adger (2000), Armah et al. (2010), Motsholapheko et al. (2012)
	Business size	Norris et al. (2008)

3.12 Chapter Summary

This chapter has described the conceptual framework for this study. It illustrated a broad range of theoretical models and frameworks that have been developed to assess community resilience which highlight and identify the main indicators that can be used to enhance the community resilience level. It has been found that community resilience is influenced by several dimensions such as social, economic, physical and institutional. These dimensions are beneficial in terms of assessing the resilience of a community in an integrated way, and in developing an assessment framework in the context of the UAE. Therefore, the framework of this study was initially developed as shown in Figure 3.5, and then it will be further refined and developed after the data collection stage with more details that could be applied to the study. It contains four main dimensions, namely physical, institutional, social and economic dimensions, of resilience that help to assess community resilience to pluvial floods in the UAE. The research methodology adopted for this research is discussed in the next chapter.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The research methodology is considered to be the central construct and the main part of any research. Saunders et al. (2016) opined that an appropriate research methodology is determined through carefully analysing the issues related to the research aim and objectives. Researchers have emphasised that, while undertaking any research, developing a logical approach becomes an inevitable requirement, and the next thing is the facilitation of data collection by employing a set of suitable methods and activities (Gardner & Lehmann, 2002). To achieve the research aim and objectives, this research is conducted to better understand community resilience and to determine the main factors to assess community resilience to pluvial floods in the UAE. Therefore, this chapter provides an overview on the various research philosophies, strategies and different types of data collection techniques in the current research. Furthermore, the chapter explains the suitable data collection methods combined with the validity and reliability of the research results.

4.2 Research Methodological Design

Collis and Hussey (2009) simply identified research methodology as “the overall approach to the entire process of the research study”. It is also described as a process in which the researcher finds a solution to a particular problem when s/he securitises all types of ascertainable evidence relevant to a definable problem after performing a comprehensive and watchful investigation. The development of a research methodology is an important process for carefully considering research studies and selecting a suitable research method and approach (Connaway & Powell, 2010). Dainty (2008) however noted that, in addition to the methods in a given research study, a research methodology included philosophical assumptions used to support the research. In most studies, a researcher uses techniques to collect and analyse research data in order to meet research objectives and to address research questions (Creswell, 2012). A research methodology is therefore an essential process that enables a researcher to monitor the process to achieve the research aim and objectives.

Many studies have shown that there is some confusion among mixed-methods research such as the terms ‘method’ and ‘methodology'. The term method, as defined by Creswell and Plano Clark (2011), is the practical processes of data collection and analysis. Moreover, Saunders et al. (2016) defined ‘methodology’ as a philosophical assumption of the research, in which a researcher develops research questions and chooses suitable methods to achieve the research aim and objectives, while pragmatism refers to the utilisation of several methods such as mixed, multiple, qualitative or quantitative. Nevertheless, the current study does not use the term 'methods' to refer to a research methodology, but as the technique for collecting and analysing data. Thus, the main purpose of the research methods approach employed in the research study is to analyse and examine the key gaps identified when similar topics were reviewed in past research, so that better understanding could be made through further investigation or primary data collection (Creswell & Miller, 2000; Gall et al., 2002).

There are several research methodological designs available in the literature, including the nesting model created by Kagioglou et al. (2000), which contains three key layers for determining the research methodology. The first layer is the philosophy of research, which leads to the second and third layers. Moreover, Creswell (2014) introduced another research design model which also consists of three interconnected steps. The model starts with the identification of the philosophical position that guides the research design. For data collection and analysis, an appropriate research method is then chosen which is considered to be the third layer of the research design model. Although three layers are included for both nested model and research design model, Saunders et al. (2016) introduced the research onion model, which contains six main layers. The research onion provides a clear direction for the researcher to properly and effectively determine the research method through a number of logical steps. Therefore, to articulate the research methodology, the researcher will follow Saunders et al.'s (2016) research onion model.

Bryman (2012) highlighted that the benefits of the 'Research Onion' model can be justified in terms of its adaptableness to practically all kinds of research methodology and it can be utilised in a broad range of situations. Saunders et al. (2016) viewed that it is vital to thoughtfully design and plan all the layers in the research onion model so that reliable and valid data collection could be obtained in response. Similarly, Punch (2005) emphasised that it is vitally important to take into consideration all those issues that are associated with the research project's planning and execution, which is also referred to as the 'research design'. It is crucial to answer the key questions when making the research design, such as: what strategy is to be employed, the conceptual framework to be used, who or what would be taken into consideration for studying purposes, and, for the sake of collection and analysis, what procedures and tools are to be employed (Punch, 2005). Figure 4.1 displays a visual picture of the research methodology in the shape of the research onion with six layers (Saunders et al., 2016). The first layer presents the research philosophy, the research approach is the second layer, while the third layer reveals the methodological choice. The research strategy made by the researcher becomes the fourth layer, the fifth represents the time horizon, while the sixth layer shows data collection and analysis.

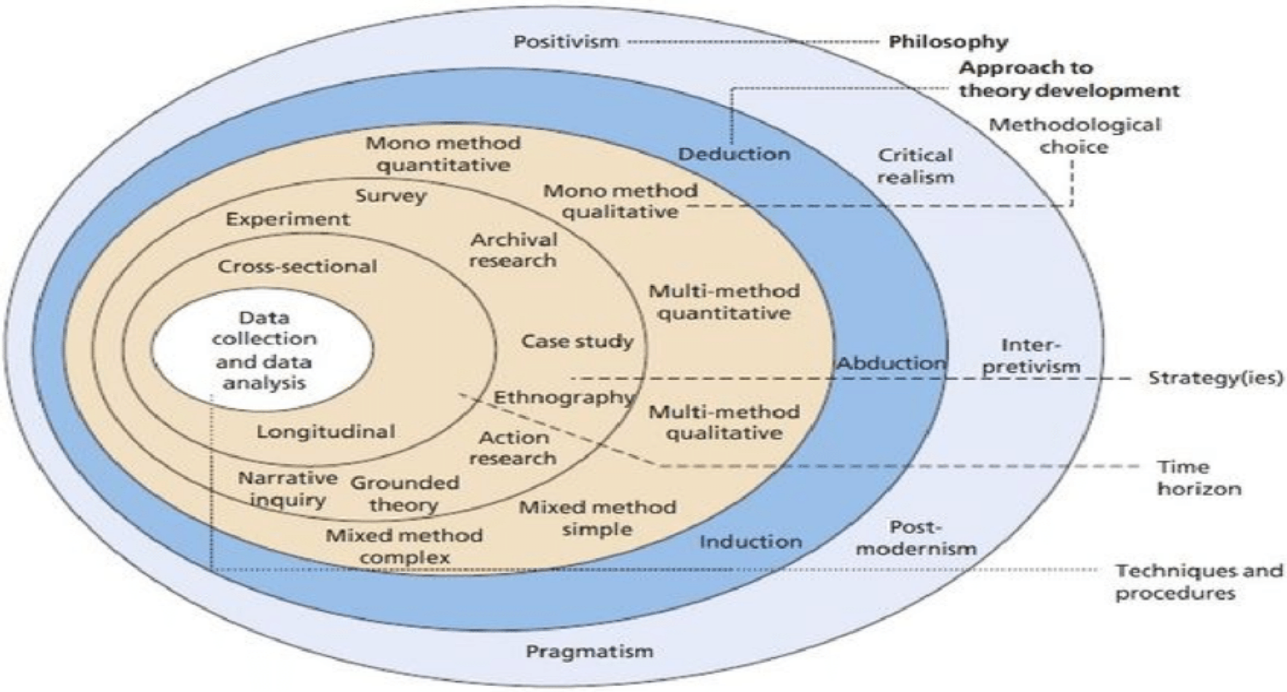

Figure 4.1: The research onion model (Saunders et al., 2016).

The exploratory process is suitable for this research because of its nature and scope. The reason being that the key aim of this research revolves around developing an assessment framework to enhance community resilience to pluvial floods in the UAE through investigating the main dimensions and factors. Moreover, to determine the appropriate methods for the research, Saunders et al. (2016) suggest 'concepts', which are represented as layers in Figure 4.1. Therefore, to evaluate several selected methods to gather valid and reliable data, the research onion is adopted for the current research study. The next sections illustrate the research onion that is used for explaining the research methods employed in this research study with justification of the most appropriate philosophy for enhancing community resilience to pluvial floods.

4.3 Research Philosophy

When it comes to determining the research design, it is essential that the research philosophy is taken into consideration. The research philosophy demonstrates the way we think about the development of knowledge, which influences the way we go about conducting research. It holds the main assumptions about how the researcher views the world (Saunders et al., 2012). The selected research strategy and research method chosen by the researcher are underlined through these assumptions. Researchers have argued that there is no hard and fast rule to select a particular research philosophy in order to conduct every piece of research (Yin, 2009; Collis & Hussey, 2009). This implies that it is the available sources of data collection, research questions or hypothesis, objectives, research aim, or scope of the research on which the research philosophy depends. The research philosophy therefore contains crucial assumptions supporting the research strategy and methods. The rationale of the research and data collection and analysis techniques are determined through a suitable philosophical approach.

Many researchers recommend and underline the vitality of comprehending matters of philosophy because it lends a helping hand in terms of clarifying the research design suitable for conducting research (Easterby-Smith et al., 2004). Certain elements – such as the reality's nature and perception (ontology), describing acceptable knowledge and facts (epistemology), and the role of values and opinions (axiology) – influence the research philosophy. Many approaches are related to the identification of the philosophy, i.e., research philosophy in management, including positivism and interpretivism, realism and pragmatism (Easterby-Smith et al., 2015; Gray, 2014). However, researchers also argue that, when it comes to minutely analysing the research philosophies that are applicable in social sciences, two key philosophies come out on top: interpretivism and positivism (Saunders et al., 2009; Collis & Hussey, 2009).

Formation of research questions or hypothesis generation takes place in the positivist philosophy which is employed for the testing, and it also allows the research study to conduct the measurement of explanations against the accepted knowledge of quantifiable results (Saunders et al., 2009). On the other hand, Kumar (2014) argued that interpretivism reflects the meaning that people attribute to the world, particularly the concerning problems of social life and the things which influence people grounded on their own perception. However, most methodological experts including Saunders et al. (2016) and Collis and Hussey (2014) have claimed that the research design is mainly based on three main philosophical positions: Epistemology, Ontology and Axiology. Pragmatism suggested that the research questions are the main determinants of the research philosophy adopted by any researcher (Saunders et al., 2012). Thus, to achieve this research study's aim and objectives, the following sections justify and explain the research's philosophical positions, which includes three main assumptions, namely: ontological, epistemological and axiological

4.3.1 The Ontological Assumption

Ontology means what is reality (of being); researchers opine that, in any research study, the ontological assumption is closely associated with the nature of reality (of being) (Collis &

Hussey, 2009). Saunders et al. (2009) said that ontology is related to the reality of nature, which leads the researchers to place questions regarding assumptions on how the world operates. There are two sides of ontology assumptions: objectivism, the role of social factors that exist in reality external to social players concerned with their presence; and subjectivism, social entities which are made by the perception and actions resulting from those entities involved with their existence (Saunders et al., 2009). However, it has been identified that reality is seen by objectivism as singular and objective, from the researcher's part, whereas subjectivism reflects reality as multiple and subjective, as perceived by the participants (Collis & Hussey, 2014).

Easterby-Smith et al. (2012) indicated that ontology is divided into four assumptions, which are: realism, internal realism, relativism and nominalism. In social science, arguments about ontological assumptions are mainly based on positions of internal realism, relativism and nominalism, and answers depend on the research topic and the researcher's preferences. Table 4.1 shows how the facts and truths are described by the four assumptions of ontology.

Table 4.1: Four main ontological assumptions (Easterby-Smith et al., 2012, P.19).

Ontology	Realism	Internal Realism	Relativism	Nominalism
Truths	Single truth	Truth exists, but is obscure	There are many truths	There is no truth
Facts	Facts exist and cab be revealed	Facts are concrete, but cannot be accessed directly	Facts depend on viewpoint of observer	Facts are all human creations

In the same context, Collis and Hussey (2009) indicated that, when it comes to examining the positivist philosophy with regard to ontology, the reality is believed to be an external thing to the researcher, reality is objective as well as structured, which is normally at odds when compared with the natural sciences at large. Sutrisna (2009) opined that we all experience one form of reality in particular and by adapting to scientific means we can verify this reality. Contrarily, Collis and Hussey (2009) stated that, according to interpretivists, the reality in the world is an unknown entity. However, Sutrisna (2009) viewed that in interpretivist philosophy, reality is not a single entity, and there is more than one reality for the reason that people perceive and construct realities differently.

4.3.2 The Epistemological Assumption

Sexton (2004) opined that epistemology is all about what and how one can find out the reality, how do we gather and accept the reality-based knowledge about the world. It is all about analysing the knowledge theory, the associated methods, validity, and the probable methods of attaining knowledge. Thus, epistemological assumption is the manner of comprehending and describing that what we know, how we know (Crotty, 1998). According to Pollock and Cruz (1999), it is an effort to make sense of nature, possibility, and limits intellectual achievements for humans by signifying the difference between opinion and knowledge about what it is really to believe or to know.

It has been identified that there are two epistemological positions: positivism and social constructionism (interpretivism) (Saunders et al., 2012; Collis and Hussey, 2014). When it comes to describing the epistemological assumption in positivist research, the existence of the social world should be taken as an external thing and only objective methods should be employed to measure its characteristics, instead of drawing results merely on subjective senses, intuition, or reflection (Easterby-Smith et al., 2012). This approach is used by scientists, who apply deductive logic through experiments and observation to discover theories that can be used in prediction. Therefore, Saunders et al. (2012) stated that a researcher who is adopting a positivist approach would be concerned with facts, rather than with undertaking the research in a value-free approach.

In contrast, instead of measuring the social reality, interpretivists pay attention to the meaning of knowledge. The reason being, they focus more on comprehending the reality phenomenon to get the required answers to research question like how, what and why (Sutrisna, 2009). Collis and Hussey (2009) said that the philosophy of interpretivism is an exploratory type of research in which research is not separate and independent from what is being researched. The interpretivists underline and emphasise that, only once the researcher is profoundly interested in the investigation process, can the constituents of knowledge and the reality be interpreted and understood accordingly, and this is the most suitable method of conducting a research investigation. Table 4.2 shows the key distinctions between the two philosophies (Easterby-Smith et al., 2004).

Table 4.2: The key distinctions between positivism and interpretivism philosophies (Easterby-Smith et al., 2004).

	Positivism	**Interpretivism**
The observer	The observer should be separate and independent	The observer is considered as a part of the research study
Human interests	The human interests must be immaterial	Human interests are what drive the study scientifically
Explanations	The relationship between cause and effect must be demonstrated	It aims to enhance the overall comprehension of the scenario
Research progress through	Development of hypotheses and the subsequent deductions	The induction of ideas takes place by collecting rich data
Concepts	Concepts should be brought under operation to make them measurable	The perspectives of stakeholders should be taken into consideration
Units of analysis	Should be sub-divided into simple, understandable terms	It might show the complete situation's complexity
Generalisation through	Statistics related to probability	Theoretical-related abstraction
Sampling needs	A random selection of large numbers	A few sample cases which are selected for valid reasons

On the other hand, the researcher uses a pragmatist philosophy as philosophical position, where this research is with a practical problem to provide a solution for further practice (Saunders et al., 2016). Pragmatism philosophy includes both positivist and interpretivist philosophies and it has become more popular again recently after a decline in usage. Giacobbi Jr et al. (2005, P. 21) explained pragmatism as "A philosophy of knowledge construction that emphasises practical solutions to applied research questions and the consequences of inquiry". Thus, it is important to adopt a philosophy that uses a data collection method that includes both qualitative and quantitative data. This philosophy allows a researcher to describe in detail certain initial themes to establish a hypothesis that the researcher then checks through an extra data collection process (Creswell, 2014). Pragmatists, therefore, argue that a researcher should be open to the use of several methods to answer research questions, rather than focusing on a single methodological position. Thus, as indicated by Saunders et al. (2009), pragmatism constitutes a beneficial research philosophy especially for mixed-methods research.

4.3.3 The Axiological Assumption

The axiological assumption is known as the last philosophical position which discusses the study's value roles (Collis & Hussey, 2014). This kind of philosophical assumption is associated with what is considered as 'value' in the world at large, and what actually establishes and constitutes value (Collis & Hussey, 2009). Moreover, it has been found that all human actions are guided by our values, and axiological skill is demonstrated to formulate the researcher's values (Heron, 1996). There are two features of axiology: **value free**, "the choice of what to study and how to study", and **value laden**, the "researcher is part of the data collection process" (Collis & Hussey, 2014; Remenyi et al., 2003).

The positivist research philosophy believes that the research is unbiased, neutral and value-free for the reason that the researcher is independent and separate from the topic being researched. On the opposite side, in the interpretivist philosophy, research is a value-laden process. This implies that, when it comes to describing human existence, the role of value becomes central (Collis & Hussey, 2009). Researchers' explanation of axiological skills is based upon the formulation of values as a ground for judgement-making scenarios about the subject under investigation, and that is how they formulate how the research process will be carried out (Heron, 1996). Table 4.3 displays the differences among the four main research philosophies and summarises the explanations of axiology, epistemology and ontology (Saunders et al., 2012).

Table 4.3: Differences between the four main research philosophies (Saunders et al., 2012).

	Positivism	**Realism**	**Interpretivism**	**Pragmatism**
Ontology	Real, external, objective and social actors, independent	It is objective and occurs separately from human ideas and knowledge of their nature (realistic); however, it is interpreted by social conditioning (critical realistic)	Complex, rich, socially constructed from experiences, subjective	Complex, rich, external, view chosen to best enable answering of research questions

Epistemology	Only measurable phenomena may provide credible evidence. Specific attention is paid to causality and law-like generalisations, reducing phenomena to simple elements	Observable phenomena give credible evidence. Inadequate data means sensational inaccuracies (direct realism). Phenomena also create sensations open to misinterpretation (critical realism). Concentrate on explaining in contexts	Subjective meaning and social phenomena. Concentrate on situation details, a fact behind these details, actions are motivated by subjective meanings	Whether observed phenomena and subjective meanings can provide appropriate information based on the issue of study. Emphasis on realistic applied research, which integrates various perspectives in order to understand the data
Axiology	Research is carried out in a value-free way, the researcher maintains an objective position and remains independent of the data	Research is value laden; the researcher is dependent on world views, experiences and education	Research is value-bound, the researcher is part of the study, cannot be separated (subjective)	The researcher adopts both objective and subjective points of view as values play an essential role in interpreting results
Data collection techniques used	Highly structured, large samples, measurement, quantitative	Methods selected must be relevant to subject matter, it could be quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

It can be argued that this study falls in the social sciences category, where the research aims at investigating the real-world experience of the participants, and it would be indicated that a mixed-methods research approach is the key element of this research study. Hence, the philosophical elements which surround and influence the current research study are composed of the ontological assumption which reflects that reality is constructed socially as well as the epistemological assumption which denotes the collection of knowledge that is conducted after analysing an individual's views and perceptions regarding community resilience against floods in the UAE. Moreover, the axiological assumption which says that the participant's bias or the bias present in the researcher might have an impact on the research study is negated for the reason that the data validation is performed by employing a mixed-methods approach. However, Bryman (2012) argued that the research is not totally isolated from the researcher's own values because they do exist in the process of choosing the research area, formulating the research questions, selecting the techniques and methods, implementing data collection, and the stage where data is finally interpreted by the researcher and conclusions are drawn.

Based on Table 4.3 and the explanation provided, the current research focuses on developing an assessment framework to improve community flood resilience in the UAE through investigating and analysing key factors to assess community flood resilience. Due to the research objectives, this study will adopt a pragmatist philosophical stance. According to Creswell (2014), the main reason for using a pragmatist philosophy is that it enables researchers to answer the research questions by using a number of methods and data collection and analysis techniques

Therefore, to summarise the above-mentioned evidence, Figure 4.2 sets out the complete research philosophy stance relating to this research, which can be positioned in the middle of different types of philosophies, as follows:

- For ontology assumptions, it has been identified that a study can be even objective and external to the researcher, or socially constructed and made by the perceptions and actions of the human actors (Collis and Hussey, 2009). Thus, this research deals with both objective and subjective issues and therefore it falls in between the two ontological assumptions.
- The researcher seeks to investigate and analyse key factors to assess community flood resilience which will help to improve the UAE's community flood resilience. Then, depending on the nature of these research questions and by applying a mixed-methods design, it can be identified where the epistemological assumption relies on the pragmatism assumption.
- Since the values of the researcher influence the methods used for analysis and the interpretation of the research results, and the researcher will count on the methods of data collection through a mixed-methods approach, so values play a major role in interpreting the research findings as the researcher takes both subjective and objective views.

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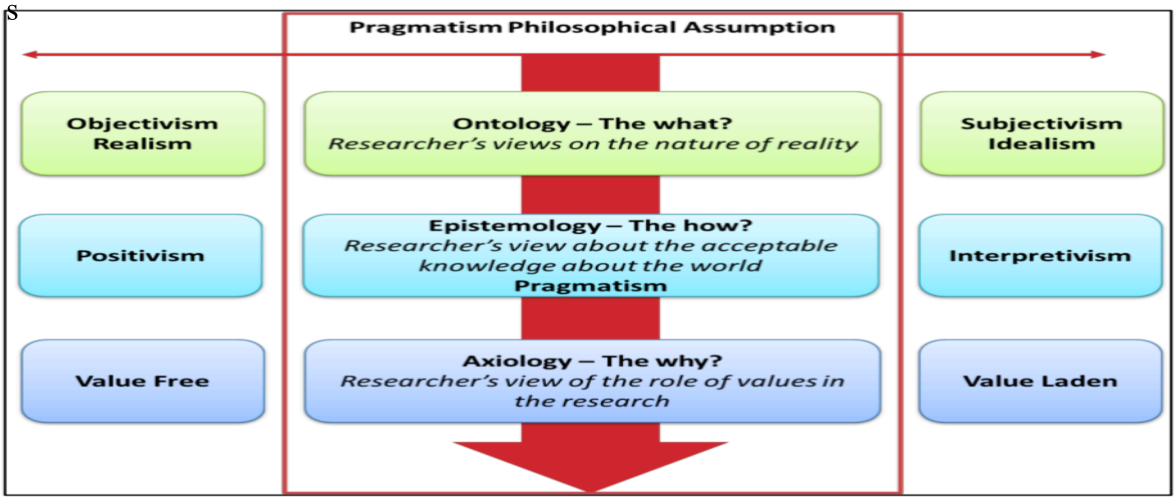

Figure 4.2: The research philosophical position.

4.4. Research Approach

The research approach makes the second layer in the "Research Onion". May (2011) argued that explanations are needed in every research project from the perspective of theory which results in either accepting or rejecting the observation and hypothesis which motivated the research. Creswell (2012) said that the inductive and deductive approaches handle the decision associated with the perspective, limitations and research aim to determine the most suitable method for the research. It is the reasoning adopted by the researcher on which inductive and deductive approaches rely (Ketokivi & Mantere, 2010). They further said that a third type of reasoning also exists which is commonly used in research studies and it is called abductive reasoning. However, based on Saunders et al. (2012), inductive approach and deductive approach are the two key types of research approach.

In the deductive approach, an already established theory is taken up by the researcher and he attempts to formulate an explanation alongside testing the theory. The deductive research approach can be utilised in any research that is grounded on positivism philosophy. On the other side, Saunders et al. (2012) opined that the inductive approach is considered to be the process of theory building. It initiates with a direct observation of a particular case study, and afterwards the researcher establishes the generalisations about the subject under exploration. Saunders et al. (2012) argued that there is a 'surprising fact' observation based on which the abductive approach begins, and then it turns into a reasonable theory detailing how this could have happened.

Putting it more simply, when the research study commences with the development of a hypothesis or more than one hypothesis, or theory, and then either the hypothesis or the theory is move forward through a test or critical process, and the whole process concludes with either rejection or acceptance of the hypothesis, then it would be called a deductive approach. Differently, when the research study starts with generalisations and concludes in theory development based on the generalisation's pattern, then it is said to be an inductive approach (Sutrisna, 2009). Moreover, when the data collection process is executed by the researcher in a bid to gain insight into the phenomenon, the researcher identifies the themes and describes the patterns either to modify an existing theory or to create a new one. Afterwards, the researcher tests the existing theory by collecting additional data; this process is referred to as the abductive approach (Ketokivi & Mantere, 2010). The relationship between these three approaches, based on Saunders et al. (2012), is stated in Table 4.4.

Table 4.4: Differences between deductive, inductive and abductive approaches (Saunders et al., 2012).

	Deduction	Induction	Abduction
Logic	The conclusion must be true if the premises are true in a case of deductive interpretation	The untested conclusions are generated by using the known premises in an inductive interpretation	The testable conclusions are generated by using the known premises in an abductive interpretation
Generalisability	General to the specific generalisation	Specific to the general generalisation	Connections between the specific and the general to make a generalisation
Data usage	The process of data collection is utilised to assess the hypothesis and prepositions associated with existing theory	The process of data collection is utilised to investigate a phenomenon, classify the patterns and themes, and formulate a conceptual framework afterwards	The process of data collection is used to explore a phenomenon, classify the patterns and themes, make a conceptual framework and then perform the succeeding data collection for testing this and so on
Theory	Verification of a theory	Theory generalising and building	Generalising of theory or modifying: the incorporation of existing theory either modifies the theory or creates a new one.

This research is an exploratory study, in which the researcher attempts to explore the phenomenon in a context in which there is a lack in literature about community flood resilience in the UAE. Therefore, since this study is exploratory in nature, the researcher has opted to use a mixed-based methodology in which both deductive and inductive approaches are employed (abductive). To justify that, in the first phase, the researcher starts with a theory which is formulated after analysing the academic literature associated with the events of pluvial floods and their impacts, and examining the particular factors that influence community resilience to pluvial floods. In this phase, which is deductive, the researcher moves from the general level towards the specific. The next phase comes with the process wherein the researcher conducts interviews with senior managers in a bid to collect the relevant data so as to explore and identify the factors and challenges facing community flood resilience in the UAE. The third phase includes a questionnaire technique where the researcher tries to analyse the factors identified from semi-structured interviews to further analyse and validate the data gathered. The final phase involves using the AHP method to prioritise the identified factors based on their importance, which helps to develop the conceptual framework.

4.5 Methodological Choice

The research choices are justified and considered essential in a research study to make sure that it maintains consistency so as to ensure the validity of the collected data. May (2011) indicated that there are certain benefits and limitations for each choice, and they should be taken into consideration based on their attributes and relevance to the philosophical position of the research. This section discusses the context and the choice of qualitative, quantitative and mixed methods. There are two key approaches associated with the methodological choices (Saunders et al., 2012), as follows: 1) mono-method (quantitative or qualitative) and 2) multiple methods, which is also sub-divided into two approaches, i.e. a) multimethod (multi-method-qualitative studies and multi-method-quantitative studies), and b) mixed method (mixed-methods research and mixed-model research), as shown in Figure 4.3. However, Yin (2009) explained that the quantitative and qualitative methods are the two key types of social science research methods through which positivism and interpretivism are represented.

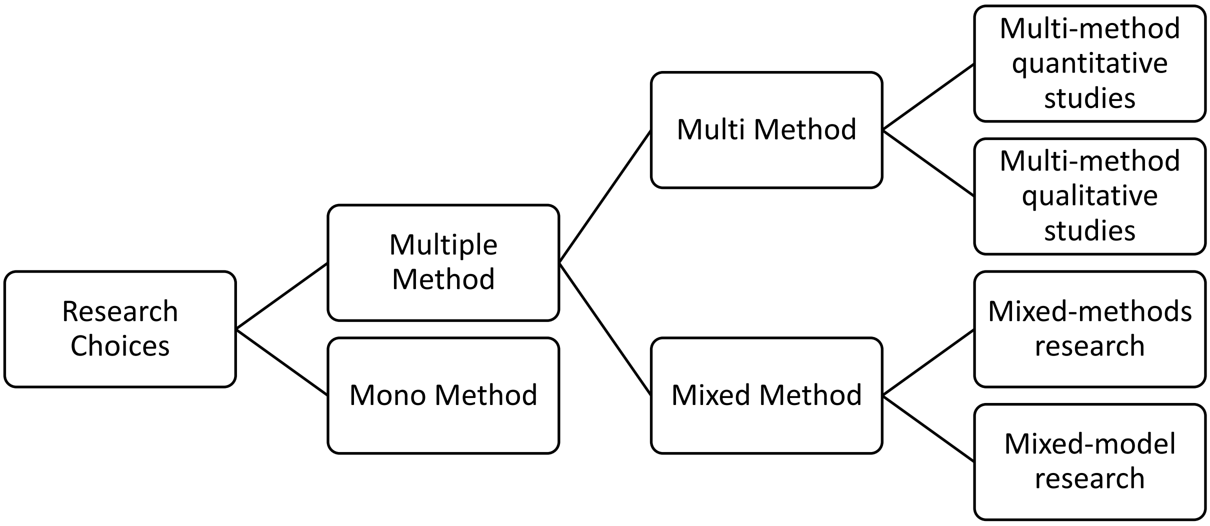

Figure 4.3: Research method choices (Saunders et al., 2012).

The philosophy of interpretivism represents the qualitative research method in which the examination and study of the phenomenon is conducted in natural settings. This type of research methodology commonly includes questionnaires and interviews. On the other hand, the philosophy of positivism represents the quantitative research approach (Collins & Hussey, 2009), wherein measurable observable facts are involved. This kind of research includes the usage of numbers and statistical methods, and applicable hypotheses are tested in this kind of research alongside different kinds of numerical measurements grounded upon the particular aspects of the research problem and the inferences drawn from hypothesis testing (Thomas, 2003).

It is worth noting here that there is no single category into which most of the research fits in practice. In fact, many research studies are combined together by adopting a mixed-based methodology. Saunders et al. (2012) explained that mixed-methods research is a branch of multiple research methods wherein both quantitative and qualitative analytical procedures and data collection processes are utilised. Through using more than one method, the mixed-methods design has several advantages as it allows researchers to obtain more information on different aspects of the research subject. Some researchers have argued that the mixed approach will bridge the gap between quantitative and qualitative approaches by providing additional information and evidence related to the research study. It also helps researchers to answer research questions that cannot be addressed exclusively by quantitative or qualitative approaches, through providing sufficient resources and evidence to achieve the research aim and objectives. Therefore, the use of the mixed-methods approach can provide better diversity and lead to appropriate confidence in the conclusion of the research (Creswell & Plano Clark, 2011).

Nonetheless, Creswell et al. (2011) stated that a mixed-methods approach requires sufficient time and resources, including administrative assistance and qualified support staff. Further, the presented data would be limited with regard to publication of mixed-methods approach in related case studies. Cameron (2009) claimed that the nature of the research problem being studied is the main reason for using a mixed-methods approach in empirical studies. Therefore, it is important that the research problem be addressed correctly by gathering more information and evidence or reviewing the investigative method. Table 4.5 lists the differences between quantitative and qualitative research methods (Johnson & Christensen, 2008).

Table 4.5: Distinctions between quantitative and qualitative research Johnson & Christensen, 2008).

	Quantitative Research	**Qualitative Research**
Nature of Reality (Philosophy)	Single reality; objective	Multiple realities; subjective
Purpose	To test hypotheses, look at causes & make predictions	To understand & interpret social interactions
Research Objectives	Describe, explain & predict	Explore, discover & construct
Reasoning	Deductive (top-down) (testing theory), (hypothesis testing)	Inductive (bottom-up) (generating theory)
Method	Questionnaire, experiment	Observation, interview

View of Human Behaviour	Behaviour is regular and prediction	Behaviour is fluid, dynamic, situational, social & personal
Questioning	Structured question	A broad range of questions (unstructured)
Sample	Large	Small
Nature of Data	Variables	Words, images categories
Form of Data Collected	Collect quantitative data (numbers, close-ended items, rating scales …)	Collect qualitative data (interview, open-ended questions …)
Data Analysis	(Statistical analysis)	(Interpretivism) search for patterns & themes
Result	Generalisable finding	particularistic finding (viewpoint)
Form of Final Report	Statistical report (mean, correlation, regression …)	Narrative report with contextual description
Strength	Reliability	Validity

Apart from this, the research focuses on meaning and it aims to deeply investigate and comprehend factors which will help to assess community flood resilience in the UAE. The present research study aims to gather the data about community resilience to pluvial floods by using the literature, interviews, questionnaire and focus group to gather the necessary suggestions, thoughts and opinions of participants in a bid to develop an assessment framework to enhance community flood resilience. Therefore, based on the above-mentioned reasons and the research's philosophical position, this research study adapts a mixed-methods approach as a suitable research choice to facilitate triangulation, as described by Saunders et al. (2016). The factor of triangulation provides help in the sense of ensuring that the data supports the results interpretation and is complementary to the research. According to Teddlie and Tashakkori (2009), the benefits and strengths of each strategy are adopted in a mixed method, so the outcomes of the research become more valid and stronger.

On the other hand, the purpose of a research which is more often used in research methods is classified into three types, i.e. descriptive, explanatory and exploratory (Saunders et al., 2009). In this context, Robson (2011) argued that exploratory research is an appropriate way to investigate what is happening, to ask questions, to seek and evaluate new insights. Robson (2002, P.59) explained the purpose of descriptive research is "to portray an accurate profile of persons, events or situations". While, the aim of explanatory research is to develop relationships between variables so as to comprehend and know the causes and nature of the issue at hand.

Furthermore, Saunders et al. (2016) indicated that mixed-methods research designs are mainly divided into four types: 1) concurrent, 2) sequential exploratory, 3) sequential explanatory and 4) sequential multi-phase. According to Creswell (2014), there are two main forms of sequential design, which are: exploratory sequential research design and explanatory sequential research design. Creswell (2014) also indicated that, in this exploratory sequential design, measurements are developed by the researcher during the qualitative stage with particular samples, and, afterwards, the researcher attempts to generalise them in the second stage, which is referred to as the quantitative stage of data collection. When a researcher is investigating a new research topic or developing a framework, exploratory sequential design is useful (Creswell & Plano Clark, 2004).

Thus, an exploratory sequential research design has been selected due to the nature of the current study. The justification is based on the fact that the researcher would first explore and analyse the qualitative data, and then utilise the results in the second stage, which is referred to as the quantitative phase, to confirm the framework outcomes. The researcher needs to develop a set of measures of the quantitative process, as elements of the study being examined are unknown in the context of the UAE. Moreover, this will enable the researcher to gain a deep understanding of pluvial floods and resilience, as well as additional information from interviewees' explanations, in order to establish the context and factors that influence community flood resilience, which will help to generalise the findings.

4.6 Research Strategy

Research strategy is the fourth layer in Saunders' onion model, and it is defined as "a plan of how a researcher will go about answering the research questions" (Saunders et al., 2012, P.173). It is grounded on the ontological assumptions, axiological purposes and epistemological activities. Denzin and Lincoln (2005) stated that the research strategy is the methodological association between the research philosophy and the research method choice for data collection and analysis. It has been identified that the research situation is the main factor when selecting the research strategy. Every research strategy has unique advantages and disadvantages and it employs a specific data collection and analysis techniques (Yin, 2014). The research strategies are classified as narrative inquiry, grounded theory, archival research, ethnography, action research, case study, survey and experiment (Saunders et al., 2012; Yin, 2014). Therefore, choosing a strategy is crucial and extra care is required because every strategy has its own pros and cons. For example, when it comes to employing the 'experiment method' in natural sciences (it is a typical method which is used in natural sciences), Collis and Hussey (2009) said that it involves the examination of casual links in which, when an independent variable undergoes a change, it triggers a change in another, dependent, variable. In the deductive approach, normally a survey strategy is employed in which the researcher gathers a huge amount of data from a large population size. However, to examine documents and records as the main data source, historical analysis of archival information is employed (Saunders et al., 2012). Table 4.6 illustrates the differences between research strategies.

Table 4.6: Research strategies and their main features.

Research Strategies	Characteristics/Key Features
Experiment	It provides the definition of the theoretical hypothesis, sample selection from the population, random sample allocation, controlling of the entire research variables, and measurement of the research findings (Punch, 2005; Saunders et al., 2009).
Survey	It permits the quantitative data collection, representative samples, it allows independence to the researcher and restricts his/her bias, allows objective observation, and the analysation of data takes place in a quantitative manner (Kumar, 2014; Gilbert, 2008).
Case study	It provides a quick and better comprehension of a real situation, it allows the utilisation of triangulation of more than one data source, it could be in the shape of single or multiple case studies, and it could also be embedded and holistic as well (Yin, 2009; Punch, 2005; Saunders et al., 2009).
Action Research	In this scenario, the research is executed in action, the field practitioners participating in the research, the researcher is also part of the organisation on which the research is being carried out, encourages change within the organisation being researched, it frequently achieve the research sponsors' requirements and the research aim (Creswell, 2014).

In the case of management studies, the case study is considered to be the most appropriate and effective approach. The case study strategy is defined by Yin (2014, P.17) as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the margins between phenomenon and context are not obviously apparent". It is equally good in studies which involve social work, professional fields like management science, and the academic disciplines. There are three conditions which the research can employ to choose the suitable research strategy, as explained by Yin (2014):

- The type of research question posed.
- The degree of control the researcher has over actual events related to behaviour.
- The extent of attention on contemporary events rather than on the historical events.

Table 4.7 outlines the association between research strategies, type of research question, control of events related to behaviour, and attention on contemporary events (Yin, 2014).

Table 4.7: The differences between research strategies (Yin, 2014).

Strategy	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

When examining the contemporary issues in the present research study, it becomes clear that all the strategies like case study, archival analysis, survey, and experiment can be used. Considering the uniqueness of the present research study in which stakeholders' requirements to improve community resilience to pluvial floods are analysed, it is not recommended to use an archival or experimental strategy. However, Denscombe (2014) argued that case study is a strategy in which the researcher can use a variety of data sources during the research investigation process. Zainal (2007) mentioned that a case study technique allows a researcher to carefully examine the data within a specific context. Moreover, as per Velde et al. (2004) and Saunders et al. (2012), the case study strategy is considered a suitable strategy if the investigator needs to deeply investigate and understand the process being used and the research context; hence, in this research, the case study strategy has been selected as the most suitable strategy.

Furthermore, Yin (2014) illustrated that the case study methodology describes a real-life situation where the occurrence of the case study took place and the said methodology is applied to describe the cause & effect relations in real life which are beyond the scope of experimental or survey strategies. In other words, the case study is an exploratory type of methodology which can also be used for explanatory or descriptive purposes. However, it could be observed that a case study is capable enough to accommodate many types of research techniques. It is also quite possible that the case study employs a mixed-methods, qualitative or quantitative approach. A broad range of data collection could be dealt with in the case study like questionnaires, documentary analysis, observation and interviews. While case studies have many benefits, they can include several challenges, such as being time-consuming as they require direct observation of real situations and also demand the use of multiple research methods and techniques with a trained researcher (Meredith, 1998). However, the results of a case study could have a positive effect as they could create new and creative visions for better understanding of the phenomenon under consideration (Voss et al., 2015).

The present study employs a case study methodology to comprehend all the essential information required to investigate community resilience to pluvial flood in the UAE. Yin (2014) explained that, whenever 'why and how questions' are being posed, the case study methodology comes top of the most preferred approaches, and this is the case in a situation where the events are not completely controlled by the investigator, and likewise s/he does not have much control over analysing the contemporary events as well. Because this study is primarily exploratory, as described above, this research seeks to explore and analyse key factors that affect community flood resilience through answering research questions concerning what or how in the case study. Therefore, the case study allows the researcher to apply a wide range of methodological approaches in combination with several processes of data collection which helps to check the validity of the research.

4.6.1 Single Case or Multiple Cases

When applying a case study methodology, it is necessary to make a distinction that the design is based on a single case study, such as on a single social context or executed in one organisation, or the design is grounded on multiple case studies wherein more than one social context or organisation is under investigation. The case study designs are divided into four major categories: single holistic case study, single embedded case study, multiple holistic case study and multiple embedded case study design. It is significant to note that a holistic case study covers a whole organisation or society, while an embedded case study covers an organisation with sub-units, for example, sections or departments. A further explanation for choosing a single case is that it offers an opportunity to investigate phenomena in more detail and depth (Yin, 2014).

Using a single case study is considered to be a feasible strategy which offers in-depth understanding of the case that is tagged as a longitudinal case, representative case, a unique or an extreme case. There are five rationales, as described by Yin (2014), when selecting a single case study: 1) when it shows a critical type of case to test a well-established theory, 2) where there is a unique or extreme case in the study area, 3) where the case study is a typical case or representative and 4) for a revelatory case. This is the scenario when there is a previously inaccessible area of the enquiry of social science, and the investigator takes the opportunity to explain it by observing and analysing the situation, and 5) a longitudinal case: in this situation, the investigator studies an identical case at multiple points in time (two or more points).

In contrast, multiple case studies include more than one single case study. Remenyi et al. (2003) stated that the evidence from multiple case studies is more compelling with more reliable and stronger findings. Similarly, Yin (2009) argued that, when resources and data are available as a reason to increased generalisability and replication possibility, multiple case studies are preferred to a single case study. A case study approach will be more applicable if the researcher wants to obtain in-depth understanding of the processes being applied and the research context. However, using multiple case designs should follow a replication, not a sampling logic, and each case must be chosen carefully (Yin, 2014). Therefore, the researcher should carefully select the case study to the degree that achieving similar results is expected.

The present research poses both types of research questions, 'why and how questions', which is why, after thoroughly analysing the nature of the research questions, the researcher opted for a **holistic single case study design** wherein the case is Abu Dhabi city. The single case study offers the opportunity for a deeper and more detailed exploration of phenomena (Yin 2014). It can thus be argued that a single case study employing an appropriate design can provide more effective understanding than multiple case studies if they are not designed and conducted in an appropriate way. Also, due to the limited time related to the PhD programme in this research, the single case study is more suitable. Hence, the researcher would be able to gain reliable data sources in order to conduct the analysis.

The investigation relates to pluvial floods in the UAE and what are the community flood resilience factors. Thus, when it comes to the rationale for selecting a single case study, it can be argued that it is a **critical case** as it seeks to develop an assessment framework that will help to measure the UAE's community resilience to pluvial floods. The conceptual framework will be developed based on the participants' opinions using the qualitative stage, and it will be confirmed based on the questionnaire survey and focus group method. Moreover, as mentioned earlier, there is lack in the literature on community resilience and flooding in the UAE; this gave the researcher the opportunity to explore and analyse a phenomenon which few might explore. The next section also discusses the further reasoning for selecting this case study.

4.6.2 Justification for Selecting Abu Dhabi City as the Case Study

The reason behind choosing Abu Dhabi city as the case study is that there is a lack of published literature related to community resilience and flooding in Abu Dhabi city, which is the capital of the UAE where all federal governmental authorities and most of critical infrastructure and properties are located, which is advantageous in that it allows close contact with decision makers. The city is also experiencing a significant growth in population and expansion in the field of construction. The city's urbanisation rate has recently increased with a large number of facilities and buildings, which puts the city at risk of climate change consequences. Moreover, the city has previously been exposed to a number of natural hazards especially pluvial floods, which cause negative impacts for lives and livelihoods (Perring, 2016; Almarzooqi, 2017). On the other hand, it is important to identify the unit of analysis as it the most important part of the research design. It refers to what or who is being investigated (Yin, 2014; Saunders et al., 2016). Hence, the unit of analysis in this research is the critical factors that influence community resilience to pluvial floods in the UAE, so that the assessment framework to evaluate community flood resilience can be developed.

4.7 Research Time Horizons

The fifth layer of the 'research onion' is formed by the time horizon. Saunders et al. (2009) stated that this time horizon could be used either in a long-term study (longitudinal) or in a short-term study (cross sectional). Cross-sectional studies of the time horizon are restricted to specific time frames used to complete the research project. Longitudinal studies, by comparison, analyse developments and changes over time and provide a better picture of reality, which may consume more time (Sekaran & Bougie, 2016). In the current research, the time horizon is justified and Bryman (2008) explained that any research process reaches successful completion with a key aspect of timeframe in which this research requires to be completed. This does not imply that the present research study is going to analyse the pluvial flood phenomenon on the UAE community over a time period nor will it make a comparison of the impacts of these floods from one specific time to the other. Therefore, the work in this study is similar to cross-sectional studies since the variables included in the current research are gathered at the same particular time period. The cross-sectional time horizon is appropriate for the nature of research activities that are aimed at accomplishing the research objectives and finding answers to the research questions at hand.

4.8 Data Collection Techniques

The last layer in the 'research onion' model is related to data collection and analysis. There are many applicable methods which could be employed to extract information from people. Easterby-Smith et al. (2004) underlined a few methods such as using archival material or observations, interviews, questionnaires and others. At the same time, not all studies can count on any one single method; according to Yin (2014), the suitable method(s) to be employed depends on many factors such as the research aim and objectives, the strategy, the approach, philosophy and specific requirements.

As the research design is a sequential mixed-methods design, the data can be sub-divided into two main types, which are qualitative data and quantitative data. The method of data collection through a qualitative approach allows the researcher to collect a lot of valuable information with deep insight into the study area. On the other hand, utilising quantitative data enables the researcher to gather reliable data. According to Levy and Lemeshow (2008), the data collected through qualitative methods includes a direct connection and interaction with respondents either one on one or on a group basis. However, the collection of research data is widely divided into two key types, referred to as primary data and secondary data (Collis & Hussey, 2009). Silverman (2013) explained that, in the case of primary data collection for the purpose of a study, the data is collected straight from sources, materials and people. However, secondary data is different from primary data because it is collected from existing research sources from the relevant study area. Researchers say that theoretical foundations of the study are built upon secondary data; that is why they are important (Collis & Hussey, 2009). Hence, in this research, secondary data was collected mainly from secondary sources such as existing research papers, articles and books, whereas semi-structured interviews, questionnaires survey and focus group methods were used to gather primary data. Table 4.8 outlines the types of data collection methods and sources used to achieve the research objectives.

Table 4.8: Data sources and types of data collection method.

Data Sources	Types of Data Collection Method
Secondary Data	1. The literature review considering flood management measures, and community resilience. 2. Review of existing community disaster resilience frameworks. 3. Documentary analysis of technical reports from related local organisations which are about flood impacts and measures in the UAE.

Primary Data	1. Qualitative semi-structured interviews. 2. Quantitative questionnaire survey. 3. Focus group conducted with experts to prioritise key factors through the AHP to develop an assessment framework. 4. Another focus group conducted with senior managers to validate the framework.

In fact, many researchers have suggested that data collection should be performed by using multiple methods so that the possibility of bias with any single method could be avoided and the reliability and validity of the research could be improved (Denzin & Lincoln, 2005; Collis & Hussey, 2009). Due to the specific research questions in the presents study and the recommended methods to answer those research questions, the researcher decided to employ multiple methods of data collection. Furthermore, by utilising multiple sources, the triangulation of evidence could be accomplished. Triangulation is defined as “The use of more than one method or source of data in the study of a phenomenon so that findings may be cross-checked” (Bryman, 2008, P 700). It represents using more than one data source and several hypotheses to endorse claims and assumptions. Hence, Yin (2014) further explained that the clarification could be made entirely to the phenomenon under investigation, and the data validity could also be enhanced. The importance of triangulation is also noticeable and necessary to reach research questions and objectives. As case study strategy has been chosen for the current research study; it has been found that the case study approach can count on six key sources of evidence for a research study. Table 4.9 lists all these methods based on their weaknesses and strengths (Yin, 2014).

Table 4.9: Strengths and weaknesses of data collection methods (Yin, 2014).

Evidence Source	Advantages	Disadvantage
Documentation	Stability factor: researcher can repeatedly review; Exactness: the details, references and names are all exact.	Irretrievable: it could be biased selection from researchers end, could be low, the author can use his own bias which can be further blocked by the author due to privacy as well.
Archival records	Quantitative and precise, same as above.	The privacy concerns could limit the accessibility, same as above.
Interviews	Targeted: The cause and effect associations are good because they focus on relevant studies.	Badly constructed questions could trigger bias, Response bias could be seen as respondents say what the interviewer wants to hear.

Direct observation	Reality: tagged with real-time events. Contextual: the event contexts are covered.	Consumes time. Selectivity: unless the coverage is wide, it is poor. Reflexivity: the processing of events could be different.
Participation/ direct observation	Same as above direct observation, provides insight into motives and interpersonal social behaviour.	Nothing different than direct observation above, as researcher controls the events, bias is there.
Physical artefacts	The technical operations and cultural features are highlighted.	Availability and selectivity.

It is clear from Table 4.9 that the conditions of timing and availability are what determine the archival records, direct observation/participation and physical artefacts so that they could be employed in a research area. Because there is very little published literature relevant to the subject area (UAE's community flood resilience) and it is illogical for the researcher to wait for a natural disaster to occur and then start this investigation, therefore, the physical artefacts and archival records are also inappropriate options in this research. These facts give credence to the viewpoint that the documentation and interview techniques would be the most feasible methods in this research. However, Yin (2014) confirmed that the questionnaire survey technique also resembles an interview type in the case study.

One of the main types of evidence to collect from different sources is documentation. Many qualitative researchers consider it to be a useful research method in their research strategy (Bryman, 2012). Yin (2014) has stated it is anticipated that documentation reviews are applicable to each case study subject and help to obtain a more comprehensive and contextual case description. He also indicated that letters, minutes of meetings and some kinds of reports may be considered as documents. This type of data can be analysed qualitatively and quantitatively, and it can be used with other data sources such as interviews or questionnaires to triangulate research findings (Saunders et al., 2012). In this study, documentary data related to the impacts and measures of flood events in the city of Abu Dhabi was used as an additional technology for overcoming the low data reliability generated through the semi-structured interviews, questionnaire and focus group. Thus, this evidence or resources (documents) can also enable data to be triangulated.

When it comes to analysing the case studies, the perceptions of people can be easily accessed by using the interview method, the discussion, problem definitions and meanings which help the researcher to obtain their deep insight based on the research problem at hand. Moreover, Saunders et al. (2012) opined that, when there is a large sample of participants in the research, the best way to collect data is through a questionnaire. From the above discussions, the key method for gathering primary data in this research in order to develop an assessment framework to enhance community flood resilience is through interviews, questionnaires survey and the AHP through focus group. This research will use sequential mixed methods as the methodological approach, which consists of qualitative and quantitative data. This approach will involve a literature review, semi-structured interviews, questionnaire survey and the AHP.

The research gap in disaster management related to flooding and community resilience was revealed from a literature review of the secondary data. To collect primary data, firstly semi-structured interviews are conducted to investigate key factors that influence community flood resilience. After that, a questionnaire survey will be used to analyse and validate the identified factors. Then, the AHP method will be carried out to prioritise the main factors based on their importance through using a focus group with a panel of experts, and that will help to develop an assessment framework for enhancing community flood resilience in the UAE. Finally, a focus group will be conducted with senior managers to validate the developed framework. Figure 4.4 illustrates the research design and timescale, which includes four main stages for primary data collection.

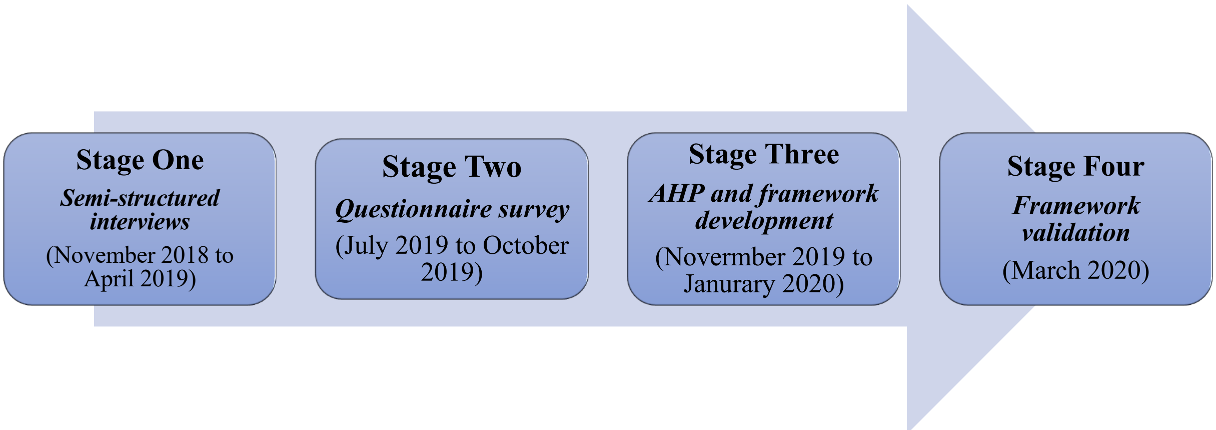

Figure 4.4: The research design and the timescale for primary data.

4.9 Stage One: Semi-Structured Interviews

Most of the research approaches use interviews as a broad and key form of data collection technique. Schostak (2006) opined that participants can explain and describe phenomena or events being studied through interview methods. Particularly, there are three main interview types, as explained by Saunders et al. (2009), which are: structured interviews, semi-structured interviews and unstructured interviews. The unstructured interviews, as the name indicates, are a random form of interviews and, according to Sekaran and Bougie (2016), the interviewer poses unpredictable questions to the respondents. Moreover, the interviewer should have complete understanding and knowledge about the subject to be explored (Saunders et al., 2012). In contrast, structured interviews follow a proper set of questions which would be referred to as the ‘interview schedule’, and Oppenheim (1992) stated that the interviewer would use an identical order of questions, wording and phrasing.

Yates (2004) argued that, apart from the advantages of structured and unstructured forms of interviews, semi-structured interviews are considered as the most feasible as they provide benefits of both methods. When it comes to conducting qualitative research, semi-structured interviews have gained much popularity and are broadly being used as an authentic interview format which can be conducted with an individual and also with groups. In this regard, Oppenheim (1992) explained that it is quite possible that the interviewer gains different information from the initial respondents compared to participants who are interviewed later in the schedule. There are many advantages of semi-structured interviews; for example, based on the answers obtained, the researcher can take the liberty to change the questions during the interview.

In addition, Easterby-Smith et al. (2008) presented their viewpoint that the researcher can further explore inadequate or ambiguous answers whereas the restricted questionnaire or structured interview would not permit the researcher to accomplish this. Similarly, the interviewer is able to explore and examine the responses to build up a profound understanding due to the freedom provided in these interviews. This is also supported by Gray (2014), as he stated that semi-structured interviews enable the interviewer to construct trust with the participants, which will increase the research findings’ validity. Managers are more likely to participate in a semi-structured interview, particularly when the research subject is important and relevant to their job. Semi-structured interviews can be beneficial in determining specific questions to be asked in a questionnaire survey (Teddlie & Tashakkori, 2009). However, Yates (2004) and Yin (2014) indicated that the there are some disadvantages of semi-structured interviews such as they are time-consuming, and they are comparatively more expensive than other methods, especially in cases when the researcher is going to interview a large number of participants. However, despite these possible issues, semi-structured interviews are adopted in this research so that the respondents feel comfortable to express their personal experiences and own perceptions, thus supporting the study’s abductive nature.

4.9.1 Designing Semi-Structured Interview Questions

In this study, it is important to figure out the main factors/variables that influence community resilience to pluvial floods in the UAE. There are different dimensions of community resilience in the present research study, including physical, institutional, social and economic. Hence, the interview process was designed subjectively in advance to cater for these dimensions. As explained by Yin (2009), every interview participant was given an overview of the aim and objectives of the research. McNamara (2009) emphasised the significance of the interview preparation phase to keep a clear focus on how the interviews will be constructed and that helps to maximise the benefits of the proposed research. Thus, to prepare the interviews, the researcher performed the following steps: (a) appropriate candidates were chosen for interviews based on a non-probability sample technique for gathering data from participants with research-related knowledge and experience, (b) conducted a pilot test to determine if there are any defects or other limitations, and that will help to conduct the necessary review to improve the interview design and gather reliable data (See Table 4.10).

The internal reliability and validity of the data is based on question design and structure, and on an accurate pilot test (Saunders et al., 2009). Moreover, using pilot test data, preliminary analysis may be carried out to determine that collected data allows the researcher to investigate the research subject. According to Saunders et al. (2012), to help the researcher make the necessary changes and clarification to the questionnaire, a pilot study is important to obtain appropriate feedback and suggestions from participants. Thus, keeping these facts and information in mind, the following steps were employed to shape the research protocol:

- The first draft of questions would be formulated from the literature review with relevancy to flooding and community disaster resilience frameworks.
- As per the first pilot study, a meeting would be conducted with four PhD students in the related field of emergency and disaster management and two academics from the University of Salford, so that questions could be revised accordingly.
- The second pilot study would be conducted with four emergency managers from related organisations in Abu Dhabi city.
- Questions would be modified based on the feedback response of the two pilot studies.
- The final modified questions would be administered accordingly.

Table 4.10: The purpose of the semi-structured interviews questions.

No of Question	Questions	Aim
1	Based on your experience, what are the current measures used to mitigate and manage pluvial floods in the UAE?	To investigate the current measures that help to mitigate pluvial floods in the UAE.
2	How could you evaluate the current infrastructure in the UAE, especially the rainwater drainage system, to mitigate pluvial floods?	To explore and evaluate the current infrastructure state including the rainwater drainage system.
3	In your opinion, do you think the location of the built environment can help to reduce pluvial floods hazards? Please explain, and what are other important measures that may influence community resilience to pluvial floods in term of physical dimension?	To explore the role of location of the built environment factor to minimise pluvial flood hazards. Also, to investigate the other key factors in term of physical aspect to enhance community resilience to pluvial floods.
4	Does your organisation has an emergency plan and conduct emergency training exercises to deal with pluvial floods? Do you think that the preparedness level is sufficient? Please explain.	To investigate the effectiveness of emergency plan and training exercise being used by the government organisations to manage pluvial floods
5	How could you evaluate the level of coordination and cooperation between local authorities in the case of pluvial flood events?	To evaluate the level of coordination and cooperation between government organisations in the case of pluvial flood events
6	Do you think the current regulations and legislations are sufficient to manage pluvial floods? How do they influence community flood resilience? What other measures do you think are important to improve community resilience in terms of the institutional dimension?	To explore the sufficiency of the current regulations and legislations to manage pluvial floods. Also, to investigate the other key factors in term of institutional aspect to improve community resilience to pluvial floods.
7	How could you evaluate local citizens' awareness level about pluvial floods hazards? How could they be aware of actions taken in case of pluvial floods?	To evaluate the awareness level between local citizen about pluvial floods hazards. Also, to identify the measures needed improve flood awareness level.
8	Do you think religious beliefs or faith may influence community flood resilience? Please explain, and what are other measures you think are important to improve community flood resilience in terms of social dimension?	To explore the relationship between religious beliefs (faith) and community flood resilience. Also, to investigate the other key factors in term of social aspect to improve community resilience to pluvial floods.

9	How would you rate the income of local citizens in the UAE? How it influences community resilience to flood hazards? What other measures do you think are important to enhance community resilience to pluvial flood in terms of economic dimension?	To explore the income level of local citizens in the UAE and identify its influence on community resilience to flood hazard. Also, to investigate the other key factors in term of social aspect to improve community resilience to pluvial floods.
10	What are the main faced challenges for improving community resilience to pluvial floods?	To explore and identify the main challenges for improving community resilience to pluvial floods.
11	Based on the above questions, what are your recommendations and improvements needed to enhance community resilience to pluvial floods in the UAE?	To provide with any further information (measures) that could enhance community resilience to pluvial flood.

4.9.2 Interview Sampling

After choosing a suitable data collection method, the next stage is to identify the sample of participants. According to Kothari (2004), "the respondents selected should be as representative of the total population as possible in order to produce a miniature cross-section. The selected respondents constitute what is technically called a 'sample' and the selection process is called 'sampling technique'" (P. 55). The researcher uses sampling techniques to save time and money due to the need for fewer participants from whom to collect data (Saunders et al., 2015). When a researcher shows interest in a specific area of research, he should choose a sub-group from the population, which is referred to as a 'sample'. The selected sample should cover the full range of cases in a meaningful and justifiable manner (Kumar, 2014). Thus, local organisations which had historically responded to pluvial floods and natural disasters are selected and their participants included as sample participants for semi-structured interviews.

Probability sampling and non-probability sampling are the two main types of sampling technique (Saunders et al., 2012; Denscombe, 2014). When the purpose of a research study is to obtain an in-depth understanding of a phenomenon, qualitative and quantitative methods can be combined using mixed-methods sampling techniques. Probability sampling is usually used in quantitative studies due to large-scale number of units from a population and the probability of each member being included is known (Teddlie and Yu, 2007). In this sampling technique, every case in the population has an equal chance of being chosen as a subject for the research. The selection process is randomised and without bias. According to Elfil and Negida (2017), there are four types of probability sampling: random sampling, stratified sampling, cluster sampling and systematic sampling.

In a simple random sampling, all members of the population are equally likely to be selected in a sample (equal probability). Stratified sampling is used when there are potential issues with the ordinary random sampling, usually due to small samples in which the researcher divides the entire population into different sub-groups and strata, then chooses the final subjects randomly, in proportion to the different strata. In systematic sampling, researchers choose subjects to be included in the sample on the basis of a systematic rule with a fixed interval. Finally, cluster sampling can be used when making a sampling frame is difficult because of large population size. In this technique, the total population is divided into these clusters or groups, and a simple random sample is selected (Gravetter & Forzano, 2012; Elfil & Negida, 2017). In contrast, non-probability sampling includes a researcher's factor of flexibility or preference at some stage in the process of selecting, and it can be used when it is difficult for the researcher to use a random sample. It refers to a technique in which a few individuals from the population sample are selected (Wolcott, 2009; Denscombe, 2014). Non-probability sampling may be considered the best choice if a researcher needs to meet a research objective since it focuses on a small sample size. Non-probability sampling, as discussed by Saunders et al (2015), is based on four types: quotas, purposeful, volunteer and haphazard.

Quota sampling is considered to be non-random sampling, where it is usually used for structured interviews within a survey strategy. Within purposive sampling, researchers use their evaluation to identify cases that will enables them to achieve their research objectives. It is usually conducted with small samples, such as case study, and for researchers who wish to select particularly informative cases. Volunteer sampling is classified into two techniques: snowball sampling and self-selection sampling. For snowball sampling, the sample comes from one person to the next through a reference process. It is suitable when a study is sensitive or when it requires participants with specific experiences and knowledge. Self-selection sampling is performed when each individual (sample case) can identify his or her willingness to participate in the study (Saunders et al., 2012). Haphazard sampling takes place when selecting sample cases applied without any apparent organisational principles related to the research question.

In this research, the researcher needs to be able to collect suitable information by choosing small samples of individuals with the most probability of having the knowledge and experience to provide high-quality information and useful perspectives on the subject in order to address the research objectives. Therefore, **non-probability purposive sampling** is appropriate for this research, which offers the interviewees the opportunity to be selected based on their knowledge and experience. Accordingly, through using a purposive non-probability sampling method, a total of 12 semi-structured interviews were conducted with senior managers from five government organisations in Abu Dhabi city who have great knowledge of and experience in emergency management. Chapter 5 explains the respondents' profiles and the interview process in more detail. The following organisations were included in the current research study:

1) Abu Dhabi Police
2) Abu Dhabi Civil Defence
3) National Emergency Crisis and Disasters Management Authority (NCEMA)
4) Abu Dhabi Municipality
5) Abu Dhabi Distribution Company

The reason for selecting these organisations is evident from the fact that they are legally responsible for emergency management and enhancing resilience in the UAE's communities. Furthermore, the validity of the study is also increased by including senior-level personalities in the case study who could share important pieces of information from their experiences and personal viewpoints. Furthermore, in a bid to strengthen the information received from the participants, the researcher utilised triangulation to lessen the other issues that are linked with the interview process such as potential bias (Yin, 2014). To make this possible, evidence from interviews with other data sources such as questionnaire survey and focus group will be triangulated.

It has been noted that interview subjects are not fixed to a specific number. Gray (2014) stated that it very hard to decide what sample size is enough. In a case study, the sample size is often very small. Moreover, it is recommended to recruit participants until sufficient 'adequate' data is gathered from which reliable generalisations could be made, and that depends on the complexity of the study's subject (Yin, 2014). Generally, it is suggested that, for semi-structured interviews, the minimum size of the sample should be between 5 to 25 respondents (Saunders et al., 2016). However, as indicated by Creswell and Plano Clark (2011), a small number, between 4 to 10 respondents, is likely to be sufficient in case studies because it is considered to be a homogeneous population.

Furthermore, it is important to note that many factors influenced the choice of those participants, such as their availability, their experience in the relevant field of emergency management, and their legal responsibility in terms of performing their duties. Directors were invited to participate in this study through formal letters. After identifying all the participants, their readiness to contribute to the study was formed through an email including: (1) the participant information sheet; (2) the research consent form and (3) the interview questions (semi-structured interviews questions are presented in Appendix B). The researcher received a confirmation email/phone call from those who wanted to participate in the research and confirmed the exact place and time of the interview. All interviews were conducted in confidence and recorded with the permission of the participants, and each interview took around **45 minutes**. Moreover, to make sure that the respondents were able to freely express themselves, respondents' offices were chosen as the interview sites, after they confirmed their willingness to be interviewed and had agreed to take part in this research at a convenient time for them.

The interviews were conducted in Arabic and recorded, which were later transcribed also into Arabic, and inserted into a separate Word file document. During the next step, every file was renamed with participant codes. Interview transcription is time-consuming and complicated, as indicated by Halcomb and Davidson (2006), where every hour of recording requires about seven hours to be transcribed. However, the researcher attempted to minimise the time needed for data transcription by using a recording device, as indicated by Saunders et al. (2016). After that, the researcher translated the interview transcripts from Arabic to English. In terms of reducing issues related to translating interview transcripts into English, the researcher contacted an independent translator who works in a legal translation company in the UAE to conduct this process. Figure 4.5 explains the interview process conducted.

Figure 4.5: Interviews' process.

4.9.3 Qualitative Data Analysis

According to Brace (2008), the data analysis process allows the researcher to determine the research results through examining and analysing the data collected by using applicable methods. Creswell (2012) furthered that qualitative data analysis helps to gain deep understanding of the collected data. There are many tools that are used for analysing qualitative data and content analysis is one of them. Saunders et al. (2012) opined that content analysis is an analytical technique which is utilised to classify the coding of phrases, inferences and themes related to the area of research. Similarly, according to Krippendorff and Bock (2008), content analysis is used to identify the occurrence of specific words of themes within the content. By making a transcript for each interview, the content analysis technique can examine the qualitative data. It contains several approaches, such as word count and thematic processes. According to Easterby-Smith et al. (2015), patterns and themes can be identified by thematic analysis which helps to code and classify data for further analysis. Therefore, content analysis is used in this research for semi-structured interviews as there are many themes in this research, and they need to be qualified and assessed, thereby making it important to utilise a method which is able to classify the themes.

Many software programs are utilised for the analysis of qualitative data and among them is the NVivo software program. The NVivo software can help in managing, analysing and organising the qualitative data (Bazeley, 2008). It has plenty of advantages since it facilitates the examination and management of the qualitative data analysis through multiple data sources such as images, audios and videos. It also allows the researcher to make revisions in the text without impacting the coding process, and to examine and recode the coded data and perform instant code-related modifications. Furthermore, Bazeley (2008) explained that NVivo also provides instant access to both theoretical and conceptual knowledge. It presents a graphical model derived from the concepts of data and visualises the association among them. Therefore, all these advantages gave credence to using NVivo in the present research study so that the obtained results would be as objective as possible.

The researcher can choose and analyse the qualitative interviews through careful reading of the notes or transcripts, thereby extracting the words or themes which could be further utilised in the content analysis process (Saunders et al., 2009). Furthermore, to make sure that during the interview process no loss of useful information occurred, the researcher audio-recorded the interviews. Schostak (2006) argued that the process of documenting the interview discussion helps the investigator to remove the obtained information that is unimportant to the research process. Figure 4.6 illustrates the necessary steps needed to analyse data through a content analysis tool using NVivo software (Kulatunga et al., 2007).

Figure 4.6: The steps needed to analyse qualitative data through content analysis (Kulatunga et al., 2007).

As per the above discussion, the researcher selected a content analysis tool to analyse the data from the semi-structured interviews and followed a process in which written records were made from oral notes, and then the written records were classified and coded into the computer software program (NVivo version 11). The justification for the said process lies in the fact that the research study aims to explore the viewpoints and perceptions of the respondents in the context of the UAE's community resilience to pluvial floods. The themes identified within this qualitative analysis will be used to build a questionnaire survey, and the questionnaire results will be analysed quantitatively.

4.10 Stage Two: Questionnaires for Data Collection

The questionnaire technique is considered to be a multi-use instrument which includes many features of the research investigation, from the people's evaluation to the processes and training. It is able to provide both the quantitative and the qualitative data. It has been observed that the questionnaire technique is used to develop and formulate a framework that represents the attributes and attitudes of a large number of people (Saunders et al., 2009). In this study, a questionnaire was employed to examine and analyse key factors that influence the UAE's community resilience to pluvial floods based on the stakeholders' own perceptions and experiences. Thus, the questionnaire was designed based on the factors identified from stage one (semi-structured interviews).

Survey questionnaires are termed as a conventional way of conducting research, and according to Mathers et al. (2009), they are beneficial for non-experimental descriptive designs in which the researcher tends to explain the reality, and the same is true in the present research study. Questionnaire surveys have an upper edge over other forms of survey due to several reasons (Saunders et al., 2009). Based on Muijs (2010), questionnaires are considered very flexible, which allows researchers to analyse a variety of research questions and associations between different themes and factors. Moreover, they can help to collect data from a large sample with low cost and effort. However, a major limitation to the use of questionnaires is the difficulty in establishing a deep understanding of the study under investigation. Although questionnaire surveys have some disadvantages, the benefits still outweigh the disadvantages. Therefore, in this research, the questionnaire technique aims to examine and validate the main factors identified in the semi-structured interviews (the first phase of the data collection). Moreover, the questionnaire technique would help the researcher to make a generalisation regarding the identified factors, to ensure and confirm the semi-structured interview findings, and to gather more relevant data.

It is recommended by Marshall (2005) that the design of the questions in a survey should be short, to-the-point and focused in order to get a good and relevant questionnaire. It is also suggested that the questionnaire should be designed after reviewing the relevant literature (Saunders et al., 2009). There are two main objectives for designing a questionnaire (Leung, 2001): to make sure that a high return rate is achieved from the respondents; and to obtain precise answers relevant to the survey. To achieve these requirements, Bowling (2009) and Bryman (2012) argued that it is essential to concentrate on aspects such as keeping the questions and answers together, removing any ambiguous wording, giving a clear presentation, and making it simple. Thus, to examine the questionnaire for any limitations and to ensure it effectively works to gather the required data, a pilot study should be conducted.

Kothari (2004) argued that, during the pilot study, three main points should be addressed by the researcher: the general form, the question sequence, and the formulation and wording of the questions. The questionnaire was designed and piloted with the assistance of the supervisor and related emergency managers in order to ensure that it was easy to follow and understandable. Thus, a pilot study was carried out with **six emergency managers** to check the questionnaire's effectiveness as a data collection tool. A meeting was arranged for this purpose, to which some of the potential participants were invited. They were asked whether the questionnaire was clear and covered all the required areas. They had the opportunity to discuss any necessary modifications and add any possible improvements. In addition, participants were encouraged to write any comments on a hard copy of the questionnaire. Thus, the participants provided useful feedback after the discussions, and the questionnaire was changed accordingly. These changes include language modifications, improving the design and structure of questions to be clear and comprehensible, and rearranging and placing certain questions under related themes. Therefore, the purpose behind asking questionnaire questions is to measure the government officials' attitudes concerning the level of importance of the key factors identified in the semi-structured interviews, which helps to analyse and valid these factors that influence community resilience to pluvial floods in the UAE (See questionnaire design in Appendix C).

After the data collection method has been selected, a sample of respondents must be obtained. As indicated by Saunders et al. (2012), large samples of participants are needed for quantitative research as larger samples result in lower mistakes in generalising to the entire population. As mentioned before, probability sampling contains several types, including simple random, systematic stratified and cluster samples. Simple random sampling enables the researcher to choose an unbiased sample number. It is only used when the researcher has a specific sample number, which describes the entire population. Thus, this study seeks to use a simple random sample that allows the researcher to choose participants without bias (Saunders et al., 2016).

Because of the lack of time, money and other resources, it is very difficult to study the entire population (Burgess, 2001). In the exploratory sequential mixed-methods design, the sample size for the questionnaire survey will not usually be the same participants that answered the semi-structured questions at the qualitative level (first stage). This is because the findings based on a few participants at the first stage can be generalised and applied to larger samples of participants at the second quantitative stage (questionnaire survey) (Creswell & Plano Clark, 2011). Therefore, a **simple random sample** is a suitable technique for this research that enhances data collection in the second stage (quantitative data) of the exploratory sequential mixed-methods design.

To determine the sample size, this study used a finite population correction formula by (Cochran, 1997):

$$n = n_o / (1 + (n_o - 1) / N)$$

Thus, the researcher employed an assumed population size of 200 to calculate the finite population. Hence, to illustrate the formula (n_o), the sample for the population proportion should be formulated as follows:

$$no = z^2 pq/e^2$$

Where z is the selected critical value of desired confidence level. The confidence level indicates how confident you are that the entire population will choose a response within the range you specified. The most common confidence level used by researchers is 95%, so this study's confidence level is 95%, thus z = 1.96. Where the population is estimated and the researcher is unaware of the degree of variability, then the population proportion is p =0.5 and q is 1-p =0.5, where 'e' stands for margin of error, and it means that how much you're able to accept a difference between your sample mean and your population mean. It is determined to be ±5%, so e = 0.05

$n_o = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2$ $n_o = 3.8416 \times 0.25 / 0.0025 = 385$

N = is assumed population size (N = 200), and n is a new sample size.

$n = n_o / (1 + (n_o - 1) / N)$

$n = 385 / (1 + (385 – 1) / 200)$

$n = 385 / 2.92$

n = 132

There are many types of techniques regarding how a questionnaire could be designed, distributed and collected, which can be categorised into either self-completed or interviewer-completed. Respondents usually self-complete questionnaires such as electronic questionnaires using the internet, and some companies offer online questionnaire sites, such as Survey Monkey, or postal questionnaires or hand-delivered questionnaires can be utilised (Greener, 2008). While, the interviewer-completed questionnaire is recorded by the researcher by using telephone or face-to-face interviews. Figure 4.7 below illustrates the selection of questionnaires types (Saunders et al., 2016).

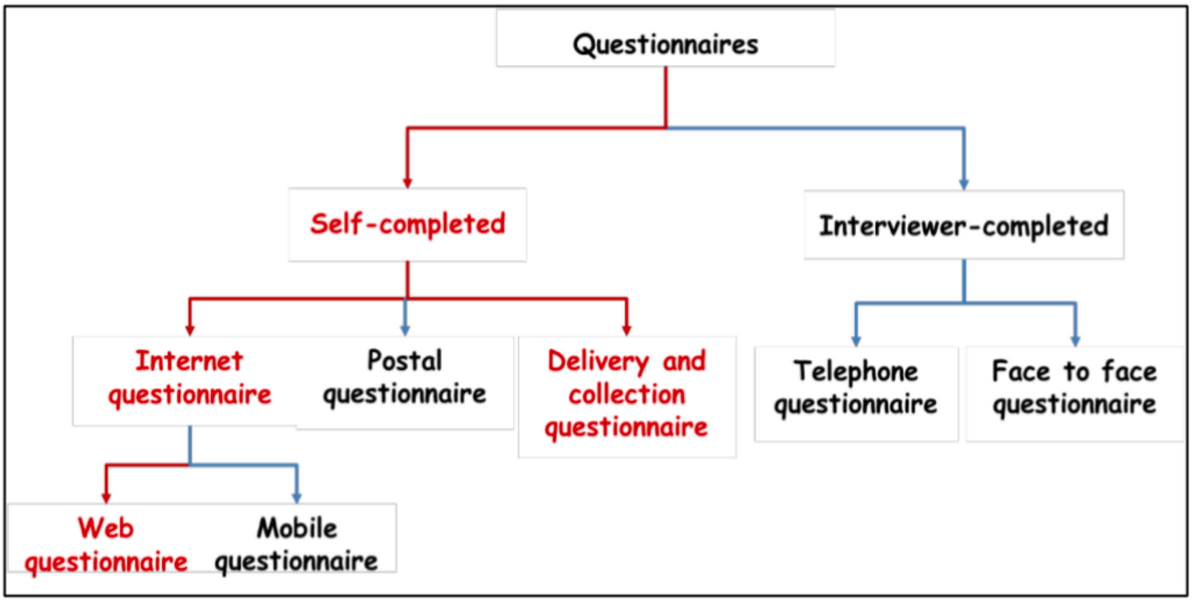

Figure 4.7: Questionnaire types (Saunders et al., 2016).

Accordingly, the respondents answered a self-completed questionnaire, which can be disseminated via the Internet as well as delivered and collected. Specifically, the use of a web questionnaire technique has many benefits such as its low cost, its ability to achieve a large sample size and its ability to be spread over a wide geographical area. Therefore, the self-administered questionnaire used in this research was administered by web questionnaire, as well as through delivery and collection techniques. The questionnaire was distributed randomly to employees from different management levels in five local organisations that are legally responsible for planning and responding to pluvial floods in Abu Dhabi, namely: Abu Dhabi Police, Abu Dhabi Civil Defence, Abu Dhabi Municipality, Abu Dhabi Distribution Company and NCEMA.

Moreover, to ensure the examination took place at the desired level, the researcher should estimate the response rate, which equates to the proportion of respondents in relation to the study population sample (Saunders et al., 2016). According to Baruch and Holtom (2008), after examining more than 490 studies including more than 100,000 organisations and 400,000 individuals between the years 2000 and 2005, the average response rate for individuals was 52.7%, while it was 35.7% for organisations. Although the total number in sample size was 132, a total of 125 questionnaires were retrieved from the selected participants over a period of two weeks. In this research, the response rate was **65.6%**, which represents **82** responses out of the **125** questionnaires.

Furthermore, as per Collis and Hussey (2014), closed-ended questions will be used in the questionnaire survey design in the present research study as they allow the respondents to choose from predetermined answers. Therefore, the researcher used a five-point Likert scale in a bid to gather the participants' opinions. The participants select their answers from many options to determine the importance of identified factors which range from "Not important" to "Slightly important", "Moderately important", "Important" and "Very important". The researcher will use this scale to gain an in-depth review to confirm and examine the main factors to assess community resilience to pluvial flood in the UAE.

4.10.1 Quantitative Data Analysis

In this research, one of the main objectives is to investigate and analyse the main factors that influence community resilience to pluvial flood in the UAE. The factors identified through semi-structured interviews within the first stage of data collection will be confirmed by using quantitative data analysis. The Statistical Package for Social Sciences (SPSS) software will be used to analyse the quantitative data collected. SPSS software is very useful to analyse quantitative data and for conducting research in different fields of psychiatry, psychology and sociology (Landau & Everett, 2004; Field, 2013).

In most researches, the quantitative data analysis includes three main phases: data preparation, descriptive statistics and inferential statistics. Data preparation included data checking or logging; data consistency checks; data entry onto the computer; data transforming and database structure documenting and development incorporating with the various measures. Measurement scales (data types) that can be used in most statistics are classified into four main types, nominal, ordinal, interval and ratio, where different relationships between allocated values are identified by each data type. Nominal and ordinal data are considered qualitative data while interval and ratio are quantitative data (Stevens, 1946). Data type (measurement scale) is known as a major part of data collection and interpretation. It is crucial also to note that each data type has specific data analysis tests that vary from other data types.

The parametric analyses can be made possible through the interval and ratio data, while nominal and ordinal analyses can be limited to non-parametric types (Naoum, 2012). According to Cooper and Schindler (2014), nominal data includes properties or names with two or more categories, and there is no intrinsic ordering of gender (male and female) and marital status (married/unmarried) categories. For an ordinal variable, it can be similar to a nominal variable, but the difference is that the data shows a clear order. This implies that the responses have a meaningful order but the numbers themselves are meaningless. For example, ordinary scales can be seen in questions requiring satisfaction ratings (very satisfied, satisfied, fair, unsatisfied, very unsatisfied) and agreement ratings (strongly agree, agree, fair, disagree, strongly disagree). Also, ordinal data can include all data rankings such as Likert scales and Bristol stool scale (Muijs, 2010).

In the same context, a common and constant unit of measurement is created between the categories in the interval data. Celsius temperature is the classic example of an interval scale as the difference is the same between values. At the same time, ratio data are similar to interval data, with a significant and non-arbitrary zero point. Examples of ratio measurement scales are weight, speed, height and area (Muijs, 2010; Cooper & Schindler, 2014). Therefore, for this research, the analysis of the data collected has confirmed its nature to be ordinal data.

In addition, when selecting a statistical test, it is important to consider whether the data is parametric or nonparametric. Garth (2008) also emphasised the importance of making assumptions about data types (parametric or nonparametric data). If a small sample is given, it has been suggested that it is practical to use non-parametric data analysis methods in order to prevent any assumptions. Moreover, ratings, classes or grades are commonly viewed as nonparametric data (Fellow and Liu, 2003). However, some researchers have claimed that large ordinal data is supposed to measure continuous variables and allow parametric testing (Orme & Buehler, 2001).

Parametric tests are built on the assumption related to underlying population distribution from which the research sample was selected. The most popular is that it was distributed normally. According to Pallant (2011), in parametric tests, the participants are randomly selected, and the data should be interval data. Because they are based on numeric data, parametric tests are often seen as more effective and powerful (Saunders et al., 2012). Nevertheless, Garth (2008) has suggested that it is safer for the researcher when analysing data to assume that the data is non-parametric in nature if it is not normally distributed. Using non-parametric testing provides a range of benefits such as: fewer data assumptions and it is potentially more applicable for specific cases when there is a small sample size. Therefore, since there were a total of 82 responses to the questionnaire survey and their ratings were evaluated based on a 5-point Likert scale (ordinal data), the data obtained was handled using non-parametric statistical tests. Descriptive analysis and inferential statistical methods were used to analyse the results of this study.

A. Descriptive Statistics

Descriptive statistics can briefly explain and summarise a specific set of data. This can be a description of a total population or a small sample. According to Fellow and Liu (2003), this method of analysis together with simple graphs is the core of almost every quantitative data analysis, and it explains what the data shows. It is divided into central tendency measures and variability measures. Central tendency measures involve many statistical tests such as the mean, mode and median, whereas the standard deviation and the minimum and maximum variables are measured by variability (Saunders et al., 2009). The mean is the value which represents the distribution in numerical forms and the median is the distribution mid-point or middle element of a data set. The mode is the most frequent value in a distribution (Fellow and Liu, 2003), while standard deviation is used to determine the extent to which the data is distributed around the mean for variability measures. It offers a more accurate and common dispersion measurement (Manikandan, 2011).

B. Inferential Statistics

Inferential statistics lead to conclusions that go beyond the immediate data, and to generalise results, which allows the researcher to reach reliable conclusions from the sample data. This technique is suitable for investigating questions, models and hypotheses (Field, 2013). The purpose of inferential statistical tests is to fill the gap identified in the literature and give a robust analysis of the results. They can help to identify the strength of a sample's relationship. In other words, by using inferential statistics, the impact of independent variables on results can be assessed. In this research, the following types of inferential testing are used to achieve objective three of this research: Spearman Correlation, Chi Square Statistics and Kruskal-Wallis Test.

1. Spearman's Correlation Coefficient

Correlation is a bivariate analysis measuring the relationship strength between two variables. Correlation coefficient value ranges from + 1 to -1. If the correlation coefficient value is exactly ± 1, then the two variables are said to have a perfect degree of association. The relationship between two variables becomes weaker as the correlation coefficient value gets closer to 0. A positive correlation indicates that if one variable increases the other variables also increase. In contrast, when one variable decreases within a negative coefficient the others increase (LeBlanc, 2004). In fact, there are usually three types of correlation in statistics: Pearson, Kendall and Spearman. Xu et al. (2010) clarified that the Spearman's ranking correlation (rho) is a non-parametric test used to measure certain attitudes and factors. Moreover, the difference between Pearson correlation and Spearman and Kendal correlations is that the Pearson is most suitable for interval measurements, while Spearman and Kendal are better suited to ordinal scale measurements (Altman, 1990). Therefore, the Spearman correlation will be used in this research.

2. Chi-Square Test

The chi-square test is used for the nominal or ordinal data types and it aims to examine and verify the possible relationships between two sets of data (Naoum, 2012). This test produces a two-way table and compares the observed counts with the expected cell counts. In other words, Moore and McCabe (2003) stated that "the chi-square statistic is a measure of how much the observed cell counts in a two-way table diverge from the expected cell counts". It comprises three kinds of analysis: homogeneity, goodness of fit and independence testing. The test can be used as both a goodness of fit test (comparing frequencies for a nominal variable to theoretical perceptions) as well as an independence test (comparing frequencies for different values of one nominal variable with a second nominal variable) (McDonald, 2009). The independence test is one of the most common types of chi square test. It is used to test the null hypothesis of no association (independent) between two classified variables when they are used for a population subject (Denscombe, 2007). In this research, a chi-square independence test will be used to check relationships between identified factors.

3. Kruskal-Wallis Test

The Kruskal-Wallis test is most frequently used when one nominal variable and one measuring variable exist, and the measuring variable does not reach normal assumption. It is known as a non-parametric test equivalent of a one-way ANOVA test. The technique uses three or more groups to compare a dependent variable measured at least at an ordinal scale (McKight & Najab, 2010). According to McDonald (2009), the Kruskal-Wallis test does not presume about normality, so that the data is not assumed within the Kruskal-Wallis test to be distributed normally. However, the observations in every group take place from populations with a similar distribution form, so the Kruskal-Wallis test may produce inaccurate results if different groups have various shapes (Fagerland and Sandvik, 2009). The KWt, sometimes called the Kruskal-Wallis H test, is often used when the data are categorical or ordinal (Likert scale/ranked scale) and considered non-normally distributed (non-parametric) (Meyer and Seaman, 2013). The KWt allows assessment of both the relationship and the differences between three or more groups of independent variables and one dependent variable (ordinal factor) (Pallant, 2011). To gain a better understanding about whether there was any significant relationship between the independent and dependent variables, it is assumed that the null hypothesis is rejected ($p < 0.05$), this indicates that there is statistically different between independent variables when ranking dependent variable.

4.11 Stage Three: The Analytic Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) is a useful tool in multi-criteria decision analysis (MCDA), particularly in hierarchical decision making. It is a systematic method used to arrange and analyse complicated decisions in according to psychology and mathematics. It was developed by Thomas Saaty in the 1970s (Saaty, 1990). This approach is commonly used by researchers and decision makers as well as organisations (Vaidya & Kumar, 2006; Viswanadhan, 2005), and can be utilised for the development of social and physical measures (Saaty & Vargas, 2001). It has the ability to structure and arrange dimensions and factors (criteria) into a more simple and clear hierarchical structure. Moreover, it enables different decision makers to contribute by quantitative means (pairwise comparisons) to clarify and classify the level of importance of each criterion. Although the AHP has several disadvantages such as unclear questions or different results based on the form of hierarchy structure, it is most widely applied as a systematic and comprehensive method for selecting the appropriate alternative under pressures of limited resources and time (Song & Kang, 2016).

In fact, the AHP has been used as an effective assessment tool to ensure coherence of judgement, simplify the ratings of preferences by using pairwise comparisons between decision-making criteria (Tahriri et al., 2008), and due to its ability to prioritise dimensions and criteria (Alidi, 1996, Vaidya & Kumar, 2006). It also offers a methodology for the calibration of the numerical scale for both qualitative and quantitative topics (Vaidya & Kumar, 2006). Since the AHP is used in a wide range of applications, some recent studies have concentrated on its application to improve its development through proper decision making across various fields: energy (Pohekar & Ramachandran, 2004), marketing (Wind & Saaty, 1980; Davies, 2001), medical and healthcare decision making (Liberatore & Nydick, 2008), and disaster management (Carreño et al., 2007; Alshehri, 2016; Almutairi, 2019). Nevertheless, the AHP suffers from a variety of disadvantages related to decision makers. For example, it has been argued that each decision maker must have the appropriate experience, knowledge and judgement to make the correct decision (Märkälä & Jumpponen, 2006).

In this research, the increasing risk of pluvial floods forces related stakeholders to seek to reduce the impact of these risks by developing an assessment framework through using a reliable method. To achieve the research objectives, an appropriate methodology is needed which could split the main dimensions into related criteria (factors) in order to develop an applicable framework to assess community resilience (Vaidya & Kumar, 2006). Thus, the AHP is used in this study due to the absence of a community flood resilience framework within the UAE context. This can be accomplished through its hierarchical structure and taking both types of required data (quantitative and qualitative data) into consideration (Vaidya and Kumar, 2006; Ishizaka & Labib, 2009). This would allow the researcher to identify the main applicable factors for community flood resilience in the UAE.

A focus group of **10 experts** was conducted to gather primary data, using expert government officials who participated in the questionnaire survey to prevent inconsistency (Lin et al., 2010). A focus group method is a roundtable forum that allows open discussion among a particular group on a specific subject conducted for research purposes, where the researcher records, guides and monitors the discussion. It is used to obtain information and meanings about the participants' shared views. It also helps to create a deep understanding of the participants' experiences and views of participants (Morgan, 1997). Similarly, Thomas et al. (1995, P.21) defined a focus group as "A method concerning the employment of in-depth group interviews within which participants are chosen as they are a purposive, even though not actually representative, sampling of a particular population, this faction being 'concentrated on a provided subject".

The selection of the experts for the panel is based on their knowledge and experience in the emergency management field in the UAE. In this case, the sampling method was non-probability purposive or judgmental sampling, where the researcher contacts participants who are experts and well known to the research topic (Crotty, 1998). The participants received a letter as invitation to attend the forum. This letter explained the forum's purpose and provided participants with the researcher's contact number for them to accept the invitation or ask about the process. One day before the forum, participants were called to confirm their attendance and a total of two sessions took place at the researcher's workplace during the afternoon. The participants could attend without disrupting their work schedule. Thus, the AHP process that includes the following steps is shown in Figure 4.8 (Tahriri et al., 2008; Lin et al., 2010):

- The creation of a hierarchy.
- Building pairwise comparisons to collect data and set priorities between factors in the hierarchical structure.
- Synthesising judgements (to get dimensions weights).
- Assessing and checking the judgements' consistency.

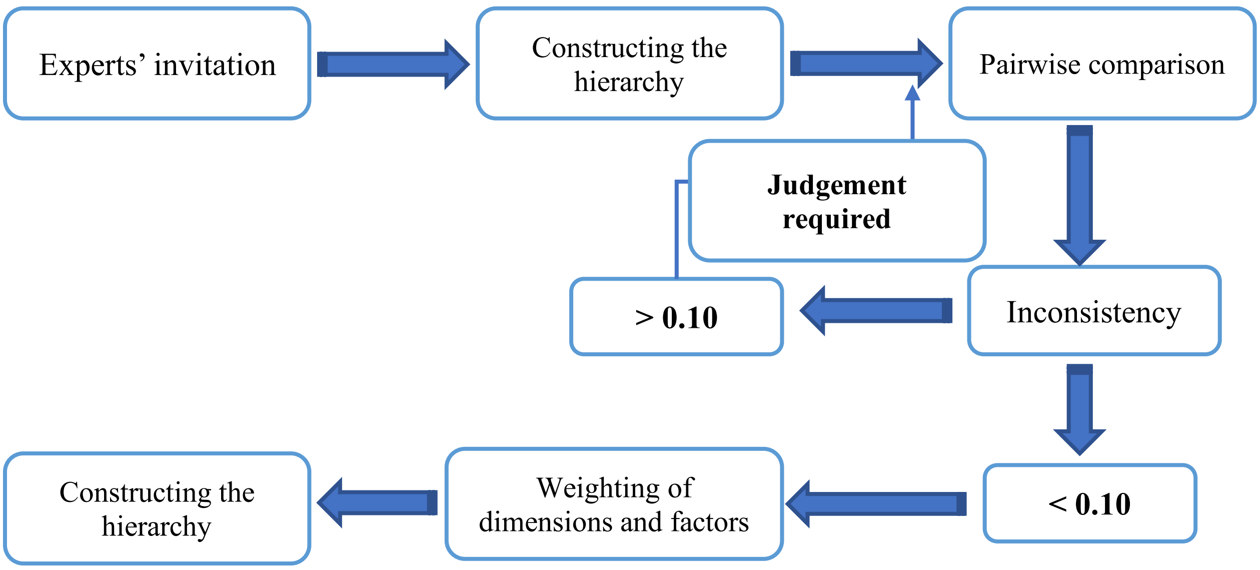

Figure 4.8: The AHP process to develop an assessment framework for this research.

4.11.1 Creating the Hierarchy

Creating the hierarchy can be performed by breaking the decision-making issue for the study into a hierarchy. This can be achieved by separating the research problem into three main sections: goal, dimension and criteria (factors) (Ishizaka and Labib, 2009). The main criteria (factors) in this research related to community flood resilience have been identified on semi-structured interviews (stage one of primary data collection) based on four main dimensions: physical, institutional, social and economic. Thus, in an AHP model, the main elements that described community flood resilience were placed on a hierarchy with three levels, where the top level defined a problem-related goal, which is community flood resilience. The second level consisted of four dimensions of resilience (physical, institutional, social and economic). Finally, there were 20 criteria (factors) in the third level related to community flood resilience dimensions.

4.11.2 Pairwise Comparison

According to Saaty (1990), after building the hierarchy, the second essential step in the AHP is to create pairwise comparisons between identified dimensions based on a comparison scale. It can present the level of importance among dimensions to reach the required purpose (Tahriri et al., 2008). To determine the importance level of four dimensions, the pairwise comparisons were completed by the expert panel. Saaty's 9-point scale listed in Table 4.10 is used to make the comparisons between the four dimensions based on a relative importance scale. A value of one would mean similar criteria, whereas a value of nine would imply an extremely important criterion. Thus, as shown in Table 4.11, a number scale is determined for the purpose of obtaining the degree to rate the importance of one criterion as compared with another criterion (Saaty, 2008). After understanding which dimension is more important and by how much, judgements will be made. Hence, the benefit of pairwise comparisons is to help decision makers to distinguish and express a preference ratio between one criterion and another. It important to note that the results of the semi-structured interviews formed the foundation for pairwise comparison values between dimensions.

Table 4.11: The fundamental scale of absolute numbers (Saaty, 2008).

Intensity of Importance	Definition	Explanation
1	Equal importance.	Two activities contribute equally to the objective.
2	Weak or slight.	
3	Moderate importance.	Experience and judgement slightly favour one activity over another.
4	Moderate plus.	
5	Strong importance.	Experience and judgement strongly favour one activity over another.
6	Strong plus.	
7	Very strong or demonstrated Importance.	An activity is favoured very strongly over another; its dominance demonstrated in practice.
8	Very, very strong.	
9	Extreme importance.	The evidence favouring one activity over another is of the highest possible order of affirmation.

Comparisons were made with each of the four main dimensions using a pairwise matrix, and three matrices were then prepared. Accordingly, as can be seen in Table 4.12, pairwise comparisons were made at the first level with the matrices used in this research to set the dimensions' weights related to community flood resilience in the UAE. However, Bahurmoz (2006) claimed that there should be limited number of alternatives to increase consistency of judgements. At the second level, pairwise comparisons were more time-consuming and complex as this study has 20 criteria that needed 190 comparisons. Pairwise comparison results are discussed more in Chapter 7.

Table 4.12: An example of pairwise comparison for this study.

9=Extreme 7=Very strong 5=Strong 3=Moderate **1=Equal** 3=Moderate 5=Strong 7=Very strong 9=Extreme																		
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Institutional
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Social
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Economic

The weighting values for community resilience dimensions are calculated by applying different mathematical formulae. Regarding the quality of the crucial decision, the consistency of experts' judgements during pairwise comparisons should be an important consideration (Saaty, 2008). Thus, through calculating the consistency ratio (CR), the AHP method can measure the consensuses of judgements revealed by the expert panel. Saaty (1999) indicated that there may be inconsistencies in expert decisions, where this may be known as inherent in the decision process, so inconsistencies of less than 0.10 (CR of < 0.10) are considered acceptable and the results are accurate and reliable. However, experts' judgements may be needed if the CR exceeds 0.10 (Andijani, 1998, Saaty, 1999). The next step in the AHP process is using Microsoft Excel to identify a percentage of each criterion (factor) that could help for better community resilience assessment.

Therefore, the researcher identified weights for each criterion by employing a calculation method. The results of the criteria (factors) means obtained from the questionnaire survey were combined with the results of the AHP as follows:

1. Through summing up all factor means collected from the questionnaires under each dimension, the researcher obtained the overall mean for each dimension by using equation 2.
2. Dividing the factor mean by the total mean of its related dimension, as shown in equation 3.
3. Multiplying the factor results obtained from equation 3 with the related dimension weight obtained from the AHP method, as illustrated in equation 4.

$$\bar{t} = \bar{m}_1 + \bar{m}_2 + \bar{m}_3 + \cdots + \bar{m}_n \quad (2)$$

$\bar{t}$ is the total factor means; $\bar{mi}$ is the factor means from the questionnaire survey.

$$p_i = \frac{\bar{m}_i}{\bar{t}} \quad (3)$$

pi is the proportion of factors in the same dimension.

$$wc_i = p_i \times wd \quad (4)$$

wd is the dimension's weight obtained from AHP; wc_i is the criteria (factor) weighting. After weighing all factors, each factor had to contribute to its dimension through a specified percentage through using equation 5:

$$tp = p_1 + p_2 + p_3 + \cdots + p_n \quad (5)$$

tp represents the total proportion of all factors related to a specific dimension. The new dimension weight was calculated for each dimension by using equation 6:

$$WD_i = wd \times tp \quad (6)$$

WD_i is the new dimension weight. Thus, the total new assessment of the community resilience to pluvial floods framework (CRPF) is determined by equation 7:

$$\text{CRFP} = WD_1 + WD_2 + WD_3 + WD_4 \quad (7)$$

The purpose of using AHP is to ensure that the Community Resilience to Pluvial Floods (CRPF) framework is completed through individual (weighted) results for its four dimensions and key factors to be utilised as a resilience measure within the context of the UAE. Hence, the proposed framework of this study for assessing community resilience to pluvial floods includes analysing the situation of four main resilience dimensions, which are physical, institutional, social and economic.

4.12 Stage Four: Framework Validation

Rykiel (1996) claimed that the validation process is critical in affirming that any guideline or proposed framework is sufficiently appropriate for its planned use. Another focus group with seven senior managers was conducted in order to validate the proposed framework. The aim of using a focus group as a framework validation technique is to ensure the application of the implementation. This includes assessing the quality factors of simplicity, completeness, flexibility, understanding of ability, acceptance, usefulness and implementation ability. The quality factors used in this research study are adapted from the ones defined by Moody and Shanks (2003) and Moody (2003). Chapter 7 illustrates the validation process of the developed framework.

4.13 Research Reliability, Validity and Generalisability

Checking the research validity and reliability is a key step to ensure that the data obtained and generated is of a high quality. According to Saunders et al. (2009), reducing the probability of incorrect answers emphasises the importance of reliability and validity in research design. Morse et al. (2002) argued that there are a number of verification strategies which are able to achieve reliability and validity in conducted research, despite the differences in reliability and validity processes of qualitative and quantitative methods.

4.13.1 Research Reliability

Reliability relates to the extent to which data collection and analysis methods can create reliable results. It represents the “extent that independent but comparable measures of the same trait or construct of a given object agree” (Churchill, 1979, p.65). In qualitative semi-structured interviews, a consistent and comprehensive approach to research design should be used by researchers to ensure reliability and consistency (Saunders et al., 2016). Thus, the reliability in this research is achieved by conducting analysis of the collected data, and explaining the research strategy process. In addition, reliability is also accomplished by using a questionnaires survey approach to reduces bias in the data collected from semi-structured interviews. Saunders et al. (2016) mentioned that different types of semi-structured questions must be formulated by using open, testing questions which improve the study topic by allowing participants to offer more comprehensive answers. Therefore, in this research, the researcher used multi-format questions in semi-structured interviews (probing and open questions) to encourage more explanatory replies from participants with regard to community flood resilience.

The reliability for the questionnaire survey was achieved using Cronbach's alpha. It is the most common method used to measure the consistency and reliability of quantitative data by identifying the alpha value, which is between 0 (no reliability) and 1 (perfect reliability), and a higher alpha value suggests a greater reliability level (Pallant, 2011; Gray, 2014). In particular, according to George and Mallery (2007), the value of Cronbach's alpha equal to 0.9 indicates outstanding reliability; 0.8 and higher means good reliability; while the value of 0.7 and higher reveals acceptable reliability. Thus, in this research, as Cronbach's alpha values were found to be greater than **0.9**, this suggests an excellent internal reliability and consistency in all questionnaire items. For the AHP method, the reliability of the results was addressed though calculating the Consistency Ratio (CR), which is equal to the Consistency Index (CI) value divided by the Random Consistency Index (RI). In this study, the Consistency Ratio value (CR) is equal to (0.0295/0.90) = **0.0266**, which is less than 0.1, and it means that the matrix is reasonably consistent and valid (Salmeron & Herrero, 2005; Cutter et al., 2014).

4.13.2 Research Validity

Validity is the true estimation of assumptions, conclusions or inferences about the collected data. It is related to whether the research findings are actually about what they appear to be about. Collis and Hussey (2009, P.64) identified research validity as "the extent to which the research findings accurately reflect the phenomena under study". Validity covers three main aspects: external validity, internal validity and construct validity (Yin, 2014). Saunders et al. (2016) suggested that the internal validity can be measured in two ways: through a literature review and by using an independent expert panel. In contrast, external validity involves generalisation of research findings, so that a researcher should carefully select an appropriate sample size to gather the required data. Therefore, this research will use a random sample to gather data from participants who represent the study population appropriately, in order to achieve a high external validity.

In a case study, construct validity uses a number of evidence sources to create a chain of evidence (Yin, 2014). Triangulation, as stated by Robson (2011), is the method to counteract all the challenges to validity in the research design such as including mixed-methods research. In addition to the data collection process, Yin (2014) affirmed that during the study triangulation requires the use of several sources of evidence. A mixture of qualitative and quantitative techniques can be described as triangulation, which aims to efficiently leverage each technique's strengths and overcome weaknesses. In this research, after an analysis of the existing literature (such as previous studies, academic papers and books), data collection methods were selected. Three different data collection stages were utilised to develop the assessment framework: semi-structured interviews, questionnaire and the AHP. These techniques were carried out with managers and employees to ensure that the most appropriate and accurate data was collected for this study, thus improving research construct validity. Moreover, based on the definition of construct validity, establishing a suitable research methodology is also a way of finding research construct validity (Yin, 2014).

4.13.3 Research Generalisability

According to Yin (2014), generalisability is associated with transferability, and it underlines the importance of external validity, which is associated with the fact that the findings or outcomes of a case study can easily be implemented in another case study scenario. However, Firestone (1993) indicated that generalising case study findings to another case context may be difficult. It is significant in any research, where the findings of a case study are limited to specific environments or populations, making it difficult to be applicable to other situations or populations (Silverman, 2013). However, the researcher should contextualise the comparison of environments, case study locations and the data with the other environments to ensure that they achieve a high level of transferability and generalisability (Collis & Hussey, 2009; Yin, 2014).

In this research, the researcher ensured that the selection of Abu Dhabi city as the case study was because it has many common features and criteria found in similar regions and communities which are exposed to pluvial floods. Thus, transferability of the research findings is possible in the context of this case study, which has similar features related to being affected by impacts of pluvial floods. Moreover, participants engaged in the semi-structured interviews and framework validation stages are senior managers from government stakeholders who have rich experience in emergency management and responsibilities to protect communities during severe incidents caused by pluvial floods. This makes it possible to engage similar respondents for future research related to this topic.

Therefore, the researcher strictly followed the above-listed points so that the research study ensured transferability. It could be argued that triangulation of data is critically important in this research since interview reliability could be subject to bias (Saunders et al., 2009). Hence, the triangulation would ensure that all biases are minimised, whereas the generalisability, validity and reliability are increased. Table 4.13 below shows the suitable research strategies and data collection techniques applied to achieve the research objectives.

Table 4.13: Relationship between research objectives and method of investigation.

Research Objectives	**Method of Investigation**			
	Literature Review	Semi-structured Interviews	Questionnaires	Focus Group
To critically review relative literature on flooding and the concept of community resilience.	**X**			
To examine the current measures to manage pluvial flood in developed countries and in the UAE.	**X**	**X**		
To investigate and analyse key factors that influence community resilience to pluvial flood in the UAE through using sequential mixed methods approach.		**X**	**X**	
To develop and validate the proposed framework with related stakeholders in the UAE for assessing community resilience to pluvial flood.		**X**	**X**	**X**

4.14 Ethical Consideration

In the context of research, ethics reflect the researcher's behavioural appropriateness in relation to the rights of those participants who form a part of the research study. Saunders et al. (2009) stated that the behavioural ideology which guides the authentic and truthful choices about relationships and behaviour with others is called ethics. Kimmel (2007) argued that for any research, 'ethics' is a significant aspect that provides guidelines and principles to reduce the risk for the participants as well as the researcher. In this context, the university's policy requires researchers to apply for ethical approval before they start investigating and exploring the field of study. In this research, the researcher took care of all the ethical considerations. The participants were engaged in complete compliance with the ethical requirements of the university for PhD research. All the research participants were given an introduction to the research area before their engagement, and they were informed about the issue of voluntary participation. The researcher used his existing network in the UAE to recruit the participants. To make this possible, he emailed them and conducted phone calls with them. Once they had given their consent to participate, he fixed a date for the semi-structured interview session with that particular participant in the comfort of the participant's office location. The researcher also followed the same process for recruiting all the potential participants for the questionnaire survey in this research study.

Apart from the recruitment processes, the participants were provided with an introduction to the voluntary participation and withdrawal, privacy policy, and the ethical guidelines used in this research study. Based on the University of Salford's ethics guidelines, the participants in this research have the right to withdraw without any risk or fear of persecution. The researcher has taken the participants' privacy seriously in order to prevent any risk or harm to them. To do this, the participant's name should not include in the cover letter of the questionnaire as well as in the semi-structured interviews. Moreover, the research subject was the only topic discussed with the participants throughout the questionnaire and interviews. Thus, it is essential to avoid personal questions in interviews and questionnaires that make participants feel uncomfortable, or that could be risky to them. Therefore, the researcher has got the ethical approval form to collect data from the field study (see Appendix A).

4.15 Chapter Summary

This chapter describes the methods and procedures adopted by this research to achieve the research objectives. These methods were used to collect and analyse qualitative and quantitative data, including validity, reliability, generalisability of research findings and ethical considerations. The research adopted the use of a sequential mixed-methods approach as the methodological choice with its justifications on this basis. To develop an assessment framework, the research structure's design was illustrated, which involved four stages to gather primary data. The first stage included semi-structured interviews to investigate and identify key factors that help assess community resilience to pluvial floods. The second stage explained the questionnaire survey utilised to examine and further validate the factors identified from the first stage. The third stage clarified the AHP and its use to prioritise and determine the importance of the assessment factors by weighting assignment. This was achieved by applying a focus group technique with an expert panel to develop the assessment framework. The final stage concludes with framework validation by conducting a focus group to evaluate the proposed framework's adequacy and application. The second focus group was carried out with six senior managers from related government organisations with rich knowledge and experience in the emergency management field in the UAE. The next chapter explains the qualitative data analysis related to the semi-structured interviews (stage one of primary data).

CHAPTER 5: QUALITATIVE DATA ANALYSIS

5.1 Introduction

This chapter describes the findings from the primary data (qualitative data) obtained through semi-structured interviews focusing on a single case study in Abu Dhabi city. This is carried out in line with the research methodology selected and justified in Chapter 4. Sections in this chapter describe and analyse the results of the qualitative data to ensure that one of the study objectives (objective three) is accomplished. The first part of this chapter presents the case study's features, including the geography, demography and pluvial floods in Abu Dhabi City. The second section describes primary data for this research by conducting semi-structured interviews with senior managers with sufficient knowledge and experience in emergency and crisis management from relevant local authorities. Interviews were carried out to obtain an in-depth understanding of the practitioners' knowledge and their perception of community resilience to flooding. The purpose of the interviews is to investigate and analyse the main factors that help to build a community in the UAE that is more resilient to pluvial floods. The final section in this chapter summarises the results and sets the context for the following chapter. (Some findings in this chapter has been published in the conference paper (Alnuaimi & Aziz, 2019)).

5.2 Case Study: Abu Dhabi City

Abu Dhabi is the largest emirate and the United Arab Emirates federal capital; it covers 84% of the national territory. It has more than 200 islands, a 700 km long coastline, and the entire emirate area is 67,340 square metres. Today, due to its status as capital, the city is considered as the centre of the nation's political and industrial activities and the major cultural and commercial hub. Moreover, Abu Dhabi is facing rapid urbanisation and development, coupled with large oil and gas reserves and production. In 2013, the city’s economy constituted approximately two-thirds of the United Arab Emirates' economy, equal to $400 billion (ADUPC, 2007; Gulf Business, 2013).

5.2.1 Geography and Demography

Abu Dhabi city is located on the Arabian Gulf coast, and it is the capital city of the UAE. It is bordered to the east by Oman, to the north by the emirate of Dubai, and to the south by Saudi Arabia. The are many districts in Abu Dhabi city such as Al Shahama, Bani Yas, Khalifa city, Al Falah and Al Bahia (ADUPC, 2007). The common climate in Abu Dhabi city is hot and desert climate with high temperature and humanity levels (temperature in summer is usually more than 40oC). The city is experiencing rare rainfall events, and the annual average of rainwater is less than 120mm. The main landscape features of the emirate of Abu Dhabi is extensive salt-flats in the coastal areas and Low-lying sandy deserts (Shahid & Abdelfattah, 2008).

Abdelsalam and Gad (2009) reported a major expansion in the building sector of the Arab Gulf Cooperation Council (GCC) countries, with over $800 billions of active projects in the Gulf. The emirate of Abu Dhabi is focused on restructuring and expansion, as outlined in the Abu Dhabi 2030 Urban Structure Framework Plan, where many large construction projects in Abu Dhabi and beyond are already underway. The development of the new Central Business District (CBD) on Al Suwwah Island by extending to the boundaries of Al Mina, Abu Dhabi Island and Al Reem is one main project in Abu Dhabi city (ADUPC, 2007). However, rapid urbanisation has many disadvantages that lead to natural hazards through causing several environmental issues and contributing to climate change impacts. In particular, as indicated by Suriya and Mudgal (2012), an increase in the built environment area leads to an increase in runoff rates, flood frequency and peak discharge. Figure 5.1 illustrates the expected residential density in Abu Dhabi city based on the Abu Dhabi 2030 Urban Planning Council (ADUPC, 2007).

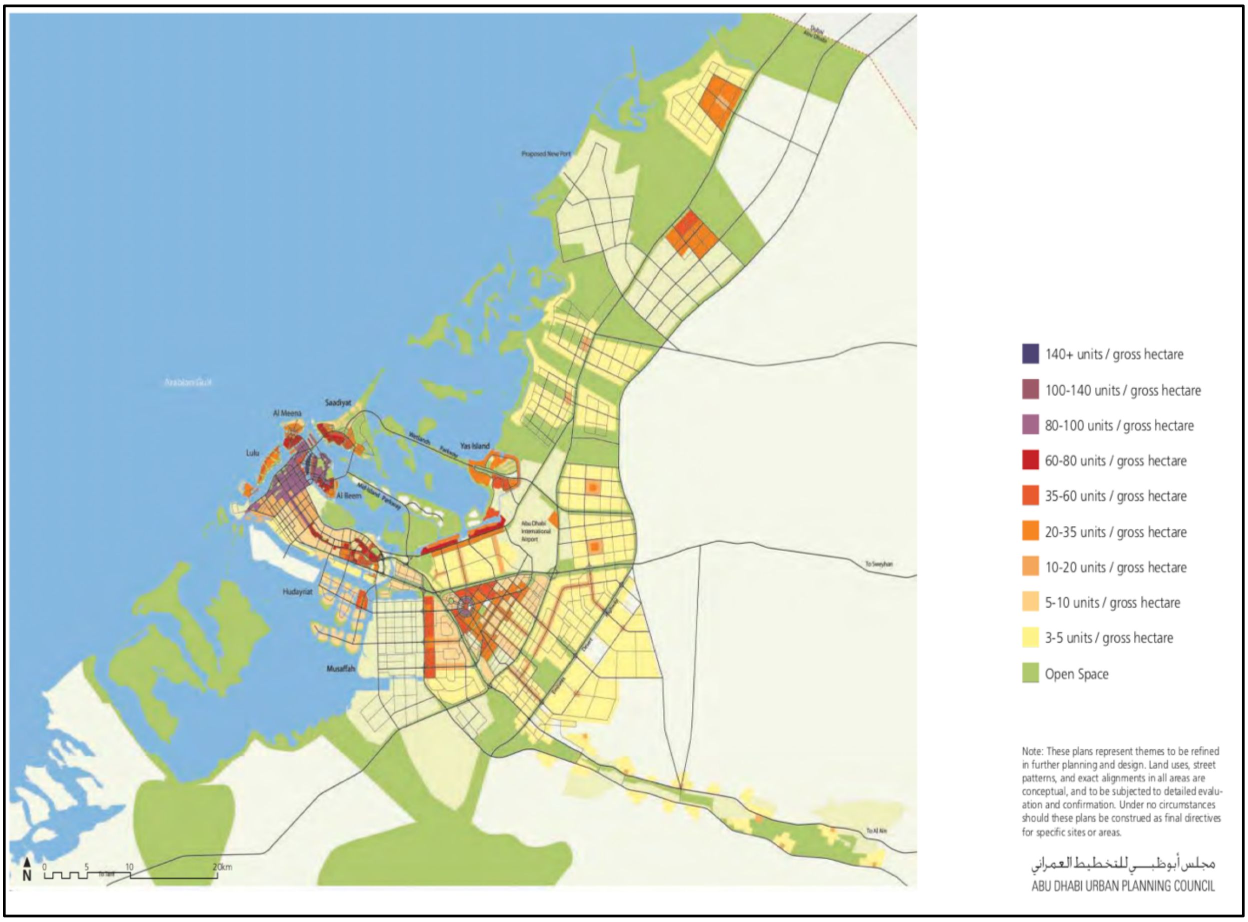

Figure 5.1: Expected residential density in Abu Dhabi city in 2030.

Although it is difficult to determine the exact number of people in Abu Dhabi since almost 80% of the total population are not citizens, statistics show that the total resident and non-resident population was 2.908 million people in 2016. Abu Dhabi has a demographic structure similar to other areas globally, where a large proportion of the population lives in urban areas. Moreover, within Abu Dhabi Emirate, there are more males than females, as the numbers show that there were 1,858,000 males and 1,051,000 females in 2016, as shown in Table 5.1. The city experienced one of the fastest growth rates, of 5.6%, between 2010 and 2016, with an influx of migrants, especially from Asian countries such as India, Pakistan and the Philippines (TAMM, 2019). The gross domestic product (GDP) of Abu Dhabi increased by 14.4% to AED 931 billion in 2018 compared to AED 814 billion in 2017 (SCAD, 2018).

The high living standards in Abu Dhabi are attracting more foreign immigrants as its main economic factors. Social structures are also main factors for long-term stay for immigrants. Immigrants have a legal right to minimum wages in Abu Dhabi, allowing them to support their families living in the UAE (Suter, 2006). However, as it is the UAE's capital city and the centre of national and regional trade, socio-cultural, industry and political activities, a large number of people from different nationalities and backgrounds are living and working in the city, which poses a slight challenge for enhancing community resilience to flood risk in the UAE. The table below displays population estimates by region and gender in mid-2010 and mid-2016 in thousand persons (Statistics Centre Abu Dhabi (SCAD), 2018).

Table 5.1: Abu Dhabi population in 2010 and 2016 in thousand persons.

Region	Males	Females	Total
Abu Dhabi Emirate			
2010	1,461	633.7	2,095
2016	1,858	1,051	2,908
Abu Dhabi Region			
2010	871.5	394.6	1,266
2016	1,122	685.3	1,807
Al Ain Region			
2010	376.8	209.2	585.9
2016	451.8	315.2	766.9
Al Gharbia Region			
2010	212.5	30.0	242.4
2016	283.9	50.1	334.0

Furthermore, the city has been vulnerable to several natural hazards such as storms that resulted in injures and damage to properties (Dhanhani et al., 2010). Therefore, in coastal areas, most of the population is vulnerable to artificial threats and several natural hazards (Ministry of Energy, 2006).

5.2.2 Pluvial Floods in Abu Dhabi

Abu Dhabi city has previously experienced frequent pluvial floods. However, although natural hazards occur in the region and have been studied, there is limited literature related to flood events. One of the most severe storms hit the city in March 2016, with a wind speed of 126 km/h, and the amount of rain recorded was more than 30 cm for five continuous days. The previous highest accumulative precipitation was around 21.4 cm in March 1982 (Ahmad & Pennington, 2016). During that time, heavy rains and winds hit the city, and schools were closed as the storm resulted in cars floating in streets and rainwater entering into buildings. Due to the high rainwater level and lack of an appropriate drainage system that allows rainwater to drain from urban areas, houses and buildings were flooded (Webster, 2016; Perring, 2016). Documented reports indicated that the rainwater level was very high as many roads were affected, and abnormal traffic delays occurred. The frequency of pluvial flooding has increased as a result of extreme precipitation events, creating the risk of inundation for the city and region.

Due to a lack of preparedness for emergencies and lack of historical rainfall data, flood events caused injuries and damage to urban areas, facilities and hundreds of vehicles. This made it difficult for ambulances and rescue teams who had to conduct rescue operations and lifesaving missions. At that time, the municipality of Abu Dhabi received reports of property damage and floods. During the 24-hour period, municipal workers deployed 117 tankers and many pumps and generators to remove over 95% of floodwater from local communities (Webster, 2016). Moreover, the authorities suspended all flights at Abu Dhabi Airport for safety reasons (Alarabiya, 2016).

Figure 5.2: The operations room in Abu Dhabi Municipality during the 2016 storm.

During the 2016 storm, 860 calls were received within three days by Abu Dhabi Municipality and related government bodies in many parts of the city. The calls mainly related to the accumulation of rainwater or damage, and the readiness of a team of engineers, technicians and staff to deal with this emergency was increased (Abu Dhabi Municipality, 2016). However, there is evidence of inefficient flood mitigation measures with ineffective and inappropriate preparation levels to deal with this storm. Figures 5.3 and 5.4 show the critical floodwater points in Abu Dhabi city in March 2016.

Figure 5.3: The critical floodwater points in Abu Dhabi city during the 2016 storm.

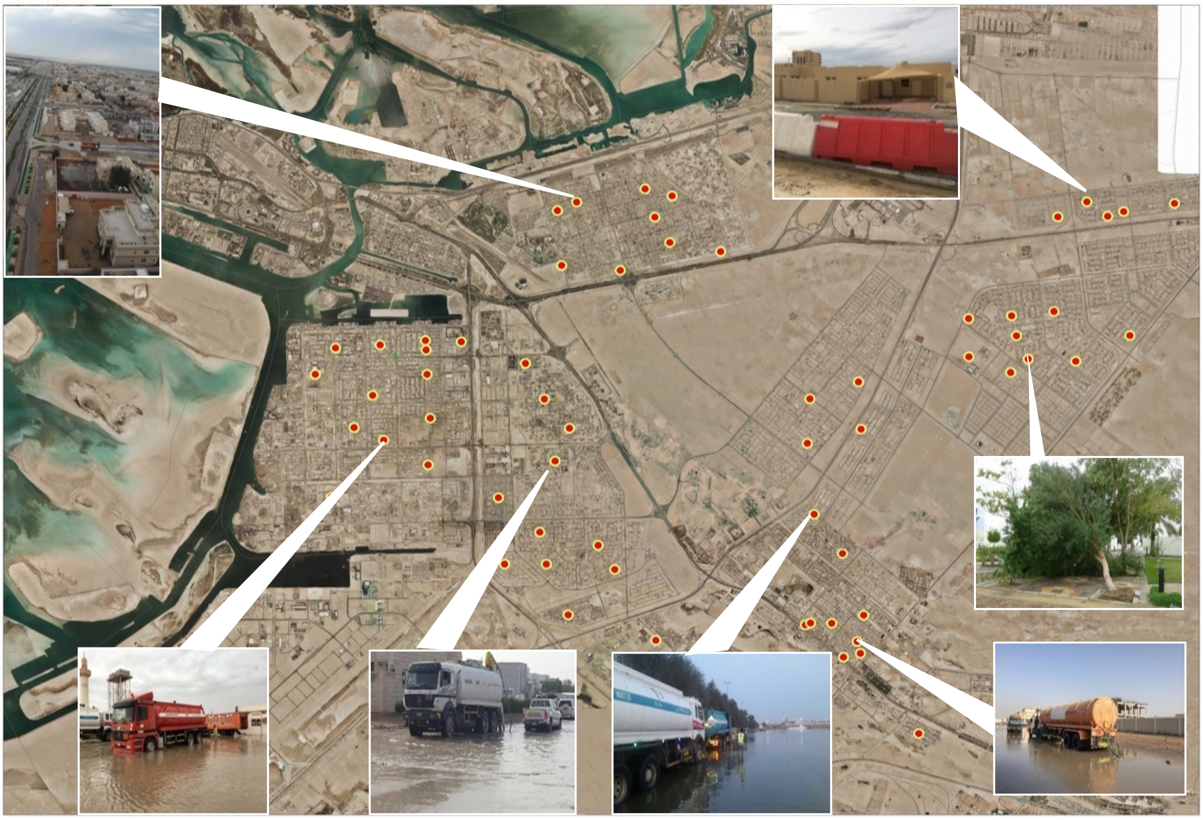

Figure 5.4: The critical floodwater points in Abu Dhabi city during the 2016 storm.

It can be seen from Figures 5.3 and 5.4 that there were many critical points as a result of heavy rain in Abu Dhabi city as a result of the 2016 storm which caused negative impacts on infrastructure, properties, people and the economy in general (Abu Dhabi Municipality, 2016). Water pools accumulated over the city and strong winds swept away trees, bent street signs and destroyed billboards. Strong winds and heavy rains caused streets to be flooded in areas around the city, such as Baniyas, Khalifa City, Tawelah and Samha. Several families with damaged homes in Baniyas were placed in hotels by the Municipality of Abu Dhabi (Ahmad & Pennington, 2016). The characteristics also showed that the floods had direct and indirect consequences that made economic activity difficult and almost impossible in certain areas, and ambulances and emergency services had some communication problems. These effects highlighted the need for appropriate preparedness to reduce or prevent flood consequences and improve community resilience. Figure 5.5 shows a complete map of Abu Dhabi city that clarifies all critical floodwater points locations, as shown in figures 5.3 and 5.4.

Figure 5.5: The map of Abu Dhabi city

5.3 Qualitative Data Analysis

As explained in Chapter 4 in the research methodology, the data collection method used in this research is a sequential mixed-methods design that contains different techniques. One of these techniques is a semi-structured interview to investigate and identify the main factors for assessing community flood resilience in the UAE. The interviews were prepared by following three main steps. Firstly, using non-probability purposive sampling, the researcher selected participants with appropriate knowledge and experience related to the research topic. Secondly, the researcher applied a pilot test which helps to define if there were any limitations or weaknesses within the design of the interview questions. The third step is that the researcher could make the necessary revisions before collecting data. Thus, 12 semi-structured interviews were conducted with senior managers from related government organisations in Abu Dhabi city who have rich knowledge and experience in emergency management. As shown in Table 5.2, each interviewee has been given the code ‘R’ and a numeric serial number.

Table 5.2: Profile of the case study interviewees.

Organisation	Department	Years of Experience	Code
Abu Dhabi Police	Emergency and Public Safety Directorate	15	**R01**
Abu Dhabi Police	Operations Department	19	**R02**
Abu Dhabi Police	Engineering Projects Department	17	**R03**
Abu Dhabi Municipality	Emergency and Crisis Department	16	**R04**
Abu Dhabi Municipality	Roads and Infrastructure Department	18	**R05**
Abu Dhabi Municipality	Environment, Health and Safety Department	25	**R06**
Abu Dhabi Distribution Company	Operation Department	17	**R07**
Abu Dhabi Distribution Company	Emergency Department	20	**R08**
Abu Dhabi Civil Defence	Operations Department	16	**R09**
Abu Dhabi Civil Defence	Public Safety and Emergency Department	19	**R10**
National Crisis & Emergency Management Authority (NCEMA)	Operations Department	23	**R11**
National Crisis & Emergency Management Authority (NCEMA)	Planning Department	18	**R12**

The interviewees' profile is important in order to make associations between their roles and responsibilities and the study area. The responsibilities and positions of the participants and their years of experience have given a valuable range of views which have contributed positively to the findings in this chapter. The verification of their competence and knowledge to provide relevant answers to the research topics. In particular through bringing valued information about the research gaps recognised in the literature review which helps to achieve the research objectives. Thus, semi-structured interviews were limited to 12 participants because the data collected appeared in the first 11 interviews in this case study, and after 12 interviews the data became saturated.

5.4 Interview Findings and Analysis

One of the main objectives of this study is to investigate and analyse key factors that allow for the effectiveness of community resilience to the pluvial flood hazard. In this research, the conceptual framework has been developed from a literature with different variables that help to enhance community resilience to pluvial flood as described in Chapters 2 and 3. In other words, based on the literature review, the interview protocol and schedule were developed, and they were focused on the main critical themes used in measuring community resilience to pluvial flood in the UAE. In reaction to this, the interview questions were constructed under four main themes, which are: **physical, institutional, social and economic** dimensions of resilience, with multiple variables under these main themes to assess community resilience to pluvial flood in the UAE. Most of the interview questions were open-ended in order to give participants enough time and opportunity to respond based on their knowledge and experiences. The average interview time was approximately **45** minutes. Participants were able to ask questions if they felt a further explanation was needed. It is important that the interviewer balances directed and free-flowing conversation during the interview process (Lee, 1999). The interviews were fully transcribed, and the interviewees were allowed to verify the accuracy of the transcripts to ensure the validity and reliability of the research data.

After extensively reading the interview scripts, the researcher analysed the main answers with regard to the factors that help to build resilient community to pluvial floods. Through using content analysis, the interview content was presented as a text which was divided into segments of information in order to obtain a general sense of the materials (Creswell, 2012). According to Easterby-Smith et al. (2015), content analysis is a technique carried out by the researcher to examine qualitative data for ideas and constructs that are initially selected. It is one of the methods used for analysing qualitative data through converting text systematically into numerical factors (Collis & Hussey, 2014). Krippendorff and Bock (2008) indicated that content analysis could involve word count or conceptual thematic analysis. However, the word could be a particular topic that cannot accurately reflect the significance of the subject under discussion. Thus, the text segments were then assigned codes, and finally the codes were reduced into themes. The transcribing and coding processes are illustrated in Figure 5.6.

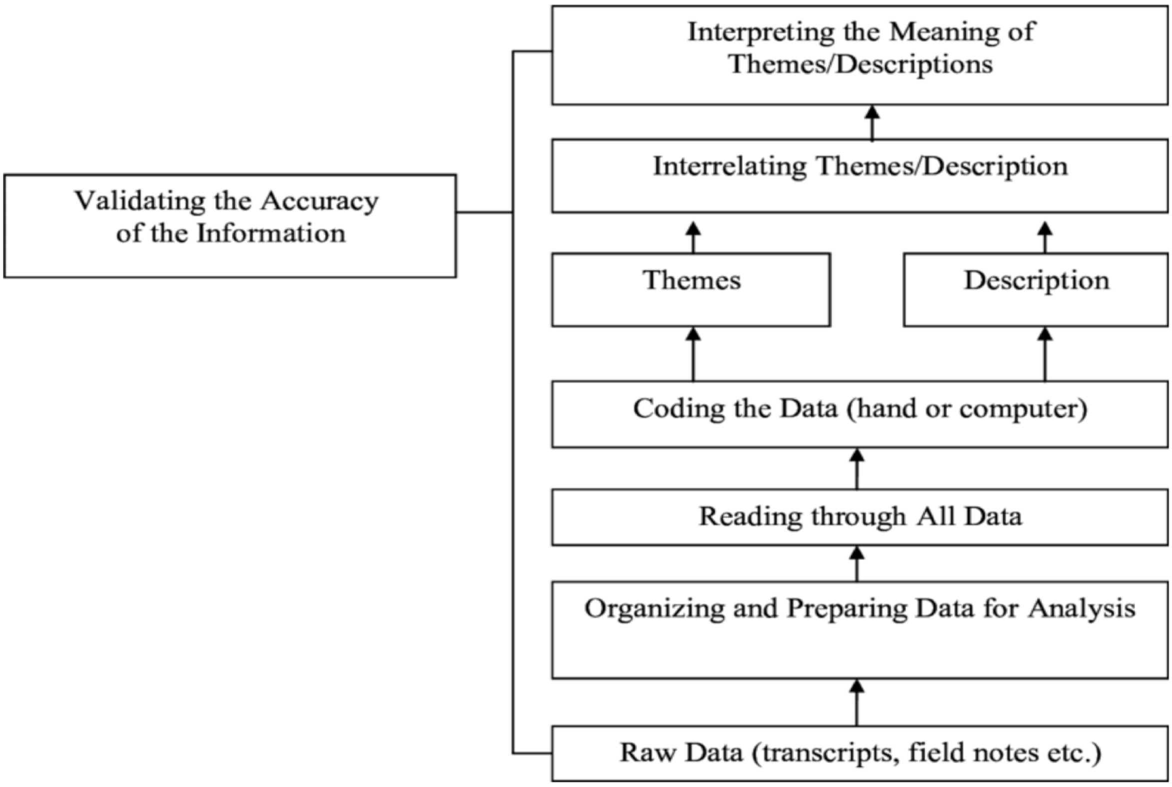

Figure 5.6: Qualitative data analysis process (Creswell, 2012).

Therefore, the interview data is coded after preparing the transcripts and identifying the key themes. According to Rubin and Rubin (2005), the process of coding interview data involves retrieving responses from interviewees and grouping them under identified themes and concepts. It helps to analyse the interview data and allows themes and concepts to be defined and coded. Once the coding process was completed, all coding references were read iteratively to minimise the final codebook through defining potential associations between the codes. The process of coding the themes from interview data into nodes was achieved by using NVivo 12 software. Zamawe (2015) recognised that one of the main advantages of using NVivo software is that it is easier to alleviate the problems and complexity of 'drowning data' through the separation of data into nodes and categories, and that offers an easier structure to explore the main themes and variables. In this research, themes and sub-themes (factors) were coded using NVivo software, as is clear in Figure 5.7.

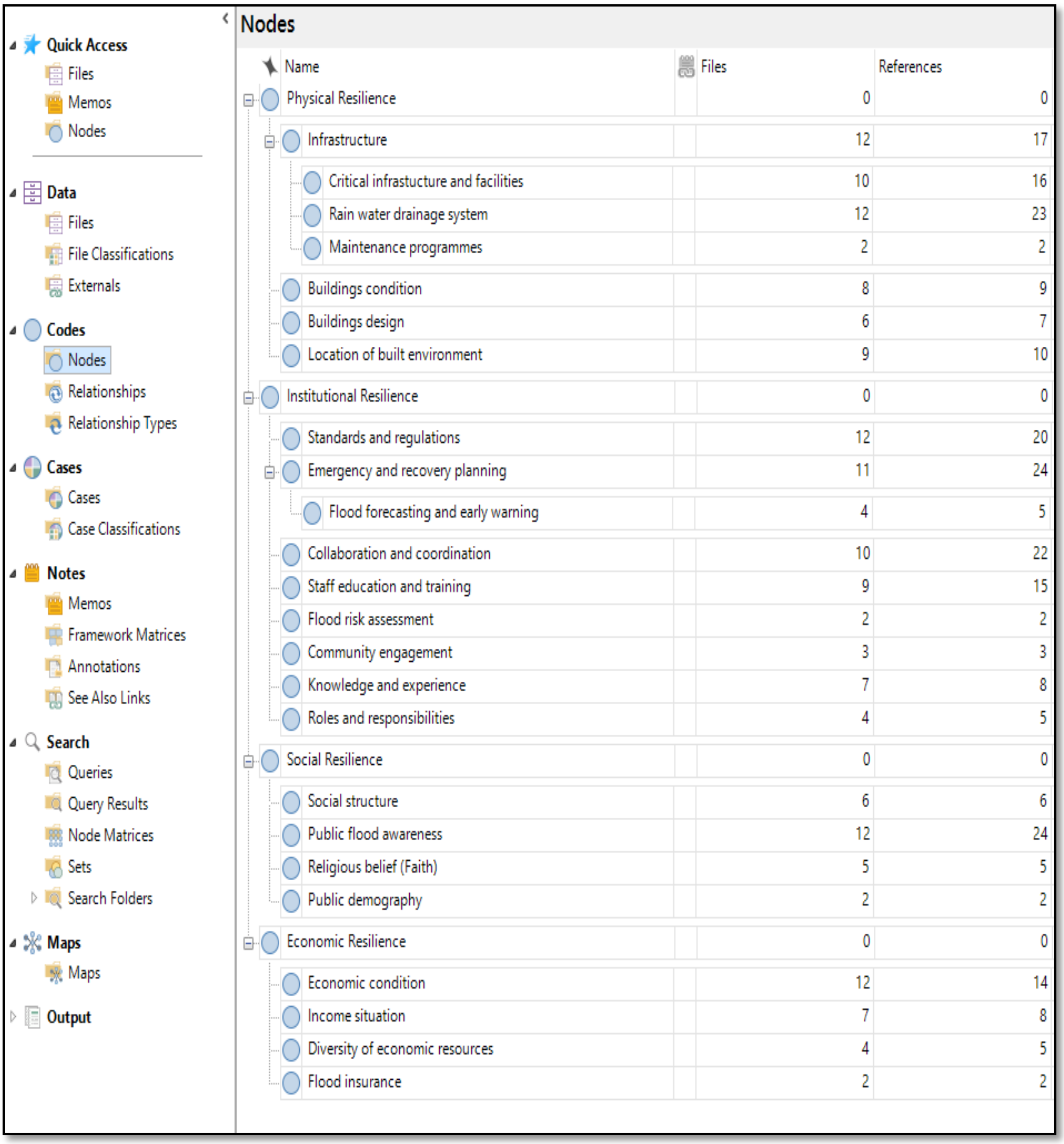

Figure 5.7: Coding structure for participant using NVivo 12.

5.5 Theme One: Physical Resilience Dimension

One of the main themes raised by participants in the semi-structured interviews is associated with community physical resilience to flooding in the UAE. As mentioned in the methodology chapter, the interview questions were prepared to investigate key factors for effective flood community resilience in terms of the physical dimension. It was found that participants stressed an effective physical resilience could enhance the community's capacity for disaster management. It can be improved by implementing several measures such as effective infrastructure, good buildings condition, advanced and effective buildings design, and appropriate location of the built environment, which benefit from preventing or mitigating pluvial flood risk in the UAE. These key factors are mentioned below.

5.5.1 Capacity of Infrastructure

Availability of an integrated infrastructure is the first critical factor to build resilient community to flood hazards. All participants supported that an integrated infrastructure plays important role in preventing or mitigating pluvial floods impacts. For example, Interviewee **R03** said that: *"I think an effective infrastructure is the main measure to mitigate or even sometimes to prevent flood impacts"*. Interviewee **R06** shared the same view, as he stated that: *"An effective physical construction such as infrastructure and critical facilities helps to reduce or avoid possible impacts of hazards and to achieve hazard resilience in systems or structures"*. He added that: *"This includes construction of a rainwater drainage system and retaining wall to protect roads and both private and public properties"*. Thus, this clearly shows that the participants affirmed that effective infrastructure could enhance community resilience to flood risk. From this main factor, 'infrastructure', there are some sub-factors (variables) that help to mitigate flood impacts, as follows:

- **Rainwater Drainage System**

All the participants agreed that an effective rainwater drainage system is considered as one of main flood structural measure in term of mitigating flood impacts where failure of drainage systems may lead to urban flooding. For example, interviewee **R02** stated that: *"One of the most important structural measures for managing floods is the existence of rainwater drainage network"*. Similarly, interviewee **R05** clarified that: "*The current infrastructure, such as rainwater drainage systems, helps to reduce flood risk and protect houses and people from flood risk, and it needs to be continuously improved"*. He also explained that the local authorities take into consideration the historical rainfall data when designing the appropriate drainage system to reduce flood risk. He said that: "*The design of rainwater drainage system based on the historical data available to consider suitable rainfall intensity. By considering appropriate rainfall intensity, optimum pipe size will be determined*".

Moreover, interviewee **R12** emphasised the importance of rainwater drainage system as a key measure to reduce flood risk: *"The main measure to manage flood risk is to have an effective rainwater drainage system"*. Another interviewee **R10** supported that as rainwater drainage system is one of the main flood structural measure; he said that: "*The effective rainwater drainage system can obviously mitigate the impacts of flood risk as it's one of the major structural measures to manage floods"*.

However, interviewees **R01**, **R03**, **R04**, **R06** and **R09** argued that the current rainwater drainage system needs more improvements as many city's zones are still not covered by a rainwater drainage system. For example, interviewee R04 said that: "*Currently, drainage facilities are not as effective in some areas as expected due to large amounts of rainfall in a one-time event; also, there are some zones in the city still not covered with rainwater drainage system*". Further, interviewee **R09** affirmed the need for regular development and assessment of rainwater drainage system; he said: "*There is a need for regular development in rainwater drainage system through increasing capacity and constructing a new one in the newly developed areas in Abu Dhabi*". Hence, there was an agreement between all the participants about the importance of a rainwater drainage system to minimise flood risk. However, the participants clarified that there is an insufficient and ineffective rainwater drainage system in some zones in Abu Dhabi city. They suggested building a new one for new projects and developing the existing one to maintain the accepted flood mitigation level.

- **Critical Infrastructure and Facilities**

The second sub-factor is related to robustness of critical infrastructure and facilities which is one of the most efficient and effective measure to reduce damages or loss probability and build more resilient community to pluvial floods. However, if the community's critical infrastructure and facilities, such as transportation system, electric power grids, and communication networks, are not robust enough to these types of hazards, local authorities' efforts must be put into disaster recovery. The majority of interviewees indicated that robustness of critical infrastructure is considered an effective measure to build more flood resilient community.

Interviewee **R08** explained that: *"During flood event or any natural hazard the lifeline services such as power and water services must be protected and maintain with the same level through integrated and well-prepared infrastructure".* Moreover, interviewee **R11** demonstrated the importance of diversity of transportation networks during an emergency and for the community's wellbeing. He said that: *"It is also necessary to consider the improvement of existing transportation system as there is no diversity in transportation system. For example, there is no train network available in Abu Dhabi city to connect different cities in the UAE where the current dependence only on the roads/ highway network, especially during emergency".*

In the same context, interviewee **R05** made the same point, stating that: *"It is essential to protect critical infrastructure such as power stations and hospitals from any expected hazard especially floods. This includes strengthening and rehabilitation of existing structures".*

However, interviewee **R07** argued that efforts must focus on quick response and recovery to the accepted level of the lifeline services as flood losses cannot be prevented in most cases. He said that: *"Sometimes the expected resilience is estimated to be below the desired targets because of the severity of flood risk, then the efforts are focus on flood response and recovery measures to return the essential services such as electricity and telecommunication to normal level as soon as possible"*. Therefore, there was an agreement between most of the respondents about robust critical infrastructure and facilities can help to enhance community resilience to pluvial floods.

- **Maintenance Programmes**

An annual maintenance programme should take place in order to preserve and improve the efficiency and effectiveness of infrastructure and facilities such as rainwater drainage system. Two interviewees confirmed that there are many advantages through applying regular maintenance of infrastructure such as rainwater system in term of preventing downstream clogging, removing pollutants and ensuring the system functions to avoid floods risks. For example, interviewee **R05** stated that: *"Through applying a good planning process to provide an efficient infrastructure and rainwater drainage system under an annual maintenance programme, the municipality undertakes maintenance tasks in order to minimise any possible flood situation. The tasks generally include cleaning storm inlets, choked culvert, cleaning and outfalls, etc., before the monsoon/rainy season starts"*. Moreover, interviewee **R04** made the same point as he said that: *"It is important to rehabilitate and maintain rainwater drainage networks before the rainy season"*. Thus, the two interviewees form Abu Dhabi Municipality affirmed that providing appropriate maintenance programmes can play a positive role in reducing and adapting flood risk in Abu Dhabi city through maintaining and improving the effective function of infrastructure and facilities

5.5.2 Location of Built Environment

Location of built environment is the second key factor to build resilient community to pluvial floods. Most participants emphasised that a safe location of built environment is important measure to avoid flood risk and help to community survival and recovery. Interviewee **R12** said that: *"I think flood risk might be prevented if houses and buildings are not located in flood-prone areas"*. He added that: *"The current land use practices in the city avoid construction in flood-prone areas such as wadis to minimise flood impacts"*.

Moreover, knowing flood-prone areas help to select an adapted flood structural measures and type of building or houses to prevent flood risks. Interviewee **R06** emphasised this point as he said that: "*It is important to protect people and buildings in flood-prone areas through increasing the elevation of houses and constructing flood defence systems such as storage ponds, levees and pumping stations*". In the same view, interviewee **R07** stressed that critical infrastructure and facilities should be built away from flood risk and in a safe area, as he stated that: "*Critical infrastructure and facilities such as power plants and hospitals should be far away from flood-prone areas".* Therefore, most the interviewees from different organisations stressed the importance of the built environment's location to prevent flooding and enhance community resilience.

5.5.3 Building Condition

The third key factor mentioned by interviewee is building condition which helps to mitigate flood risks. Eight interviewees supported buildings should be robust and maintained regularly in order to adapt to flood risk. For example, interviewee **R02** affirmed that flood impacts can be reduced if buildings or houses are structurally in a good condition. He said that: *"I think the condition of buildings could also help to enhance community resilience by mitigating the impact of floods where the average age of buildings in Abu Dhabi city is less than 30 years, and they are considered to be more adapted to natural hazards such as floods"*. Furthermore, interviewee **R10** clarified that: *"During flooding, it is obvious that damages in new buildings are much lower than in old buildings as they the former are built with good standards and materials that adopt natural hazard with strong structures"*.

Nevertheless, regular maintenance is needed for old buildings in the city to be able to adapt flood risks. Interviewee **R01** demonstrated that: *"We have generally a good and new construction in the city but there is a need to do required maintenance for old houses as some of them were built before 1980"*. Hence, most of the participants noticed that buildings and houses in the UAE are in a good condition and quite new which support to enhance community flood resilience. However, some participants form Abu Dhabi Police and Abu Dhabi Municipality emphasised the importance of applying regular maintenance for old buildings to boost their capacity to mitigate flood risk.

5.5.4 Building Design

The final factor mentioned by participants is building design. If flood risk is taken into consideration during design stage, buildings or houses can effectively mitigate flood impacts. The current design standards help to build more resilient buildings to adapt pluvial floods and that will reduce recovery costs. Six interviewees clarified the importance of building or house design to mitigate flood risk. Interviewee **R06** emphasised the importance of considering flood risk within design stage for any new project. He stated that: "*Due to the dry environment in the country, little attention has been paid to flood risk in the past. Currently, we can see the gates of many houses or buildings are in the same street level and that lets floodwater enter houses. There is a need to develop building design to adapt flood risk"*. Moreover, Interviewee **R08** affirmed that: *"We often see the level of houses is less than the level of roads or at the same level and this leads rainwater to enter and affect houses in an easy way, putting people at risk"*. Thus, due to some limitations related to buildings or houses design in the city as a result of the weather conditions, the participants from different organisations affirmed buildings design as an essential factor to adapt flood risks. They suggested that flood risk should be considered during the designing stage to build a more resilient community.

In short, physical resilience benefits communities to withstand, respond to and recover from flood risk through appropriate physical capabilities. Communities with an effective rainwater drainage system, appropriate building condition and design, and safe location, which is away from flood risk, can clearly be protected from pluvial floods. Thus, the critical factors within the physical dimension in the UAE that help to build an effective community resilience include infrastructure, location of built environment, building condition, and building design. Figure 5.8 explains these factors, as explained by interviewees.

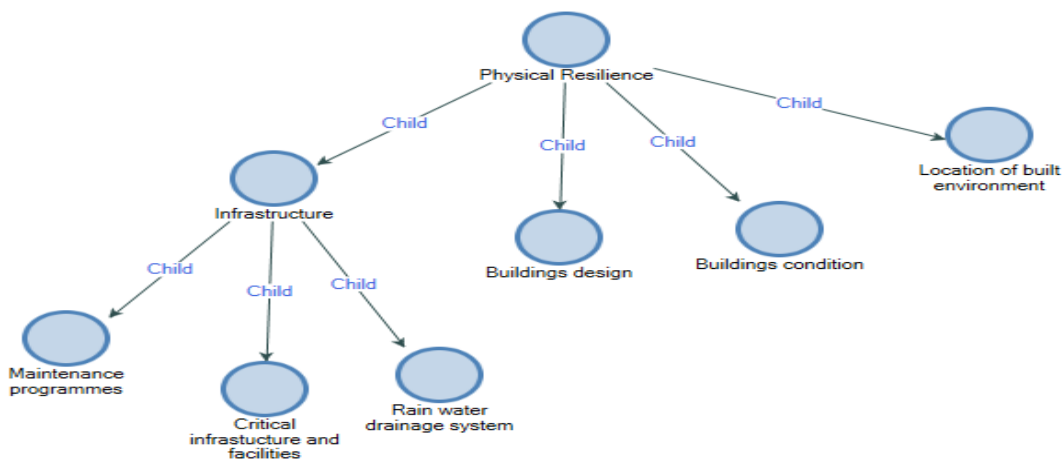

Figure 5.8: The key factors within the physical resilience theme.

5.6 Theme Two: Institutional Resilience Dimension

The institutional resilience is considered to be the second key theme raised by participants in this study which help to minimise flood risk and improve community resilience in the UAE. It was noted that it is associated with the institutional capacity of governmental bodies such as availability of effective emergency planning, appropriate staff training and education, and better coordination and collaboration between stakeholders. According to respondents in this case study, there are many critical factors under institutional resilience theme that help to build community resilience to pluvial floods.

5.6.1 Staff Training and Education

The first main factor in enhancing community resilience is government officials' training and education for managing emergency and crisis effectively. Training and educating staff members for disaster or crisis is the most effective method in managing and preventing disasters and crises that might happen suddenly at anytime and anywhere. Most interviewees mentioned employees training and education as one of the most successful measures to deal effectively with flood risk. For example, interviewee **R01** said: *"During the year, we are doing training simulations in Abu Dhabi city in different scenarios. They are updated regularly, and they rely on the type of risk, such as floods or earthquakes".* Moreover, interviewee **R10** added: *"We are doing training yearly for all sectors responsible for dealing with emergencies and it becomes completely understood from implementing".* He also explained the level of preparedness for responding to flood risk or any emergency needs regular training. He said that: "*Doing training exercises to know the capacity of the staff members, whether they are good enough or capable for quick response".*

In the same context, regular training procedures are conducted by government officials including at the local level and federal level in the UAE. Interviewee **R11** explained that: *"We're doing regular training locally with partners and with other emergency agencies in different emirates to completely know their role and share experience in managing crisis or emergency".* He added that: *"Every emirate conducted training at both local level and strategic level with all related stakeholders who are responsible for managing emergency events".*

However, there was a gap identified by several respondents from Abu Dhabi Police on training procedures on a specific type of risk, such as a flood. Interviewee **R03** declared that there is a need for improvements and specific training to deal with certain types of natural hazards that are currently increasing in severity as a result of climate change. He said that: *"Because of climate change phenomena, all countries now are vulnerable to natural hazards more than before, and we need to do regular specialised training for a certain hazard such as flood to mitigate its impacts and for quick recovery".* He added: *"We are planning to do special training for some incidents including for floods which involves all concerned local authorities".*

Similarly, interviewee **R01** emphasised this view by indicating some limitations in training procedures for managing flood incidents. He affirmed that: "*There is a need to improve training procedures as the training without previous preparation is not effective. The UAE government aims to ensure that the response time to incidents should be within four minutes*". Hence, all the participants considered that employees' training and education is one of the main elements of managing flood risks and effective response. However, there are some limitations in staff training procedures in the country, as indicated by the Abu Dhabi police participants, especially related to pluvial floods.

5.6.2 Emergency Planning

The second important factor to mitigate the impacts of floods in Abu Dhabi city is planning for emergency and recovery. It refers to the government's capacity to prepare the community to mitigate and recover from flood hazards. The majority of the interviewees stated that they have an appropriate emergency plan for major emergencies such as natural hazards. Interviewee **R12** said that: *"We have plans in case of natural hazard on how to deal with it and we are developing these plans continuously".* Moreover, interviewee **R03** explained it more, stating that: *"To prepare for any emergency or disaster such as flood happening in Abu Dhabi city, we have an emergency plan that includes response plan, evacuation and recovery plan, coordination meetings with stakeholders, and practical and theoretical exercises such as Table Top Exercise, which means making scenarios for the event theoretically on the table, and these exercises useful in the selection of staff members and distribution of roles correctly and more effectively to manage the event".* Similarly, interviewee **R01** indicated that they have both general and particular plans to respond to any emergency events like the bird flu pandemic or flooding. He confirmed that they are updated regularly, stating that: "*An emergency plan can be either a general plan for any threat or crisis, or special plan for a particular event or threat such as a bird flu pandemic, and we are updating them regularly".*

However, some interviewees from Abu Dhabi Civil Defence and Abu Dhabi Police clarified that the current emergency planning practices and preparedness level are insufficient and need to be reviewed and improved, especially for flood risks. For example, interviewee **R09** stated that: *"I think the current emergency planning practices are not enough because natural hazards are very difficult to manage. All countries now are vulnerable more than before to certain types of natural hazards including floods as result of climate change phenomena; this requires better level of preparedness".* Therefore, all participants affirmed that the availability of emergency and recovery planning can clearly ensure appropriate preparation for flood hazards. From this main factor, the participants identified a significant sub-factor, which is flood forecasting and early warning.

- **Flood Forecasting and Early Warning**

Abu Dhabi government has adopted many measures to prepare for flood risks, such as flood forecasting and early warning. They help communities in terms of proper preparation and response within a good time to minimise the possibility of loss or damage. This was illustrated by interviewee **R04**, who observed that the *"Abu Dhabi government has taken a number of measures to adopt flood risk including weather forecasting, which allows to monitor storms that cause heavy rain and monitoring of rainfall by weather stations, in addition applying early warning system and assessment of flood risk"*. Interviewee **R10** had the same view and affirmed the importance of an effective early warning system EWS in Abu Dhabi, stating that: *"It's very important for local communities to set an effective EWS which supports awareness of risk and disseminates warning and alerts"*. However, some interviewees from three different organisations, **R01**, **R03**, **R04** and **R10**, stated that there are some limitations in some flood mitigation measures, especially flood forecasting and the early warning system, as it required regular development to be an effective tool to support flood risk awareness and disseminate warnings and alerts. For example, interviewee **R03** explained that: "There is a need for regular development for flood forecasting, early warning system and emergency planning as it helps increase the preparedness of local authorities and communities for pluvial floods".

5.6.3 Knowledge and Experience

To maximise community flood resilience level in the UAE, the availability of appropriate knowledge and experience to manage flood risk is another key factor. It is important to consider that an increase in knowledge and experience among staff members will achieve the desired goals. Seven interviewees agreed that knowledge and experience is an important skill and it is considered to be main factor to enhance community resilience to pluvial floods. For example, interview **R11** explained that: *"All staff members in our organisation have enough knowledge and experience to deal with different incidents including floods because we are conducting many training programmes to be able to act in different situations"*. However, some respondents from Abu Dhabi Police and Abu Dhabi Civil Defence highlighted that some staff members have an inadequate and insufficient level of experience to manage flood incidents due to the small number of major natural hazards in the UAE. This was confirmed by interviewee **R03**, as he stated: "There is a lack of knowledge and experience between staff as few incidents or major disasters are happening in the UAE". Thus, there was an agreement among interviewees that the availability of knowledge and experience is an essential key factor to build a community that is resilient to pluvial floods.

5.6.4 Institutional Coordination

Coordination and collaboration between governmental bodies has an effective role in managing flood risks and any emergency event. The majority of interviewees declared that there is an appropriate level of coordination and collaboration between local authorities. For example, interviewee **R01** said that: *"In my view, the current coordination level between local authorities is very good as there is a crisis and disaster management committee that includes members from all concerned stakeholders. This committee meets regularly before, during and after the event, in which challenges and lessons learned from previous events in the country or even global events are discussed*". Moreover, interviewee **R12** emphasised that as there is continuous coordination between all concerned stakeholders including those in the private sector such as related contractors. He said that: *"There is continuous coordination with Abu Dhabi Police, Civil Defence, Abu Dhabi distribution company and NCEMA in the governorate, and also the private sector, such as contractors prepare and respond to any emergency including flood risks"*. He added: *"There is an emergency room with technical teams and necessary equipment to manage emergencies. The room is activated in case of any emergency such as flood"*.

However, four interviewees from Abu Dhabi Civil Defence, Abu Dhabi Municipality and NECEMA, mentioned that the level of coordination between governmental bodies needs some improvements as some organisations have their own standards, procedures and plans. For instance, interviewee **R10** explained that: "*There is a lack of cooperation and coordination between some agencies and most of them have their own standards in managing emergencies or crises which are different from others"*. Moreover, interviewee **R04** had the same approach, as he stated that: *"Improvements in coordination level between governmental bodies are needed for better preparation for flood risks, especially before rain events"*. This emphasises that effective coordination between all concerned parties before, during and after a flood risk can reduce its impacts.

5.6.5 Community Engagement

Another important factor raised by participants was community engagement for dealing with flood risk. It has been identified that good community engagement benefits all stakeholders in flood risk management and flood control processes. Three interviewees stressed that there is a need to work with communities before, during and after a flood event at a meaningful level. This is an essential step to reduce and prevent the impacts of pluvial floods as communities are the first risk responders. For example, interviewee **R03** clarified that: *"As for the communication with the local communities, we have a special branch called the Community Ambulance Branch in Abu Dhabi Police, which works to communicate with the local population, conduct lectures and public awareness publications on a regular basis, and consult them to allow them to voice their concerns and suggestions about managing floods"*. In the same context, interviewee **R09** emphasised that: *"Engaging local communities is essential step to cope with risk of flooding as they are first responders before blue light services"*. This confirmed that developing community engagement in flood risk management is considered an essential approach by local authorities to mitigate flood risks through their participating in the formulation of hazard mitigation plans.

5.6.6 Roles and Responsibilities

To maximise flood mitigation efficiency and the preparedness level, it is essential to arrange roles and responsibilities between the concerned stakeholders. Four interviewees mentioned the importance of better arrangement through well-defined roles and responsibilities to reduce flood risk. For example, interviewee **R08** stated that a better arrangement between local authorises can boost the level of preparedness for flood risk in Abu Dhabi. He said that: *"There is a clear response work plan between local authorities to respond to flood risk; all of them know their roles and responsibilities*".

However, two interviewees from Abu Dhabi Police and Abu Dhabi Municipality confirmed that there is a conflict in roles between local authorities in responding to flood risk. Interviewee **R04** explained that: *"There is a lack of cooperation and conflict of roles and responsibilities among some local agencies as they don't have clear response work plan between them to respond to flood hazard"*. Moreover, interviewee **R03** supported that, as there are overlapping roles and responsibilities to respond and recover from flood incidents, which represents a challenge to enhance community resilience to floods. He said that: *"I think there are overlapping roles and responsibilities where some local authorities have some functions similar to other departments, which [has been] identified as a challenge to address flood hazards"*. Therefore, the participants emphasised that well-defined roles and responsibilities through better arrangements between stakeholders would help to raise the level of preparedness for flood risks.

5.6.7 Flood Risk Assessment

Another key factor mentioned by interviewees in the UAE is flood risk assessment. This process evaluates the level of flood risk for a community and assesses damages or losses occurring in houses, infrastructure or assets due to pluvial floods. Two interviewees from Abu Dhabi Municipality and Abu Dhabi Civil Defence stated that flood assessment in Abu Dhabi includes damage estimation cost of properties and assets. Interviewee **R05** clarified that the: *"Flood damages assessment process is done through reports or visual observations according to site assessment via a committee of engineers from Abu Dhabi Municipality; after documenting these damages to senior managers to decide the necessary action, the authority also may compensate the people as per the available budget"*.

Moreover, interviewee **R09** shared the same view, as he emphasised the need for regular assessment for flood impacts, stating that: *"There is a need in my view to do a regular assessment for the current houses, buildings and infrastructure, and make any necessary improvements"*. Thus, Abu Dhabi authorities assess flood damages by visual observation on the ground by a committee of experts and engineers from different local authorities to estimate the losses' cost and decide on the reconstruction of the damage. Thus, the participants considered that flood risk assessment is an important factor to improve the community preparedness level by taking necessary actions and measures to mitigate flood risk.

5.6.8 Standards and Regulations

The application of standards and regulations is an additional key factor to enhance community resilience to pluvial flood. All interviewees agreed that institutional regulations help in building community resilience. For example, interviewee **R12** said: *"Governmental regulations and standards have an effective role in protecting communities from natural disasters such as floods by developing appropriate contingency plans and effective response"*. Moreover, interviewee **R06** added that: *"Building codes clarify the types of materials used in the building to make it more resilient and resistant to flooding"*.

In this context, the current regulations and standards should be updated regularly in order to manage any unexpected event as a result of climate change phenomena. Interviewees **R03**, **R04**, **R08** and **R10** indicated that the recent regulations and standards did not effectively consider flood risk and needed a great deal of improvement. For example, interviewee **R04** said that: "*I think that current regulations and building codes do not consider in detail the future impacts of climate change and pluvial flood hazards because of dry weather, where there is a need for continuous improvements to manage any potential natural disasters*". Interviewee **R03** shared the same view, stating that: "*The current regulations and legislation must be up to date and take into account potential weather risks*". Thus, institutional regulations and standards are considered an essential factor in enhancing the Abu Dhabi government's abilities by better preparing communities to deal with and mitigate flood risks.

From the above, it is clear that there are many key factors within the institutional resilience dimension that play an important role to improve community flood resilience in the UAE, and they include: staff training, emergency and recovery planning, roles and responsibilities, flood risk assessment, coordination and collaboration between local authorities, community engagement, and institutional standards and regulations. This asserts the importance of institutional resilience theme in building a resilient community. Figure 5.9 clarifies the critical factors within institutional resilience, as mentioned by participants.

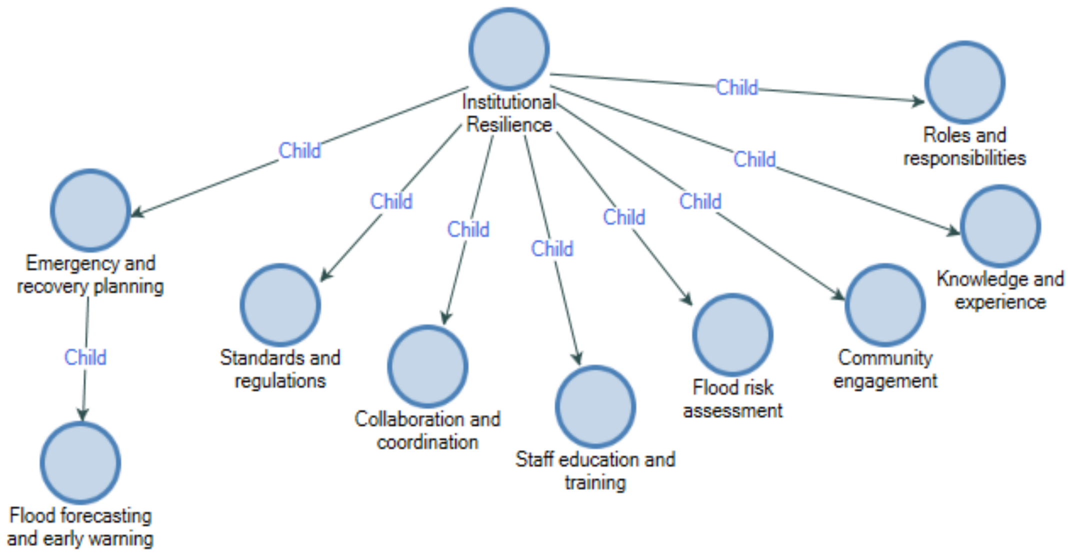

Figure 5.9: The key factors within the institutional resilience theme.

5.7 Theme Three: Social Resilience Dimension

Social resilience is the third major theme for assessing community flood resilience. In this study, participants were asked to specify the critical factors in terms of social resilience that help to enhance community flood resilience. According to participants, social resilience is developed through an appropriate social structure, community faith and beliefs, public knowledge and awareness about flood risk and demography of citizens, which can help people to increase their preparedness and recovery.

5.7.1 Flood Awareness

In an attempt to further identify the critical factors of social resilience, the interview findings showed that there are some main factors within the social dimension that contribute to community resilience to pluvial flood in Abu Dhabi city. Public awareness level is considered to be a critical factor in building a resilient community. Disaster awareness is the level of common knowledge about disaster risk that can contribute to individual or community actions to minimise vulnerability and exposure to hazards. It is established by effective dissemination of information related to possible risk through media and education channels. All interviewees commented that flood awareness is a critical measure that helps a community avoid or mitigate flood risk. In this regard, three interviewees stated that the city has a good public awareness level about flood risks. For example, interviewee R02 said: "*I think the level of awareness among citizens is good as the local authorities conduct regular awareness campaigns to raise the level of public awareness about flood risk*".

In the same context, awareness of disaster risk reduction in a community could be increased using different means, such as workshops, lectures and training. Interviewee **R03** clarified that: "*The locals could be aware of flood risks and actions that are taken in case of floods by conducting awareness programmes such as workshops, lectures, the social media network, training and education programmes*". Moreover, awareness campaigns are considered to be prevention or mitigation measures that are needed to increase the local community's knowledge level, governmental organisations, and vulnerable people to lessen the flood risk. Interviewee **R10** explained that: "*People in Abu Dhabi have appropriate levels of education and they could be aware of actions taken in case of the flood by the government such as; conducting awareness campaigns and training on safety procedures*".

However, some participants from Abu Dhabi Police and Abu Dhabi Municipality affirmed that there is a lack of public awareness about flood risks because the city has residents from different cultures, a lack of rain events, and few awareness programmes directed to the local community on flood risk. For example, interviewee **R04** said: "*The level of public awareness about flood risk is low, due to the lack of heavy rainfall events in the country*". Moreover, interviewee **R06** supported that: "*There is a lack of awareness level among the local communities about natural disasters, especially floods, where these risks are infrequent because of weather condition in the country, and because of climate change phenomenon, which has increased the possibility of these disasters. Also, there are many communities from different countries that have different cultures and languages living in the UAE, and therefore we have to do a lot of lectures and educational seminars in local councils in order to increase awareness of natural hazards*".

Therefore, there was a complete recognition among all participants from different organisations about public flood awareness as the main factor to build a more resilient community in the UAE. However, some participants from Abu Dhabi Police and Abu Dhabi Municipality were concerned about the lack of public awareness concerning pluvial flood among community members in the UAE because of the diversity of the population's culture, lack of rainfall events and lack awareness plans.

5.7.2 Social Capital

Another key factor mentioned by interviewees within the social dimension was 'social capital'. It can help to mitigate the impacts of floods through relationships and coordination between community individuals during a flood event. Six interviewees mentioned that social structures can reduce flood impacts and aid quick recovery through strong community relationships and effective communications during a flood risk. Interviewee **R11** explained that: *"Social capital may play a critical role in enhancing the resilience of communities to natural disasters by coordinating and providing assistance among community members during floods"*. Moreover, interviewee **R08** emphasised that: *"I think strong social structures between community members help to reduce flood risk through coordination, continuous communication and providing necessary assistance and quick recovery"*.

In the same context, interviewees from Abu Dhabi Police and Abu Dhabi Civil Defence mentioned that the strong social relationships among community members in Abu Dhabi are because of religious and traditional aspects, where most of the citizens are Muslims and Islam as a religion encourages strong brotherhood between community members and for them to help each other, especially in extreme events. For example, interviewee **R10** said: *"Because most people in the city are Muslims, they treat each other like brothers, especially in extreme events like floods"*. Therefore, participants saw that an understanding of social capital in a community gives an insight into the connectivity of the local community by using these relationships in a good way to reduce floods risk.

5.7.3 Community Faith or Religion

Community faith or religious beliefs may also affect community resilience as it impacts the nature and level of flood preparedness. Five interviewees stated that community faith might positively or negatively influence community disaster resilience. Religious beliefs may contribute to poor community disaster resilience, where people in some developing countries may not take necessary actions and measures to mitigate and prevent flood risk as it is an act of God. For example, interviewee **R09** said that: "*In my view, religious beliefs can have an* *impact on the resilience of communities because some communities, especially in some developing countries, may not take necessary actions and measures to cope with the threat of natural disasters such as floods as they believe that these disasters are from God*".

However, some participants from Abu Dhabi Distribution Company and NCEMA mentioned that religious beliefs may positively impact community resilience to disaster in the UAE as Islam teaches people the value of doing good actions and their best, especially in disaster conditions. Interviewee **R12** demonstrated it more, as he said that: "*In the UAE, the General Authority for Islamic Affairs and Endowments works to clarify the correct understanding of the teachings of the Islamic religion, which urge citizens to take all possible measures to manage these natural hazards*". The rest of the interviewees viewed that there is no relationship between religious belief and community resilience to flooding. For example, interviewee **R01** stated: "*No, I don't think there is a relationship between personal faith or religious and community resilience towards disasters as everyone wants to avoid or cope with disasters*". Therefore, in sum, community faith may impact flood preparedness and resilience in the UAE.

5.7.4 Community's Demography

The final factor mentioned by participants and under the social resilience dimension is the community's demographic profile such as; age, disabled population and gender. Two interviewees mentioned that it is possible to see that communities with a high percentage of young male residents and a low proportion of people with disabilities may have a higher level of resilience. For example, interviewee **R09** emphasised this view, and he said that: *"I think young, well-educated people and people without a physical and mental disability may have greater ability to prepare for flood risk and quick recovery".* Moreover, interviewee **R01** supported that: *"Communities with educated people and lower disability level can have an appropriate level of preparedness for floods. The government of Abu Dhabi provides good healthcare services to residents, lectures and educational seminars, and social media platforms to inform local citizens to prepare for any extreme event*". Thus, community demography is another key measure helping community members to have an appropriate level of readiness for flood risks.

It can be concluded from the interview data that social resilience is another significant theme to improve community flood resilience in the UAE. A community with a strong social structure, appropriate awareness level, and young, well educated people with a low percentage of disability can effectively prepare for and recover from flood risks which help to improve community resilience. Figure 5.10 illustrates the key factors of social resilience, as mentioned by participants.

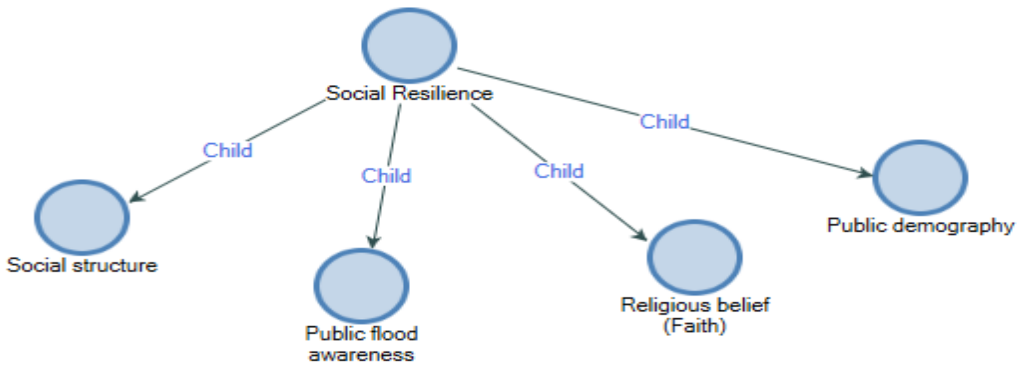

Figure 5.10: The main factors within the social resilience theme.

5.8 Theme Four: Economic Resilience Dimension

The fourth main theme to assess community resilience in the UAE identified by participants is economic resilience. It refers to the economic condition and the community's vitality. In other words, the participants believe that it is an important theme to improve community resilience since it improves the individuals and communities' economic capacity to cope with the impact of flood risks and speed up the recovery process. They mentioned a list of critical factors within economic resilience, such as the country's economic condition, community and income situation, diversity of economic resources, and flood insurance coverage.

5.8.1 Country's Economy

The data collected from the participants illustrated that there are multiple variables within the economic dimension help to improve community resilience to pluvial flood. The country's economy can reflect positively on community resilience to flood risks. Normally, countries with the good economic condition can have the appropriate flood preparedness, effective flood measures to prevent or mitigate flood impacts, and have a quick flood recovery process. All the interviewees agreed that the UAE has a suitable economic capability that contributes to effective community flood resilience. This was described by interviewee **R02** as he said: "*The UAE has a strong and cohesive economy, the second-strongest economy in the Arab world. I think that this good economic condition helps to enhance communities' resilience against natural disasters. We can see that, where a good economic condition, there is a proper* *infrastructure with effective emergency and recovery plans*". Moreover, interviewee **R06** supported this view as he said that: "*The current economic condition is very good and positively affects community resilience to flood because there is a budget to improve flood preparedness measures and construct new infrastructure projects*". This confirms that the UAE has a good economy, which helps fund many projects and improve structural and non-structural measures to deal with flood risk. Thus, there was general recognition between the participants about the condition of the country's economy as a significant factor that can help communities to adapt to flood risk through better preparation and quick recovery.

5.8.2 Income Situation

Individual or community income situation also has a significant role in increasing preparedness and speeding up the recovery process for flood risk. Seven interviewees mentioned that income situation can enhance community flood resilience as people in the UAE generally have a good income, and that increases their ability to take all the required measures to protect their homes. Interviewee **R12** stated: "*I think the higher income of individuals in the UAE leads to great ability to take mitigation measures for flood events. We can see that the impact of natural disasters, especially flooding, is much higher in some poor communities due to a lack of mitigation and recovery measures*". Interviewee **R07** had the same approach as he said that: "*I think the individual income can also improve the community resilience where the people become more able to take mitigation measures such as house design and building materials to reduce flood hazard*". This affirms that the participants considered income condition can help communities to be well prepared for and quickly recover from flood risk in the UAE.

5.8.3 Insurance Coverage

Insurance coverage is another important indicator of the economic resilience dimension. It covers any injury to people or any property damage in case of extreme events such as flooding by providing payments needed by individuals to recover from floods. Two interviewees from Abu Dhabi Municipality and Abu Dhabi Distribution Company mentioned the importance of the insurance programme that covered people to protect them from any potential risk, but in most cases, this did not cover properties in the UAE. For example, interviewee **R5** declared that: "*In Abu Dhabi, all residents have healthcare insurance and they can get treatment from any health provider, but most of resident buildings or houses are still not insured which may be affected by damages in case of any hazard including floods*". Moreover, interviewee **R8** made the same point as he said that: "*Most UAE properties are not insured against flood damages as insurance providers in the region generally do not offer specific insurance against* *flooding because of weather conditions*". In short, insurance coverage for people and properties is a significant factor. It can help communities recover quickly in the case of any extreme events by providing healthcare and essential payments needed to repair any damages.

5.8.4 Diversity of Economic Resources

Diversity of economic resources is also a key factor to enhance community resilience to pluvial floods in the UAE. Availability of several economic sources can be used as an indicator of vulnerability where it is found that the greater diversity of income resources leads to the greater community resilience to pluvial floods. Four interviewees stated that the availability of different economic resources positively affects economic growth, which will help improve community resilience to floods through developing flood preparedness and recovery level. Interviewee **R09** stated that: "*Abu Dhabi Economic Vision 2030 is a long-term plan that minimised dependence on the oil sector as a source of economic activity over time and has a greater focus on the diversity economic resources in the future*". Moreover, interviewee **R11** had the same view as he commented that: "*It is important to have different economic resources in the country to keep sustainable economic growth which will reflect on the development of construction projects and institutional capacity to deal with floods*". Therefore, the participants affirmed that the UAE, in general, depends on different economic resources that help communities improve the level of preparedness for and response to floods.

From the above evidence, it clear that the economic resilience in the UAE in good condition as there is a high economic capacity such as different economic resources and individual income, which can be utilised to prevent or mitigate the effects of the flood through better preparedness and recovery. Although most UAE firms and properties are not insured against flood hazards, the high values of the economic resilience in a community suggest a very good social capital and community trust. Therefore, the key factors within the economic resilience dimension that help to assess community flood resilience in the UAE include country economy, income situation, diversity of economic resources and flood insurance. Figure 5.11 shows the critical factors of economic resilience identified by the participants.

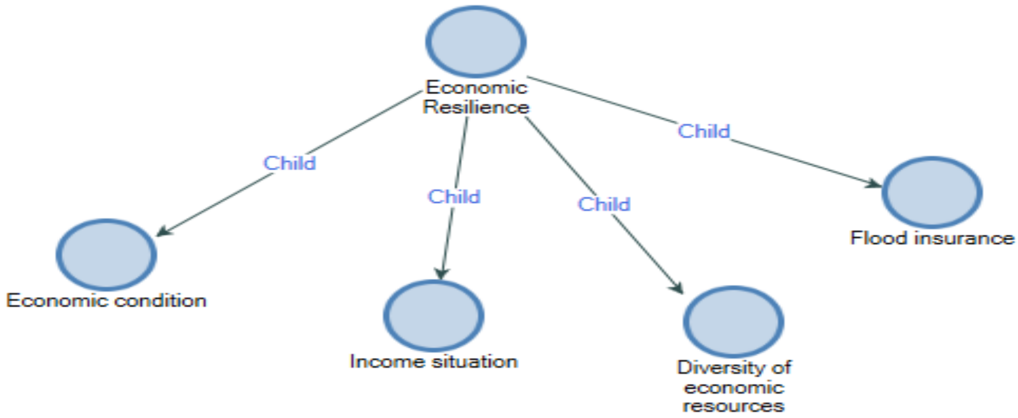

Figure 5.11: The main factors within the economic resilience theme.

5.9 Chapter Summary

This chapter covered two main sections: an introduction to the case study and the qualitative data analysis. For qualitative data, a total of 12 interviews were conducted with stakeholders (senior managers) from related organisations which are involved in emergency management in Abu Dhabi city. All interviews' data were analysed using content analysis, and a total of 20 key factors were identified and categorised under four main themes: physical, institutional, social and economic dimensions of resilience. Further, the results illustrated the preparedness level of local authorities and the measures adopted to prevent and mitigate the impacts of floods, such as rainwater drainage system, staff training, emergency planning, flood awareness and income situation.

Based on the interviews data, it was found that participants were affirmed about the capacity of infrastructure such as the rainwater drainage system as it is an important factor to protect communities and properties in the UAE from pluvial floods. The participants pointed out that the current infrastructure needs continuous improvement to mitigate flood risk from happening in the future, despite some areas in the city still not covered by a rainwater drainage network. Moreover, participants also noted that buildings and houses' design in some area was not effective and needs more development to adapt to the flood risk. Also, it was suggested that the flood risk should be considered in designing new projects as little attention has been paid before to flood risk due to weather conditions in the country.

In terms of institutional resilience, the results showed that there is a lack of staff training procedures on specific types of risks such as floods, lack of knowledge and low experience levels between some staff members to deal with flood risk, and lack of coordination between governmental bodies in emergency management as most of them have their own standards. Moreover, the participants indicated that the current emergency planning practices, such as flood forecasting and early warning system, are not sufficient and need to be reviewed and improved, especially for flood risks. It was also noted that the recent regulations and standards such as building codes did not take into account the flood risk in an effective way, and they need to be updated regularly. Further, some participants emphasised the need for local authorities to develop community engagement in flood risk management to mitigate its impacts through their participation in the formulation of hazard mitigation measures, as they are the first responders to flood risk.

For social resilience, it was found that public awareness is a major factor as it can lead to the actions taken by an individual or community to reduce exposure and vulnerability to hazards such as floods. However, participants pointed out that there is a lack of public awareness about the flood risk in the UAE as the population is very diverse, and there are few awareness programmes on flood risk directed to the local community. Moreover, the participants highlighted the importance of social capital to reduce flood impacts and quicken recovery time through effective communications during the flood risk. They believed that there is a strong social structure among community members in the UAE because of religious and traditional aspects, as most citizens are Muslims.

Finally, with regard to economic resilience, the participants highlighted the importance of the country's economic condition and the community's income situation to improve flood preparedness. They indicated that the UAE has a good economic condition, and currently, it is depending on different economic resources which can reflect positively on economic growth and enhancing community resilience through appropriate flood preparedness. Moreover, although most UAE properties are not insured against flood risk, it was found that flood insurance coverage can play a major role in helping communities to quickly recover in the case of any extreme events by providing the healthcare and essential payments needed to repair any damages. The next chapter describes the results of the quantitative data analysis.

CHAPTER 6: QUANTITATIVE DATA ANALYSIS

6.1 Introduction

This chapter illustrates the quantitative data analysis phase of the study. It discusses the analysis and interpretation techniques of the quantitative data gathered from the questionnaire survey. As discussed in Chapter 4, the questionnaire survey was distributed to participants online and manually, and it was divided into five main parts. The first part clarifies basic information about respondents, and the other four sections examine the key factors of community flood resilience based on four main themes: physical, institutional, social and economic dimensions of resilience. The five-point Likert scale was applied in each question to examine the importance of the key factors. A total of **125** questionnaires were retrieved from the government officials in Abu Dhabi city. However, **82** questionnaires were completed and received by the researcher, which makes a response rate of **65.6%.** The purpose of the questionnaires survey is to analyse and valid key factors identified in the semi-structured interviews (Chapter 5).

6.2 Questionnaire Distribution and Data Collection

The questionnaire survey is intended to test and analyse the results from the semi-structured interviews with a broader population. After the questionnaire was designed, it was first assessed by piloting before its final distribution. In the piloting process, the first draft of the questionnaire was sent to **six** respondents (emergency managers) from related stakeholders in Abu Dhabi city for feedback. Feedback and comments from respondents who participated in the pilot test were used to improve the overall questionnaire design in terms of format and structure of the questions.

The probability simple random sampling technique was applied in order to collect quantitative data in the second stage of this research. Web-based and self-completed questionnaire techniques were used to distribute questionnaires among participants from related organisations in Abu Dhabi city. According to Wright (2005), there are several benefits of using a web-based online survey, such as: quick response time, cost efficiency, faster delivery, better to address sensitive issues and ability to track. In a probability sampling technique, to distribute hard copies and an online link to the questionnaire among potential participants, Human Resources departments in each organisation were conducted and the researcher delivered and collected questionnaire data. One week after the questionnaire was distributed, the respondents were called, and a reminder email and WhatsApp messages were sent to them to attract their attention to the time restrictions for their reply in order to increase the response rate.

The survey process lasted two weeks and the survey was distributed randomly to government officials at different management levels from five local organisations which are legally responsible for planning and responding to pluvial flood incidents in Abu Dhabi, namely: **Abu Dhabi Police, Abu Dhabi Civil Defence, Abu Dhabi Municipality, Abu Dhabi Distribution Company and NCEMA**. The response rate was **65.6%**, which represents **82** responses out of **125** questionnaires. All the participants' answers were checked in order to ensure their validity for completion. Nevertheless, 7 ineligible questionnaires were neglected and considered invalid responses as some participants failed to complete the questionnaire, and therefore they are not considered in calculating the total response rate. Missing data frequently occurs in a questionnaire survey for the following reasons: the respondents refused to answer questions (no answer), they did not have an opinion, or they did not know the answer (no opinion), or by mistake: they neglected questions (Niculescu & Gu, 2012; Grilo & Jardim-Goncalves, 2010). Similarly, Golland (2002) indicated that a response rate of 30%-40% for a questionnaire survey is considered good and that one in excess of 50% is excellent. Therefore, the response rate of this research (65.6%) can be considered excellent.

Total response rate = Total Number of Responses / (Total Number in Sample – (ineligible))
Total Response Rate = 82 / (132-7) = 65.6%

The answers from the questionnaires were transferred to a data reduction sheet in Microsoft Excel software where the response data was grouped together and reviewed for evidence of bias to make sure that it had been fully completed. Then, the collected data was exported from Excel into the Statistical Package for Social Science software (SPSS) for analysis. It was important to check that the data was correct after it had all been entered into the SPSS software. This was done by the SPSS summarise cases command (Field, 2013). The findings of the summarised cases indicated that all 82 cases were eligible for statistical analyses and no data from the analysis of the case statistics was missing, as shown in Table 6.1.

Table 6.1: Case summarise statistics using SPSS software.

Case Processing Summary			
		N	%
Cases	Valid	82	100.0
	Excluded[a]	0	.0
	Total	82	100.0

6.3 Cronbach's Alpha for Reliability Test

An instrument's reliability is the degree of consistency assigned to what is supposed to be examined (Niculescu & Gu, 2012; Grilo & Jardim-Goncalves, 2010). It is important to check whether the testing method or the questionnaire is reliable. Many authors have various reviews about reliability analysis; for example, Helms et al. (2006) indicated that the analysis of reliability checks the instrument's accuracy, i.e. the degree to which the reliable values are given at all times. One of the most common methods to check the internal consistency of scaled data is Cronbach's alpha (Cronbach, 1951; Saunders et al., 2009; Gliem & Gliem, 2003). It can be used when questions or items are testing a related construct.

Using the following formula, Cronbach α measures the reliability (Cronbach, 1951):

$$\boldsymbol{\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_i^N = 1\,\sigma_{Yi}^2}{\sigma_X^2}\right)}$$

Where *N* is the number of items, σ_X^2 is the variance of the observed total test values, and $\sigma_{Y_i}^2$ is the variance of item *i*.

Many researchers have reported that a Cronbach's α value is between 1 (perfect reliability) to 0 (not reliability), with higher values indicating higher reliability (Muijs, 2010; Pallant, 2011; Gary, 2014). Particularly, the accepted criteria for Cronbach's α are when the value of α is higher than 0.9, which can be considered an 'excellent' reliability, 0.8 and above indicates 'good'' reliability, while 0.7 and above indicates 'acceptable' reliability (George and Mallery, 2007; Gary, 2014). In this research, SPSS software is used to analyse the reliability by finding Cronbach's alpha value. It can be found from Table 6.2. that the Cronbach's alpha value for the entire questionnaire (20 items) is **0.905**, which falls under the **'excellent''** category.

Table 6.2: Reliability statistics.

Reliability Statistics	
Cronbach's Alpha	**N of Items**
0.905	20

It is important that not only the whole questionnaire in the research must be reliable, but also the reliability of every variable, since the variables could affect the research as a whole if the item for each variable is unreliable. In other words, Cronbach's α should be reported in the questionnaire for individual items, rather than for all items in the survey (Rattray & Jones, 2007). Thus, the researcher conducted a reliability check of each dimension used to measure community flood resilience in order to check the reliability of identified variables, as shown in Table 6.3. The evidence showed that Cronbach's α values for dimensions were above 0.772, so the questionnaire was valid and reliable. This means that the data collected can be used for further analysis.

Table 6.3: Reliability statistics assessment for each dimension.

Reliability Statistics		
	Cronbach's Alpha	**Number of Items**
Physical Resilience Factors	0.772	4
Institutional Resilience Factors	0.922	8
Social Resilience Factors	0.824	4
Economic Resilience Factors	0.907	4
Overall	0.905	20

6.4 Descriptive Statistics for Background Profiles

The first section of the survey discussed participants' demographic information. Demographic analysis helps to understand characteristics of the population such as: age, sex and racial composition, and how this has changed over time through the simple demographic processes of migration, birth and death. Researchers should take into account the significance of demographic data in any type of research that is based on a survey analysis (Wunsch, 2012). When demographic data is available, researchers may decide to exclude from the study a certain age group and provide a more customised response. In this research, participants were asked different demographic questions to record their occupations, experience, education level and other relevant information. Particularly, there were a total of five questions in this part which were about a participant's organisation, job title, years of work experience, education level and experience in emergency management. The sample's characteristics (demographic information) are explained below.

6.4.1 Participants' Organisations

The first question in the questionnaire is about the type of organisation in which the respondents are working. This question helps the researcher to distinguish between the responses of participants from different organisations. The results show that (n=20) 24.39% of respondents worked for Abu Dhabi Police, (n=17) 20.73% for Abu Dhabi Civil Defence, (n=19) 23.17%

for Abu Dhabi Municipality, (n=15) 18.29% for Abu Dhabi Distribution Company and (n=11) 13.41% for NCEMA. Thus, the majority of the participants worked in Abu Dhabi Police and the minority worked in NCEMA. These results are illustrated in Table 6.4 and Figure 6.1.

Table 6.4: The frequency and the percentage of participants in each organisation.

Participants' Organisations					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Abu Dhabi Police	20	24.4	24.4	24.4
	Abu Dhabi Civil Defence	17	20.7	20.7	45.1
	Abu Dhabi Municipality	19	23.2	23.2	68.3
	Abu Dhabi Distribution Company	15	18.3	18.3	86.6
	National Crisis and Emergency Management Authorisation (NCEMA)	11	13.4	13.4	100.0
	Total	82	100.0	100.0	

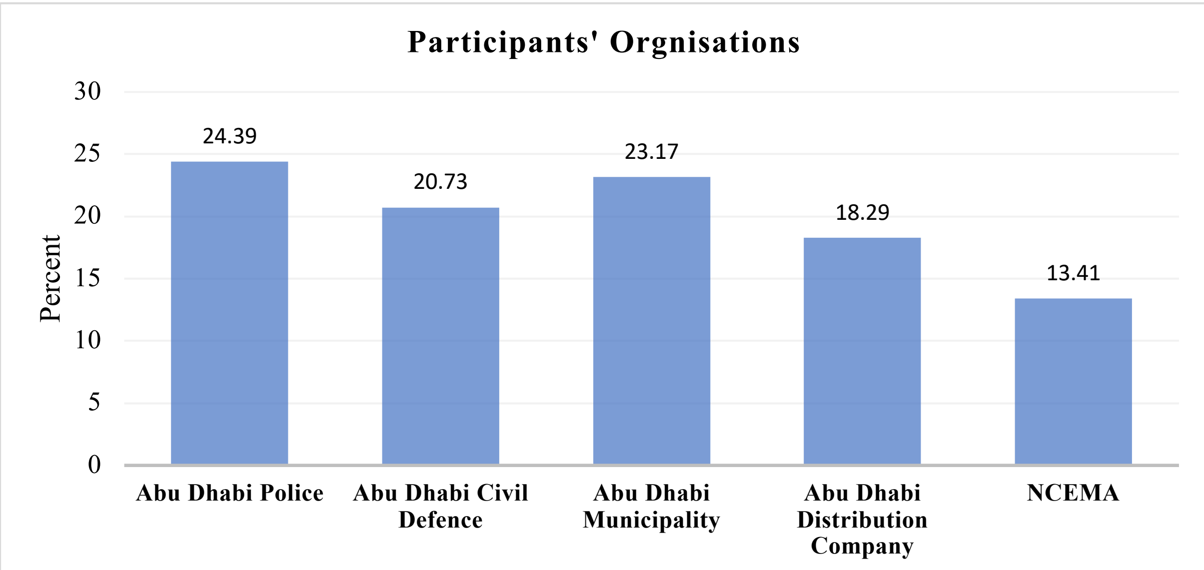

Figure 6.1: Participants' organisations in percentage.

6.4.2 Participants' Occupations

The second item related to demographic information in the questionnaire is participants' job title. Figure 6.2 shows the participants' current occupations. It can be noted from Table 6.5 that (n=23) 28.05% are engineers, (n=15) 18.29% are emergency managers, (n=11) 13.41% are branch managers, (n=10) 12.20% are section managers and (n=7) 8.54% are department managers. Moreover, (n=16) 19.51% of participants have other occupations. Thus, the majority of participants were engineers, and the fewest were department managers.

Table 6.5: The frequency and the percentage of participants in each job role.

Participants' Job Titles					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Engineer	23	28.05	28.05	28.0
	Emergency manager	15	18.29	18.29	46.3
	Branch manager	11	13.41	13.41	59.8
	Section manager	10	12.20	12.20	72.0
	Department manager	7	8.54	8.54	80.5
	Other	16	19.51	19.51	100.0
	Total	82	100.0	100.0	

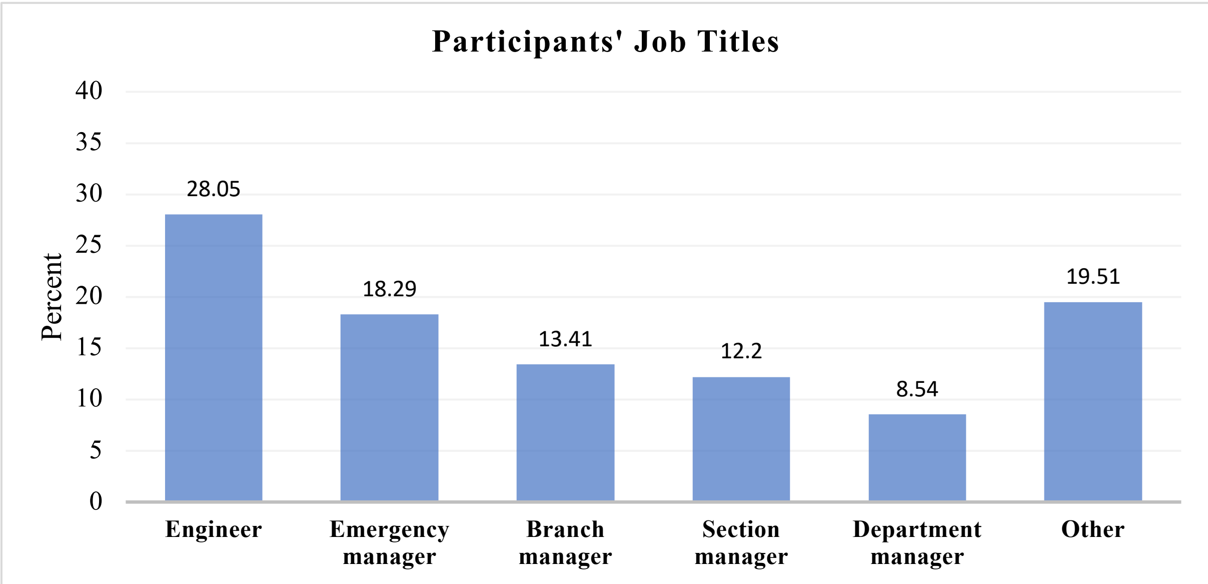

Figure 6.2: Participants' job titles in percentage.

6.4.3 Years of Work Experience

Participants were asked to specify their work experience in terms of years, which is the third item of demographic information requested in the questionnaire. The pie chart in Figure 6.3 demonstrates that most of the participants had 6 – 10 years' experience (25.61%), followed by those who had 11 – 15 years' experience (24.39%), then those who had 16 – 20 years' experience (15.85%). The next group was those with less than five years' experience (14.63%), followed by those who had 21 – 25 years' experience (12.20%). The final group was those with 25 years or more of experience (7.32%).

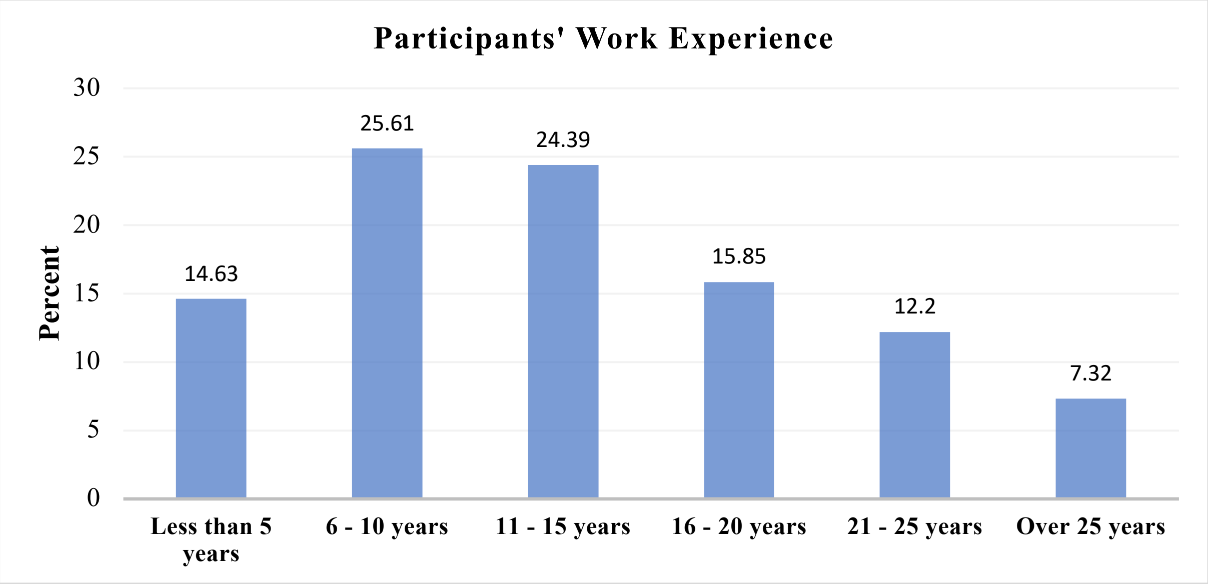

Figure 6.3: Participants' work experience in percentage.

6.4.4 Education level

Figure 6.4 illustrates the participants' education level (qualification level). It was found that the highest number of participants (52.44%) have a bachelor's degree, followed by 19.51% of participants who have a master's degree, then 17.07% of participants who have a diploma's degree and 7.32% who have a PhD qualification. Those with other education degrees or qualifications represented 3.66%. The analysis shows that, in terms of education level, the participants with other degrees were the smallest group in the sample, and that the majority had a bachelor's degree.

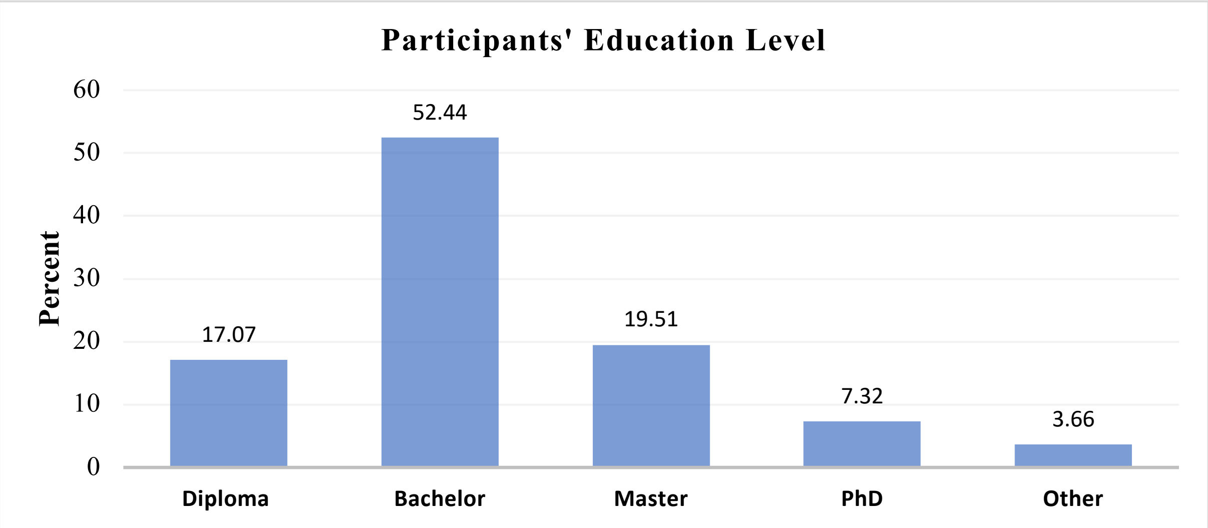

Figure 6.4: Participants' education level in percentage.

6.4.5 Experience in Emergency Management

One of the key items in the questionnaire concerned the respondents' level of experience in terms of emergency management. The reason for this question is that it might help the researcher to distinguish between answers from participants at various levels of seniority. The pie chart in Figure 6.5 explains that most participants (42.68%) had a high level of experience, followed by 23.17% of participants who had a medium level of experience. Then, 17.07% of participants had a very high experience level, while 13.41% of participants had a low experience level, and, finally, 3.66% had a very low experience level. This supported the questionnaire's validity as most of the participants had a high level of experience in the emergency management field.

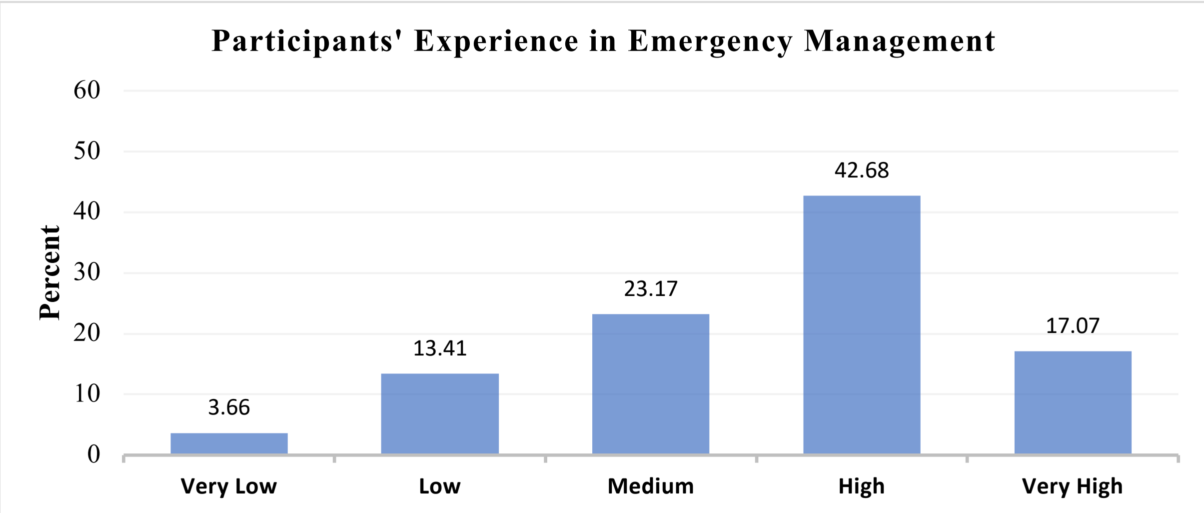

Figure 6.5: Participants' experience level in emergency management in percentage.

6.5 Descriptive Statistics

This section describes statistics for the perceptions scale regarding community flood resilience factors in order to achieve research objective three. In the questionnaire survey, participants were asked to indicate the level of importance of identified factors within four dimensions of resilience: physical, institutional, social and economic. The five-point Likert scale is applied in each question with 1 indicating 'not important', 2 representing 'slightly important', 3 representing 'moderately important', 4 representing 'important' and 5 indicating "'very important'. The weighted mean values were calculated for each factor for a better comparison of the importance of these factors. To calculate the mean values, the sum of responses number multiplied by the related response weight, which is representing from 1 to 5, divided by the total responses **82**, as clarified in Tables 6.6 – 6.10. This process enabled the researcher to compare the key factors in terms of their importance. A factor was considered to be important if ≥ 60% of the respondents found it to be important (options from 3-5). In addition, factors with a standard deviation of nearly 0 reveal a strong consensus in the panel, while those with a standard deviation of 1.5 or higher had low agreement (Goldman et al., 2008). Moreover, the interquartile range (IQR) of factors was also calculated to determine the level of consensus between the panel members. Rayens and Hahn (2000) recognised that an IQR of 20% of the rating scale would be appropriate for consensus, and thus an IQR ≤ 1 could be treated in this study as a strong consensus regarding the five-point Likert scale.

6.5.1 Physical Resilience Factors

The statistics for the key factors of community flood resilience in terms of the physical dimension are described in this section. The results showed that most of the 82 participants considered these key factors to be very important: 'infrastructure' (61%), 'building design' (53.7%), 'building condition' (58.5%) and 'location of built environment' (57.3%). It was also found that the highest rated of all factors was 'infrastructure' with a mean value of 4.46. This was followed by 'location of built environment' with a mean value of 4.38, while 'building condition' had a mean value of 4.35, and 'building design' factor has the lowest mean value of 4.30. Moreover, the standard deviation values for factors were less than 1, ranging from 0.773 to 0.908, while the interquartile range (IQR) of all factors was equal to 1. Thus, there is an agreement between participants on the importance of the key factors in terms of the physical dimension. These results are shown in Table 6.6 below.

Table 6.6: Descriptive statistics for physical resilience factors.

Factor	Not Important	Slightly Important	Moderately Important	Important	Very Important	Mean	Std Deviation	IQR	Rank
infrastructure	0	2	8	22	50	4.46	0.773	1	1
	0	2.4%	9.8%	26.8%	61%				
Building Design	0	4	11	23	44	4.30	0.885	1	4
	0	4.9%	13.4%	28%	53.7%				
Building Condition	0	5	9	20	48	4.35	0.908	1	3
	0	6.1%	11%	24.4%	58.5%				
Location of built environment	0	3	10	22	47	4.38	0.841	1	2
	0	3.7%	12.2%	26.8%	57.3%				

6.5.2 Institutional Resilience Factors

For the institutional dimension, the statistics of the main factors related to community flood resilience are described in this section. The highest mean of all the factors was 4.46 for 'emergency planning', and the lowest was 3.89 for 'community engagement'. Moreover, the standard deviation values for the factors in this dimension varied between 0.757 and 1.197, while the interquartile range (IQR) of all criteria was equal to 1. Hence, participants had a good agreement on the importance of community flood resilience factors in terms of the institutional dimension. These results are shown in Table 6.7.

Table 6.7: Descriptive statistics for institutional resilience factors.

Factor	Not Important	Slightly Important	Moderately Important	Important	Very Important	Mean	Std Deviation	IQR	Rank
Standards and regulations	0	3	14	26	39	4.23	0.865	1	3
	0%	3.7%	17.1%	31.7%	47.6%				
Emergency planning	0	2	7	24	49	4.46	0.757	1	1
	0%	2.4%	8.5%	29.3%	59.8%				
Institutional coordination	1	6	14	23	38	4.11	1.018	1	7
	1.2%	7.3%	17.1%	28%	46.3%				
Staff training and education	0	5	12	21	44	4.27	0.930	1	2
	0%	6.1%	14.6%	25.6%	53.7%				
Flood risk assessment	1	5	14	22	40	4.16	1.000	1	4
	1.2%	6.1%	17.1%	26.8%	48.8%				
Community engagement	4	8	15	21	34	3.89	1.197	1	8
	4.9%	9.8%	18.3%	25.6%	41.5%				
Knowledge and experience	0	7	10	29	36	4.15	0.944	1	5
	0%	8.5%	12.2%	35.4%	43.9%				
Roles and responsibilities	2	5	13	24	38	4.11	1.042	1	6
	2.4%	6.1%	15.9%	29.3%	46.3%				

6.5.3 Social Resilience Factors

This section describes the key factors of community flood resilience in respect of the social dimension. The results showed that the highest rated of all factors was "'flood awareness' with a mean value equal to 4.26. This was followed by 'social structure' with a mean value of 4.05, while 'community demography' had a mean value of 3.49. And, finally, the 'community faith' factor had the lowest mean value of 2.73, which indicates that it is considered to be a slightly important factor. Moreover, the standard deviations for the factors were between 0.900 and 1.199, and the interquartile range (IQR) of all criteria was equal 1. Therefore, there is a consensus among participants on the significance of the identified factors. These results are demonstrated in Table 6.8 below.

Table 6.8: Descriptive statistics for social resilience factors.

Factor	Not Important	Slightly Important	Moderately Important	Important	Very Important	Mean	Std Deviation	IQR	Rank
Social Capital	2	5	11	33	31	4.05	0.993	1	2
	2.4%	6.1%	13.4%	40.2%	37.8%				
Community demography	6	10	24	22	20	3.49	1.199	1	3
	7.3%	12.2%	29.3%	26.8%	24.4%				
Flood awareness	0	4	13	23	42	4.26	0.900	1	1
	0%	4.9%	15.9%	28%	51.2%				
Community faith	9	25	30	15	3	2.73	1.007	1	4
	11%	30.5%	36.6%	18.3%	3.7%				

6.5.4 Economic Resilience Factors

Table 6.9 illustrates the main factors of community resilience to pluvial flood regarding the economic dimension. These are: country's economic condition, income situation, diversity of economic resources and flood insurance. It was found that the highest mean value was 4.26 for 'country's economy', while the lowest mean value was 3.90 for 'income situation'. The standard deviation values were less than 1.5 for all factors and they ranged from 0.914 to 1.050, while the interquartile range (IQR) of all criteria was equal to 1. Hence, it can be said that participants had a good agreement on the significance of the economic resilience factors.

Table 6.9: Descriptive statistics for economic resilience factors.

Factor		Not Important	Slightly Important	Moderately Important	Important	Very Important	Mean	Std Deviation	IQR	Rank
Country economy		0	5	11	24	42	4.26	0.914	1	1
		0%	6.1%	13.4%	29.3%	51.2%				
Income situation		3	6	13	34	26	3.90	1.050	1	4
		3.7%	7.3%	15.9%	41.5%	31.7%				
Diversity of economic resources		2	4	16	23	37	4.09	1.033	1	2
		2.4%	4.9%	19.5%	28%	45.1%				
Flood insurance		2	6	12	33	29	3.99	1.012	1	3
		2.4%	7.3%	14.6%	40.2%	35.4%				

It can be concluded that Table 6.10 clarifies the descriptive statistics for all the main factors within the four dimensions of resilience in this research. Based on the mean values, the findings demonstrated that the factors 'infrastructure' and 'emergency planning' had a mean value equal to 4.46 and they are ranked as the highest mean values. In contrast, the factor "'religious belief (faith)' was rated as the lowest mean value (2.73). Moreover, the criteria standard deviations values were less than 1.5, which clarifies that the participants reached a good consensus on the importance of these factors.

Table 6.10: Descriptive statistics for all main factors.

Descriptive Statistics								
	N	Range	Minimum	Maximum	Mean	Median	Std. Deviation	Rank
Infrastructure	82	3	2	5	4.46	5	.773	**1**
Building design	82	3	2	5	4.30	5	.885	**5**
Building condition	82	3	2	5	4.35	5	.908	**4**
Location of built environment	82	3	2	5	4.38	5	.841	**3**
Standards and regulations	82	3	2	5	4.23	4	.865	**9**
Emergency planning	82	3	2	5	4.46	5	.757	**2**
Institutional coordination	82	4	1	5	4.11	4	1.018	**13**

Staff training & education	82	3	2	5	4.27	5	.930	**6**
Flood risk assessment	82	4	1	5	4.16	4	1.000	**10**
Community engagement	82	4	1	5	3.89	4	1.197	**18**
Knowledge & experience	82	3	2	5	4.15	4	.944	**11**
Roles and responsibilities	82	4	1	5	4.11	4	1.042	**12**
Social capital	82	4	1	5	4.05	4	.993	**15**
Community demography	82	4	1	5	3.49	4	1.199	**19**
Flood awareness	82	3	2	5	4.26	5	.900	**7**
Religious belief (faith)	82	4	1	5	2.73	3	1.007	**20**
Country economy	82	3	2	5	4.26	5	.914	**8**
Income situation	82	4	1	5	3.90	4	1.050	**17**
Diversity of economic resources	82	4	1	5	4.09	5	1.033	**14**
Flood insurance coverage	82	4	1	5	3.99	4	1.012	**16**
Valid N (listwise)	**82**							

6.6 Inferential Statistics

Inferential statistics enable researchers to evaluate their ability for drawing conclusions beyond immediate data. The use of such statistical tests allows researchers to identify if a sample reflects the population or if two or more groups of factors are different or if two or more variables (factors) are related. They are used to test the strength and significance of the relationships between the variables (Saunders et al., 2009). In other words, inferential statistics are applied to evaluate the associations between factors in a study, then to generalise and predict how the variables will contribute to a larger population (Russo, 2004; O'leary, 2005). They can be used to investigate research questions, hypotheses and models in order to achieve research objectives. Therefore, in this research, inferential statistics seek to fill gaps identified from the literature review and provide a robust analysis of study outcomes. While the purpose of this chapter is to examine and analyse key factors that were identified in the qualitative data analysis (Chapter 5), the following types of inferential statistics tests will be used to examine the relationships between factors: Spearman’s correlation, Chi-square and Kruskal-Wallis tests.

6.7 Spearman’s Correlation Coefficient

The Spearman’s correlation coefficient rho is an example of a non-parametric test. Its purpose is to examine the direction and strength of the relationship between two factors through using SPSS software (Fellows and Liu, 2003; Xu et al., 2010). It was assumed that the null hypothesis (no statistical relationship between two key factors) was rejected if $p < 0.05$.

6.7.1 Physical Resilience Factors

A Spearman's correlation coefficient rho was performed to examine the association between physical resilience factors. The findings showed that all of these factors had a positive correlation. They varied from a moderate correlation where the ρ-value was equal to 0.05, to a significant correlation where the ρ-value was less than 0.01. According to the analysis, there was a significant positive correlation between factors 'infrastructure' and 'building design' (rs= .265, ρ = 0.001, 2-tailed). Moreover, the 'building design' factor showed a significant correlation with 'building condition' (rs= .426, ρ = 0.000, 2-tailed), and 'location of built environment' (rs= .317, ρ = 0.004, 2-tailed), while the 'building condition' factor expressed a significant correlation with 'location of built environment' (rs= .471, ρ = 0.000, 2-tailed), which means that the null hypothesis was rejected. However, there was no significant correlation between 'infrastructure' and 'building condition' (rs= .206, ρ = 0.064, 2-tailed), and 'infrastructure' and 'location of built environment' (rs= .14, ρ = 0.21, 2-tailed), which indicates that the null hypothesis was retained. These results are revealed in Table 6.11 below.

Table 6.11: Correlations of physical resilience factors.

Correlations			**Capacity of infrastructure**	**Building design**	**Building condition**	**Location of built environment**
Spearman's rho	**Capacity of infrastructure**	Correlation Coefficient	1	**.265***	0.206	0.14
		Sig. (2-tailed)	.	0.001	0.064	0.21
		N	82	82	82	82
	Building design	Correlation Coefficient	**.265***	1	**.426****	**.317****
		Sig. (2-tailed)	0.016	.	0	0.004
		N	82	82	82	82
	Building condition	Correlation Coefficient	0.206	**.426****	1	**.471****
		Sig. (2-tailed)	0.064	0	.	0
		N	82	82	82	82
	Location of built environment	Correlation Coefficient	0.14	**.317****	**.471****	1
		Sig. (2-tailed)	0.21	0.004	0	.
		N	82	82	82	82

6.7.2 Institutional Resilience Factors

It can be seen from Table 6.12 that there was a positive correlation between all community flood resilience factors regarding the institutional dimension. However, there was a difference in the significant correlation between some factors. For example, according to the statistical analysis, the factors ‘standard and regulations’ showed a significant correlation with ‘emergency planning’, ‘coordination and collaboration’, ‘flood risk assessment’ and ‘community engagement’. However, there was no significant correlation between ‘standards and regulations’ and ‘staff education and training’ (rs= 0.216, ρ = 0.051, 2-tailed), ‘knowledge and experience’ (rs= .155, ρ = 0.164, 2-tailed) and ‘roles and responsibilities’ (rs= .069, ρ = 0.537, 2-tailed). Moreover, it was found that four factors, ‘emergency planning’, ‘collaboration and coordination’, ‘flood risk assessment’ and ‘community engagement’, expressed a significant correlation with all the remaining institutional resilience factors, which means that the null hypothesis was rejected.

Table 6.12: Correlations of institutional resilience factors.

Correlations			**Standards and regulations**	**Emergency planning**	**Institutional collaboration and coordination**	**Staff education and training**	**Flood risk assessment**	**Community engagement**	**Knowledge and experience**	**Roles and responsibilities**
Spearman's rho	**Standards and regulations**	Correlation Coefficient	1	**.496****	**.263***	0.216	**.231***	**.283****	0.155	0.069
		Sig. (2-tailed)	.	0	0.017	0.051	0.037	0.01	0.165	0.537
		N	82	82	82	82	82	82	82	82
	Emergency planning	Correlation Coefficient	**.496****	1	**.576****	**.379****	**.391****	**.530****	**.418****	**.402****
		Sig. (2-tailed)	0	.	0	0	0	0	0	0
		N	82	82	82	82	82	82	82	82
	Institutional collaboration and coordination	Correlation Coefficient	**.263***	**.576****	1	**.614****	**.628****	**.728****	**.584****	**.554****
		Sig. (2-tailed)	0.017	0	.	0	0	0	0	0
		N	82	82	82	82	82	82	82	82
	Staff training and education	Correlation Coefficient	0.216	**.379****	**.614****	1	**.655****	**.548****	**.529****	**.549****
		Sig. (2-tailed)	0.051	0	0	.	0	0	0	0
		N	82	82	82	82	82	82	82	82
	Flood risk assessment	Correlation Coefficient	**.231***	**.391****	**.628****	**.655****	1	**.632****	**.584****	**.725****
		Sig. (2-tailed)	0.037	0	0	0	.	0	0	0
		N	82	82	82	82	82	82	82	82
	Community engagement	Correlation Coefficient	**.283****	**.530****	**.728****	**.548****	**.632****	1	**.767****	**.686****
		Sig. (2-tailed)	0.01	0	0	0	0	.	0	0
		N	82	82	82	82	82	82	82	82
	Knowledge and experience	Correlation Coefficient	0.155	**.418****	**.584****	**.529****	**.584****	**.767****	1	**.624****
		Sig. (2-tailed)	0.165	0	0	0	0	0	.	0
		N	82	82	82	82	82	82	82	82

	Roles and responsibilities	Correlation Coefficient	0.069	**.402****	**.554****	**.549****	**.725****	**.686****	**.624****	1
		Sig. (2-tailed)	0.537	0	0	0	0	0	0	.
		N	82	82	82	82	82	82	82	82

6.7.3 Social Resilience Factors

The results in Table 6.13 showed a strong and positive correlation between the main social resilience factors to enhance community resilience to pluvial floods. The significant value (ρ-value) is almost 0.000, which is less than .01, and so it can be said that there is a significant correlation between all the social resilience factors. Based on the correlation analysis, there was a significant positive correlation between the factors 'social capital' and 'community demography' (rs= .706, ρ = 0.000, 2-tailed), 'public awareness' (rs= .388, ρ = 0.000, 2-tailed) and 'religious belief (faith)'' (rs= .342, ρ = 0.002, 2-tailed). Thus, the null hypothesis was rejected.

Table 6.13: Correlations of social resilience factors.

Correlations			Social Capital	Community Demography	Public Awareness	Religious Belief (Faith)
Spearman's rho	Social capital	Correlation Coefficient	1	**.706****	**.388****	**.342****
		Sig. (2-tailed)	.	0	0	0.002
		N	82	82	82	82
	Community demography	Correlation Coefficient	**.706****	1	**.498****	**.447****
		Sig. (2-tailed)	0	.	0	0
		N	82	82	82	82
	Flood awareness	Correlation Coefficient	**.388****	**.498****	1	**.578****
		Sig. (2-tailed)	0	0	.	0
		N	82	82	82	82
	Religious belief (faith)	Correlation Coefficient	**.342****	**.447****	**.578****	1
		Sig. (2-tailed)	0.002	0	0	.
		N	82	82	82	82

6.7.4 Economic Resilience Factors

In terms of economic resilience variables, the analysis clarified a strong and positive correlation between the main social resilience factors to improve community flood resilience. There was a significant correlation between all social resilience factors as the significant value (ρ-value) was less than 0.01. For example, a significant positive correlation was found between factors 'country economy' and 'income situation' (rs= .649, ρ = 0.000, 2-tailed), "'diversity of economic resources' (rs= .640, ρ = 0.000, 2-tailed) and 'flood insurance' (rs= .506, ρ = 0.000, 2-tailed), which means that the null hypothesis was rejected. These results are displayed in Table 6.14 below.

Table 6.14: Correlations of economic resilience factors.

Correlations			**Country Economy**	**Income situation**	**Diversity of economic resources**	**Flood insurance coverage**
Spearman's rho	**Country economy**	Correlation Coefficient	1	**.649****	**.640****	**.506****
		Sig. (2-tailed)	.	0	0	0
		N	82	82	82	82
	Income situation	Correlation Coefficient	**.649****	1	**.776****	**.451****
		Sig. (2-tailed)	0	.	0	0
		N	82	82	82	82
	Diversity of economic resources	Correlation Coefficient	**.640****	**.776****	1	**.449****
		Sig. (2-tailed)	0	0	.	0
		N	82	82	82	82
	Flood insurance coverage	Correlation Coefficient	**.506****	**.451****	**.449****	1
		Sig. (2-tailed)	0	0	0	.
		N	82	82	82	82

Table 6.15 shows all the key factors identified in this research. It can be concluded that this test helps to examine the direction and strength of the relationship between identified factors. It showed that a significant correlation existed between some factors, while there were no significant relationships among others. Moreover, Table 6.15 demonstrates that there were positive and negative correlations between community flood resilience factors. This is because of differences and similarities in addressing and rating these factors within different dimensions. For example, a significant correlation was found between 'infrastructure' and 'public awareness' (rs= .310, ρ = 0.005, 2-tailed). However, as the ρ value was larger than 0.05, there was no significant relationships between 'infrastructure' and other factors such as: 'standards and regulations', 'emergency planning', 'income situation' and 'social structure'. It is important to note that the findings indicated mostly significant and positive correlations between the main identified factors within each resilience dimension. Therefore, these key factors are crucial to achieve community flood resilience, and they will be beneficial in developing the assessment framework for this study.

Table 6.15: Correlations matrix for all community flood resilience factors.

Spearman's rho Correlations																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.Capacity of infrastructure	**Correlation Coefficient**	1.000	.265*	0.206	0.140	0.070	-0.123	-0.030	-0.002	-0.020	0.061	0.087	-0.079	0.141	0.159	.310**	.267*	0.176	0.015	0.080	-0.038
	Sig. (2-tailed)		0.001	0.064	0.210	0.531	0.273	0.792	0.989	0.859	0.585	0.439	0.483	0.207	0.154	0.005	0.015	0.113	0.892	0.473	0.737
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
2.Building design	**Correlation Coefficient**	.265*	1.000	.426**	.317**	0.208	0.086	0.092	-0.053	-0.046	0.127	0.149	-0.084	-0.045	0.010	0.164	0.177	0.138	0.194	0.148	-0.150
	Sig. (2-tailed)	0.016		0.000	0.004	0.061	0.440	0.410	0.635	0.682	0.254	0.181	0.452	0.689	0.932	0.141	0.111	0.217	0.081	0.183	0.179
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
3.Building condition	**Correlation Coefficient**	0.206	.426**	1.000	.471**	0.137	0.045	-0.028	-0.108	-0.197	-0.036	0.036	-.245*	0.000	0.102	0.070	0.187	0.056	0.182	0.051	-0.004
	Sig. (2-tailed)	0.064	0.000		0.000	0.221	0.687	0.806	0.333	0.075	0.748	0.747	0.026	0.999	0.362	0.534	0.092	0.618	0.102	0.646	0.970
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
4.Location of built environment	**Correlation Coefficient**	0.140	.317**	.471**	1.000	0.090	0.206	.242*	0.065	0.135	0.166	.300**	0.002	0.148	0.163	.326**	0.165	0.198	0.159	0.150	0.132
	Sig. (2-tailed)	0.210	0.004	0.000		0.423	0.064	0.028	0.559	0.228	0.137	0.006	0.988	0.185	0.145	0.003	0.140	0.075	0.153	0.178	0.239
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
5.Standards and regulations	**Correlation Coefficient**	0.070	0.208	0.137	0.090	1.000	.496**	.263*	0.216	.223*	.283**	0.182	0.069	0.058	0.054	.252*	0.217	0.133	0.057	0.109	-0.041
	Sig. (2-tailed)	0.531	0.061	0.221	0.423		0.000	0.017	0.051	0.044	0.010	0.103	0.537	0.602	0.627	0.022	0.051	0.233	0.614	0.330	0.713
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
6.Emergency planning	**Correlation Coefficient**	-0.123	0.086	0.045	0.206	.496**	1.000	.576**	.379**	.448**	.530**	.418**	.402**	0.203	0.094	.247*	.319**	.362**	.312**	.348**	0.215
	Sig. (2-tailed)	0.273	0.440	0.687	0.064	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.068	0.399	0.025	0.003	0.001	0.004	0.001	0.053
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
7.Institutional collaboration and coordination	**Correlation Coefficient**	-0.030	0.092	-0.028	.242*	.263*	.576**	1.000	.614**	.638**	.728**	.544**	.554**	.285**	.236*	.339**	.229*	.330**	.237*	.261*	0.155
	Sig. (2-tailed)	0.792	0.410	0.806	0.028	0.017	0.000		0.000	0.000	0.000	0.000	0.000	0.009	0.033	0.002	0.039	0.002	0.032	0.018	0.166
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
8.Staff training & education	**Correlation Coefficient**	-0.002	-0.053	-0.108	0.065	0.216	.379**	.614**	1.000	.609**	.548**	.529**	.549**	.421**	.323**	.367**	.279*	0.188	0.142	0.191	0.121
	Sig. (2-tailed)	0.989	0.635	0.333	0.559	0.051	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.003	0.001	0.011	0.091	0.204	0.085	0.278
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
9.Flood risk assessment	**Correlation Coefficient**	-0.020	-0.046	-0.197	0.135	.223*	.448**	.638**	.609**	1.000	.687**	.556**	.708**	.403**	.309**	.353**	.257*	.251*	0.096	0.212	.221*
	Sig. (2-tailed)	0.859	0.682	0.075	0.228	0.044	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.005	0.001	0.020	0.023	0.390	0.056	0.046
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
10.Community engagement	**Correlation Coefficient**	0.061	0.127	-0.036	0.166	.283**	.530**	.728**	.548**	.687**	1.000	.752**	.686**	.437**	.372**	.430**	.279*	.417**	.384**	.377**	.316**
	Sig. (2-tailed)	0.585	0.254	0.748	0.137	0.010	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.001	0.000	0.011	0.000	0.000	0.000	0.004
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
11.Knowledge and experience	**Correlation Coefficient**	0.087	0.149	0.036	.300**	0.182	.418**	.544**	.529**	.556**	.752**	1.000	.584**	.473**	.344**	.389**	.235*	.410**	.415**	.375**	.361**

	Sig. (2-tailed)	0.439	0.181	0.747	0.006	0.103	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.002	0.000	0.034	0.000	0.000	0.001	0.001
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
12.Roles and responsibilities	**Correlation Coefficient**	-0.079	-0.084	-.245*	0.002	0.069	.402**	.554**	.549**	.708**	.686**	.584**	1.000	.386**	.249*	.348**	0.113	.251*	.239*	.224*	.239*
	Sig. (2-tailed)	0.483	0.452	0.026	0.988	0.537	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.024	0.001	0.312	0.023	0.030	0.043	0.031
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
13.Social structure	**Correlation Coefficient**	0.141	-0.045	0.000	0.148	0.058	0.203	.285**	.421**	.403**	.437**	.473**	.386**	1.000	.706**	.388**	.342**	.349**	.270*	0.214	.348**
	Sig. (2-tailed)	0.207	0.689	0.999	0.185	0.602	0.068	0.009	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.002	0.001	0.014	0.054	0.001
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
14.Community demography	**Correlation Coefficient**	0.159	0.010	0.102	0.163	0.054	0.094	.236*	.323**	.309**	.372**	.344**	.249*	.706**	1.000	.498**	.447**	.427**	.327**	.353**	.327**
	Sig. (2-tailed)	0.154	0.932	0.362	0.145	0.627	0.399	0.033	0.003	0.005	0.001	0.002	0.024	0.000		0.000	0.000	0.000	0.003	0.001	0.003
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
15.Public awareness	**Correlation Coefficient**	.310**	0.164	0.070	.326**	.252*	.247*	.339**	.367**	.353**	.430**	.389**	.348**	.388**	.498**	1.000	.578**	.613**	.373**	.384**	.304**
	Sig. (2-tailed)	0.005	0.141	0.534	0.003	0.022	0.025	0.002	0.001	0.001	0.000	0.000	0.001	0.000	0.000		0.000	0.000	0.001	0.000	0.005
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
16.Religious belief (faith)	**Correlation Coefficient**	.267*	0.177	0.187	0.165	0.217	.319**	.229*	.279*	.257*	.279*	.235*	0.113	.342**	.447**	.578**	1.000	.571**	.397**	.460**	.477**
	Sig. (2-tailed)	0.015	0.111	0.092	0.140	0.051	0.003	0.039	0.011	0.020	0.011	0.034	0.312	0.002	0.000	0.000		0.000	0.000	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
17.Country economy	**Correlation Coefficient**	0.176	0.138	0.056	0.198	0.133	.362**	.330**	0.188	.251*	.417**	.410**	.251*	.349**	.427**	.613**	.571**	1.000	.649**	.640**	.506**
	Sig. (2-tailed)	0.113	0.217	0.618	0.075	0.233	0.001	0.002	0.091	0.023	0.000	0.000	0.023	0.001	0.000	0.000	0.000		0.000	0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
18.Income situation	**Correlation Coefficient**	0.015	0.194	0.182	0.159	0.057	.312**	.237*	0.142	0.096	.384**	.415**	.239*	.270*	.327**	.373**	.397**	.649**	1.000	.776**	.451**
	Sig. (2-tailed)	0.892	0.081	0.102	0.153	0.614	0.004	0.032	0.204	0.390	0.000	0.000	0.030	0.014	0.003	0.001	0.000	0.000		0.000	0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
19.Diversity of economic resources	**Correlation Coefficient**	0.080	0.148	0.051	0.150	0.109	.348**	.261*	0.191	0.212	.377**	.375**	.224*	0.214	.353**	.384**	.460**	.640**	.776**	1.000	.449**
	Sig. (2-tailed)	0.473	0.183	0.646	0.178	0.330	0.001	0.018	0.085	0.056	0.000	0.001	0.043	0.054	0.001	0.000	0.000	0.000	0.000		0.000
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82
20.Flood insurance coverage	**Correlation Coefficient**	-0.038	-0.150	-0.004	0.132	-0.041	0.215	0.155	0.121	.221*	.316**	.361**	.239*	.348**	.327**	.304**	.477**	.506**	.451**	.449**	1.000
	Sig. (2-tailed)	0.737	0.179	0.970	0.239	0.713	0.053	0.166	0.278	0.046	0.004	0.001	0.031	0.001	0.003	0.005	0.000	0.000	0.000	0.000	
	N	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82	82

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

6.8 Chi-Square of Independence Test

The Chi-square test of independence (Pearson Chi-square test) is used when the data is nominal or ordinal, and also it proposes to analyse the association between two sets of data (variables) (Naoum, 2002). In this section, the analysis was performed to identify the relationships between the first three factors in each resilience dimension (based on descriptive analysis (mean value)) and key survey demographics (participants' job titles). It was assumed that the null hypothesis (no statistical association between independent variables and dependent variables) was rejected if $p < 0.05$. Six job titles were identified in the survey, namely: engineer, emergency manager, branch manager, section manager, department manager, and others.

A. Relationship between participants' job titles and physical resilience factors for effective community flood resilience.

Table 6.16 illustrates that there was no relationship between participants' job titles and the main three physical resilience factors. The Pearson Chi-square values for 'infrastructure' were χ^2=18.914, ρ=0.218, for 'building condition' they were χ^2=14.160, ρ=0.513, and for 'location of built environment' they were χ^2=12.709, ρ=0625. The results indicated that the ρ values were higher than the significance level ρ<=0.05, and that means there is no statistical association between participants' job titles identified in the survey and how physical resilience factors are rated in the UAE. Thus, the null hypothesis was retained.

Table 6.16: Chi-square test compares participants' jobs and physical resilience factors.

Physical resilience factors	df	Pearson Chi-Square	Asymp. Sig. (2-sided)
Capacity of infrastructure	15	18.914	0.218
Building condition	15	14.160	0.513
Location of built environment	15	12.709	0.625

B. Relationship between participants' job titles and institutional resilience factors for effective community flood resilience.

The main three variables in institutional resilience based on descriptive analysis are: 'emergency planning', 'staff training and education' and 'standards and regulations'. It can be noted from Table 6.17 that there was no relationship between participants' job titles and three institutional resilience factors. The Pearson Chi-square values for 'emergency planning' were χ^2=8.799, ρ=0.888, for staff training and education' they were χ^2=22.143, ρ=0.104 and for ‘standards and regulations’ they were χ^2=13.708, ρ=0.548. Because ρ> 0.05, there is no relationship between participants’ job titles and the evaluation of institutional resilience factors in the UAE. Thus, the null hypothesis was retained.

Table 6.17: Chi-square test compares participants’ jobs and institutional resilience factors.

Institutional resilience factors	df	Pearson Chi-Square	Asymp. Sig. (2-sided)
Emergency planning	15	8.799	0.888
Staff training and education	15	22.143	0.104
Standards and regulations	15	13.708	0.548

C. Relationship between participants’ job titles and social resilience factors for effective community flood resilience.

Table 6.18 demonstrates again that there was no statistical relationship between participants’ job titles and the main social resilience factors except for the ‘public awareness’ factor. The Pearson Chi-square values for ‘public awareness’ were χ^2=29.262, ρ=0.015, for ‘social structure’ they were χ^2=31.317, ρ=0.051 and for ‘community demography’ they were χ^2=20.018, ρ=0.457. At a significant level ρ<=0.05, there is only statistical association between participants’ job titles and public flood awareness, and thus, the null hypothesis was rejected. This means that the public flood awareness factor within the UAE is an important factor in enhancing community flood resilience, and it is associated with participants’ jobs identified in the survey, where higher community floods awareness improves communities’ ability to manage these hazards and quick recovery.

Table 6.18: Chi-square test compares participants’ jobs and social resilience factors.

Social resilience factors	df	Pearson Chi-Square	Asymp. Sig. (2-sided)
Flood awareness	15	29.262	0.015
Social capital	20	31.317	0.051
Community demography	20	20.018	0.457

D. Relationship between participants' job titles and economic resilience factors for effective community flood resilience.

It can be inferred from Table 6.19 that there was no statistical association among participants' jobs and economic resilience factors. The Pearson Chi-square values for 'country economy' were χ^2=6.241, ρ=0.975, for 'diversity of economic resources' they were χ^2=13.148, ρ=0.871, and for 'flood insurance coverage' they were χ^2=26.142, ρ=0.161. Hence, the results indicated that ρ values were greater than the significance level 0.05, which means there is no statistical relationship between the main three economic resilience factors and participants' job titles in the UAE. Thus, the null hypothesis was retained.

Table 6.19: Chi-square test compares participants' jobs and economic resilience factors.

Economic resilience factors	df	Pearson Chi-Square	Asymp. Sig. (2-sided)
Country economy	15	6.241	0.975
Diversity of economic resources	20	13.148	0.871
Flood insurance coverage	20	26.142	0.161

6.9 Kruskal-Wallis H Test

The Kruskal-Wallis test was performed to investigate any significant differences between two or more groups of participant organisations (independent variable) that are responsible for emergency management in Abu Dhabi city regarding the first three factors in each dimension of resilience (based on descriptive analysis (mean value)). The five participants' organisations identified in the survey were: Abu Dhabi Police, Abu Dhabi Civil Defence, Abu Dhabi Municipality, Abu Dhabi Distribution Company and NCEMA. It offers a non-parametric method to compare mean values of two or more independent random samples. The one-way analysis of variances was performed on key factors on the basis of the classification of governmental organisations. It was also used to examine any significant differences between different participants' organisations (independent variable) in the comparison of average values (McDonald, 2009). It was assumed that the null hypothesis (no significant difference among the five organisations) was rejected if $p < 0.05$, which indicates that some of the mean ranks differed statistically among those variables. However, it is important to know that the Kruskal-Wallis test cannot determine which particular groups of independent variables are different from others; it just indicates that at least two independent variables were different.

A. Physical Resilience Factors and Participants' Organisations (Statistical Differences)

The top three physical resilience factors identified in the descriptive analysis based on mean values were: 'infrastructure', 'location of built environment' and 'building condition'. The Kruskal-Wallis test was applied to evaluate the mean value of these three factors with more than two independent variables (participants' organisations). The participant's organisations were considered as independent variables, and physical resilience factors were used as dependent variables. The main information from the analysis outcomes was: Kruskal-Wallis H, degree of freedom (df) and significance level (Asymp. Sig). The results in Table 6.20 show that there was a statistically significant difference between the participant's organisations and 'location of built environment' H (4) = 19.444, ρ=0.001. However, The Kruskal-Wallis test for 'infrastructure' was H (4) = 4.383, ρ=0.357, and 'building condition' was H (4) = 6.146, ρ=0.188).

Table 6.20: Kruskal Wallis test of top three physical resilience factors in participants' organisations.

Test Statistics[a,b]			
	Infrastructure	Building condition	Location of built environment
Kruskal-Wallis H	4.383	6.146	19.444
df	4	4	4
Asymp. Sig.	.357	.188	.001

It can be concluded that based on significance level (ρ<=0.05), there is a significant difference among participant organisations classified in the survey and the assessment of the 'location of built environment' factor, which means the null hypothesis was rejected. This means that this factor is critical in achieving community resilience to pluvial floods. This is corroborated by Peacock et al. (2010) 's findings that people living near flood-prone areas are more likely to experience floods negative impacts. However, there is no significant difference among the five organisations which are involved in emergency management in the UAE and how infrastructure and buildings conditions factors were rated.

B. Institutional Resilience Factors and Participants' Organisations

Based on descriptive analysis, the top three factors according to mean value are: 'emergency planning', 'staff education and training', and 'standards and regulations'. The findings in Table 6.21 illustrated that that there was no statistically significant difference between the participant organisations and institutional resilience factors. The Kruskal-Wallis test for 'emergency planning' was H (4) = 7.676, ρ=0.104, for 'staff education and training' it was H (4)= 3.102, ρ=0.541, and for 'standards and regulations' it was H (4)= 7.281, ρ=0.122. At the significant level ρ<=0.05, there is no significant difference between the five organisations classified in the survey based on test score. Thus, there is no significant difference in the rating of institutional resilience factors across the five participant organisations which are involved in emergency management in the UAE. Thus, the null hypothesis was retained.

Table 6.21: Kruskal Wallis test of top three institutional resilience factors in participants' organisations.

Test Statistics[a,b]			
	Emergency planning	Staff training and education	Standards and regulations
Kruskal-Wallis H	7.676	3.102	7.281
df	4	4	4
Asymp. Sig.	.104	.541	.122

C. Social Resilience Factors and Participants' Organisations

For social resilience, the first three variables based on mean value are: 'flood public awareness', 'social structure' and 'community demography'. As clarified in Table 6.22, the outcomes demonstrated that there was a significant difference between the participant organisations and how some social resilience factors were evaluated. The Kruskal-Wallis test for 'public flood awareness' was H (4) = 29.923, ρ=0.000, for 'social structure' it was H (4) = 8.723, ρ=0.068, and for 'community demography' it was H (4) = 7.913, ρ=0.095. At the significant level ρ<=0.05, there is significant difference among participants' organisations classified in the survey when it comes to rating the 'flood awareness' factor in the UAE, and thus, the null hypothesis was rejected. This shows that the importance of flood awareness as the main social resilience factor to mitigate flood risks. This is supported by Alhmoudi (2016)'s findings which clarify that a higher community awareness of disasters leads to increase community resilience, which improves communities' ability to deal with these disasters and return to a normal situation. On the other hand, there is no significant difference among the five organisations in the UAE and how the 'social structure' and 'community demography' factors are assessed. Thus, the null hypothesis was retained.

Table 6.22: Kruskal Wallis test of top three social resilience factors in participants' organisations.

Test Statistics[a,b]			
	Flood awareness	Social capital	Community demography
Kruskal-Wallis H	29.923	8.723	7.913
df	4	4	4
Asymp. Sig.	.000	.068	.095

D. Economic Resilience Factors and Participants' Organisations

The main three variables in economic resilience based on mean values are: 'country economy', 'diversity of economic resources' and 'flood insurance coverage'. Table 6.23 shows that there was a significant difference among participant organisations and the evaluation of one economic resilience factor. The Kruskal-Wallis test for 'country economy' was H (4) = 19.482, ρ=0.001, for 'diversity of economic resources' it was H (4) = 8.650, ρ=0.070 and for 'flood insurance' it was H (4) = 7.043, ρ=0.134. Thus, there is a significant difference among participant organisations classified in the survey when it comes to rating the 'country economic condition' factor in the UAE, and thus, the null hypothesis was rejected. This means that the country's economy is an essential factor in the assessment framework that benefits building community resilience. Countries with a good economic condition have effective flood measures to prevent or mitigate flood impacts, and a quick recovery process. However, there is no significant difference across the five organisations in the UAE and how the 'diversity of economic resources' and 'insurance coverage' factors are rated. Thus, the null hypothesis was retained.

Table 6.23: Kruskal Wallis test of top three economic resilience factors in participants' organisations.

Test Statistics[a,b]			
	Country economy	Diversity of economic resources	Flood insurance coverage
Kruskal-Wallis H	19.482	8.650	7.043
df	4	4	4
Asymp. Sig.	.001	.070	.134

6.10 Chapter Summary

This chapter has presented quantitative data analysis and results. The findings of this chapter confirmed the qualitative data analysis of Chapter 4 and provided a broad view on the importance of the key factors on the extent to which physical, institutional, social and economic dimensions of resilience are important to build flood resilient community in the UAE. A total of 125 questionnaires were distributed to experts and employees from different management levels in five local authorities which are legally involved in and responsible for planning and responding to pluvial flood incidents in Abu Dhabi city. The response rate of participants recruited from these organisations was 65.6%, which represents 82 responses out of 125 questionnaires. Moreover, the value of Cronbach's alpha for the Reliability Test for all questionnaires (20 items) is 0.905, which falls under the 'excellent' category.

The survey results were presented using both descriptive and inferential statistics. Descriptive statistics were used to summarise the sample and measures using figures, numbers and tables. They help to classify the key factors that were identified based on mean values. The results showed that the majority of respondents (n=20; 24.39%) were from Abu Dhabi Police, and the minority (n=11), 13.41% were from NCEMA. According to the descriptive analysis, respondents were asked to rate the importance of the key physical resilience factors; 61% of respondents considered 'infrastructure' as a very important factor that influences community flood resilience in the UAE, with a mean value of 4.46. For institutional resilience, it was found that the highest mean rate of all the factors was 4.46 for 'emergency planning', with 59.8% of respondents seeing it as the most influential factor for building a flood-resilient community in the UAE. Moreover, the results indicated that the highest rated of all factors within social resilience was 'flood awareness', with a mean value of 4.26. While, in terms of economic resilience, 51.2% of respondents indicated that 'country's economic condition', with a mean value of 4.26, was the most significant factor for effective community flood resilience. Standard deviation and interquartile range (IQR) values indicated that participants were agreed on the importance of the key factors. This result confirmed and clarified problems and gaps identified earlier in this research.

Inferential statistics are also used to determine the strength of relationship within a sample and significant level. Several types of inferential analysis tests have been used: Spearman correlation test, Chi-square and Kruskal-Wallis test. Spearman correlation test was used to check the strength and direction of relationships between key factors. The results showed that there was a significant positive correlation between all community resilience factors within the same dimension of resilience. However, there was no significant association between some key factors within different resilience dimensions. The Chi-square test showed that there was no statistical association between participants' job titles identified in the survey and how the key factors within three resilience dimensions – physical, institutional and economic – are rated in the UAE. However, the findings also indicated that there was a statistical relationship between participants' job titles and the evaluation of the 'flood awareness' factor within the social resilience dimension in the UAE. Moreover, regarding Kruskal-Wallis test, there was a significant difference among the five participants' organisations identified in the survey which are involved in emergency management in the UAE and how some main factors within the four dimensions of resilience such as 'location of the built environment', 'flood awareness' and 'country economy', are rated to enhance community flood resilience. Therefore, the findings of this chapter and the development of the assessment framework to enhance community resilience to pluvial flood in the UAE are discussed in the next chapter.

CHAPTER 7: FRAMEWORK DEVELOPMENT & VALIDATION

7.1 Introduction

The aim of this study is to develop an assessment framework to enhance community resilience to pluvial floods in the UAE. This chapter is divided into three main sections, and it attempts to address the last objective of this study, which is "To develop and validate an assessment framework with related stakeholders in the UAE for effective community resilience to pluvial flood". The first section reflects the discussion of the qualitative and quantitative findings and their implications, associated with a comparison of what has been discussed in the literature. The second section presents the development of the conceptual framework for this study through implementing a weighting system for the identified dimensions and factors using the Analytic Hierarchy Process (AHP) as an effective method for developing a framework. Through a focus group method, and by using pairwise comparisons, experts' opinions were collected to assess and prioritise the process outputs. The weighting system provides a qualitative and quantitative assessment tool to assess community resilience to pluvial floods in the UAE and regions that have similar characteristics. The last section clarifies the validation of the suggested assessment framework that can be used by related local authorities in the UAE. This is an important step towards finalising the framework for ensuring its implementation in the UAE context.

7.2 Discussion of the Key Findings

The critical discussion of qualitative and quantitative data is focused on four key themes which were defined in the literature. This discussion demonstrates how the findings in this study and the related literature are different or similar. There are some similarities and differences between many studies regarding community resilience dimensions and related factors. It was found that the framework dimensions of this study are different to a number of current studies such as Mayunga (2007), Peacock et al. (2010), Cutter et al. (2010) and Chacowry (2014). However, these dimensions are in agreement with a number of other studies, including Ainuddin and Routray (2012) and Qasim et al. (2016), which consist of four main dimensions of resilience (physical, institutional, social and economic).

7.2.1 Physical Resilience

This dimension is essential in building resilient communities to natural disaster. It refers to the location of the built environment, properties and infrastructure such as critical facilities and lifeline services (Mayunga 2007; Peacock et al., 2010). Community physical resilience is crucial and needs to be maintained, where it is considered to be the first line of defence against flood disasters. According to the findings of this study, there are four key factors within the physical dimension that may help to build community flood resilience in the UAE. These main factors are infrastructure, location of the built environment, building condition and building design.

Infrastructure is one of the most influential factors within the physical resilience dimension (Mayunga 2007). Communities must have an effective infrastructure that can cope with flood disasters and recover quickly from their impact (Perera et al., 2010). Lack of physical infrastructure or critical facilities may directly influence a community's ability to respond to and adapt to these disasters (Peacock et al., 2010). Within the UAE context, it was found from the qualitative results that the availability of an integrated and effective infrastructure helps to protect communities and properties from flood risks. An effective infrastructure has a basic role in mitigating flood impacts. This was also confirmed by the quantitative results as the infrastructure factor achieved the highest rating among all physical resilience factors with a mean value of 4.46.

In particular, the results also clarified that the infrastructure factor covers multiple criteria including rainwater drainage system, critical infrastructure and facilities, and maintenance programmes. The rainwater drainage system is the main flood structural measure to mitigate flood risk. However, it was stressed that there is a need to improve the existing rainwater drainage network and construct a new one in some areas in the UAE. Moreover, it was found that the most effective way to build a more resilient community is to make its critical infrastructure and services robust through minimising loss or damage probability. For example, communities with a poor transportation network are expected to struggle to evacuate their people and thus to have a low level of resilience (Teo et al., 2015). An annual maintenance programme is another important sub-indicator to maintain the efficiency and effectiveness of infrastructure facilities such as rainwater drainage systems to mitigate pluvial floods. Thus, the findings are in the line with Peacock et al. (2010) and Alshehri (2016), who indicated that an appropriate infrastructure increases the ability of a community to reduce disaster impacts.

Location of built environment is another important factor in maintaining a community's ecological environment and protecting it against natural hazards that could decrease its resilience (Peacock et al., 2010). People living near flood-prone areas are more likely to experience floods, and this can lead to negative effects. In this study, it was found that the built environment's location is a critical measure to avoid and mitigate flood risk. Its related characteristics contribute to community survival and recovery. This is supported by most participants as they affirmed the importance of avoiding constructing in flood-prone areas as an essential step to protect community and facilities from flood risks. The outcomes of the questionnaire survey also confirmed that the second significant factor within the physical resilience dimension is location of the built environment with a mean value of 4.38. Therefore, this result supports many studies which disclosed that the more that construction in flood-prone areas is avoided, the greater the resilience for communities in terms of loss reduction and quick recovery from floods (Peacock et al., 2010; Alshehri, 2016; Almutairi, 2019).

Furthermore, the good condition of buildings and houses can have a positive influence on reducing flood risk, where buildings that are in a poor condition can easily be affected by floods as they are more vulnerable to natural disasters (Qasim et al., 2016). Buildings should be robust and maintained regularly in order to adapt to flood risk. With regard to this study, it was found that buildings in the UAE are mainly in a good condition, which reflects their ability to reduce flood impacts and improve community resilience. However, as explained by participants, it was affirmed that old buildings in the country require regular maintenance to protect communities from flood risks. The questionnaire results confirmed the importance of this factor as 58.5% of participants rated it as 'very important'. Therefore, this finding is in line with Qasim et al.'s (2016) study which explained that the building condition factor has significant influence on flood prevention, as new buildings are constructed from strong materials and with robust structures and foundations.

The final main factor within the physical resilience dimension is building design. Extreme climate events like flooding and earthquakes have recently placed new requirements on the design of houses and buildings to reduce their impacts by using mitigation measures such as land levelling, landscaping or water drainage design. The current design standards seek to reduce the potential of spiralling operational failure costs due to destructive events by choosing better building designs to improve resilience efficiency (Watson & Adams, 2010). The findings from this study showed that the design of buildings is essential to minimise the flood risk.

However, developments in design strategies are required in order to adapt to the flood risk as little attention has previously been paid to this risk due to the weather conditions in the country. This was also supported by the questionnaire findings which indicated that 53.7% of the participants rated the building design factor as 'very important' with a mean value equal to 4.30. Therefore, this finding is in agreement with Bowker's (2007) study, which emphasised that effective building design can obviously reduce flood consequences by taking the necessary flood mitigation measures such as building elevation by raising buildings up on pillars or having extended foundation walls or elevated earth structures or flotations.

7.2.2 Institutional Resilience

The institutional resilience dimension is one of the main aspects for adaptive capacity and overall community resilience through how the community is managed and controlled before, during and after disasters. It is considered to be the fundamental aspect of any community resilience framework. According to Bendimerad (2003), good governance is recognised as the foundation of the means and results of disaster risk reduction. It also includes preparation, mitigation and previous disaster experience elements. The absence of institutional provisions and standards may further influence community resilience in terms of facing climate change impacts and weather conditions. In this study, the results demonstrated that there are eight key factors within the institutional resilience dimension that help to enhance community flood resilience in the UAE. These main factors are: standards and regulations, emergency planning, institutional collaboration and coordination, staff education and training, flood risk assessment, community engagement, knowledge and experience, and roles and responsibilities.

The review of the literature has revealed the importance of standards and regulations as an institutional resilience factor which can enhance community disaster resilience. The qualitative findings of this study showed that regulations and standards are considered an essential factor to enhance the abilities of the UAE government through better preparing communities to deal with and mitigate flood risks. The current institutional regulations help to protect communities in the UAE from natural disasters such as floods through developing appropriate contingency plans and effective responses. However, there is a need to update the current regulations regularly and consider flood risks to manage any unexpected event as a result of climate change phenomena. The quantitative outcomes also supported that, as 46.3% of the participants considered it to be a 'very important' factor. Thus, this finding corresponds with studies by Pathirage et al. (2015) and Ortiz-de-Mandojana and Bansal (2016) that showed that poor building codes and standards make communities more vulnerable to flood risks. The implementation of land use plans and legislations for new developments should be carried out by the appropriate institutions to avoid flood risks through moving developments to safer areas and preserving the protective characteristics of the natural environment.

Emergency or disaster preparedness is known as a set of plans, decisions, exercises and actions that have been carried out to ensure the ability to deal with any emergencies or disasters (Kapucu & Özerdem, 2011). Many scholars have indicated that emergency planning is an essential process to manage emergencies effectively as it is subject to a wide range of varied activities designed to determine emergency response capability (Alexander, 2014; IEDC, 2016). In this study, evidence from qualitative results showed that appropriate emergency planning is a critical element to manage major emergencies such as natural hazards. Most participants confirmed that there is an emergency plan to prepare for any emergency or disaster such as flood in the country and it includes a response plan, evacuation and recovery plan, coordination meetings with stakeholders, and practical and theoretical exercises. Moreover, the results illustrated that the UAE government has adopted measures to prepare for flood risks, including flood forecasting and early warning. This helps the community to plan and act appropriately within an adequate amount of time to decrease the possibility of loss due to flood risk.

This was also confirmed by the quantitative results as the emergency planning factor achieved the highest rating among all institutional resilience factors (59.8% of participants rated is as a 'very important' factor) with a mean value equal to 4.46. Therefore, this finding is in accordance with studies by Rahman and Kausel (2013) and Alhamoudi (2016) which indicated that a community with robust warning and appropriate emergency planning demonstrates increased resilience as it is capable of dealing with incidents through better preparation and early warning of emergencies, which allows the efficient and timely response of individuals responding to an incident.

In relation to the institutional collaboration and coordination factor, the qualitative findings indicated that coordination between governmental bodies has an effective role to play in managing flood risks and any emergency event. For operations and effectiveness, coordination between different organisations is essential as effective emergency response requires frequent cooperative efforts between various stakeholders. The participants clarified that there is continuous coordination with all concerned stakeholders including those in the private sector such as contractors. However, the level of coordination between local authorities needs many improvements as some organisations have their own standards, procedures and plans to manage emergencies. Likewise, this is supported by the quantitative findings as 28% of participants rated this factor as ‘important’ and 46.3% as ‘very important’. This is supported by different studies such as Mohanty et al. (2006, Kusumasari et al. (2010) and Alshamsi (2017), which affirmed that coordination between stakeholders has been described as an emergency management factoring issue. In order to extract regional best practices and coping mechanisms, the connections between all organisations working on emergency management need to be improved and strengthened. Coordination at various levels should be considered, including local, national, regional and international levels.

In addition, staff training and education is another institutional factor highlighted in the review of the literature and in the qualitative and quantitative findings. This factor was revealed as an important factor for enhancing community resilience in the UAE. Training of emergency management professionals is considered to be the most effective way to deal with and avoid accidents and emergencies that may occur at anytime and anywhere unexpectedly. Institutions need to implement training and education programmes related to the disaster management field to develop capacity and knowledge related to disaster management initiatives. It was found that most participants termed staff training and education as one of most successful measures to deal effectively with flood risks. Regular training procedures are conducted by governmental officials including at the local level and federal level in the UAE.

Nevertheless, there was a gap identified by a number of participants on training procedures on the specific type of risk, especially flood events. This was also evidenced from the quantitative findings, which revealed that 25.6% of participants rated this factor as ‘important’ and 53.7% rated it as ‘very important’ with a mean value equal to 4.27. Thus, as was evidenced from the literature, the development of situation awareness among employees allows them to be more conscious of their capacity and performance to address potential problems (Bullough et al., 2014). This can be achieved by offering them the necessary education and training on a variety of disaster prevention and control skills. Various studies have reported a number of training issues, for example, the lack of support and knowledge among participants (Nazli et al., 2014; Sharma et al., 2015). Moreover, it may be argued that it is difficult to design ideal emergency training programmes, since the training programmes are based on country circumstances, availability of resources, the type of danger and the response system priorities.

Regarding the flood risk assessment factor, it assesses the level of flood risk to a community through evaluating damages or losses that might occur to houses, infrastructure or assets as a result of pluvial floods. This factor was highlighted in both qualitative and quantitative findings as an important factor to minimise flood risk. According to the qualitative findings, the UAE authorities assess flood damage by visual observation through a committee of experts from different local organisations to estimate the losses' cost and decide on the damage reconstruction required. Moreover, the quantitative results stressed the importance of this factor, as 26.8% of participants rated it as 'important' and 48.8% valued it as 'very important' with a mean value equal to 4.16. This result is also supported by the literature, as risk assessment is focused generally on evaluation and control of flood mitigation activities, appropriate allocation of resources and flood management strategies (Hall et al., 2003).

Furthermore, community engagement is recognised by participants as an important factor to mitigate flood risks. Developing individual and community engagement in flood risk management is considered to be a significant approach by local authorities to mitigate flood risks. The qualitative findings showed that there is a need to work with communities in the UAE before, during and after flood events at a meaningful level to reduce and minimise the impacts of pluvial floods as communities are the first risk responders. This was also confirmed by the quantitative results as 25.6% of participants evaluated this factor as 'important' and 41.5% as 'very important'. This finding is in accordance with studies by Oloruntoba (2015), Moe and Pathranarakul (2006) and Alshehri (2016), which indicated that a community's capacity to reduce risk is influenced by its ability to engage its members in risk mitigation systems in order to develop connections with institutions for protecting the social system and building a resilient community. Local communities should be allowed to participate in the process of decision making and local experts should be used.

As another important factor related to knowledge and experience, it is important to consider that an increase in knowledge and experience of staff members leads to achieving the desire goals through mitigating flood risks. The qualitative results clarified that knowledge and experience is an important skill and it is considered to be a main factor to improve community resilience to pluvial floods in the UAE. The quantitative findings were similar, as most participants emphasised the importance of the knowledge and experience factor (35.4% of participants evaluated this factor as ‘important’ and 43.9% as ‘very important’) as well as for successful operations and to enhance community flood resilience. This is in accordance with the findings from the literature, which indicated that emergency staff members are able to know what needs to be done and predict what could happen in the future if they have adequate experience and knowledge. Moreover, emergency management experts should be treated as key staff members for training development, in which their experience and knowledge leads to increasing the effectiveness of team training plans by providing useful guidance and assessment (Hosseini and Izadkhah, 2010; Mishra, 2014).

The factor ‘roles and responsibilities’ is the final one in this study within the institution resilience dimension. It is important to organise and arrange roles and responsibilities between the concerned stakeholders. The qualitative results showed that the participants emphasised that well-defined roles and responsibilities help to raise the level of preparedness to flood risks through better arrangement between stakeholders. However, as indicated by participants, there is a degree of overlapping roles and responsibilities among stakeholders in the UAE to respond to and recover flood incidents, which represents a real challenge to enhance community resilience to floods. Moreover, the quantitative findings revealed that this factor has been recognised as an important factor to minimise flood risk (35.4% of participants evaluated this factor as ‘important’ and 43.9% as ‘very important’). This finding agrees with a study by the OHFS (2006), which explained that local organisations should simplify and arrange stakeholders' roles and responsibilities in order to prevent confusion and overlap. Blurring roles could lead to a duplication of certain activities that waste resources and can potentially cost lives, while other vital activities could be neglected or overlooked.

7.2.3 Social Resilience

Social resilience is an important component in developing community resilience frameworks (Cutter et al., 2010; Poortinga, 2012; Joerin et al., 2012, Ainuddin & Routray, 2012; Alshehri, 2016). This represents community interaction or social cohesion which offers an effective disaster safety net and often allows people to access available resources (Walter, 2004). Social resilience in other words relates to the features that comprise a community's physical, social and cultural structure and its relationship with building resilient communities (Teo et al., 2015). The results of the qualitative and quantitative data in this study showed that there are four main factors within the social dimension to enhance community flood resilience in the UAE. These main factors are: public flood awareness, social structure, community faith or religious beliefs and community demography.

The review of the literature and analysis identified the importance of public awareness as the main social resilience factor to avoid and mitigate flood risks. Raising disaster awareness is important step to inculcate disaster preparedness, prevention and mitigation in a community's members. With a lack of knowledge, individuals become more vulnerable, while communities need to be effectively strengthened to deal with disasters in order to minimise any losses (Shiwaku & Shaw, 2008). Higher community awareness of disasters leads to increase the level of community disaster resilience, which is more likely to improve the ability of communities to deal with a disaster and return to a normal situation. This can be achieved by providing appropriate education and training on how to reduce the potential risk of disasters (Izadkhah & Hosseini, 2005). In recent years, the rise of natural hazards in the UAE together with the lack of public awareness have increased the need for and significance of disaster management training and preparation for communities. Appropriate information, skills and technology have led to the provision of valuable knowledge about disaster risk reduction for the benefit of community members, stakeholders, organisations and policy makers (Alhmoudi, 2016). This information should be disseminated to citizens in relevant formats and in different languages at appropriate times to improve community resilience.

In this study, the qualitative findings showed that all participants emphasised that awareness is a critical measure which helps a community to avoid or mitigate flood risks. The awareness of a community about the DRR approach can be improved by different means such as seminars on awareness, lectures, training and sufficient dissemination of information across media and educational networks. However, there is a lack of public awareness about flood risks in the UAE because of many reasons such as diversity of citizens' cultures, lack of rain events, and the fact that only a few awareness programmes have been conducted by local authorities about flood risks. This is also supported by the quantitative results as the public awareness factor achieved the highest rating among all the social resilience factors (28% of participants rated this factor as 'important' and 51.2% as 'very important') with a mean value of 4.26. This finding is in agreement with recent studies (Peacock et al., 2010; Alshehri, 2016; Almutairi, 2019) which demonstrated that public awareness is the main factor in the social resilience aspect to enhance community disaster resilience through improving people's abilities to deal with disasters effectively.

Another important factor to enhance community flood resilience related to community social capital. Natural disasters studies have stressed the importance of social capital for better preparedness, response to and recovery from disasters (Islam & Walkerden, 2014). It relates to the nature and degree of connection and relationships between community members including families, friends, religious associations and working groups. During disaster events, community social capital networks offer access to several important resources such as information, assistance, childcare, financial resources and psychological support (Elliott, Haney & Sams-Abiodun, 2010).

Evidence from this study emphasised the importance of a community's social capital to mitigate flood hazards. It was found that most participants stressed that social capital can help to reduce flood impacts and increase recovery times through strong community relationships and effective communications. Generally, local communities in the UAE have strong social structures in terms of relationships because of religious and traditional aspects. Most citizens are Muslims and Islam encourages them to have a strong brotherhood between community members and to help each other, especially in extreme events, and that helps to improve community resilience towards disasters. However, the diversity of the UAE populations, where more than 200 nationalities are living in the country and most of them are classified as labourers, creates a substantial challenge in terms of connections and relationships between community members. The quantitative results also supported the qualitative results as the social structure factor was considered to be a significant factor in building resilient communities (40.2% of participants evaluated this factor as 'important' and 37.8% as 'very important'). This result agrees with studies by Aldrich (2011) and Islam and Walkerden (2014), which clarified that communities with strong bonding and linking ties are more resilient to disasters than communities without these links.

Furthermore, the function of the demographic characteristics of a community is an important factor to build community resilience. Many studies have suggested that communities with a lower percentages of elderly people are more resilient to disasters. This can be linked to several causes, including the ability of a younger population with a small proportion of disabled people to learn about and access appropriate disaster-coping information (Mayunga, 2007). Moreover, it was emphasised that educated and male individuals can help to improve community planning and become more resilient to natural disasters. However, communities with a higher percentage of women and old or unemployed people in the overall population as well as a lower education level would be more vulnerable to disasters, with lower resilience than communities with different characteristics (Cutter et al., 2010; Ludin et al., 2019). This agrees with the qualitative findings in this study which demonstrated that well-educated people and people without physical and mental disabilities may have an appropriate ability to prepare for flood risk and quick recovery in the UAE. It was also affirmed by the quantitative findings as the community demography factor was considered to be an important factor (26.8% of participants rated this factor as 'important' and 24.4% as 'very important').

The final main factor in this study within social resilience was faith or religious beliefs. This factor can play an important role in engaging community members and building disaster resilience. The role of religion in disasters has been increasingly emphasised in several disaster management studies (Johakim & White, 2015; Gianisa & Le De, 2018). This is important as the UAE is an Islamic country that has a high level of religious faith. In fact, some researchers have indicated that religious beliefs may raise public awareness of the likelihood of disasters (Johakim & White, 2015). In comparison, many authors have argued that believing God's power to be a reason for natural disaster can be also a key factor in disaster vulnerability since it causes a low awareness level of disasters (Gaillard and Texier, 2010). Religious non-governmental organisations (NGOs) can improve the community's ability to withstand disasters as demonstrated by several Muslim and Christian NGOs in the field of disaster management in many regions around the world. These organisations often gain local communities' trust, which can be used to increase awareness about the risk of disasters (Clarke, 2008).

Although there was some evidence in the qualitative analysis that there was no relationship between religious beliefs and community resilience, the results also indicated that religious belief or community faith has a positive impact on community resilience to flood risks in the UAE, as Islam teaches people the value of performing good actions especially in disaster conditions. The General Authority for Islamic Affairs and Endowments works to raise awareness and understanding of Islamic teachings, which encourages citizens to cope with and manage these natural hazards to protect lives and livelihoods. However, because of the diversity of the UAE population, there was little evidence on the role of faith for disaster resilience in poor communities, where some people from developing countries believe that natural disasters are an act of God and they should not take necessary actions to mitigate and avoid risk. This was supported by the quantitative findings which showed that this factor has been recognised as a moderately important factor to minimise flood risks (30.5% of participants evaluated this factor as 'slightly important' and 36.6% as 'moderately important'). This finding is broadly in alignment with Alshehri's (2016) study in Saudi Arabia which showed that Islam urges people to be able to avoid and manage natural disasters, and people are generally willing to deal with these disasters in a positive way.

7.2.4 Economic Resilience

Economic resilience is an essential dimension to assess community resilience since it improves the capacity of individuals and communities to cope with the impact of flood disasters and speed up the recovery process. People with adequate earnings and the ability to access to financial resources can recover quicker from disaster impacts than those without these resources (Walter, 2004; Qasim et al., 2016). In other words, a community with a higher percentage of high-income residents has sufficient money to spend on disaster absorption, response and recovery (Yoon et al., 2016). The economic aspect deals with the economic issues of the affected area. By adapting mitigation strategies aimed at reducing the likelihood of failure, the role of economic resilience in lessening financial losses due to disasters can be achieved (Rose, 2004). The findings from this study showed that there were four main factors within the economic dimension to build community flood resilience in the UAE. These main factors are: country's economy, community income situation, diversity of economic resources and flood insurance coverage.

The country's economy is an important factor to build communities that are resilient to disasters. It reflects positively on community resilience to flood risks, where countries with a good economic situation can have appropriate flood preparedness, effective flood measures to prevent or mitigate flood impacts, and a quick flood recovery process. However, developing countries (low-income countries) are particularly vulnerable to disasters due to their dependence on primary exports, their history, inequality and poverty, limited physical and social infrastructure, inappropriate land use, and limitations in public administration and governance (Pelling & Uitto, 2001). Additionally, as indicated by Bowen et al. (2012), developing countries experience challenges related to rising population growth rates. The findings of this study agreed with the literature as the UAE has an excellent economy (the second-strongest economy in the Arab world) and that helps the country to implement flood measures, such as appropriate infrastructure and effective emergency and recovery plans, for better preparation and quick recovery from floods. Moreover, the quantitative outcomes also affirmed the importance of this factor as it achieved high consensus from the participants (29.3% of participants rated this factor as ‘important’ and 51.2% as “’very important’) with a mean value equal to 4.26. Thus, this finding is in agreement with Pelling & Uitto, (2001) study. In relation to the community income situation, it helps a community to increase its level of preparedness and speed up the recovery process for flood risks. A community with high-income residents can have a sufficient budget to absorb, respond to and recover from flood risks (Yoon et al., 2016). Evidence has shown that low-income people are particularly vulnerable to extreme weather conditions due to insufficient housing quality, poor environmental conditions and economic insecurity. Natural hazards also threaten local economies through stopping people from getting to work and even completely destroying small businesses (Ross, 2013). Investment in communities with lower incomes is therefore necessary to ensure their economic development and thereby improve their capacity to cope with natural hazards. Similarly, the outcomes of this study revealed that people in the UAE generally have a good income and that increases their ability to take all the flood measures necessary to protect themselves and their homes. The quantitative results also emphasised the significance of this factor as it achieved a high agreement level between participants (41.5% of participants ranked this factor as ‘important’ and 31.7% as ‘very important’) with a mean value equal to 3.9.

Furthermore, the review of the literature and analysis identified the significance of diversity of community resources to absorb and cope with flood risks. It has a clear influence on community disaster resilience, where communities with several income resources have the ability to adapt to and recover from natural hazards. Moreover, economic diversity has helped communities cope with the downturn following a flood and has speeded their return to long-term work trends and income growth (Xiao & Drucker, 2013). In contrast, communities with less diversified income sources cannot easily recover from the effects of a hazard. The degree and the variety of income sources may be considered to be a vulnerability indicator where it is hypothesised that the greater the income resources, the greater the resilience (Adger, 2000). With regard to this study, it was found that the availability of different economic resources has a positive and significant influence on economic growth which will help to improve community resilience to floods through developing flood preparedness and recovery levels. Currently, the UAE has both short-term and long-term plans to enhance its economy through significantly focusing on different economic resources (not only on oil as the main resource). Also, the quantitative outcomes indicated that the diversity of community economic resources was considered to be an important factor (28% of participants ranked this factor as ‘important’ and 45.1% as ‘very important’) with a mean value equal to 4.09. Hence, this finding is in in alignment with Xiao & Drucker (2013) study.

The final key factor within economic resilience was flood insurance coverage. Researchers and policy makers have advocated that communities purchase flood insurance as a way to secure more extensive insurance cover for those at risk. However, purchasing flood insurance remains low in many areas at risk of flooding, reducing its effectiveness as a resource to improve community resilience. Through speeding recovery and reducing the impact of hazards, flood insurance improves the resilience of communities and individuals. Insurance speeds up the recovery process by making funds available for reconstruction immediately after a flood. This actually helps the individual household to recover but, since more households and businesses have insurance, the whole community recovers more rapidly. Self-insurance may also be preferable, particularly for low- and moderate-income households whose savings may not be sufficient for them to recover from significant damage, and whose failure to insure can impose costs on their communities (FEMA, 2011; Kousky & Shabman, 2015).

Similarly, in this study, it was found that flood insurance coverage for people and properties is a significant element in the UAE as it helps communities who are at risk to quickly recover by providing the healthcare and essential payments needed for quick recovery. However, it was noted that most UAE properties are not insured against flood damage as insurance companies in the region generally do not offer specific insurance against flooding because of the dry weather conditions in the country. Thus, there is a need to review the current insurance policies and regulations for all natural hazards including floods in the country, so that these hazards are mitigated and quickly recovered from. The quantitative findings also empathised the importance of this factor, where 40.2% of the participants ranked it as ‘important’ and 35.4% as ‘very important’.

7.3 Development of the Conceptual Framework

To develop the CRPF framework, the researcher has adopted a sequential mixed-methods (qualitative and quantitative data analysis) involving: a literature review, semi-structured interviews, questionnaire survey and Analytic Hierarchy Process (AHP) (as mentioned in Chapter 4). The assessment framework aims to assess and enhance community resilience to pluvial floods in the UAE. In fact, an appropriate understanding of community resilience helps to effectively assess the impact of any disaster. This would benefit decision makers and communities to develop policies and plans for effective management of various disaster phases including: preparedness, mitigation, response and recovery (Ewing & Synolakis, 2011). Nevertheless, as Kirmayer et al. (2009) noted, it is crucial to assess resilience over time in order to ensure that the resilience measures are always updated, as the characteristics of a region can differ from time to time since they are based on several physical, structural, social and economic factors. In addition, many studies have shown that the framework that is adopted for assessing the resilience of a community is specifically designed for the area under investigation (Gou & Lau, 2014, Seinre et al., 2014). The available frameworks were found to be designed for specific areas that faced particular hazards, and, although they are overlapping in several measures, their applicability is also different. These frameworks were considered inappropriate for application in the context of the UAE. Hence, it is crucial to develop a new framework to assess community resilience to pluvial floods faced by the UAE and similar Gulf regions.

In this study, the development of the CRPF framework is structured into three main stages. The first stage, as explained in Chapter 4, included semi-structured interviews with people from the top management level from related local authorities to gather qualitative data. The second stage contained quantitative data collection through a questionnaire survey distributed to stakeholders' employees to examine and analyse the identified factors regarding community flood resilience in the UAE. The results of the qualitative and quantitative data, with the literature review, allowed the researcher to explore and analyse key factors under four main dimensions. In the final stage, a focus group was conducted with a panel of experts in the field of emergency management to gather data in order to address the following research question: "What is the most applicable weighting system of identified factors for appropriate assessment of community resilience to pluvial floods in the UAE?". It focuses on using the AHP technique to determine the weight of dimensions and factors based on their importance. The AHP was used because of its beneficial features, such as the ability to organise and analyse complex decisions by evaluating quantitative and qualitative data (Wedley, 1990). This was applied by a rating system of 1 to 9, so that qualitative data collected from the focus group technique could be converted into quantitative data. At the end, the framework for assessment of community flood resilience was finalised, where dimensions and their related factors were used to develop the framework.

7.4 Prioritising and Weighting Community Flood Resilience Factors

7.4.1 The AHP process

A focus group method was implemented to collect the required data to facilitate the AHP process. As discussed in the methodology chapter, a focus group is a qualitative research method where selected respondents are asked about their expectations, values, attitudes and opinions about a topic, and this method has become popular among social science academics (Creswell, 2012). It can produce large amounts of data over a relatively short period, and the results can allow researchers to proceed with quantitative procedures (Rabiee, 2004). Like one-to-one interviews, the focus group outcomes can be uncomplicatedly interpreted with lay terms backed by participants' quotations. According to Glitz (1997), the focus group typically includes 6 to 10 participants who have the appropriate knowledge and experience in the topic.

Since the knowledge and experience of selected participants are important elements when conducting an AHP method, a group of **10 government officials** with experience in the field of emergency management from five mentioned government organisations in Abu Dhabi city have been chosen as an expert panel. These government orgnisations are Abu Dhabi Police, Abu Dhabi Civil Defence, Abu Dhabi Municipality, Abu Dhabi Distribution Company and NCEMA. The AHP is built on three basic principles: the principles of structuring hierarchy, the priorities setting principle and the logical consistency. Hence, it is important to gather experts' views using pairwise comparisons for prioritising and weighting dimensions and factors in order to develop the CRPF assessment framework. The panel of experts was invited from those involved in the initial survey in this study to avoid inconsistencies and contradictory information (Lin et al., 2010). There were two main requirements used to decide the selection of experts for the panel, as follows:

- The experts must have participated in the questionnaire survey of this study.
- The experts must have the appropriate knowledge and experience (at least 10 years of experience) in the field of emergency management.

There were two panel sessions held at the researcher's office during afternoon hours. Ten participants attended the first focus group session, and they were given printed materials in order to make a comparison between the four main dimensions using pairwise comparisons with the matrices used to determine the dimensions' weights of the community flood resilience in the UAE (see appendix D). The discussion between participants continued for approximately **1.5** hours until agreement in their judgements was reached. The second session was held for almost **1** hour with the same participants, and the aim of the second session was to determine the consistency of the judgements and to validate the findings. It is important to note that, during the two sessions, the researcher gave participants the opportunity for free discussion so as to make it possible for them to raise any issues that would be important for the study and thus to generate ideas and opinions.

7.4.2 Structuring the Hierarchy

As clarified in the methodology chapter, pairwise comparisons were used to compare and prioritise the various resilience dimensions of the assessment framework. They were discussed with the expert panel until consensus was reached on the importance of each resilience dimension. The consistency ratio (CR) was used to determine the responses' dependability and to check whether the values measured were accurate or not. If the value of CR above 0.1, it suggests that the findings were not consistent and so the results lack reliability. Then, the factors' weights and group consensus were determined using Excel software.

The issue related to decision making must be simplified and divided into three main levels during structuring hierarchy, namely: goal, criteria and sub-criteria (Ishizaka & Labib, 2009). These are represented by the AHP in the form of a three-level hierarchy. Figure 7.1 illustrates the components of community resilience to pluvial floods which are described in this study in a three-tier hierarchy in the AHP model, the first level being a problem-related goal. The second level is composed of four dimensions: physical, institutional, social and economic. In the third level, there are 20 key factors based on dimensions of resilience. All these criteria were explored by semi-structured interviews with top level management from concerned stakeholders in the UAE and they were further confirmed and validated by a questionnaire survey, as explained in chapters 5 and 6.

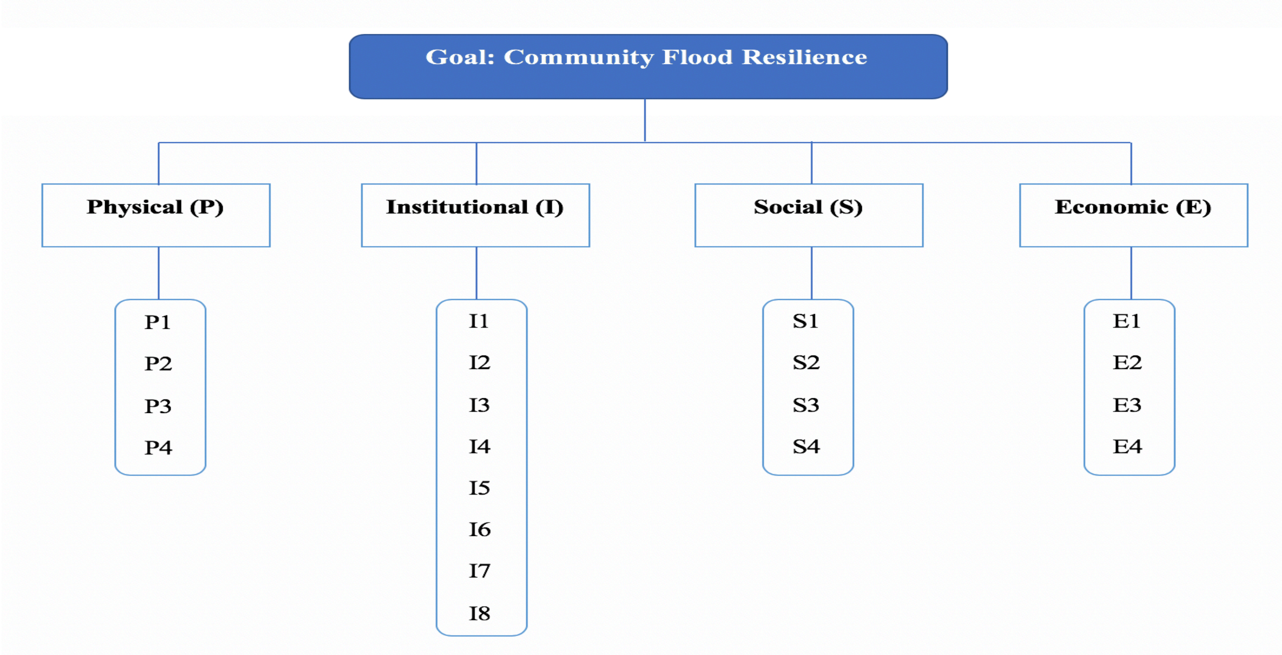

Figure 7.1: Overall hierarchical structure of the AHP.

7.4.3 Results and Discussion

When a new method for measuring community resilience is developed, weighting systems need to be adjusted to match local and regional priorities. According to Ameen and Mourshed (2019), the weighting system provides an effective way in which each community resilience criterion can be adequately allocated based on local preferences. In this study, firstly, a number of comparisons were conducted through consulting the expert panel by using 1-9 scales in order to determine the relative importance of the different dimensions to achieve the required goal (enhancing community flood resilience). It is important to note that, after a judgement is completed based on a dimension's importance, the values in the lower half of the diagonal are determined by using the following formula:

$a_{ji} = 1/\ a_{ij}$

Where 'i' and 'j' describe the columns and rows of the matrix and 'a' represents the cell value. An example is shown below in Table 7.1, where the expert panel has assigned a value of 2 to 'physical' compared with 'institutional' resilience, which suggests that the expert slightly prefer 'physical' over 'institutional'. The comparisons between dimensions in this matrix (Table 7.1) started Horizontally. Cells in the lower matrix triangle are just the inverse of the related cells in the upper triangle, and it equals 0.5=1/2.

Table 7.1: Results of the pairwise comparison matrix according to the expert panel's decision.

	Physical	Institutional	Social	Economic
Physical	1	2	3	3
Institutional	0.5	1	2	2
Social	0.33	0.5	1	0.5
Economic	0.33	0.5	2	1
Sum	2.17	4	8	6.5

Secondly, the above matrix needs normalisation first in order to find the dimension weights. This is shown in Table 7.2, where each cell element is divided by the sum of each column to determine the normalised value.

For example, the physical-social value is equal to 3, and, after normalisation, the value obtained is equal to 0.375, as shown in the Table 7.2. The normalised value is found by dividing the value 3 by the sum value 8 (3/8=0.375), and the same procedure is applied to all normalised values.

Thus, the dimension weight is equal to the average of the normalised values in each dimension. For example, the dimension weight for the physical component is equal to (0.462+0.5+0.375+0.462)/ 4 = 0.45, and same calculations were performed for the rest of the dimension weights.

Table 7.2: Normalisation of the pairwise matrix.

	Physical	Institutional	Social	Economic	Dimension weights
Physical	0.462	0.5	0.375	0.462	**0.45**
Institutional	0.231	0.25	0.25	0.308	**0.26**
Social	0.154	0.125	0.125	0.077	**0.12**
Economic	0.154	0.125	0.25	0.154	**0.17**

Thirdly, to examine the judgements' consistency, a Consistency Index (CI) is used which is calculated by the equation below:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Here λ_{max} represents the Eigen value, while 'n' describes the matrix size, which is equal to 4.

Table 7.3: Testing the consistency of the judgements.

	Physical	Institutional	Social	Economic	Weighted sum value	Ratio
Physical	0.450	0.519	0.361	0.512	1.841	4.091
Institutional	0.225	0.260	0.240	0.341	1.066	4.106
Social	0.150	0.130	0.120	0.085	0.485	4.037
Economic	0.150	0.130	0.240	0.171	0.691	4.047

To find λ_{max} value, the weighted sum values were calculated as shown in Table 7.3, which equalled the summation of unnormalised values multiplied by dimension weights, where the comparisons between dimensions in this matrix (Table 7.3) started vertically.

For example, in physical dimension column, the first physical-physical value is equal to unnormalised values (1) obtained from (Table 7.1) multiply by physical dimension weight (0.45) obtained from (Table 7.2) = 0.45. Similarly, physical to institutional value equal to unnormalised values (0.5)* physical dimension weight (0.45) = 0.225. Further, in social dimension column, social to institutional value equal to unnormalised values (2)* social dimension weight (0.12)= 0.240.

The same process was applied to the rest of the matrix values and the first weighted sum value for the physical dimension, for example, is equal to 0.450+0.519+0.361+0.512=1.841.

Then, the ratio value should be found which is equal to the weighted sum value divided by dimension's weight. For example, the first ratio value for physical dimension is equal to (1.841/0.45) = 4.091. Therefore, λ_{max} is equal to the average of four ratio values equal

λ_{max} = (4.091+4.106+4.037+4.047) / 4 = 4.072.

Consistency Index (CI) = (4.072-4) / (4-1) = 0.0239.

Finally, the Consistency Ratio, which is a comparison between the Consistency Index (CI) and the Random Consistency Index (RI), can be obtained by using the following equation:

CR= CI / RI

The Random Consistency Index (RI) is obtained from Table 7.4 (Saaty, 1990), where the size of matrix (number of dimensions) n = 4, so that RI = 0.90.

Table 7.4: Average random consistency (RI) (Saaty, 1990).

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Random Consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Therefore, it can be concluded that the consistency ratio value (CR) is equal to (0.0239 / 0.90) = **0.0266**, which is less than 0.1, and it means that the matrix is reasonably consistent and valid (Cutter et al., 2014; Salmeron & Herrero, 2005).

Therefore, the weights assigned for the dimensions were **0.45 + 0.26 + 0.12 + 0.17 = 1.000**. In terms of the resilience dimension, the findings illustrate that the physical resilience dimension had the highest weight, which represents 45% of the total weight of the hierarchy. Other resilience dimensions are weighted as follows: institutional dimension 26%, economic dimension 17%, and the social dimension is the lowest weighted dimension which represents 12%. To find the weights of criteria (factors) under each dimension, the equations explained in Chapter 4 were used in this research (Alshehri, 2016). The details of the weights allocation (WC) and proportions (P) taken by each factor within the related dimension are listed in Table 7.5 to Table 7.8. Therefore, they can be used to assess community resilience to pluvial floods within the UAE context.

A. Physical Resilience Dimension

The physical resilience dimension was calculated as the highest weighted dimension (0.45) in this study. Many studies have considered this dimension to be fundamental for increasing the adaptive capacity of communities to mitigate the impacts of future disasters (McDaniels et al., 2008; Longstaff et al., 2010). As revealed in Table 7.5, the associated proportions of the physical factors are between 0.246 and 0.255. The most critical factor to enhance community flood resilience in this dimension was 'infrastructure' with a weight value of 0.1146, which describes rainwater drainage networks and critical facilities that serve the whole community through mitigating flood impacts and returning the whole community to a normal level. This is closely followed by 'location of built environment' and "'building condition' with weights of 0.1126 and 0.1118 respectively. 'Building design' was the least important factor in this dimension with a weight of 0.1105. Thus, the results showed that all these factors are critical to enhance community resilience to pluvial floods in the UAE. The more effective these measures, the better the opportunity provided to communities to mitigate flood hazards.

Table 7.5: Factors weighting for the physical resilience dimension.

Dimension	Code	Criteria (Factor)	ρ	WC	WC%
Physical	P1	Infrastructure	0.255	0.1148	11.48
	P2	Building design	0.246	0.1107	11.07
	P3	Building condition	0.249	0.1120	11.20
	P4	Location of built environment	0.250	0.1125	11.25
Sum			**1.000**	**0.45**	**45**

B. Institutional Resilience Dimension

Table 7.6 demonstrates the institutional resilience dimension, which has the second highest weight of 0.180, and the key factors. The relative importance of each criterion (proportion) was indicated as being between 0.117 and 0.134. It was found that the most important factor in this dimension is 'emergency planning' with a weight of 0.0347. This confirmed that the availability of an emergency plan will improve emergency preparedness and response, therefore allowing communities to quickly recover from a disaster. Moreover, early warning and flood forecasting help to inform citizens about floods that could happen, and that allows them to make better preparations and responses. However, the result also showed that the 'community engagement' factor had the lowest importance level with a weight of 0.0303. These findings are consistent with other studies that affirm the significance of the institutional resilience dimension in adapting to and managing flood risks (Ahrens & Rudolph, 2006; Lebel et al., 2006; Alshehri, 2016). This means that these key factors are significant to achieve community flood resilience in the UAE.

Table 7.6: Factors weighting for the institutional resilience dimension.

Dimension	Code	Criteria (Factor)	ρ	WC	WC%
Institutional	I1	Standards and regulations	0.127	0.0329	3.29
	I2	Emergency planning	0.134	0.0347	3.47
	I3	Institutional coordination	0.123	0.0320	3.20
	I4	Staff training and education	0.128	0.0332	3.32
	I5	Flood risk assessment	0.125	0.0324	3.24
	I6	Community engagement	0.117	0.0303	3.03

	I7	Knowledge and experience	0.124	0.0323	3.23
	I8	Roles and responsibilities	0.123	0.0320	3.20
Sum			**1.000**	**0.26**	**26**

C. Social Resilience Dimension

Table 7.7 displays the social resilience dimension that has the lowest weight (0.12) from the AHP approach and involves key factors with proportions between 0.188 and 0.293. 'Flood awareness' is the most significant criterion within this dimension with a weight of 0.0352. Thus, awareness allows people to better prepare for and respond to flood risk, which increases the resilience of communities. These results are in agreement with many studies which indicated that higher levels of disaster awareness led to increasing the community's preparedness level and enables them to cope with these disasters and have a quick recovery from them (Izadkhah & Hosseini, 2005). Moreover, Ainuddin and Routray (2012) and Qasim et al. (2016) used risk awareness as an important measure to evaluate community resilience levels. Thus, the appropriate preparation for flood risks through better awareness levels benefits a community by enabling it to reduce the potential damages and losses, which represents greater resilience. The findings also indicated that 'community faith' factor was less important compared with other social resilience factors with the lowest weight of 0.0226. This means that this factor was less critical in achieving community flood resilience in the UAE.

Table 7.7: Factors weighting for the social resilience dimension.

Dimension	Code	Criteria (Factor)	ρ	WC	WC%
Social	S1	Social capital	0.279	0.0335	3.35
	S2	Community demography	0.240	0.0289	2.89
	S3	Flood awareness	0.293	0.0352	3.52
	S4	Community faith (religion)	0.188	0.0226	2.26
Sum			**1.000**	**0.12**	**12**

D. Economic Resilience Dimension

As shown in Table 7.8, the economic resilience dimension has a weight of 0.17 from the AHP approach. The proportion column (ρ) shows the associated proportions of criteria ranging from 0.240 to 0.262. Although the weighing values for all factors are very close, the most important is 'country's economy, with a score of 0.0448, while 'community income situation' is the lowest at 0.0410. These findings are in line with some studies which show that economic resilience factors are crucial in assessment of community resilience to deal with disasters (Peacock et al., 2010; Alshehri, 2016). Hence, these key factors are essential in building community resilience to pluvial floods in the UAE.

Table 7.8: Factors weighting for the economic resilience dimension.

Dimension	Code	Criteria (Factor)	ρ	WC	WC%
Economic	E1	Country's economy	0.262	0.0448	4.48
	E2	Community income situation	0.240	0.0410	4.10
	E3	Diversity of economic resources	0.252	0.0430	4.30
	E4	Flood insurance	0.246	0.0419	4.19
Sum			**1.000**	**0.17**	**17**

It can be concluded that the CRPF framework provides an assessment tool to evaluate the community resilience level to cope with flood risks in the UAE. The purpose of using the AHP is to ensure that the CPRF framework is completed by providing weighted scores for its four main dimensions and associated factors to be used for community resilience measuring in the context of the UAE. Resilience dimensions were assigned a weighting through pairwise comparisons, and the final weighting for each dimension is: 45% for the physical dimension, 26% for the institutional dimension, 17% for the economic dimension and 12% for the social dimension. This framework is considered to be the first step needed to assess and build community flood resilience in the UAE. Figure 7.2 illustrates the final outcome of the CRPF framework to assess community resilience to pluvial floods in the UAE.

In order to facilitate the calculation process and provide results, the final weight for each dimension is presumed to be 100%. Thus, to calculate the new community resilience score, the new weighing for each factor can be obtained by multiplying the criteria weight from AHP percentage with the percentage of criteria that represent the current status, as shown in Figure 7.2. For example, if the assessment of current infrastructure in the UAE is 80%, then the new weighting for the infrastructure factor is equal to (0.8 * 0.1148= 0.0918); and this process is applied for all remaining factors in order to calculate the total score of the current community resilience to pluvial flood. The findings of the CRPF framework can be shown on a spider diagram representing the relative importance of the four resilience dimensions and key factors.

CRPF Framework

Physical	WC%	New WC%	Social	WC%	New WC%
Infrastructure (P1)	11.48	New	Social Capital (S1)	3.35	New
Building design (P2)	11.07	New	Community Demography (S2)	2.89	New
Building condition (P3)	11.20	New	Flood awareness (S3)	3.52	New
Location of built environment (P4)	11.25	New	Community faith (S4)	2.26	New
Total	**45**	**New**	**Total**	**12**	**New**

Institutional	WC%	New WC%
Standards and regulations (I1)	3.29	New
Emergency planning (I2)	3.47	New
Institutional coordination (I3)	3.2	New
Staff training and education (I4)	3.32	New
Flood risk assessment (I5)	3.24	New
Community engagement (I6)	3.03	New
Knowledge and experience (I7)	3.23	New
Roles and responsibilities (I8)	3.2	New
Total	**26**	**New**

Ecomomic	WC%	New WC%
Country economy (E1)	4.48	New
Community income situation (E2)	4.10	New
Diversity of economic resources (E3)	4.30	New
Flood insurance (E4)	4.19	New
Total	**17**	**New**

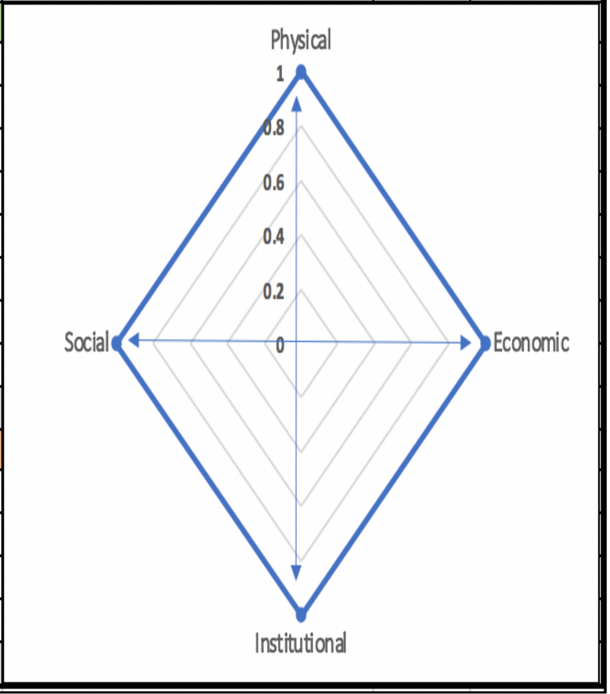

Figure 7.2: The CRPF framework to assess community flood resilience in the UAE.

It is important to note that each community has special characteristics, including geographic, socio- cultural, political and economic, which may influence its level of resilience (Tam et al., 2013). The interrelationship between community individuals can be both multifaceted and frequently changing. This relates to the criteria importance for a community as a reason of the variability in application of the framework between different communities. This weakness can be overcome by identifying specific community criteria.

7.5 Community Resilience Benchmarks

The use of benchmarks is a crucial step to assess the level of community disaster resilience (Doyle, 1996; Sharifi, 2016). Cutter et al (2010) mentioned that through defining baseline measurement (benchmark), changes in community resilience can be monitored in particular places over time and compared from one location to another. Hence, there is a need to identify benchmark resilience scores for the CRPF framework to evaluate community flood resilience in the UAE.

Some studies have employed percentages to assess community resilience as Benchmark Resilience Scores, while others used values from 1 to 5 or 0 to 1. For example, Alshehri (2016) and Almutairi (2019) suggested scales ranging from 0 to 5 that could be used to provide completed evaluation of community resilience based on five levels as follows: 5 represents excellent resilience (81–100%), 4 indicates very good resilience (61–80%), 3 represents good resilience (41–60%), 2 reveals fair resilience (21–40%), and 1 indicates poor resilience (1–20%), and 0 indicates that there is no resilience. Other studies have suggested different Benchmark Resilience Scores based on percentage between 0% and 100% in five levels to assess an organisation's resilience (Stephenson et al., 2010). Score ratings between 81% and 100% are the highest and display an excellent resilience, while score ratings less than 49% represent the lowest resilience. Therefore, this study suggests five resilience scores adapted Alshehri (2016) and Almutairi (2019) studies.

Table 7.9 illustrates the community resilience which contains five levels ranging from a score of 0 to 1 (0 to 100%). For example, a community with a score of 0 means that the resilience is missing, and that community is highly vulnerable to flooding. Also, when community resilience is measured as below 21% (score <= 0.2), it will be classified as having 'poor resilience', and measures need to be developed to improve its resilience, while a community at a level of 21% to 40% (score 0.2-0.4) will be recognised as having 'fair resilience', which indicates that the resilience level is between low to medium. Moreover, when a community measures between 41% and 60 % (score 0.41- 0.6), it will be considered as having 'good resilience', where the community at this level has a moderate resilience to floods. A community assessed as between 61% and 80% (score 0.61- 0.8) will be classified as having 'very good resilience', which means that the community has a high level of resilience at that point and is capable of coping well with flood risks. Finally, if a community is rated between 81% and 100% (score 0.81-1), it will be recognised as having 'excellent resilience', which reveals that the level of resilience is great, and the community has the ability to cope effectively with flood risks.

Therefore, benchmark resilience scores for the CRPF framework were identified to assess the community flood resilience in the context of the UAE (Table 7.9). The scores reflect the amount of work required to identify and strengthen the underlying criteria. The CRPF framework was then developed to assess community resilience to pluvial floods in the UAE, and it is based on the application of the four main dimensions and 20 factors. It helps to assess and enhance community resilience to pluvial floods by determining the strengths and weaknesses for each identified factor.

Table 7.9: Benchmark resilience scores of the CRPF framework.

Score	Resilience Status	Description
0	Absence of resilience R=0	Resilience is missing at this level, which makes the community highly vulnerable to flood risks. This level indicates an immediate need to identify resilience measures for enhancing community flood resilience.
0.2	Poor 1% < R < 20%	Resilience is low and the community is still highly vulnerable to flood risks. Similar to level 0, measures need to be identified to enhance community resilience to pluvial floods.
0.4	Fair 21% < R < 40%	At this level, the degree of resilience is medium to low. The community is vulnerable to flood risks but has a basic level of resilience and several measures must be identified to improve community flood resilience.
0.6	Good 41% < R < 60%	The level of resilience is medium, which makes the community moderately vulnerable to pluvial floods. Half of the criteria in this community are achieved, but non-performing measures must be improved to enhance community flood resilience.
0.8	Very Good 61% < R < 80%	The resilience level is high, and the community can appropriately cope with flood risks. However, there are some improvements required as some criteria can be improved to build a community that is resilient to pluvial floods.
1	Excellent 81% < R < 100%	The resilience at this level is excellent, where most of the criteria are achieved and the community would be able to cope effectively with flood risks.

7.6 CRPF Framework Validation

The validation process of the developed CRPF framework is a significant stage in this research. Rykiel (1996) emphasised the importance of a validation process to ensure that any proposed guideline or framework is reliable enough for implementation in a working environment. In some instances, validation helps provide a better understanding of the practicability of the framework suggested. Malak and Paredis (2007) also pointed out that the validation process ensures that any proposed model or framework can provide a better range of reliability and accuracy. While the best way to validate measures related to the disaster field is to constantly check them after main disaster events and develop them consequently, this will take a significant amount of time (Simpson & Katirai, 2006).

Thus, to achieve the last objective of this research, the CRPF framework has been validated through a focus group method. The focus group was carried out in a total of two sessions with **seven senior managers** from related local organisations with rich knowledge and experience in the field of emergency management as well as the responsibility for enhancing resilience in Abu Dhabi city. The sessions took place at Abu Dhabi Police General Headquarter and they lasted for approximately **two** hours. The first session aimed to gather the required data and the second session was to validate the collected data. The purpose of using a focus group method is to validate the framework in order to ensure that the framework is suitable and can be implemented in the UAE context. Thus, the researcher contacted participants at the validation stage to ensure that they had a complete understanding of the research aim and results.

After that, the senior managers were asked to answer questions on the framework quality factors of simplicity, completeness, flexibility, understanding of ability, acceptance, usefulness and implementation ability. The quality factors used in this research study are adapted from the ones defined by Moody and Shanks (2003) and Moody (2003). Five-point Likert scale questions were distributed to participants and were used to measure their knowledge and opinions about the accuracy and validity of the framework (Boone & Boone, 2012). The five-point Likert scale ranged from strongly disagree = 1 to strongly agree = 5, which was helpful in gathering specific information or facts about the CRPF framework. Participants were encouraged to respond in full satisfaction as their answer represents their viewpoint accurately.

7.7 Validation Results

The findings of the validation process illustrate that the CRPF framework is suitable and reliable within the study context. Table 7.10 and Figure 7.3 show the results of the focus group method with **seven senior managers** from related organisations in Abu Dhabi City.

Table 7.10: CRPF framework validation results.

CRPF Framework	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Do you believe that the framework is simple enough to assess community resilience to pluvial floods? (Simplicity)				√√√√	√√√
2. Do you believe that the framework has captured all the factors to assess community resilience? (Completeness)			√√	√√√√	√

3. Do you believe that framework is flexible enough to adapt to any change in community flood resilience? (Flexibility)			√	√√√	√√√
4. Do you believe that the framework content and structure are easy to understand? (Understandability)				√√√√	√√√
5. Do you think that the emergency managers from local authorities in the UAE will accept the CRPF framework? (Acceptability)			√	√√√√	√√
6. Do you think that the framework components are useful for the emergency managers? (Usefulness)				√√√√√	√√
7. Do you consider that the framework can be adopted and implemented in your working environment? (Implementation ability)			√	√√√√√	√

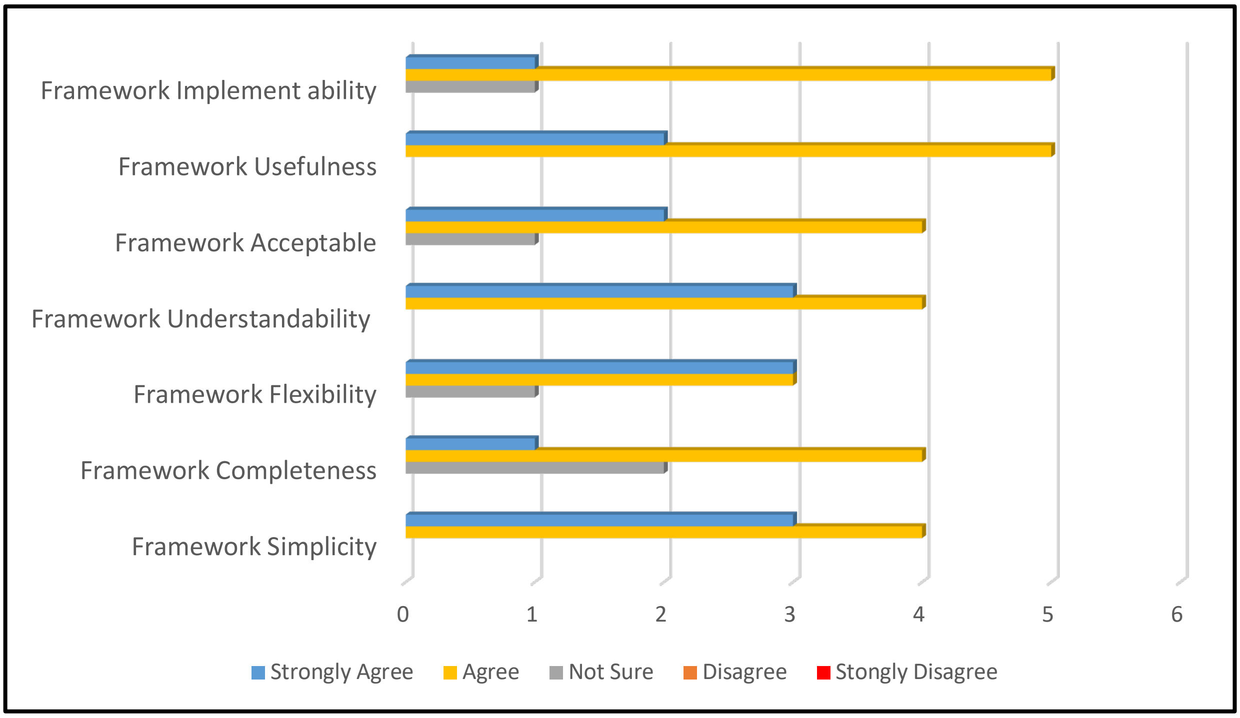

Figure 7.3: CRPF framework validation results.

7.7.1 Framework Simplicity

The first quality factor demonstrates the simplicity of the CRPF framework. Findings in Figure 7.3 above indicated that **three** participants strongly agreed that the CPRE framework is simple, while **four** participants agreed that it is simple to measure community flood resilience. It is important to note that none of the participants were unsure if the CRPF framework was simple enough or responded to the options disagree or strongly disagree. Thus, as the proportion of respondents that agreed and strongly agreed was 100%, this result helps to confirm that the framework is simple enough to assess community resilience to pluvial floods in the UAE context.

7.7.2 Framework Completeness

The second quality factor related to completeness of the CRPF framework content and if it covered all the factors needed to assess community flood resilience. Figure 7.3 showed that **one** participant strongly agreed that the framework is complete, and **four** participants also agreed that the framework is complete. However, **two** participants were unsure about this. It is important to note that no-one responded with disagree or strongly disagree. Therefore, it can be concluded that participants were mostly between agree and strongly agree about whether the CRPF framework is complete and has captured all the factors needed for measuring community resilience to pluvial floods. This confirms that the content of the framework is complete enough to assess community resilience to pluvial flood in the UAE.

7.7.3 Framework Flexibility

The third quality factor evaluated whether the framework is flexible enough to adapt to any change in community flood resilience. Figure 7.3 revealed that **three** participants strongly agreed and another **three** agreed that the CRPF framework is flexible. However, **one** participant was not sure if the framework is flexible enough to adapt to any change. Accordingly, this result suggested that most participants were between strongly agree and agree about the fact that the CRPF framework is flexible. It is important to note that no-one disagreed or strongly disagreed. Thus, the findings for this quality factor confirm that the framework contents are flexible enough to adapt to any change in community resilience to pluvial floods.

7.7.4 Framework Understandability

The fourth quality factor helps to address the question of whether the framework content and structure are easy to understand (Understandable). As shown in Figure 7.3, the findings revealed that **four** participants agreed that the framework is understandable, and **three** participants strongly agreed the CRPF framework content and structure are easy to understand. Therefore, it can be concluded that the participants' opinions were between agreed and strongly agreed about the framework being understandable and none of the participants disagreed. The evidence from these results confirms that the contents and structure of the CRPF framework are easy to understand.

7.7.5 Framework Acceptability

The fifth quality factor was designed to address the question of whether the CRPF framework would be approved and accepted by emergency managers from related organisations in the UAE. Table 7.10 shows that **four** participants agreed that the framework is acceptable, and **two** strongly agreed, while **one** participant was not sure if the emergency managers would accept the framework. It can be noted that none of the participants disagreed or strongly disagreed that the emergency managers would accept the framework. Therefore, it can be concluded that most participants agreed and strongly agreed that the emergency managers would accept the framework. These results indicate that the CRPF framework content is acceptable.

7.7.6 Framework Usefulness

The sixth quality factor relates to usefulness of the CRPF framework components for emergency managers in the UAE. Table 7.10 and Figure 7.3 illustrate that **two** participants strongly agreed that the CRPF framework is useful for emergency managers in the UAE context, and **five** participants agreed that the framework is useful. It can be seen that none of the participants disagreed, strongly disagreed or were even not sure if the framework components are useful to emergency professionals. Thus, it can be concluded that the participants' opinions about the usefulness of the framework components to emergency managers were only between agreed and strongly agreed. This result indicates that the CRPF framework is useful to measure community flood resilience in the UAE.

7.7.7 Framework Implementation Ability

The final quality factor was about the implementation ability of the CRPF framework in the working environment of emergency managers. Figure 7.3 revealed that **five** participants agreed that the CRPF framework could be implemented in their emergency management organisations, and similarly **one** participant strongly agreed, while only **one** participant was not sure if the framework could be implemented and adapted in his working environment, as he claimed that the framework must be tested during real flood events. Moreover, it can be noted that none of the participants disagreed or strongly disagreed about the implementation ability of the CRPF framework. Therefore, it can be noted that most participants were between agreed and strongly agreed. The result confirms that the CRPF framework can be adapted and implemented in emergency management organisations in the UAE.

7.8 Chapter Summary

The purpose of this chapter was to achieve the last objective of this study through the development and validation of the CRPF framework. The chapter discussed qualitative and quantitative findings and their association with literature. Through a sequential mixed method, this study employed semi-structured interviews, questionnaire survey and the AHP to gather primary data in order to develop an assessment framework that can be used in the UAE context. The AHP method aims to ascertain the weight of each dimension and factor based on their importance to assess community flood resilience. The CRPF framework is the first practical tool to assess community resilience to pluvial floods in the UAE. Assessment of a community based on main dimensions and factors is an important step to determine the community's resilience, where its measurable outcomes can then be compared to the benchmark resilience scores. Finally, to confirm that the CRPF framework would be suitable to evaluate community resilience to pluvial floods in the UAE, a focus group method was carried out with senior managers in the emergency management field in Abu Dhabi city to validate the framework. Validation results showed that the CRPF framework is simple, complete, flexible, understandable, acceptable, useful, and can be possibly adopted and implemented in the emergency management organisations in the context of the UAE. Therefore, it can be concluded that the framework is reliable and valid for generalisation of its findings to similar communities in the region.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

8.1 Chapter Introduction

The previous chapter presented the development and validation process of the assessment framework. Accordingly, this chapter concludes the study by firstly discussing the research outcomes in terms of achieving its aim and objectives. Then, the contributions of this research to the body of knowledge and practice regarding community resilience to pluvial flood in the UAE are highlighted, and the study limitations are also discussed. Finally, this chapter ends with recommendations for practice and future research outlining further work needed to ensure the successful implementation of the CRPF framework within the UAE context.

8.2 Achievement of the Research Aim and Objectives

The research problem in Chapter 1 motivated this study and influenced the developing of the research questions, aim and objectives. It relates to the need to improve community flood resilience in the UAE context. Thus, the aim of this research is to develop an assessment framework to enhance community resilience to pluvial floods in the UAE through using Abu Dhabi city as a single case study. To improve the reliability and validity of the study results, an appropriate methodology was chosen to achieve the research aim and objectives. The selection of the methodology for this study took place after reviewing literature related to the research area.

The research adapted the use of a sequential mixed-methods approach as the methodological choice. Particularly, the research structure's design was illustrated to involve four stages to gather primary data, as was explained in the methodology chapter (Chapter 4). Firstly, semi-structured interviews were conducted with participants in top level management to explore key factors that influence community flood resilience. After that, a questionnaire survey was used to further examine and analyse the identified factors. Then, the AHP method was carried out to determine the weights of the four main dimensions and associated factors based on their importance through using a focus group with an expert panel, and that helped to develop the CRPF framework to assess community flood resilience in the UAE. Finally, another focus group was conducted with senior managers from government stakeholders to validate the developed framework and to ensure its application within the UAE context. Therefore, it can be affirmed that the research aim has been achieved effectively through the research objectives being fulfilled. The findings of the research objectives are explained in the following sections.

8.2.1 Objective One: To critically review the relevant literature on pluvial floods and the concept of community resilience.

In light of achieving this objective, the study reviewed the literature to gain a better understanding of floods and their impacts and to deliver in-depth descriptions and explanations about flood risk management, flood measures, and the concept of community disaster resilience. Floods have been found to be the world's most common and destructive events for several reasons, some of which are linked by the convergences of hydrological and meteorological factors which are exacerbated by human activities. They are causing many direct and indirect losses in terms of human, physical, social and economic impacts to both developed and developing countries. Moreover, pluvial floods are unpredictable and less well known and understood by the public, and they happen because of heavy rainfall in a short period of time, so that they are difficult to manage effectively by a rainwater drainage system or through infiltration to the ground. It was also indicated that most flood and pluvial flood victims are poor people in developing countries, who are the first casualties of such incidents and suffer the most as poor communities often live in unhealthy urban environments and have a lack of awareness, resources and coping mechanisms. Thus, managing flood hazards effectively is essential to minimising their impacts, and that helps to build more resilient communities.

In addition, a critical review of the literature focused on concepts of resilience and community disaster resilience which reflect the ability of communities to adapt to and cope with disasters. This could be improved by increasing community disaster awareness, stressing the value of improving various flood management practices and measures, and encouraging active collaborations and interactions between emergency managers and community members. Moreover, the study examined several existing frameworks and their application for assessing community disaster resilience, which is considered to be an important step in being better prepared for and able to adapt to these disasters. Frameworks were analysed for their different factors which were identified based on their dimensions of resilience. This study mainly focused on four main resilience dimensions, namely: physical, institutional, social and economic, as appropriate in the context of the UAE. The conceptual framework for this study also emphasised the significance of disaster management phases' activities (mitigation, preparedness, response and recovery) in improving community flood resilience. Moreover, the critical factors that influence community resilience with their related dimensions were also reviewed and identified from the related literature.

8.2.2 Objective Two: To examine the current flood measures adopted by developed countries and the UAE.

This objective focused on analysing the current measure for adapting to pluvial floods which are applied in many developed countries and the UAE context as they as they are beneficial in reducing flood impacts. This particularly helped in achieving the first research question, which is **"What are the current measures to manage pluvial floods in developed countries and in the UAE?"**. The literature review in section 2.11 in Chapter 2 revealed that there are several measures and practices taken by developed countries such as the UK to address flood risks. These measures are categorised as both structural and non-structural measures. Through structural measures, the impact of a flood can be prevented or reduced through constructing flood defences, dams, basins, dikes and rainwater drainage systems. Staff training education, increasing public awareness, flood insurance, emergency planning, and flood forecasting and warning are common non-structural measures.

However, related literature highlighted several gaps in the knowledge, which were identified by several researchers related to flood risk management and flood measures in the UAE. Moreover, from analysing the primary data of this research, the author found the current practices and measures in the UAE are ineffective and insufficient, and they need many improvements to manage pluvial floods. This was supported also from evaluating documentary sources on flood management measures in the UAE, as there is a lack of historical rainfall data and measures needed to mitigate flood risks, such as having a rainwater drainage system and emergency planning. As a result of that, the UAE has been exposed in recent years to flood risks which have caused many injuries and large amounts of damage to urban areas, facilities and assets.

8.2.3 Objective Three: To investigate and analyse key factors that influence community resilience to pluvial flood in the UAE.

The main factors of community resilience to pluvial floods were explored and identified by firstly applying a semi-structured interview method with top level managers from related stakeholders in Abu Dhabi city (case study). This helped to answer research question **"What are the key factors that influence community resilience to pluvial flood in the UAE?"**. As the study proposes an assessment framework focused on four resilience dimensions (physical, institutional, social and economic), a total of 20 main factors were identified from analysing primary data from the semi-structured interviews (Chapter 5). Secondly, the factors were subsequently analysed to ensure the validity of the research findings through a questionnaire survey which was distributed to a selected panel of experts (Chapter 6). Thus, the results identified key factors of community resilience to pluvial flood that were essential for development of the CRPF framework.

The AHP was then employed to help to prioritise each resilience dimension and factor based on their importance and to indicate its significance related to other factors. This provided support in addressing the research question **"What is the most applicable weighting system of identified factors for an appropriate assessment of community resilience to pluvial floods in the UAE?"** This was achieved by conducting various pairwise comparisons through using a focus group method with an expert panel from related organisations in Abu Dhabi city. Thus, by using the AHP along with a method of calculations, the weighting system for each dimension and factor was proposed (Chapter 7). This helped to develop the CRPF framework and allowed the use of benchmarking scores against which the flood resilience of different communities could be measured and compared.

8.2.4 Objective Four: To develop and validate CRPF framework with related stakeholders in the UAE for effective assessment of community resilience to pluvial flood.

This objective has been achieved through applying three different data collection stages to develop an assessment framework for enhancing community flood resilience in the UAE. Firstly, semi-structured interviews were conducted to explore key factors that influence community flood resilience in the UAE context (Chapter 5). After that, a questionnaire survey was used to further confirm and valid the identified factors (Chapter 6). Lastly, the AHP method was carried out to prioritise the main resilience dimensions and factors based on their importance through using a focus group with an expert panel (Chapter 7). The literature review also supported the findings related to community disaster resilience. Thus, based on the primary data of both qualitative and quantitative findings, an assessment framework has been developed and it consists of four main dimensions and 20 factors.

In order to answer the fourth research question, **“How can CRPF framework determine measurable outcomes of community resilience to pluvial flood?”**, benchmark resilience scores for the CRPF framework were identified to measure community flood resilience within the UAE context. This scale can help to evaluate the strengths and weaknesses for each resilience dimension and factor within the CRPF framework. The benchmark resilience score of this study is suggested to include five levels ranging from a score of 0 to 1 (0 to 100%) as follows: a community with a score of 0 means that the resilience is missing, ‘Absence of resilience’, and a community is highly vulnerable to flooding. A community scoring below 21% will be classified as having ‘poor resilience’, while a community measuring between 21% and 40% will be described as having ‘fair resilience’. Moreover, a community assessed between 41% and 60% will be considered as ‘good resilience’; a community evaluated between 61% and 80% will be defined as having ‘very good resilience’; and, finally, a community will be classified as having ‘excellent resilience’ if it is assessed as between 81% and 100%.

Moreover, the study achieved this objective successfully in the validation section (Chapter 7) as the CRPF framework has been validated through a focus group method. The focus group was carried out with seven senior managers from related organisations with rich knowledge and experience in the field of emergency management as well as responsibility for enhancing the resilience in Abu Dhabi city. The validation results showed that the CRPF framework is simple, complete, flexible, understandable, acceptable, useful, and can be possibly adopted and implemented in emergency management organisations in the UAE context. Therefore, the CRPF framework will contribute to decision makers in the field of community flood resilience in general. This framework can be considered to be the first milestone in building resilient communities to pluvial flood in the UAE.

8.3 Contribution to Knowledge and Practice

This study makes a notable contribution to theory and practice in the subject of community flood resilience. The next two sections illustrate this contribution.

8.3.1 Contribution to Knowledge

This study has contributed to knowledge through developing theory related to pluvial floods and their impacts, flood risk management, and current flood measures taken by developed countries and the UAE. The development of this theory was fulfilled by reviewing the available literature related to the research topic. Moreover, the study contributes to theory and provides in-depth understanding of the significance of resilience and community disaster resilience concepts which were previously discussed in limited form in relation to the UAE. Through analysing existing community disaster resilience frameworks, the study helps to develop an assessment framework for the UAE context. The framework has provided a comprehensive understanding for assessing community flood resilience based on four main dimensions (physical, institutional, social and economic) and 20 critical factors, as shown in Figure 7.2.

Furthermore, the research undertaken has added significant data to the existing knowledge using a single case study (Abu Dhabi city) and the methodology described in detail in Chapter 4. As was noticed from the literature, there is a lack of academic research related to floods and community disaster resilience in the UAE; this study contributes to theory in generalising the research findings. The findings of this study will add further understanding in the field of disaster management, and they will encourage decision makers to improve community resilience to pluvial floods.

8.3.2 Contribution to Practice

This study contributes to practice through developing a useful tool (CRPF framework) for decision makers, particularly for government organisations, which will help to ensure the successful mitigation of pluvial flood risks. The new assessment framework has been developed to assess community flood resilience and to allow emergency agencies to examine the necessary changes. The framework is based on four main components (dimensions) and 20 key factors. Moreover, the study provides a weighting system for the main dimensions and factors regarding their importance through conduction of an AHP technique, and that helps to assess community flood resilience in the UAE and beyond based on the Benchmark Resilience Scores. Theses scores describe the amount of work needed to identify and improve key factors related to community flood resilience. The above contributions represent the research novelty.

8.4 Limitations of the Study

Although the research aim and objectives were reached, it should be noted that there are some limitations related to the research process. These limitations should be described in order to provide a clear understanding of the work that was achieved. The limitations of this research are detailed below:

1. According to the literature review, there is a lack of studies on the subject of floods, flood risk management and community disaster resilience in the UAE context. This has made reviewing the literature more challenging.
2. Difficulties in interviewing senior managers to collect primary data due to the long process required to allow them to participate in the interviews and provide the required data.
3. Some of the documents were restricted, and the researcher was only able to check them during the semi-structured interviews.
4. This research has utilised an exploratory sequential mixed-methods design in order to link between qualitative and quantitative approaches and to make the research content more generalisable. In the quantitative stage (questionnaire survey), because the PhD study has a limited time period, it has been difficult and time-consuming to achieve a large sample size of emergency management experts. A number of respondents refused to participate in the survey, claiming lack of experience in community resilience or that they were too busy with work responsibilities. The researcher had to follow up and contact human resources departments in related organisations on several occasions in order to collect the required data.
5. The CRPF framework is limited only to related emergency agencies. It is important to note that non-government organisations are thus not included in using or implementing the framework to assess community resilience. Moreover, the framework is geographically limited to the UAE and further community-specific frameworks are needed to evaluate community flood resilience, as each community has its own features and characteristics.

8.5 Recommendations

Through this study, a number of recommendations were found which were basically divided into two main sections. The first section outlines recommendations for practice in the field of emergency management in order to improve community flood resilience in the UAE. This is to ensure that the study results can adequately be used and applied in the UAE or in any country with similar issues as the UAE. The second section illustrates the recommendations needed for further research work that encourage investigations into area that focus on community resilience to pluvial floods.

8.5.1 Recommendations for Practice

Reviewing literature and the research findings revealed that there is a lack regarding some issues related to community flood resilience in the UAE. It is important that the CRPF framework should be adopted and implemented by decision makers in order to enhance community resilience to pluvial flood. Therefore, this section summarises the recommendations for consideration in the subject based on the research findings:

1- The current infrastructure should be evaluated and improved, including the rainwater drainage system and critical facilities to mitigate flood impacts. The research finding revealed that there are some issues related to the rainwater drainage system as many residential zones are still not covered by a drainage system and such improvements are needed for the existing ones. Moreover, improvement in buildings design is required in order to adapt pluvial flood risks. This is an essential step towards building resilient communities to pluvial floods.

2- Review the current insurance regulations related to flood risks. Flood insurance should be implemented and should cover all properties, especially in flood-prone areas, as this will increase the resilience of communities by both speeding recovery and lessening the disruption of floods through providing enough funds for flood mitigation measures.

3- It has been highlighted in this study that there is a lack of public awareness regarding flood risks. Thus, a number of practical and theoretical activities should be performed for community members such as workshops, lectures, training and exercises to increase flood awareness, which will enable communities to have the appropriate ability to handle flood risks or any other emergencies.

4- Emergency or disaster plans and strategies need to be evaluated frequently and improved as an essential process to manage emergencies effectively, which will help to increase community resilience through having a better preparedness level.

5- Increase the knowledge and ability of the staff members in emergency organisations through conducting training and simulation exercises to check arrangements to manage flood risks, which requires improving the level of risk knowledge and ability to prioritise action plans for reducing pluvial flood impacts.

6- Review and evaluate any gaps in the disaster management regulations and policies, and that includes an emphasis on community flood resilience. This is essential towards building community resilience to pluvial floods.
7- It is important to improve the level of coordination and collaboration between all emergency organisations at federal, national and local levels as an effective emergency response requires frequent cooperative efforts between various stakeholders. Roles and responsibilities should be defined appropriately to ensure a higher degree of preparedness in order to prevent any confusion between stakeholders during emergencies or disasters such as floods.

8.5.2 Recommendations for Future Research

During this study, research areas that may require further investigation were identified. Although the findings of the study revealed the effectiveness of the CRPF framework to assess community flood resilience, further improvements may still be needed. In this section, the recommendations for future research are discussed as follows:

1. This study was conducted through an exploratory sequential mixed-methods design (qualitative then quantitative), which could provide a first step for other researchers as there are several research methods available such as quantitative methods in order to examine key factors to build communities that are resilient to pluvial floods.
2. Because of the lack of published evidence, further research is needed on the subjects of floods, flood risk management and community flood resilience.
3. An annual review should also be carried out to find any areas of improvement in the proposed framework, especially after pluvial floods have occurred.
4. The CRPF framework should be assessed in various regions in the UAE to examine the level of community flood resilience. This process will help to identify the absence or lack of key factors to measure community flood resilience.
5. The CRPF framework needs to be implemented across the Gulf Cooperation Council (GCC) countries in order to investigate community flood resilience factors. This should yield almost similar results as the countries surrounding the UAE have similar weather conditions and face comparable pluvial flood events.
6. Future research could be of benefit in designing policies and regulations for implementation of the CRPF framework and application of disaster risk management strategies to manage pluvial floods.

7. The CRPF framework is intended to be employed only by government emergency agencies. The findings of this study may form basic information for non-government organisations to conduct future research as they will have a shared interest with government organisations.

8.6 Chapter Summary

This chapter has provided an overview of the research findings, contributions to knowledge and practice, limitations and recommendations. The study has covered a topic that is important for the UAE due to the negative impacts that are caused by pluvial floods. With the advent of climate change and the increased frequency of pluvial flood events, assessment of community flood resilience is crucial. Thus, the study has successfully achieved its aim and objectives through developing an assessment framework which has been validated through a focus group method with senior managers from related emergency organisations. Overall, the results of this study provide valuable evidence and information especially to emergency managers and decision makers. However, although the results of this research seemed to be reasonable, they should be considered as initiatory until additional studies have been carried out for further validation. Therefore, by achieving the recommendations for future work, the UAE will be able to enhance community resilience and establish a flood risk management system that will benefit it through appropriate preparation and quick recovery. This study will be the starting point for future research in the context of the UAE and surrounding regions.

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APPENDIX A Ethical Approval Letter

University of Salford MANCHESTER

Research, Innovation and Academic Engagement Ethical Approval Panel

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15 January 2019

Musabbeh al nuaimi

Dear Musabbeh,

RE: ETHICS APPLICATION STR1718-04 – Developing a Framework for Enhancing Community Resilience to Flash Flood Hazards in the UAE

Based on the information you provided, I am pleased to inform you that your amended application STR1718-04 has been approved.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible by contacting S&T-ResearchEthics@salford.ac.uk

Yours sincerely,

APHigham.

Dr Anthony Higham
Chair of the Science & Technology Research Ethics Panel

APPENDIX B Semi-Structured Interviews Questions

Firstly, I would like to take this opportunity to thank you for agreeing to participate in this study. This interview is part of my PhD research which aims to **develop an assessment framework to enhance community resilience to pluvial floods in the UAE**. Your response is really important for the success of this study. I would like to assure you that your response will be **Strictly Confidential** and will be used for academic purposes only. Further, you may decide to stop being a part of the research study at any time without explanation.

If you agree, I would like to record this interview to allow me to go back and listen to it in more detail at the interview analysis stage. Further, please feel free to let me know if there are particular instances where you would want me to temporarily switch off the recorder.

Thank you in advance for participating in this study. If you have any queries, please do not hesitate to contact me.

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Musabbeh Alnuaimi

Section One: Background and Demographic	
Organisation	
Current job title	
Years of experience	
Education level	

Section Two: Interview Questions
1) Based on your experience, what are the current measures used to mitigate and manage pluvial floods in the UAE?

2) How could you evaluate the current infrastructure in the UAE, especially the rainwater drainage system, to mitigate pluvial floods?
3) In your opinion, do you think the location of the built environment can help to reduce pluvial flood hazards? Please explain, and what are other important measures that may influence community resilience to pluvial floods in term of physical dimension?
4) Does your organisation has an emergency plan and conduct emergency training exercises to deal with pluvial floods? Do you think that the preparedness level is sufficient? Please explain.
5) How could you evaluate the level of coordination and cooperation between local authorities in the case of pluvial flood events?

6) Do you think the current regulations and legislations are sufficient to manage pluvial floods? How do they influence community flood resilience? What other measures do you think are important to improve community resilience in terms of the institutional dimension?
7) How could you evaluate local citizens' awareness level about pluvial flood hazards? How could they be aware of actions taken in case of pluvial floods?
8) Do you think religious beliefs or faith may influence community flood resilience? Please explain, and what are other measures you think are important to improve community flood resilience in terms of social dimension?

9) How would you rate the income of local citizens in the UAE? How it influences community resilience to flood hazards? What other measures do you think are important to enhance community resilience to pluvial flood in terms of economic dimension?
10) What are the main faced challenges for improving community resilience to pluvial floods?
11) Based on the above questions, what are your recommendations and improvements needed to enhance community resilience to pluvial floods in the UAE?

APPENDIX C Questionnaires Design

This survey is a part of my PhD research which aims to **develop an assessment framework to enhance community resilience to pluvial flood in the UAE**. I'm requesting for your voluntary participation in filling this questionnaire and it will take less than 10 minutes. Please select the most appropriate answer as per your knowledge and experience for each question within the space provided. If you decide to participate in this study, your participation and any information collected from you will be treated as strictly confidential, and only available to the research team.

Thank you very much for your precious time taken to complete this survey.

For more information and if you have any concerns please do not hesitate to contact me.

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Musabbeh Alnuaimi

Section 1: Respondents Background

Q1: What is your organisation?
A. Abu Dhabi Police
B. Abu Dhabi Civil Defence
C. Abu Dhabi Municipality
D. Abu Dhabi Distribution Company
E. National Crisis and Emergency Management Authorisation (NCEMA)

Q2: What is your current job title?
A. Engineer
B. Emergency manager
C. Branch manager
D. Section manager
E. Department manager
F. Other

Q3: How many years of work experience do you have?
A. Less than 5 years
B. 6 – 10 years
C. 11 – 15 years
D. 16 – 20 years
E. 21 – 25 years
F. Over 25 years

Q4: What is your highest academic qualification?
A. High School
B. Diploma
C. Bachelor
D. Master
E. PhD
F. Other

Q5: How would you rate your experience in disaster management?
A. N/A
B. Very low
C. Low
D. Medium
E. High
F. Very High

Section 2: Physical Resilience

Please indicate the level of importance of each physical resilience factor to enhance community resilience to pluvial floods in the UAE:

	Not Important	**Slightly Important**	**Moderately Important**	**Important**	**Very Important**
Capacity of infrastructure					
Buildings design					
Buildings condition					
Location of built environment					

Section 3: Institutional Resilience

Please indicate the level of importance of each institutional resilience factor to enhance community resilience to pluvial floods in the UAE:

	Not Important	**Slightly Important**	**Moderately Important**	**Important**	**Very Important**
Standards and regulations					
Emergency planning					
Institutional collaboration and coordination					
Staff education and training					
Flood risk assessment					

Community engagement					
Knowledge and experience					
Roles and responsibilities					

Section 4: Social Resilience

Please indicate the level of importance of each social resilience factor to enhance community resilience to pluvial floods in the UAE:

	Not Important	Slightly Important	Moderately Important	Important	Very Important
Social capital					
Community Demography					
Flood Awareness					
Religious Belief (Faith)					

Section 5: Economic Resilience

Please indicate the level of importance of each economic resilience factor to enhance community resilience to pluvial floods in the UAE:

	Not Important	Slightly Important	Moderately Important	Important	Very Important
Country economy					
Income situation					
Diversity of economic resources					
Flood insurance coverage					

APPENDIX D Pair-Wise Comparisons

9=Extreme 7=Very strong 5=Strong 3=Moderate **1=Equal** 3=Moderate 5=Strong 7=Very strong 9=Extreme

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Institutional
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Social
Physical	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Economic

9=Extreme 7=Very strong 5=Strong 3=Moderate **1=Equal** 3=Moderate 5=Strong 7=Very strong 9=Extreme

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Institutional	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Social
Institutional	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Economic

9=Extreme 7=Very strong 5=Strong 3=Moderate **1=Equal** 3=Moderate 5=Strong 7=Very strong 9=Extreme

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Social	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Economic