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An analysis of the Iranian post-earthquake management and structural assessment system

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An analysis of the Iranian post-earthquake management and structural assessment system

By

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Copyright Statement

An analysis of the Iranian post-earthquake management and structural assessment system

Nirvan Razaghi-Kashani

Abstract

This thesis investigated the theory and practice of structural assessment, as a component in a more extensive post-earthquake disaster management system. The research focused on Iran as a case study, and in particular the capital city of Iran (Tehran). This study aimed overview of the system used for post-earthquake disaster management and structural assessment in Tehran. This thesis examined three specific sub-components of the system, namely: The Earthquake Information Management System (EIMS), seismic hazard education programs, and initiatives to engage communities in the disaster management process. A blended phenomenological and ethnographic approach provided the basis for the analysis of collected data and results from the research has provided new insights about how to enhance urban resilience; by improving systems used to manage post-earthquake structural assessment.

This research utilized a mixture of phenomenological and ethnographic methods. In this research, phenomenological method was used by the author to study the experience and behavior of ordinary people in Tehran, towards the post-earthquake structural assessment within disaster management system. The utilization of phenomenological research method enables the identification of patterns how concerning individuals residing in Tehran perceive and interpret significant life events such as earthquake. Therefore, this study used an Interpretative Phenomenological Analysis (IPA) approach to define and make judgements about strengths and weaknesses in the Iranian earthquake management system, and in particular the post-earthquake structural assessment system.

The ethnographic element of this research involved the author travelling to Tehran and living for a period of time in the community, while collecting useful data for the project. For the of gathering data, a questionnaire survey was conducted, targeting Three communities within the Tehran population: residents of multi-story reinforced concrete residential buildings (N=151), professional civil/structural engineers (N=20) and representative of organizations responsible for managing the Iranian EIMS (N=4).

The results obtained in this research study were divided in four main chapters, where the first chapter is about EIMS in Iran. While the second chapter focusses on the post-earthquake structural assessment system in Iran. The third chapter explores opportunities to enhance education programs within the EIMS and linked to post-earthquake structural assessment. Lastly, the fourth and final chapter explores opportunities to enhance engagement within post-earthquake structural assessment activities. For each element of the results, the author has structured a narrative around a relevant piece of observational data that he collected during his visit to Tehran. In this thesis, the obtained results utilize observation as a mechanism to bring attention to new learning and convey new understanding arising from the analysis of collected data. Following the principals of ethnographic research, the author initiates the analysis by examining the phenomenological data from the perspective of their personal research journey. Subsequently, the author proceeds to analyze the quantitative results obtained from the survey.

This research was able to verify some of the findings from prior studies that looked at elements of the earthquake management system in Iran and was able to contribute new knowledge about the extent to which recent efforts by local authorities have improve the systems in operation. In addition, the IPA approach was judged to be successful in revealing previously unreported detail about strengths and weaknesses in both the EIMS and post-earthquake structural assessment systems of Iran. Finally, the ethnographic analysis enabled the author to contribute a well-grounded and evidence-based set of proposals outlining ways in which the EIMS and post-earthquake structural assessment systems of Iran could be improved with more structured education and engagement programs.

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I would like to express my sincere gratitude to all the people who helped me in this research. I could not have completed this thesis without their guidance, support, and encouragement.

Author declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

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Chapter 1 - Introduction

Iran is one of the biggest countries in Asia, encompassing an area of 1,648,195 square kilometres (Talebian, 2004). It has a long history, as archaeological records have revealed details of cultures occupying modern Iran dating as far back as 4000 BC (Disaster Risk Management Profile, 2006). Alongside the long social history, its current political structure is complex and sophisticated, with two types of political or governmental institution: one elected by popular vote and the other chosen by a collection of senior “council” members (BBC Country Profile,2015). Iran has a very young and fast-growing population, currently standing at over 80 million, but expected to reach 100 million by 2050 (CIA Fact Book, 2015). For the context of this research, the ancient infrastructure of Iran is being challenged by the fast growth of its population and large areas are vulnerable to severe disruption if seismic events occur close to population centres.

From an earthquake management perspective, it is important to note that Iran is not a single crustal block and is divided between 4 active earthquake belts. It has approximately 1000km of fault lines, which makes it prone to earthquakes across most of its land area (Tavakoli and Ghafory-Ashtiany,1999). Iran has been actively and accurately recording its earthquakes since 1960, when it started installing seismological stations across the country. That infrastructure enabled disaster managers to predict the likelihood of a severe earthquake in the city of Bam. However, it was not able to minimise the very destructive impact that the subsequent earthquake caused, which resulting in more than 30, 000 deaths (Yazdani and Kowsari, 2012). Hence, that there is need to ensure that authorities and engineers in Iran are fully aware of the latest and best practice in disaster management Education and engagement planning and have effective systems for post-earthquake damage survey assessment in high earthquake areas.

The Bam earthquake with the magnitude of 6.6 Mw was moderate earthquake and it was good example how unprepared communities are in Iran. Between 30,000 to 50,000 was killed in Bam earthquake (Berberian, 2014). In addition, 17,500-50,000 died or injured from aftershock of the earthquake as they were trying to enter their building to collect their belongings (Nadim *et al*., 2004); Berberian, 2005; Garazhian and Yazdi, 2008; Berberian, 2014).

The performance of the residential building during the bam earthquake was disastrous (Meheri *et al.*, 2005). In addition, the non-engineered building cased a huge number of casualties (Meheri *et al.*, 2005). The Bam earthquake in 2003 was indicating that Iran needs to improve the disaster management system and post-earthquake damage survey assessment (Nadiam *et al.,* 2004; Maheri *et al.*, 2005). Even in the Ahar-Varzeqan earthquake in 2012 and Bushehr earthquake in 2013, we can see the lack of improvement in the post-earthquake damage survey assessment (Nadiam *et al.*, 2004; Maheri *et al.*, 2005).

The lack of building inspection and the quality of construction and material can be highlighted from Bam earthquake. It shows that the Iranian government needs to improve the construction management system (Hosseinzadeh,2004).

Most buildings in Bam earthquake, such as hospital, Police station, fire Station, Schools and government building suffered from structural failure or failure of non-structural elements of the building. In Bam earthquake, there was not enough building inspectors or plan to inspect the buildings (Nadim *et al*., 2004); Eshghi and Naserasadi, 2005); Parsizadeh and Izadkhah, 2005).

The Bam earthquake brought to attention the importance role of community education and engagement within the disaster management system, as there was nothing left apart from the neighbours who could help each other until the help arrived (Nadim *et al*., 2004; Eshghi and Ahari, 2005; Abolghasemi *et al.*, 2008).

The absence of organized disaster management system and initial post-earthquake building assessment increased the death toll (Movahedi, 2005; Tierney *et al.*, 2005; Ibrion *et al.*, 2015).

The majority of people under the debris were saved by family members, neighbours, and other community members, which shows the impotence of the earthquake education and engagement programme within the community. Additionally, this shows the importance of “Golden time” after the earthquake and the role of the community within the disaster management cycle and the necessity to improve the earthquake education and engagement in Iran (Ibrion *et al.,* 2015).

Lessons learnt from Bam earthquake in Iran identified many points to improve such as earthquake management planning initial post-earthquake damage assessment to save lives and long term monitoring of important building such as schools and hospitals and movement building (Parsizadeh, 2011).

As this research was in development, earthquake events have continued to occur in Iran. One notable recent earthquake happened in the region of Kermanshah, near the city of Sar Pol Zahab. Kermanshah is located in western Iran, near Iran and Iraq border and the earthquake occurred on 12th November 2017 at 9 pm local time (Feng *et al.*, 2018). The city of Sar pol Zahab has a population of 35,000 and the epicentre of the earthquake was located 34.88°N and 45.84°E near the Iran–Iraq border with a depth of 23 km (Feng *et al.*, 2018). The epicentre of the earthquake was 5 km away from the town of Ezgeleh, 43 km away from city of Sar pole Zahab and 46 km away from the city of ghasr-e-Shrin. According to (Feng *et al.*, 2018), the earthquake had magnitude of 7.3 M and happened on a fault unknown to Iranian agencies. Prior to this event there was only one major earthquake in Kermanshah city, which was in 1957 with the magnitude of 7.6 M and the epicentre was located at 34.35°N and 47.67°E with about 35 km depth (Feng *et al*., 2018). The Kermanshah earthquake serves as a good case study to illustrate the need for an effective earthquake disaster management system in Iran.

In Sar-e-Pole Zahab in Kermanshah earthquake shows that the lack of post-earthquake damage survey assessment to the building and comprehensive earthquake management system blamed for high number of casualties.

It is unfortunate that what should have been learned from the Bam earthquake was not realised in the Kermanshah earthquake. Many government agencies were not well coordinated and did not have current technology and up-to-date information about the area that were needed for relief efforts (Ahmadi and Bazagan-Hejazi, 2018).

After the Sra-e-Pol Zahab earthquake most of the newly built hospitals and tower blocks in were heavily damaged, which reveals that most of the hospitals and new tower blocks were not compliant with the Iranian code of practice for seismic resistance of buildings (Ahmadi and Bazagan-Hejazi, 2018).

This Thesis intends to analyse the post-earthquake management and damage survey assessment system used in Iran. A considerable amount of modelling has been done in Iran to evaluate the structural performance of new buildings in the event of an earthquake, but most Iranian buildings are more than 100 years old or non-engineered building, for which the modern modelling assessment has little benefit (Berberian, 2004). Some effort has been made to improve disaster management in Iran, but many issues remain, especially in relation to the quality of the existing building stock and even in new building that were constructed after earthquake events (Ghafory-Ashtiany, 1999; Fallahi, 2008; Nasrabadi, 2007; Nataghi, 2000; Rafieian and Asgary, 2013). Specifically, the system for post-earthquake damage survey assessment has been highlighted as an area in need of improvement (Berberian, 2004).

Examples of post-earthquake damage survey assessment systems in use throughout the world, such as the FIMA system in USA the Building Safety Evaluation system from New Zealand NZSEE (2009) and the post-earthquake damage survey assessment system were used to define the state-of-the-art practices for comparison with the system in use in Iran. The Iranian system was compared with the other international post-earthquake damage survey assessment systems to reveal areas of strength and weakness. This study tried to compare post-earthquake damage survey assessment systems from different countries, including Japan, Turkey, Greece, Italy, and America. In particular, the thesis will draw lessons from the American ATC-20 building safety evaluation system, Italy's usability and damage post-earthquake structural assessment system, the Greek rapid and first-degree post-earthquake structural assessment system, and the Turkish the initial post-earthquake structural assessment system (Gunes Yilmaz, Kacmazerk, and Von Meding, 2013).

Nataghi (2000) provided ideas on how the disaster management strategies used in Iran could be improved and the expectation is that this research will help to build on that process of improvement. In particular, this research plans to help Iranian organisations, such as the Ministry of Interior (Law of Foundation of National Committee for Mitigation of Natural Disaster Effects), the Bureau for Research and Coordination of Safety and Reconstruction Affairs (BRCRA) and The National Disaster Task Force (NDTF), all of which are engaged in post-earthquake damage survey assessment of buildings, to be more effective when responding to future earthquake events.

After an earthquake, all buildings including hospitals, police stations, and fire stations, as well as all the critical infrastructure, such as roads, are needed to be checked to make sure that they are safe. For the most part, buildings are built out four main construction materials: concrete, steel, wood and/or masonry. In this research the Author focused on residential buildings with a reinforced concrete superstructure. That choice was made because, in Tehran, most residential buildings have reinforced concrete frames.

It is critical for effected people by earthquake to have accurate information as where to find help and what they need to do. This should be part disaster management cycle and it was missing in Tehran earthquake. The lack information about road closure, open petrol station was another issue with disaster management system in Iran and lack of knowing how to face earthquake in Tehran.

This thesis utilised a mixture of phenomenological and ethnographic methods. Phenomenology is one of the oldest methods of qualitative research. Willing (2013) considered that phenomenology is useful for the study of the world as it is experienced by humans, within a particular context and at times. Whereas (Howitt, 2016) proposed phenomenology as an effective method for studying the behaviour of ordinary people in special situations, such as disasters. Smith, Flowers, and Larkin (2009) added that a system of Interpretative Phenomenological Analysis (IPA) provides added refinement to the basic phenomenological method. IPA helps to reveal patterns in the way people make sense of their major life experiences and Lyons and Coyle (2016) stated that IPA can be used to examine individual lived experiences following difficult situations, like earthquakes. Therefore, this research used an IPA approach to define and make judgements about strengths and weaknesses in the Iranian earthquake management system, and in particular the post-earthquake structural assessment system.

In contrast to phenomenology, ethnographic research can help the researcher to collect data about the self-representations of a community in assumption with its relations with others (Christensen, 2001; Howitt, 2016; Parker, 2005). Ethnographic research methods are used to understand how social systems evolve from individual actions and individuals' reflections about those actions (Breakwell, Hammond and Fife-Schaw, 1995). According to Giles' study (2004), to be effective, the ethnographic researcher needs to travel to the area where he wants to do his research and collect his data away from his office or institution, in order to observe and become a member of the community. The ethnographic element of this research involved the author travelling to Tehran and living for a period of time in the community while he collected data for the project. The actual data collection activity included structured interviews and a questionnaire survey.

1.1 Aim

Analyse the post-earthquake management and damage survey assessment system used in Iran in relation to state-of-the-art practices implemented in other seismically active regions of the world such as Turkey, USA, and Greece, with a view to identifying strengths and weaknesses in the Iranian system and to propose actions that Iranian organisations can take in order to improve the current system.

1.2 Objectives

- This thesis will then be developed proposals to address areas of weakness and to exploit areas of strength in the Iranian post-earthquake damage survey assessment and disaster management system.
- Define state-of-the-art practices in post-earthquake management and damage survey assessment from seismically active regions of the world.
- Analyse existing practices in post-earthquake management and damage survey assessment in Iran.
- Identify strengths and weaknesses in the Iranian system, in relation to state-of-the-art practices implemented in other seismically active regions of the world by comparing their post-earthquake damage survey assessment and disaster management system.
- Propose actions that Iranian organisations can take to enhance the current system of post-earthquake management and damage survey assessment in seismically active regions of Iran.

1.3 Research Questions

1. Iran is at risk to frequent large earthquakes of magnitude of 7.0 and higher. Although Iran has a good educational system and well-developed guidelines for the management of seismic events, it has a fast growing and young population that lacks the skills and experience of major events that leads to an insufficiency of knowledge, about how best to apply state-of-the-art practices in the post-earthquake management and damage survey assessment system.
2. Iran is susceptible to a prolonged period of economic and political sanctions for last 40 years by western power. Such that USA has largely cut-off its academic and professional engineering community from the rest of the world. This has made it difficult for both Iranian and foreign academics to study Iranian post-earthquake management and damage survey assessment systems in relation to state-of-the-art practices implemented in other seismically active regions of the world including Turkey, Greece, and USA.
3. The capital of Iran (Tehran) is growing very fast. The post-earthquake damage survey assessment (from Bam and Sar e Pol Zahab earthquake) and disaster management system in Iran shows that Iran is struggling to cope with the pressure. Hence, it is a significant need to analyse the post-earthquake management and damage survey assessment system used in Iran in relation to state-of-the-art practices implemented in other seismically active regions of the world, with a view to identifying strengths and weaknesses in the Iranian system and to propose actions that Iranian organisations can take to enhance the current system used in Iran.

1.4 Scope of the research

This research study does not focus entirely on the technical engineering aspects of post-earthquake damage survey assessment of buildings. Instead, it looks at how damage survey assessment fits within a wider earthquake information management system. This approach includes an analysis of how qualitative and quantitative measures are used to make post-earthquake damage survey assessment more effective and efficient. Specifically, the thesis explores education and engagement aspects of the post-earthquake disaster management system. This research does not go into the analysis of failure mechanisms in buildings or try to come up with new computer modelling systems. Rather, this research explores new methods that Iranian authorities can implement to improve post-earthquake damage survey assessment and how to blend the system into the wider disaster management system in Iran.

1.5 Outline of the project

This study provides an overview of the Iranian post-earthquake damage survey assessment and disaster management education and engagement system; an outline of the phenomenological and ethnographical aspects of this thesis; and an overview of the strength and weaknesses of the earthquake information management system in Iran. Additionally, the project presents an overview of the strength and weaknesses of the Iranian post-earthquake damage survey assessment and to provides the strength and weaknesses of the engagement system in post-earthquake disaster management and damage survey assessment in Iran. This is to provide the strength and weakness education system in post-earthquake disaster management and damage survey assessment in Iran. Lastly, the project delivers conclusion and recommendations for future research.

Chapter 2 – Literature Review

As explained in Chapter 1, the aim of this thesis is to analyse the post-earthquake management and building damage survey and usability assessment system used in Iran. That analysis will be conducted in relation to state-of-the-art practices implemented in other seismically active regions of the world and with a view to identifying strengths and weaknesses in the Iranian system. Based on the analysis, the author hopes to be able to propose actions that Iranian organisations can take to enhance the current system. To initiate the analysis, this chapter will provide an overview of the Iran system for post-earthquake disaster management and structural assessment. The chapter also includes an overview of systems used in Japan, Italy, Greece, and Turkey, which serve as proxies to facilitate the assessment of strengths and weaknesses in the Iranian system. The chapter examines three sub-components of a wider disaster management system, namely: the requirements of an Earthquake Information Management System (EIMS), seismic hazard education programmes and initiatives to engage communities in the disaster management process. Post-earthquake structural assessment provides the context for the analysis and the author has highlighted insights that were gained from the literature and that will form the basis for more detailed examination of the subject matter in latter chapters of the thesis. The chapter starts by providing an overview of the country of Iran and the research study area, Tehran.

2.1 An introduction to Iran

This section intends to show Iran's geographical position on the map of the Middle East, as well as explaining its social and economic history. It also describes the most important cities and the system of governance in the country. Finally, an overview is provided of the main areas of economic activity and its major infrastructure, such as roads, railways, ports, energy production and water supply system.

2.1.1 The social and economic geography of Iran

Geographically, Iran is one of the biggest countries in Asia, encompassing an area of 1,648,195 square kilometres. It is bordered by the Caspian Sea, Turkmenistan and Azerbaijan in the North, Afghanistan and Pakistan to its East, Iraq and Turkey to its West and the Persian Gulf, the Gulf of Oman, Saudi Arabia, Qatar, Bahrain, United Arab Emirate and Oman to its South (Figure 2.1). Iran is the eighteenth largest country in the world and the second largest in the Middle East Talebian (2004). Talebian (2004) described Iran as being surrounded by mountains and deserts. The two main Iranian mountain ranges are the Zagros and the Alborz. The Alborz is located in Northern Iran starting at the Iran-Azerbaijan border in the northwest and running to the southern end of the Caspian Sea, a range of 900 kilometres. The Zagros mountain range lies between Iran, Iraq and Turkey. The Zagros mountain range is 1500 kilometres long and it is the longest mountain range in Iran (Talebian,2004). Iran also has two deserts, the Great Salt Desert (Dasht-e-Kavir) and The Emptiness Desert (Dasht-e-Lut). Dasht-e-Lut is 480 km long and 320 km wide, can reach temperatures of 70 Celsius and is the largest salty desert in Iran. Dashet-e-Kavir is 800 km long and 320 km wide and occupies an area south of the Alborz Mountains. In addition, 190,000 hectares (10% of the land area) of Iran is covered by forest, these are mainly located in the provinces of Golestan, Mazandran and Gilan. This description reveals that the terrain in which this research is to conducted may be hot, dry and/or mountainous. The terrain may serve to illustrate some of the challenges to developing effective disaster management plans and systems for assessing the resilience of structures to earthquake damage. High, extensive, and remote mountain ranges pose different challenges to disaster managers compared to hot and dry desert conditions. Also, the scarcity of vegetative cover leads to a traditional design architecture that predisposes many structures to earthquake damage (explored further in Section 2.3).

Figure 2.1 Relief map of Iran with major Cities and Towns.

(Source: Eduljee, 2016)

Modern Iran, which was known as Persia until 1935, is located in Southwest of Asia and has a history that dates back to 4000 BC (Disaster Risk Management Profile, 2006). Its history is peppered with Dynastic regimes, the longest of which (the Sasanians) governed for 1000 years. The Sasanian period made Iran one of the most powerful empires in the World, rivalling its contemporary, the Roman Empire. Throughout its history, Persia was attacked by Greeks, Turks, Arabs, and Mongols. It was the attack by Arabs in the 8th century, and that attack resulted in a change to the established religion of Iran, from Zoroastrian to Islam. After the Arab attack, and until the 15th century, Iran was part of a larger Islamic Empire. Post 15th Century, the Safavid came to power, and they introduced the Shia version of Islam, marking a shift away from the main Sunni version that dominated the Islamic Empire. Most recently, following the revolution in 1979, the Islamic Republic of Iran was established (Ambraseys and Melville, 1982). For this research, this history points to a deep seated and traditional system of governance, with strong links to its religious beliefs.

Politically, in Iran there are two types of political or governmental institution, one is elected by popular vote and other is chosen by a collection of senior “council” members (Figure 2.2). The Supreme Leader is at the top of political structure, he is chosen by the Judiciary, the Guardian Council, the Commander of the Armed Forces and senior Government Ministers (Shirazi, 1997). According to Shirazi (1997), the president is the second most powerful person in the country and is elected by popular vote every four years. The President is not able to stay in the office for more than two successive terms. Cabinet Ministers are chosen by the President, but their appointment needs to be approved by the 290 members of parliament. As with the President, the Members of Parliament are elected every four years (BBC Country Profile, 2015). Separate to the Parliament, there is an Assembly of Experts: 86 people who have a clerical background. The Assembly of Experts is responsible for choosing the Supreme Leader and ensures that he undertakes his duties responsibly. The Assembly of Experts hold their positions for 8 years (Shirazi, 1997). There is also a Guardian Council: 12 members, six chosen by the Supreme Leader and six from the Judiciary. The Guardian Council members hold their positions for six years and their role is to monitor every Bill that comes out the Parliament. The Guardian Council the right of veto over any Bill and can deselect Members of Parliament, Presidential candidates, and Assembly of Experts members to prevent them standing for the election. The Judiciary is headed by six senior judges, who are responsible for enforcing Islamic Law. The head of the Judiciary is chosen by the Supreme Leader. Understanding this political structure is important for this research, as any proposals to improve disaster management policy and practice will need to be mindful of the political framework within which any proposals would be enacted.

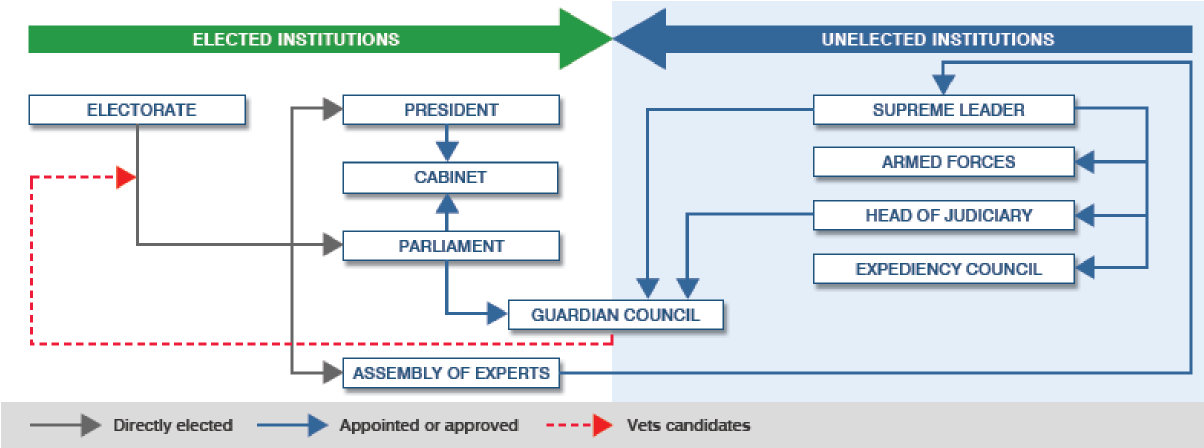


Figure 2.2 Iranian Governance System.

(Source: BBC, Country profile, 2015)

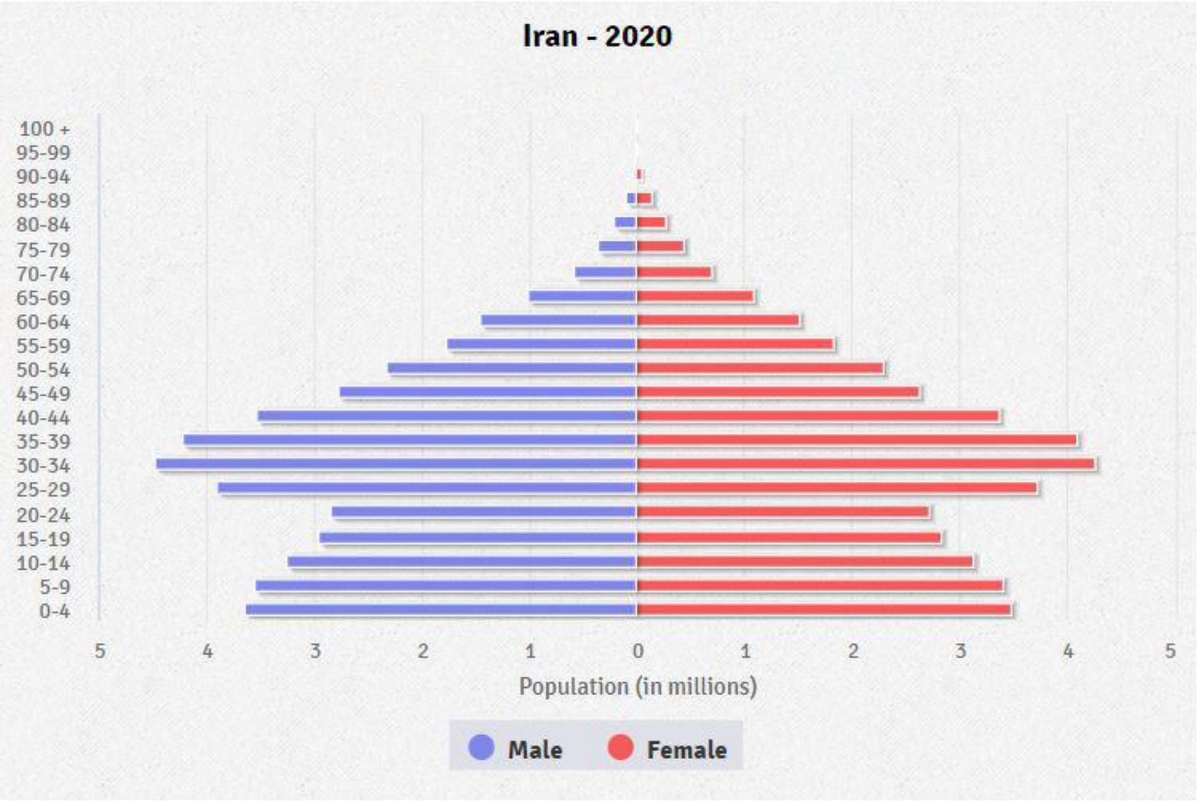
Iran has a population of 80,840,713 and the population is expected to reach 100 million by 2050 (CIA Fact Book, 2015). Iran also has one of the most ethnically diverse populations in Asia, with eight distinct ethnic groups:

Table 2.1 The Iranian ethnic group and their population percentages (CIA Fact Book, 2015).

Iran Ethnic Groups	**Populations Percentage**
Persian	53%
Azeri	16%
Kurd	10%
Lur	6%
Baloch	2%
Arab	2%
Turkmen	2%

According to the CIA Fact Book (2015), the population of Iran is also a very young one, with 42% below the age of 25years old:

Table 2.2 The Iranian age group and their percentages (CIA fact book, 2021).



The same source reveals that most of Iran's population is concentrated in 6 major cities: Tehran (the capital, with 7.304 million), Mashhad (2.713 million), Esfahan (1.781 million), Karaj (1.635 million), Tabriz (1.509 million) and Shiraz (1.321 million). In addition, for most of the last 20 years, Iran has hosted up to four million refugees. This is one of the largest refugee populations in the world. Most of the population of refugees are fleeing conflicts in Iraq and Afghanistan. This data is of significance for this research, as it reveals how the population of Iran is growing fast, putting pressure on authorities to allow development to house the growing and diverse population. Such development may be in areas of significant seismic risk and be undertaken by unskilled worked, possibly migrants, who are unfamiliar with structural requirements to make buildings earthquake resistant.

The main Iranian cities, with the highest population, are located in the Western half of the country (Figure 2.1). Figure 2.1 also shows that several major towns are also located in the Western part of Iran (Including: Khuzestan, Bushehr, Chahar Mahal va Bakhtiari, Kohgiluyeh va Buyer Ahmad, Ilam, Lorestan and Kermanshah). The concentration of towns and cities in the West is linked to oil and gas production, most of which passes through the region (BBC, Country Profile, 2015). Iran is the second largest economy in Middle East and North Africa (after Saudi Arabia) and relies heavily on the production of natural gas (61%), and petroleum (37%) World Bank (2015). Only 10% of the land in Iran is suitable for agricultural, most of which is located near the Caspian Sea and in the Northwest of Iran (Iran Disaster Risk Management Profile, 2006). Iran's other main industries centre around iron and steel production. In relation to oil and gas, Iran is the second largest oil producer in Organisation of Petroleum Exporting Countries (OPEC) and has the second largest natural gas reserve in the world Iran Disaster Risk Management Profile (2006). What this section reveals are that any vulnerability that can impact on the oil and gas system will have a serious impact on the Iranian economy. For this research the author will not focus on the oil and gas facilities themselves, but on the vulnerability of resident populations that staff and run the industry.

2.1.2 Key Infrastructure in Iran

Iran has 140,220 kilometres of roads, out of which only 49,440 kilometres have been paved (investiniran, 2016). One of the main highways in Iran runs from the Turkish border to Afghanistan, called the A1, and is 2500 kilometres in length. There is another highway, called the A2, running from the Iraq border to the Pakistan border. The city of Tehran has 470 kilometres of motorway, connecting it to other major cities. From a highway point of view, Iran could be considered moderately well developed, but from the earthquake point of view; the towns and cities are vulnerable to being cut off by earthquakes, as the roads are very poorly maintained (investiniran, 2016).

Figure 2.3 The Iran road network system.

(Source: Wikimedia.org)

According to website source “The Railways of the Islamic Republic of Iran” (2015), the Iranian railway system started construction during the Second World War. The longest railway line is 5600 kilometres and runs between Tehran and Van, in the East of Turkey (Figure 2.3). The railway network in Iran is good, connecting Tehran to most of the major cities in the country, but there is no train between Tehran and Shiraz, which is one of the most important cities in the South of the country and very vulnerable to earthquakes. There is also no rail network from Tehran to the city of Kermanshah and its province in East of the country.

Figure 2.4 The Iran railway system

(Source: Wikimedia.org)

Iran has several sea and airports. Some sea ports, such as Abadan and Khorramshahr, were destroyed in Iran-Iraq war. Currently the most important seaport is Bandar Abas in the South of Iran, on the Persian Gulf coast. Bandar Abas port is responsible for the export and import of 12 million tons of cargo every year (investiniran, 2016). Other ports include Bandar Bushehr, Bandar Lengeh, and Bandar Chah Bahar are all located along the Persian Gulf coast. Tehran, Qeshm, and Kish airports are considered the most important airports in Iran and they do carry the most passengers and cargo transport on yearly basis (investiniran,2016) The biggest airport is the Imam Khomeini International Airport, located in Southern Tehran and which transfers over 30 million passengers a year (investiniran, 2016).

Historically, the water supply network of Iran has not been very well developed. Iran is a dry country with mainly seasonal rainfall, so in recent year Iranian authorities have been building dams in many regions of the country. Many regions with a high vulnerability to earthquakes now have many new dams. The most vulnerable areas in the South and West of the country with new dams are:

Table 2.3 Most vulnerable cities in Iran and number of dams

Vulnerable Cities	Number of Dams
Kerman	21
Hormozgan	25
Fars	10
Khuzestan	20
Booshehr	1
Kohkelooye va Boirahmad	2
Azerbaijan	44
Qazvin	2

Most of Iran's electricity (90%) has traditionally been produced by coal, oil, and gas. But recently Iran has produced 3000-5000 MW electricity from new nuclear power plants and in the future Iran plans to produce more electricity using nuclear power sources. The Iranian nuclear power plants are located in South and West of Iran. One is in Bushehr, which is in the South of Iran close to the Persian Gulf. Natanz and Isfahan nuclear power plants are located in Esfahan, South of Tehran and the Arak and Qum nuclear power plants are near Tehran itself. There is a major gas pipe running from Bushere, in the South to Gilan in the North, which passes through several areas highly susceptible to earthquakes. There are also five oil refineries, located in Isfahan, Tehran, Bushehr, Khuzestan and Hormozgan.

Overall, this summary of Iran's infrastructure reveals that large parts of Iran are vulnerable to severe disruption if seismic events cut through or damage key roads, railways, dams or energy sources. This research does not have the scope to assess in detail the systems in place for each of these key areas, but it does help to illustrate why every region and population centre in Iran needs to have its own robust earthquake management system. If a disaster happens, communities may be cut-off from outside help and may need initiate their own recovery efforts.

2.1.3 Seismology of Iran

Talebian (2004) stated that Iran is not a single crustal block; consequently, Iran is divided between 4 active earthquake belts of Zagros, Kopeh-Dagh-Alborz-Talesh and Central Iran and the Dash-e- Lut Basin. According to Yazdani and Kowsari (2012) Due to its geographical position between Arabian plate in the south and southeast and the Indian plate in the east Iran is subject to very high levels of seismic activity, Iran is one of the most earthquake prone areas in the world. Iran has approximately 1000km of fault lines, which makes prone to earthquakes across much of its land area (Figure 2.5). Iran's plateau could be described as an active fault region, but the most sensitive earthquake line in Iran is concentrated along the Zagros fold thrust (Tavakoli and Ghafory-Ashtiany, 1999). Seismicity is less active along the central and eastern Iranian fault lines.

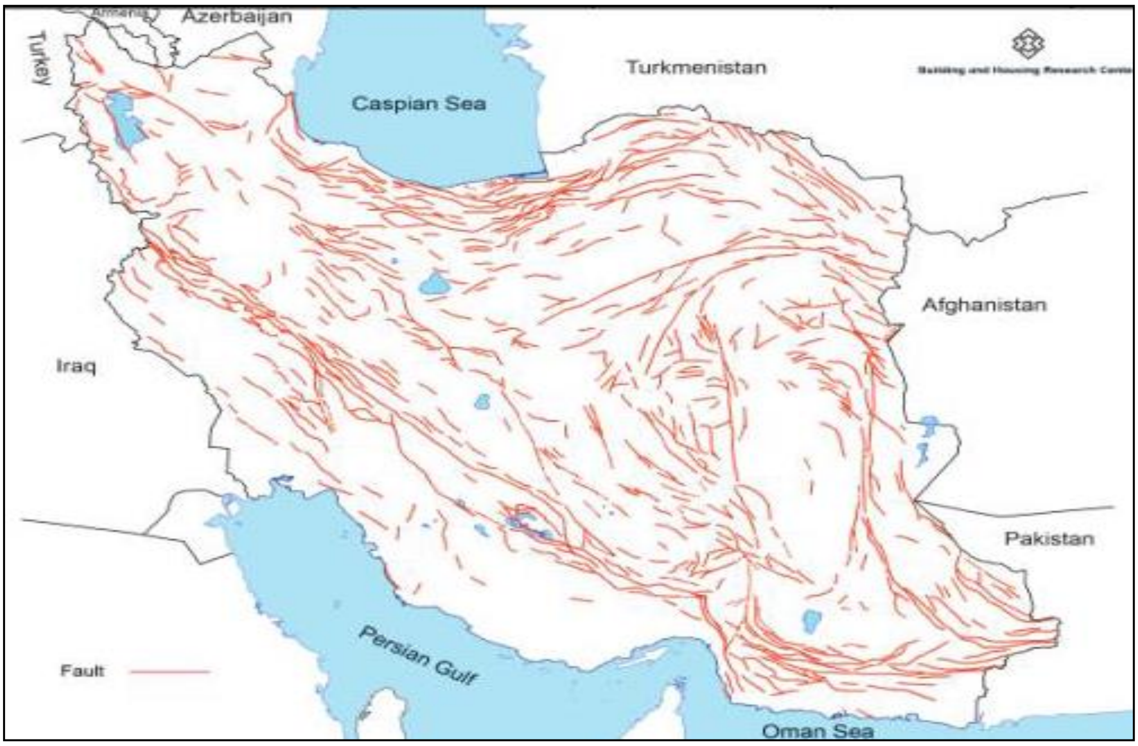


Figure 2.5 Fault map of Iran.

(Source: Moinfar, Naderzadeh and Nabavi 2012)

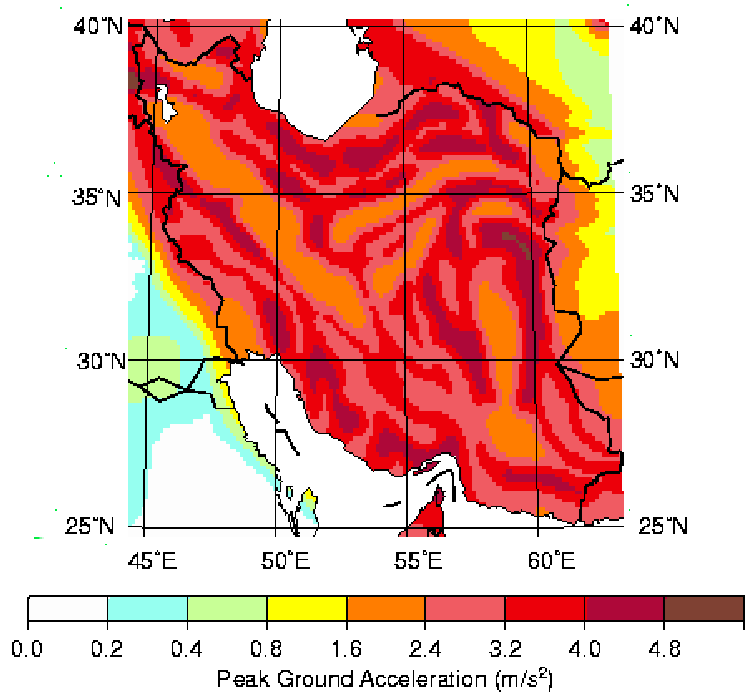


Figure 2.6 Seismic Hazard Map of Iran.

(Source: GSHAP, 2007)

Iran has been actively and accurately recording its earthquakes since 1960. The country has been able to record the earthquake location accurately, when it started to the installation of seismological stations across the country. The seismic analyses of the Iranian earthquakes have been conducted by (Wilson, 1930; Niazi and Basford, 1968; Nowroozi 1976; Banisadr, 1971 and Tchalenko,1975). The reports have revealed that the destructive earthquakes in Iran happen every few years and some of the most notable recent earthquakes are:

Table 2.4 The most destructive earthquake in Iran (Yazdani and Kowsari, 2012).

Earthquake	**Magnitude and Year**
Silakhor	Ms = 7.4, 1909
Kopeh-Dagh	Ms = 7.3, 1929
Salmas	Ms = 7.4, 1957
Sahne	Ms = 7.0, 1957
Buyin Zahra	Ms = 7.2, 1962
Dasht-e-Bayaz	Ms = 7.4, 1968
Fars	Ms = 7.2, 1972
Tabas	Ms = 7.7, 1978
Kerman	Ms = 7.3, 1981
Rudbar-Manjil	Ms = 7.2, 1990
Birjand- Qayen	Ms = 7.3, 1997

In 21st century Iran, no earthquake bigger than magnitude of 7 has yet occurred. However, it is just a matter of time before an earthquake with the magnitude of 7 or more will occur Moinfar, Naderzadeh and Nibali (2012). Figure 2.7 shows that the least earthquake prone areas in Iran are Esfahan-Siran, the Persian Gulf, Kavir-e-Lut and the Arvand-Shatt-Al-Arab provinces. Using this kind of map researchers in the 1980's was able to predict that the Southwest and Northeast regions of Iran were overdue a magnitude 6 or larger event (Nowroozi and Ahmadi 1986). In line with those predictions, the Bam earthquake was not unexpected, but that did not minimise the very destructive impact that it caused, resulting in more than 30, 000 deaths (Yazdani and Kowsari, 2012).

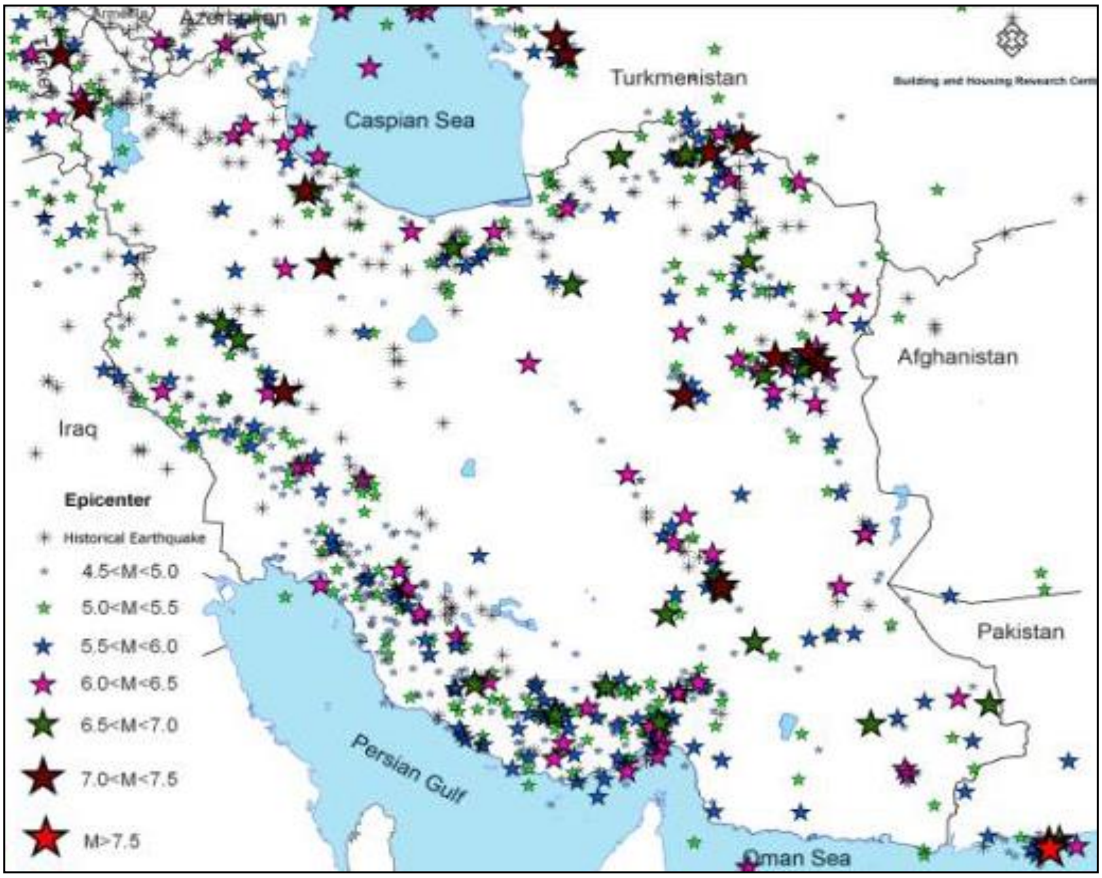


Figure 2.7 Map of earthquake epicentres in Iran.
(Source: Moinfar, Naderzadeh and Nibali, 2012)

In the past, the error between the actual epicentre of earthquake and the epicentre predicted by measuring instruments was significant (Moinfar, Naderzadeh and Nibali, 2012). For example, in the 1909 Silakhor earthquake (Ms 7.7) the instrumentation predicted the epicentre, which turned out to be 400 km away from the actual epicentre of the earthquake. After a further earthquake monitoring error in the 1972 Ghir-Karzin (Ms7.2) event, Iranian authorities decided to upgrade their equipment and a new network of instruments was installed and this has kept growing. Recent research shows that the network now is running with over 1140 instruments (Moinfar, Naderzadeh and Nibali, 2012).

According to Moinfar, Naderzadeh and Nibali (2012), the first Iranian seismic hazard code was first introduced in 1962 after the Buin-Zahra earthquake (Ms 7.2) and it has been revised every 6 years since then. There is a committee that has been working on the seismic code and which updates the code when required. The committee has several sub-committees, working on seismic zoning, geology (tectonic), seismology, earthquake engineering, sociology, and economy. In 2012, in an effort to consolidate numerous hazard and fault maps, the committee produced a new seismic hazard map of Iran. The map was produced used the following criteria:

1. Only faults over 20 km in length were mapped.
2. Only faults published in geological maps with the scale of 1:1000,000 to 1:250,000 were included, to avoid inferred and questionable faults.
3. As far as known, the mechanisms of faults were presented.
4. The magnetic basement lineaments were not taken into consideration.

The process identified 700 faults, which were assessed using 5 criteria:

1. Evidence of seismic events along the fault in the twentieth century
2. Capable (quaternary and seismogenic) faults
3. Faults on boundaries of mountains and plains
4. Faults with no indication of seismic movement
5. Concealed faults

Figure 2.8 shows the new hazard zoning map with an overlay of epicentres for recorded seismic events and serves to illustrate how important the research for this thesis is for the people of Iran. This overview of the seismicity of Iran reveals that there are scarcely any areas in Iran that are not vulnerable to seismic events. As such, it is imperative that authorities and engineers in all towns and cities of Iran are fully aware of the latest and best practice in disaster management planning and in assessing the integrity of the built environment where they have jurisdiction.

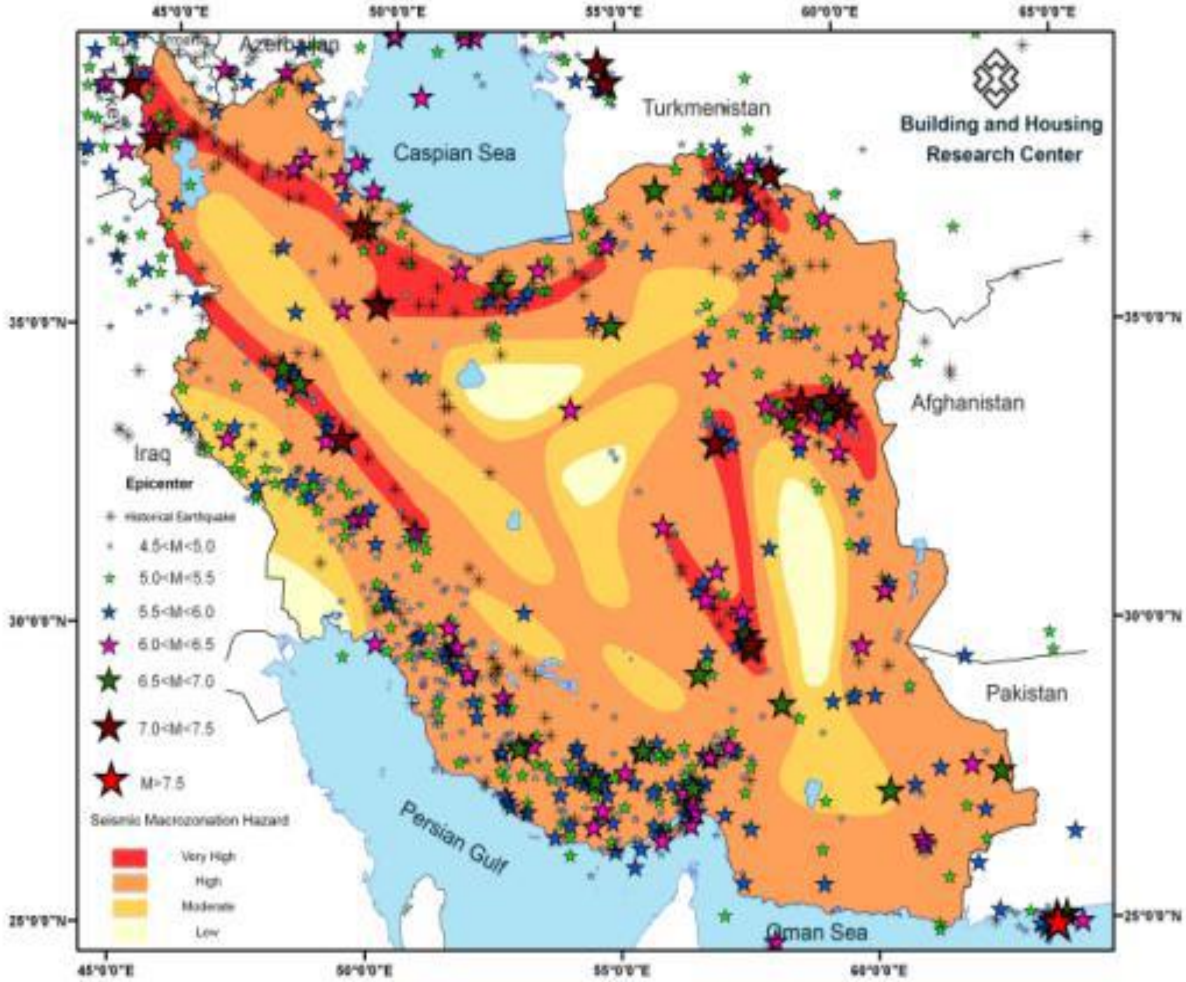


Figure 2.8 New hazard zoning map with seismic epicentres in Iran.

(Source: Moinfar, Naderzadeh and Nibali 2012)

2.2 Disaster Management in Iran

This section reviews the disaster management system, as it operates in Iran, with a view to revealing gaps in the established system that this research can help to fill. The review is split into four sections; first the overall system for disaster management in Iran is described. Next, and because this research has a particular focus on management issues relating to the Earthquake hazard in Iran the Iranian Earthquake Information Management System (EIMS) is analysed. Finally, two specific areas of interest are explored, namely the systems used to address disaster management education and how engagement of parties in the disaster management process is conducted.

2.2.1 The Disaster Management system in Iran

As previously highlighted in Section 2.1, Iran is no stranger to disasters arising from earthquake events. Researchers who have investigated the disaster management system in Iran have highlighted several issues that are relevant to this thesis. One such issue that seems to have been prevalent for several years in Iran is the lack of emphasis in developing disaster management capacity at the local level. Ghafory-Ashtiany (1999) effectively described the need for local disaster management capacity in his analysis of three earthquake events that hit Iran in 1997. According to Ghafory-Ashtiany (1999) the overall response was effective but lessons from reconstruction efforts in rural communities revealed challenges arising from state-controlled resource allocation, which often prioritised cost saving over the development of local capacity in the response. Nateghi (2000b) shed some light onto how this outcome arises, as the number of organisations involved in Disaster Management in Iran is extensive and complex. Nateghi (2000b) called for a new system, designed with the specific aim of making planning and implementation of disaster response more effective. More recently, research by Fallahi (2008) highlighted the vulnerability of populations living in ancient, culturally important sites. Iran has many settlements of that type, and in such places Fallahi (2008) suggested that there is a need for local level disaster management capability. It will be important for this research to investigate the extent to which Iran disaster management policy has addressed the need to raise disaster management capacity at the local level.

Ghafory-Ashtiany (1999) also highlighted challenges relating to the control of quality in the reconstruction work that followed disasters in Iran. Poor quality construction raises concerns about vulnerability to future seismic events. However, in Iran new construction is not the only problem, as Nateghi and Izadkhah (2004) revealed in a study of health centres in Tehran. Health centres are critical in times of emergency, so vulnerability in these buildings needs to be taken seriously. Nateghi and Izadkhah (2004) surveyed 110 hospitals and found several in need of serious structural adjustment to make them more resilient to earthquake damage. In another study by Rafieian and Asgary (2013) concerns were raised about the quality of housing provided after the 2003 Bam earthquake. In their study, Rafieian and Asgary (2013) suggested that Iranian disaster management policy needs to differentiate between structural requirements for emergency, intermediate and long-term structures. The issue of whether or not Iranian disaster management policy has adequately taken on board concerns about construction quality for new and existing buildings will be investigated by this research. In addition, and in relation to the latter point made by Rafieian and Asgary (2013), this research will assess the extent to which Iranian disaster management policy has elaborated the specific requirements for emergency, intermediate and long-term structures.

Nateghi (2000) provided some ideas on how to improve disaster management strategies used in Iran. He focussed on proposing a system for large cities, which included three steps:

1. Risk assessment of the city.
2. Planning and decision making on the response to the risks.
3. Implementation of the plans at the field level.

The suggestion was that these three steps needed to be implemented within the framework of engineering and construction, physical planning, economic planning, policy guidance, and public response (Nataghi, 2000a). In a further paper Nataghi (2000b), the Iran disaster management system was described as too complicated, and the recommendation was made to move planning closer to the President’s Office. Such an action was judged to provide advantages in making disaster management planning more effective. This research will analyse the extent and effectiveness of any measures taken by Iranian disaster management authorities to address these recommendations.

According to Nateghi (2000) The development of the earthquake management system in Tehran is a complex task to do, as Tehran has heavy population pressure and high population density, and it grows rapidly without thoughtful planning. So, for that reason, this research has been done to test the earthquake management system in Tehran from the community and civil engineers' point of view to see what improvement is needed according to the sustainable development goals and Sendai framework for disaster risk reduction.

2.2.2 Earthquake Information Management Systems (EIMS) as part of the Disaster Management system in Iran

In order to analyse an Earthquake Information Management System (EIMS), crisis management needs to be defined first. Crisis management involves programmes and activities that governmental organizations develop and implement before, during, and after disasters (Ajani, Fatahi and Moradi, 2006). It is important that all disaster management system record how past crises were managed, so that lessons can be learned to mitigate the impact of future events (Ajmani, Fatahi and Moradi, 2006). An EIMS is the system that records, collects and analyses earthquake information Seismological Bureau of Yunnan Province 2001. The main aim of the EIMS is to help individuals and organisations make better decisions in planning, managing and monitoring earthquake events (Lippeveld *et al*., 2000). According to Ajani *et al*., (2006) Iran lacks an EIMS that can be compared to others is developing and developed countries. Ajmani, Fatahi and Moradi (2006) proposed that Iranian lawmakers could directly benefit from such a system, by creating a clearer model of how responsibility for earthquake disaster management is spread between Iranian disaster management organizations.

A World Bank report, which analysed local disaster management assessment and implementation strategies Amini-Hosseini *et al*., (2009a), found that building capacity for responding to the next earthquake was the most important concern for disaster management organizations. The report stressed the need for disaster management organizations to have short- and long-term plans for reducing the impact of earthquakes. Mili, Hosseni and Izadkhah (2018) introduced a new model EIMS, which they called the ''Integrated Earthquake Safety Index" (IESI). The model built on earlier work by Davidson and Shah (1997), which promoted the use of an "Earthquake Disaster Risk Index" (EDRI), using a systematic vulnerability assessment and risk analysis of the buildings and infrastructure.

The IESI model assesses earthquake risk in an area based on hazard proximity, community vulnerability, and institutional response capacity. The assessment process can be completed in two stages. The first stage focuses on the short-term and the second stage on the long-term. The short-term assessment system looks at local community-based disaster management and search and rescue activities. In the long term, system looks at actions to reduce vulnerability. According to Mili, Hosseni and Izadkhah (2018), the IESI system can easily be changed according to the local conditions. IMPS (2004) stated that, there is evidence of an emerging IEMS system in Iran; however, it is focused on data collection during and immediately after an earthquake and it is not designed to address the longer-term needs of different regional and local areas within Iran.

Moreover, according to Kirschenbaum, Rapaport, and Canetti (2017), there are many ways an EIMS can be used to give information to the public about earthquakes. The study showed that the number of deaths, injuries, and damages to buildings will drop by giving the right information and education to the community living in the risk zone area. Thus, it has been suggested that information about earthquakes can be broadcasted in two ways:

1. Formal information can be broadcast through government agencies, mass media such as TV, radio, and Internet.
2. Informal information could be spread by word of mouth through friends and family members.

Additionally, the research showed that most of the earthquake preparedness has been done through the informal communication network. Kirschenbaum, Rapaport, and Canetti (2017) identified four different models for broadcasting information about post-earthquake disaster management to the public:

1. Information Likelihood Model (ILM).
2. Protective Action Decision Model (PADM).
3. Reasoned Action and Planned Behaviour Model (RADM).
4. Crisis and Emergency Risk Communication Model (CERCM).

The effectiveness of the communication with the public depends on three issues:

1. How are we hearing the message?
2. Do we believe the message?
3. Will we respond to the message?

Kirschenbaum, Rapaport and Canetti (2017) found that the attitude of people was changed by giving them more accurate and better information, the main aim was to make communities more earthquake resistance. However, the most important issue is the degree of trust to the source of information, which is influenced by the members of a community past experience of the source of information and that experience and can affect the individual's disaster preparedness. The Japanese EIMS, which is called the Preement Hyogos Emergency management Network for Disaster Information Exchange (PHOENIX), collects all the information about an earthquake. Such information includes economic losses (loss magnitude and quality) at collective and local levels. In Japan the EIMS is managed by the Prime Minister's office and other National Government ministries (Ajmani *et al.,* 2006). Collecting data for the Japanese EIMS is done by independent experts, government departments and non-governmental organizations. After collection, important seismic information in Japan is made publicly available, via the Hyogo Framework for Action website (Ajmani *et al.*, 2006).

The public dissemination of earthquake data is judged to be a very useful part of the EIMS, as it is effective in disseminating Earthquake information to important stakeholders and the wider public (Hyogo Framework for Action, 2005-2015). Highly developed systems like those in Japan can offer important lessons for Iran in its efforts to build a state-of-the-art EIMS system of its own.

Due to the perceived disparity between the level of development of the Iranian EIMS system and the system running in Japan, Turkey potentially offers more opportunities than Japan to learn lessons that can be quickly and easily applied in Iran. Turkey has a seismic risk, geography, and level of development that is comparable to Iran. Also, Turkey's culture and history are more closely aligned to Iran than is the case with Japan. As with Iran, Turkey has a number of active earthquake zones and the country is growing at a fast pace, so Turkey's need for a clear and effective EIMS is similar to Iran (Eraslan *et al.,* 2004; Ajani, Fatahi and Moradi, 2006). Unlike Iran, Turkey has made inroads to establishing such an EIMS, which is overseen by a dedicated Government Ministry. As part of the Turkish EIMS, every Government Ministry runs its own database according to their needs and goals (Eraslan *et al*., 2004). The Turkish EIMS is called AFAYBIS and is based in the city of Istanbul. AFAYBIS compiles earthquake information for the whole of the country and provides essential services during and after a seismic event. For Iran, Ajani, Fatahi and Moradi (2006) judged that considerable challenges exist if it chose to follow the Turkish model, as in Iran there are many government agencies involved in earthquake management and the planning process is not clearly defined.

In other research, Amini-Hosseini *et al*., (2009a) found that not many countries have access to financial support for disaster assessment activity, which forces disaster managers to make decisions based on predefined assessments of each development zone in a disaster effected area. According to Xu *et al*., (2018), post-earthquake structural assessment information has been collected mainly manually which time consuming and sometime inaccurate and make the decision making slower and not efficiently. After an earthquake, many buildings have been damaged and assessing all these building is time consuming process, so it needs to be done the best way possible to enable the disaster managers and to make the best decision as quickly as possible. Damage assessment systems in many countries, including the USA and Greece, are using pictures for post-earthquake building assessment ATC-20, Xu *et al*., (2018), so Xu *et al.,* (2018) explored how mobile phone pictures could be used to collect data on building damage by uploading them onto the world wide web, for centralized data management. Xu et al., (2018) found a number of problem issues with the current system of:

- Many post-earthquake damage assessment forms have no system to links with photos of damaged buildings.
- The paper-based collection system slows down information sharing between different parties.
- Many photos as simply not used in building damage analysis.

This research will explore the extent to which the problem issues highlighted by Xu *et al*., (2018) are prevalent in Iran.

Amini-Hosseini and Izadkhah (2020) considered that the Iranian EIMS contains many weaknesses and lacks clarity on the roles played by different organizations involved in the management of earthquake information. The Iranian IEMS also lacks a proper data recording system covering before, during and after earthquake events. In addition, there is no proper classification of the information from earthquake information management's point of view (ibid). As a consequence of the analysis by Amini-Hosseini and Izadkhah (2020), Iran's IEMS may be judged to be weak, or at best, insufficient. This research will seek to up-date the assessment of the Iranian EIMS, looking specifically at how it collects earthquakes information and how effective it is at publishes data at the right time and making it accessible to organizations and the wider public.

An important part of this thesis research will be to evaluate how the Iranian EIMS utilises the news media. Dedeoglu (2008) highlighted valuable lessons from Turkey about the role that news media plays in disaster preparedness. In comparison to Turkey and Japan, Iran's use of news media in disaster preparedness is not well-developed (Ajani *et al*., 2006). The Iranian news media is used to relay information about recent earthquakes, mainly at the time of happening rather than in advance and as part of a system to educating the public. In Turkey, the news media are engaged more proactively, talking to officials who are involved in earthquake management, in ways that are more directed to informing and educating the public Dedeoglu, 2008). In relation to that system, Ajani *et al*., (2006) and Ajani, Fatahi and Moradi (2006) considered that the main weaknesses of the Iranian earthquake and disaster management system were:

- Lack of clarity of roles
- Lack of clear system for recording information before, during and after earthquakes
- No clear system to classify types of data for further analysis.

2.2.3 Lessons to take forward for further investigation

- Iran is subject to frequent large earthquakes and, although Iran has a good educational system and *well-developed guidelines for the management of seismic events*, it also has a fast growing and young population that lacks the skills and experience of major events that leads to a lack of knowledge in how best to apply state-of-the-art practices in the post-earthquake management and structural assessment system.
- Iran has been subject to a prolonged period of economic and political sanctions that has largely cut-off its academic and professional engineering community from the rest of the world, which has made it difficult for both Iranian and foreign academics to study Iranian post-earthquake management and structural assessment systems in

relation to *state-of-the-art practices implemented in other seismically active regions of the world*.

- There is now a significant need to analyse the post-earthquake management and structural assessment system used in Iran in relation to state-of-the-art practices implemented in other seismically active regions of the world with a view to identifying strengths and weaknesses in the Iranian system and to propose actions that Iranian organisations can take to enhance the current system used in Iran.

Based on the above literature review, the author considers that the Iranian post-earthquake structural assessment and disaster management system needs to include the following points in their system to align with current good practice.

1. Collect data before, during and after an earthquake (Ajani *et al*., 2006); Seismological Bureau of Yunnan Province, 2001; IMPS, 2004; Eraslan *et al*., 2004; Xu *et al*., 2018).
2. Analyse the data collected to assess risk, vulnerability and impact (Amini-Hosseini *et al.,* 2009ª; Mili, Hosseni and Izadkhah 2018; Davidson and Shah 1997).
3. Learn lessons from prior events (Ajani, Fatahi and Moradi, 2006).
4. Describe how earthquake events will be planned, managed and monitored (Lippeveld *et al*., 2000).
5. Define clear lines of responsibility (Ajani, Fatahi, and Moradi, 2006);
6. Include short- and long-term planning.
7. Implement actions to build capacity, reduce vulnerability and mitigate risk (Amini-Hosseini *et al*., 2009ª)
8. Disseminate information and analysis.
9. Utilise a variety of media systems to disseminate data.
10. Work to build trust in the system.

2.3 Disaster Management and Community Education

A lot of research has been conducted, assessing the Iranian earthquake and disaster education programmes (UNCRD, 2003); Shaw, 2012; UNISDR, 2012); Robat *et al*., 2018; UNCRD, 2019). That research revealed how the education of local resident communities, if conducted in advance of a devastating earthquake event, can make the management of the event more effective. That effect was most apparent after major earthquake events, when the wait for government help can last a very long time. In those situations, no one is closer and more able to provide help another than the local community, so a community well educated in disaster management systems will be an important asset in a disaster response.

Ranghieri and Ishiwatari (2014) reported how, after the Kobe Japan earthquake in 2005, the government of Japan learned the importance of the community-based disaster prepared groups and decided to support and priorities the education, training, and support for such groups. According to Ranghieri and Ishiwatari (2014) the community-based group saved countless lives in the last Great Japan Earthquake and Tsunami in 2011. In similar studies, Marahatta (2012) and Suppasri *et al*., (2015), examined community-based disaster education programmes in Nepal, and the resulting community-based groups. The conclusion was that the groups played a major role in disaster management and post-earthquake response in a major earthquake in 2015. Hosseini *et al*., (2014) reported on a Turkish community-based earthquake education programme, called Neighbourhood Disaster Volunteer (SDC), which started work in 1999. The main goal of the SDC was to giving proper and correct education and equipment to help prepare local community to respond and recover from earthquake events. Matthies (2017) described a case in the Philippines, where a volunteer group called PUROK, worked on earthquake disaster risk reduction education in communities. Finally, Liu *et al*., (2016), examined community-based disaster risk management programmes in China, which focussed on educating the community. The Chinese example illustrated the importance of support for the programmes from experts in disaster management, the police, and Red Cross agencies.

This research will explore the extent to which good practices, as outlined above, are evident in the Iran system of disaster education.

2.3.1 Disaster management education in Iran

This section will examine in more detail the disaster management education system in Iran. In a recent study, Amini Hosseini and Izadkhah (2020), explained the history of earthquake disaster education in Iran, tracing its origins back to a safety education programme for schools in 1996. Iran has an organization called the 'International Institute of Earthquake Engineering and Seismology" (IIEES) that, according to Fallahi and Parsizadeh (1997), is responsible for increasing the attention paid to the effectiveness of earthquake management strategies, including the development of new policies and the review of structural design codes. Importantly for this research, the IIEES also advises disaster management authorities on earthquake education and on raising public awareness about effective actions to take during and after earthquake events. The system overseen by the IIEES comes under the heading of the Iranian Earthquake Risk Reduction Strategy.

According to UNISDR (2012) Iran significantly improved its earthquake and disaster education in the twenty years since it started running the school education programmes. However, it was still far from the having a good disaster management system for the whole country. The UN report considered that the most important problem issues within the Iranian disaster management system was the general lack of disaster education and management in communities outside the limits of major cities.

Perhaps in response to the UNISDR (2012) report, in 2015 the IIEES expanded the school programme and started to run events in the wider community. That programme was referred to as the “Safe School and Resilient Communities” (SSRC) programme. The main aim of the SSRC was to improve public participation in disaster management at a local level. The hope was to increase resilience, by developing local capacities for emergency response and help communities adapt to conditions after an earthquake disaster Amini Hosseini and Izadkhah (2020). In the programme, the community was taught elements of earthquake risk assessment, including topics such as vulnerability checking and the diagnosis of weaknesses and strength in disaster preparedness planning within each community neighbourhood. ECORFDRR (2017) explained that the SSRC programme was designed around the use of school buildings in each community. According to Norris *et al*., (2008) and Jahangiri, Izadkhah and Tabibi (2011), community-based disaster education programmes are most effective when the community connect with the local government. In that regard, Amini-Hosseini and Izadkhah (2020) explained that the Iranian programme promoted the use of local government schools as the base for local disaster management activity.

One Iranian study, by Hosseini and Hosseini (2009), assessed a community-based disaster education system in Iran’s Capital city, Tehran. They found that the system involved many organizations such as the Iranian National Disaster Management Organization (NDMO); the Tehran Municipality, the Iranian Red Crescent Society (IRCS); emergency response volunteer groups (in particular a group called DAVAM). However, in relation to the latter organisation, a report by the Iranian Red Crescent Society IRCS (2019) found that the DAVAM group had not achieved its aim of educating emergency response volunteer groups in Tehran communities. As such, other disaster management organisations had stopped collaborating with DAVAM, citing a lack of sustainable resources. After the DAVAM group stopped training local communities the IRCS stepped in to provide earthquake disaster preparedness education and training to local volunteer groups. That education programme was delivered via a new group called DADRAS. The training that DADRAS have been providing to community has included:

1. Rescues and relief after the earthquake.
2. Emergency shelter.
3. First medical aid and firefighting.

Recently, the ICRS (2019) reported that the DADRAS programme has its own problem issues, as the programme relies heavily on student volunteers, who are not as reliable or affective as was hoped. The student volunteers were accused of not promoting the programme properly and not taking messages from the central administration to the communities effectively. There was a sense that the Tehran experience was not unusual and that all similar community-based group in Iran have the same problem. The causes seemed to be lack of financial support, a lack of experience in disaster management education and the lack of a strong local disaster management system.

Ghafory-Ashtiany and Parsizadeh (2005) reviewed the Iranian Earthquake Risk Reduction Strategy and its efforts to create, what it called a “Safety culture”, by raising awareness and preparedness of the public. Although such strategies have been in existence since 1991, Iranian society is still not completely prepared for any major earthquake Parsizadeh (1998). To improve the levels of preparedness, Iranian authorities needed to undertake further work to ensure that the education strategy was clearer, more reliable, and easier to understand. To that end, Heshmati and Parsizadeh (2007) looked in more detail at the educational component of Iran’s Earthquake Risk Reduction Strategy, dividing it into three parts:

1. Disaster management education for managers

2. General public education
3. School’s earthquake education: awareness and preparedness

The Iranian earthquake risk reduction management has a set training programme for all the managers in every town and cities across the country. In this course managers are educated about active faults, seismicity and seismic hazard of each town and cities as well human loss, economic loss, and physical damage. This training is conducted face-to-face (direct) and it has changed the point of view of many key people in their city and their provenance (Heshmati and Parsizadeh, 2007).

Ghafory-Ashtiany and Parsizadeh (2005) explained that the Earthquake Risk Reduction Strategy sets out what authorities need to do to improve public awareness about earthquake and its consequences, namely:

1. Explain the seismic risk and disaster preparedness strategy.
2. Demonstrate the benefits of prevention and risk reduction actions.
3. Creating incentives for members of the public to act.
4. Provide examples of how to be prepared for an earthquake event.

Izadkhah and Hosseini (2005), considered that targeted disaster education is one the most effective ways to make people ready for disaster events and they suggested that educating the young children, when they are keener and more open to learn, about earthquakes is an effective means of getting important information to other family member. That ideas reflected the view of Twigg (2004), who proposed that focussing earthquake education programmes in schools is an effective method to disseminate earthquake disaster management material, as children are learning new material all the time. According to Petal (2008), since 1980 many countries prone to earthquakes, such as Nepal, Turkey, and Indonesia, have included disaster risk reduction elements in their school subject curricula.

Izadkhah and Hosseini (2017) found that Iran has produced a number of publications to support its school education (Figure 2.9). These publications mainly explain what an earthquake is, how frequently they occur and how to prepare for an earthquake event.

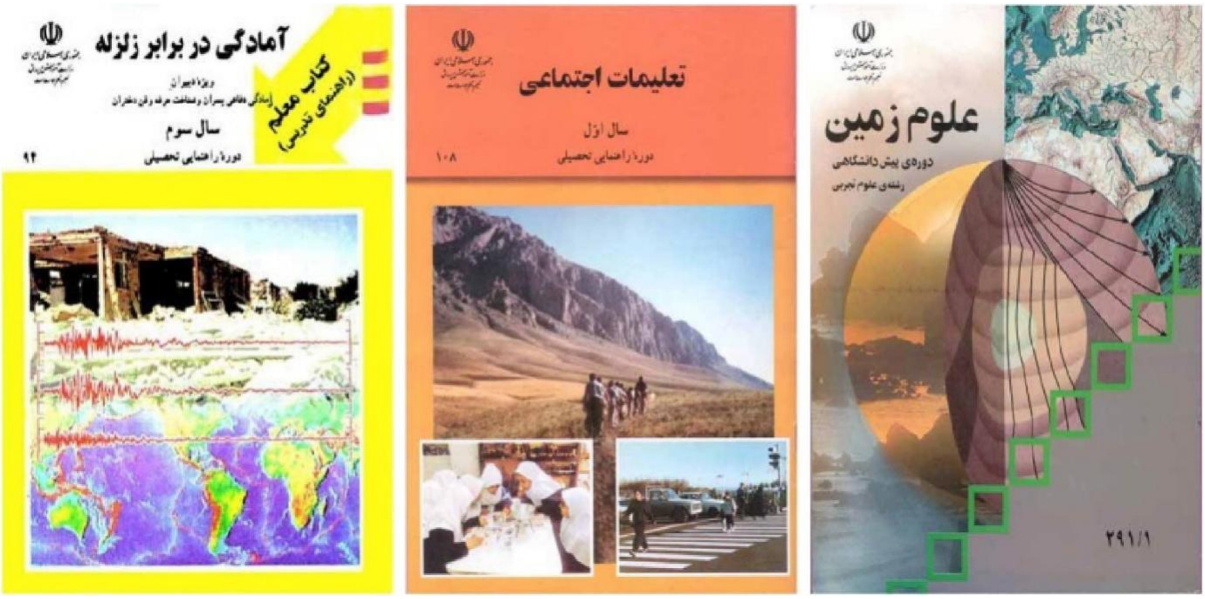


Figure 2.9 Some Iranian publications for schools about earthquake preparedness.

(Amini Hosseini, O. Izadkhah, 2020)

Ghafory-Ashtiany and Parsizadeh (2005) considered that, because Iran has a very young population (with 25 million people under the age of 19) a policy of earthquake education focussed on schools is a very good starting point. The young population of Iran can play a major role in creating a safety culture, taking earthquake preparedness messages from the school to their homes and disseminating messages to their parents and their local community. In order to achieve all these purposes, Ghafory-Ashtiany and Parsizadeh (2005) proposed that the Iranian Earthquake Risk Reduction Strategy needed to be enhanced with measures such as:

1. Improve provision of audio-visual earthquake preparedness material.
2. Improve coordination of publication of booklets, pamphlets and posters on earthquake risk and preparedness.
3. Expand the school's earthquake education, awareness and preparedness scheme.

Audio-visual earthquake preparedness material – Proposals included short films on past earthquakes and economic losses, the code of practice for making buildings safe against earthquake events and how to conduct earthquake drills for children in schools and public.

Booklets, pamphlets and posters on earthquake risk and preparedness – Many different Iranian organizations publish material specific to different environments, such as office buildings, houses, hospitals, hotels, and markets. Most of these booklets have good graphics and pictures to show how to be prepared against an earthquake during and after and how to protect the interior of the house and office spaces against an earthquake.

School earthquake education, awareness, and preparedness scheme – Disaster management education in schools is an important part of any disaster management programme (Hosseini and Izadkhah, 2006). The Iranian educational system is divided in to three levels: primary school is five years; secondary school is three years and high school is four years. The Iranian earthquake risk reduction management organization has planned that students in primary school would learn about the general knowledge about earthquake and their safety procedure during an earthquake and then during their secondary school and high school they would learn about emergency responses such as first aid and their safety during and after earthquake (Heshmati and Parsizadeh, 2007).

Looking specifically at school earthquake education scheme, Rezaeepanah and Parsizadeh (1997) reviewed information provided in Iranian school textbooks. They divided the material into three main areas:

1. Scientific subjects on earth and earthquake.
2. Earthquake preparedness, respond and recovery.
3. Technical and engineering aspects of safe building.

Scientific subjects on earth and earthquake - these areas gave students the general information about earthquakes, earthquake faults, seismicity, and seismic hazard.

Earthquake preparedness, response, and recovery - students would be introduced to most important activities before, during and after an earthquake and how they can use the basic first aid until the proper help arrives.

Technical and engineering aspects of safe building -in this area, basic information about the earthquake resilience of structures and safe construction methods are introduced.

One of the most important goals of the Iranian “safety culture” programme is to reduce the loss of human life from earthquakes. The Iranian Earthquake Risk Reduction Strategy states that protecting children’s lives is an important part of this goal (Ghafory-Ashtiany and Parsizadeh, 2005). However, Iran suffers from a legacy of unsafe construction in schools, with most the schools in rural areas and small towns not built to adequate levels of seismic resistance, making them unsafe during an earthquake. According to Parsizadeh, Seif and Heshmati (2007) the Iranian Earthquake Risk Reduction Strategy has addressed that legacy by introducing a “School earthquake safety drill” in 2003. The drill is designed to ensure all the theoretical knowledge and textbook information has been practically implemented. On the 29th of November, every year, all the high schools across the country perform the safety drill during. This programme is continuously updated, to make sure that the best outcome is achieved. In addition, a new “Natural disaster reduction workshop” has been introduced, to be run on the 11th of October each year. This workshop involves more than 12,000 students and is design to supplement the earthquake drill exercise.

Table 2.5 below shows the Grade and number of students who have been participated in earthquake school safety programme since 1996 and the place of the programme that has been conducted.

Table 2.5 Participation in the Iranian earthquake school safety programme, since 1996. (Hosseini and Izadkhah, 2020)

	Year	Grade	Number of Students	Place
1st Pilot Drill	1996	Preschool and Elementary schools	1000	Tehran
2nd Pilot Drill	1997	High Schools	–	Tehran
Tehran Drill	1998	High Schools	537.237	Tehran
1st National Drill	1999	High Schools	4.580.688	Across the Country
2nd National Drill	2000	Secondary and High Schools	11.000.000	Across the Country
3rd National Drill	2001	Secondary and High Schools	11.800.000	Across the Country
4th National Drill	2002	Secondary and High Schools	12.000.000	Across the Country
5th National Drill	2003	All levels	16.591.225	Across the Country
6th National Drill	2004	All levels	16.027.956	Across the Country
7th National Drill	2005	All levels	15.264.349	Across the Country
8th National Drill	2006	All levels	14.331.902	Across the Country
9th National Drill	2007	All levels	14.434.526	Across the Country
10th National Drill	2008	All levels	14.415.668	Across the Country
11th National Drill	2009	All levels	13.957.960	Across the Country
12th National Drill	2010	All levels	12.800.000	Across the Country
13th National Drill	2011	All levels	12.652.320	Across the Country
14th National Drill	2012	All levels	11.579.730	Across the Country
15th National Drill	2013	All levels	12.242.000	Across the Country

The author of this thesis suggests that there is a need for new research that investigates how effective the actions taken to improve public awareness and preparedness about earthquakes in Iran have been. Assessing the extent to which the actions taken in schools is changing the overall public perception about the level of earthquake preparedness in the country and the effectiveness of strategies to mitigate the effects of seismic events.

2.4 Disaster Management and Community Engagement

The Iranian authority realised the importance of the public engagement in disaster management after the bam earthquake in 2003, but there is still a shortage of understanding about the earthquake community engagement before, during and after earthquake events (Mirhashemi, 2003). A joint publication by the Japanese International Cooperation Agency and the Tehran Disaster Mitigation and Management Organization (2004), stated that there is no single organization in Iran with responsibility to organise and manage the engagement of people in the disaster management process.

According to Movahedi (2003) the public engagement in Iran was low because:

There was not enough media coverage on how to the public can engage with the system. consequently, the public were not familiar with disaster management systems in their local area and most of the information and training was not focussed on engagement activity.

There was also a problem that the city authorities did not have a good relationship with their local governments, which resulted in the cutting off any local engagement with government exercises for earthquake preparedness.

Okano (2005) stated that there are barely any non-governmental organizations who are officially engaged with disaster mitigation and disaster management in Iran. In Iran there are many Community-Based Organizations (CBOs). CBOs include religious foundations, which help with religious ceremonies; medical organizations, which help run clinics and hospitals; educational charities, which are involved in the construction of schools. According to the Master Plan for Relief and Rescue of Iran (2003), the Ministry of Interior has developed some activities aiming to engaging NGOs, CBOs. CBOs are often engaged in humanitarian training and disaster relief, but much of that work is done without official support from Iranian Government authorities.

Hosseini (2009) explained that some Iranian organizations have tried to engage local communities with their disaster management systems. In one example, the Swiss Agency for Development and Cooperation (SDC), was cited as having worked with the Tehran Municipality to create an organization, called DAVAM. DAVAM's aim was to engage in local volunteer groups in the emergency response to an earthquake event. The programme built on similar efforts in Japan, USA, Turkey, and Nepal. These programmes were reported to have had a positive impact and Japan has increased the number of such programme significantly since the Kobe earthquake of 1995.

Izadkhah (2009) found that there is no regular training for rescue and relief, first aid, firefighting, and evacuation in case of an earthquake and paper posters need to be made in a way that everyone from different backgrounds and different levels of education can understand. Engaged actions needed to focus on:

1. Employees in organizations.
2. School students.
3. General public Disabled people, elderly and people with special needs.

In this literature review, the author found a complete lack on guidance on engagement in basic post-earthquake structural assessment. There was also very little evidence of how engineers are engaged in the disaster management system in Iran. The Iran engagement programme, in that sense, was judged to be very weak and research is urgently needed to address that gap.

2.5 Post-earthquake damage survey assessment

This section will review current theory and practice in the field of post-earthquake building damage survey and usability assessment. Whilst the theory draws on literature from all regions of the world, the literature relating to the practice of post-earthquake assessment draws mainly from sources in regions close to or of similar character to the Iranian context, as this offers the maximum potential for effective cross-referencing with the Iranian system. Specifically, post-earthquake building damage survey and usability assessment systems used in Italy, Japan, Greece, and Turkey are reviewed (ATC-20, 1989 &1995; Baggio *et al.*, 2000; Building Research Institute, 2002; Dandoulaki *et al.*, 1998; Goretti, 2001&2002).

2.5.1 Lessons about post-earthquake damage survey assessment from Italy, Greece, and Turkey

Two papers by Goretti (2001 & 2002) analysed post-earthquake structural assessment systems used in Italy, Japan and Greece and provide a useful illustration of the different manifestations of such systems in practice. In Italy, the post-earthquake structural assessment system is triggered by the property owner's demands. Inspection results are sent to the local goverment office and consequently the "Centre for Damage Surveys" for classification. If the building is classified as unsafe for its current usage, then the local goverment office would either order evacuation or curtail the building usage to limit risks to building users. In Japan, the post-earthquake structural assessment system is only used on multi-owner buildings and the results would be a suggestion to the owners of the building, unless the public safety is affected. In Greece, the post-earthquake structural assessment system is done on all buildings in the area classified as the epicentre of the earthquake and only at the request of building owners/occupiers in areas outside the epicentre Goretti (2002). For this thesis the important lessons are that different stakeholders can be engaged in the structural assessment process, but the structural assessment processes itself needs to be tailored to match the type of structure being assessed and resource constraints often limit the speed and extent of the structural assessment process.

According to Guidoboni (1987), one of the earliest examples of a post-earthquake structural assessment system can be found in Italy. After the 1574 Ferrara Earthquake, the king of Italy ordered the architect Ligorio to start the structural assessment on public and private building. The assessment from Ligorio was very detailed, describing the different type of material and different construction techniques used for different type of buildings. This system acted as a blueprint for future damage assessment surveys and in Italy there have been many earthquakes since 1574. After the Second World War the Italian authorities rationalised, their post-earthquake building damage survey and usability assessment system into three basic steps National Seismic Survey (2001):

1. Decide on the assessment methodology.

2. Set up Local data collection procedures.

3. Management data collection and processing protocols.

After the Parma earthquake in 1983 the Italian government decided to change one of the steps to include a wider regional damage assessment (National Seismic Survey, 2001). Since 2001 the Italian department for National Civil Protection (NCP) and the National Seismic Survey (SSN) decided to use a unified standard classification procedure for usability and damage assessment in all the regions in Italy. The procedure follows two steps:

Step 1. Damage classification based on the post-earthquake reconstruction aim: short term usability assessment, economic loss and the funding need for reconstruction, social impact assessment and emergency management.

Step 2 Data classification by subject disciplines Building Research Institute (2002):

- Geo-Science: to collect ground motion data.
- Structural Engineering: to assess structural integrity after the earthquake for reconstruction purposes.
- Social science: to assess the level of homelessness and personal injury.
- Economics: to assess the economic damage and the funds needed for reconstruction

The methods that the Italian NCP and SSN employ vary based on when data are collected, what the data reveal about the building and the correlation of the data to construction standards in different parts of the country (Building Research Institute, 2002). The methods that Italian NCP and SSN employ are divided in to four categories Building Research Institute (2002):

1. **Pre-event**: - the pre-event assessments are based on quick, visual inspections.
2. **First Post-event assessment: 2 to 3 days after the event** - the initial damage assessment of the effect of the earthquake on buildings.
3. **Second Post-event: 3 to 60 days after the event** - an assessment that focusses more on usability of buildings.
4. **Third Post-event: up to 1+ years after the event** - focussing on long-term usability of the buildings.

In Italy there are three levels a data classification Building Research Institute (2002):

- level I: Data collected using visual inspections.
- level II: Data about the condition of structural elements in a building.
- level III: Data from an engineering evaluation of the building structure.

For this research, the analysis of the Italian system provides insights about what may be found when analysing the Iranian system. Specifically, the system should classify the nature of damage and the nature of the data needed to assess damage. The term structural assessment is used in a very broad sense, to include engineering, social and economic elements.

The post-earthquake building damage survey and usability assessment system in Greece divides buildings into three states Anagnostopoulos *et al*., (2004):

1. **''Safe for use''** which is shown by a green colour. In this state there is no or just a little damage done to the main structure of the building. The state has two sub-classifications: 1. stands for no structural damage and 2. For slight structural damage.
2. **''Unsafe for use''** which is shown by a yellow colour. In this state the main structure of the building has been damaged and the entry to the building would be at owner's risk. The public are not allowed to enter or use the building and the owner is required to repair the building as soon as possible. The state has two sub-classifications: 2. stands for requiring moderate repair to the building and 3. Stands for requiring heavy repair to the building.
3. **''Dangerous for use''** which is shown by a red colour. In this state damaged buildings are liable to collapse with any aftershocks. No one can use or enter the building and the neighbouring buildings are assessed for any need to be protected. The state has two sub-classifications: 3. stands for severe repair to the building and 4. Stands for total demolition of the building.

Post-earthquake structural assessment of buildings in Greece is conducted on four levels, following the sub-classifications in each of the three building states described above Anagnostopoulos *et al*., (2004):

Level 1 for building with no structural damage: a. No signs of any distress. b. Very light or non-structural damage. c. Fine cracks in few infill walls and in mortar, light spalling of concrete.

Level 2 for building with slight damage or requiring moderate repair:

a. Small cracks (d≤3.0 mm) in a few infill or partition walls.
b. Cracks and/or spalling of concrete in some structural elements. Indicative crack widths are: beams with width of diagonal cracks ≤ 0.5mm, widths of vertical cracks ≤ 2.0mm; columns: width of diagonal cracks ≤ 0.5mm, widths of horizontal cracks ≤ 2. 0mm; shear wall: width of diagonal cracks ≤ 0.5mm, widths of horizontal cracks ≤ 1.0mm; and stairs: width of cracks ≤ 3.0mm and slab crack width ≤ 1.0mm.
c. Disturbance, partial sliding or falling down of roof tiles.
d. Cracking or partial failure of chimneys and parapets.
e. Inclination of building barely visible.

Level 3 for buildings with heavy damage or needing moderate repair: a. extended large diagonal or other cracking in partition or infill walls (widths of cracks ≥ 3.0mm) in one or more stories. Detachment or partial failure of walls. b. Spalling-partial disintegration of concrete. Larger cracks in several structural elements. Indicative crack widths are as follows: beam width of diagonal cracks ≤ 2.0 mm, widths of vertical cracks ≤ 4.0mm. Columns: width of diagonal cracks ≤ 2.0mm, widths of horizontal cracks ≤ 5.0mm. Shear walls: width of diagonal cracks ≤ 1.0mm, widths of horizontal cracks ≤ 3.0mm. Stairs: width of cracks ≤ 10.0 mm. Slabs: width of cracks ≤ 2.0 mm. Joints: width of cracks ≤ 2.0 mm. c. dislocation and/or partial collapse of chimneys and parapets. Sliding and/or failure of roof tiles d. visible inclination of building. Slight dislocation of structural elements. e. Minor ground movement but no signs of foundation failure.

Level 4 for buildings with Severe damage or liable to collapse: a. partial or total collapse b. widespread failure of infill walls or severe cracking visible from both sides in one or more stories c. large number of crushed structural elements and connections, exposure and buckling of reinforcement in several locations, disintegration of concrete, indicative crack widths are: beams: width of diagonal cracks > 2.0mm, widths of vertical cracks > 4.0mm. Columns: width of diagonal cracks > 2.0mm, widths of horizontal cracks > 5.0mm. shear walls: width of diagonal cracks > 1.0mm, width of horizontal cracks > 3.0 mm. stairs: width of crack > 10.0mm. Joints: width of diagonal cracks > 2.0mm d. collapse of chimneys and parapets. Extensive damage and/or sliding of roof. e. considerable dislocation of structural elements, residual drift in any story or dislocation of the whole building f. Substantial ground movement, uplift of footings or fracture of foundation

Anagnostopoulos *et al*., (2004) added that there are two types of inspection in Greece after an earthquake:

1. **Rapid inspection**: in this type of inspection the building is only assessed from outside and the damage extent will not be recorded.

2. **Detailed inspection**: in this type of inspection severity and extent of the damage will be recorded.

According to Anagnostopoulos *et al*., (2004), the usability and damage assessment questionnaire used by Greek authorities has been created by having four aspects in mind:

1. Easy and short for effected people to fill in.

2. The form includes both rapid inspection and detailed inspection.

3. Helping and directing the inspected engineer to check all aspects of structural and non-structural damage assessment.

4. The form should be self-explanatory and if any data needed, it should be included at the back of the form.

In addition, the information in the earthquake damage inspection form is classified in six groups Anagnostopoulos *et al.,* (2004):

1. Building location which consists of street, postcode, and town.

2. Type of building consists of number of stories, mathematical area of story, year of construction, type of structural system and usage type.

3. Damage information consists of type of inspection, ground problem and damage severity.

4. Overall assessment for use of the building which consists of safe for use, unsafe for use and dangerous for use.

5. Human loss of life which consists of number of deaths and number of injuries.

6. Actions to take which consists of none damage buildings and require no action, remove local hazards, urgent support required, urgent re-inspection required, and urgent demolition required.

Anagnostopoulos and Moretti (2006) reported that the main aims for organizations involved in post-earthquake structural assessment in Greece are to protect human life and save properties, namely by:

1. Minimising the number of homeless people and the loss of economic activity.
2. Indicating unsafe areas around hazardous building.
3. Providing the necessary data for obtaining reliable estimates of the disaster that will allow authorities to take relief measure, formulate disaster mitigation policies and allocate available resources.
4. Providing data that will identify frequent causes of damage.
5. Providing data for practical research studies that may lead to re-evaluation of existing codes and construction practice, to updates of seismic hazard maps and to elaboration of seismic vulnerability models for pre-earthquake planning purpose.

In Greece the damage assessment of the building would be done by two experience or well-trained structural engineers. The main aim of rapid inspection would be to realise the safe building from unsafe building as quick as possible. In rapid inspection the structural engineers would assess the outside of the building and if it is safe, they would check the ground floor of the building and it should take more than 10-30 minutes for each building.

The point that structural engineer would look at it in rapid inspection are as follows Anagnostopoulos and Moretti (2006):

1. Damage to the bearing elements or secondary elements such as (chimneys, roof, infill walls, façade).
2. Any sign of residual drift of the whole building or part of it.
3. Any sings of permanent displacement at the ground level, for example small gaps between columns and ground.

The detailed inspection would be more interested about the condition of the building, and it would be done for all the building with yellow to red postings. The detailed inspection would be done for all the important building in the affected area such as: hospital, police stations, fire stations and schools. The detailed inspection would take about 1-2 hours for each building. In detailed inspection first, the structural engineer would look at the outside of the building and examine all the structural and non-structural elements, any ground problems, or geological hazards such as: settlement, ground fissures, sign of liquefaction and, in case of hillside building, signs of slope movement and rock fall hazards. If all these conditions have been met and structural engineers would realise that it is safe, they can enter the building. The inspection inside the building would start from the ground floor going upwards. If the building has a basement, it would be checked for any possible problem with foundation or uneven settlement Anagnostopoulos and Moretti, (2006).

The operational emergency damage inspection management system in Greece consists of chief of operation as a head of the department who must be a senior structural engineer, have good leadership, be familiar with emergency mobilisation plan, and the chief of operation would be chosen by emergency agency planners. His duties are as follows:

- Direct the setting up of the operation, i.e., secures personnel, assigns duties, and set up local field office.
- His main duties are overseeing work progress, chairs meetings with coordinators, approves or changes daily work program, decides on tasks for the team of experts, resolves conflicts, communicates with other emergency officials and authorities,

replace personnel if needed and gives pertinent information to the appropriate authorities and submits final report.

The main duties of the Team of structural engineer are:

- To inspect the effected building and assess them for appropriate solution.
- To advice the chief of operation on technical issues.

The main duties of coordinator of intervention are as follows:

- Coordinate and supervise the work of 10-15 inspection team.
- Name the leader of each team.
- Assign the areas of responsibility for each team.
- Secure the availability of material for the inspection teams.
- Receive the damage inspection forms and rank the degree of urgency of the required actions.
- Make spot checks of inspected buildings.
- Give copies of the damage inspection forms for data processing.
- Participate in the end of the day meeting with the chief of operations and the coordinator of the support and demolition crews to prepare the intervention list for next day, review progress and solve problem.
- Resolve conflicts between their teams.
- Seek the assistance of the team of experts if the need arises.

The duties of the department such as data processing, system support and public request are as follows (Anagnostopoulos and Moretti, 2006):

- Process the data on the damage inspection forms.
- Produce lists with requirements for further action.

- Process the data of the Emergency Intervention Forms.
- Produce summary reports.
- Provide clerical and secretarial support to the operation.
- Maintain stock and supply the materials required for the operation.
- Support the smooth operation of PEADAB (post-earthquake assessment of the damage building).
- handle requests by the public

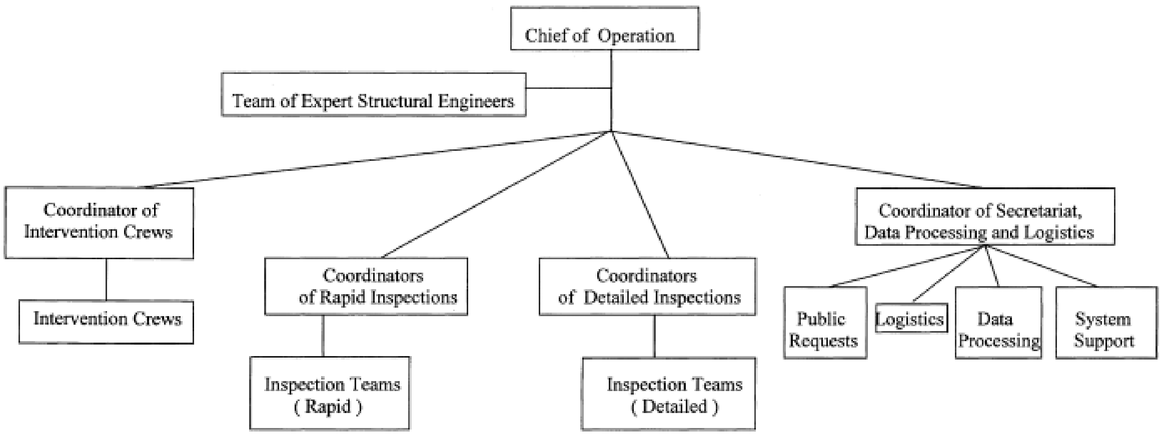


Figure 2.10 Operational damage inspection system in Greece.

The computer system the Greek post-earthquake emergency damage assessment would have employed is called PEADAB. The PEADAB software has got three main functions (Gerbesioti, 2004):

1. To support the planning of the post-earthquake emergency inspections operation by storing the available resources (human and material).
2. To support the execution of the operation by processing the data of the inspection and intervention forms, checking the agreement of the recorded damage with the given posting colour classification, and by providing reports on various aspects of the operation in progress.

3. To provide information concerning the progress of the operation, inclusive of daily lists of the buildings requiring emergency intervention

The basic purposes of PEADAB software are as follows:

1. Plan operation:
    a. Definition of agencies.
    b. Definition of available resources from each agency.
    c. Selection of personnel and equipment for the operation.
    d. Division of the area into sections and assignment to coordinators.
2. Review and update operation.
3. Execute operation.
4. View-extract information gives the information on the following topic Gerbesioti (2004):
    a. The personnel and equipment involved in the operation and that kept in reserve and still available at each agency. Buildings inspected and display by inspection team, by section and assessment for use. Building requiring emergency intervention shown by category of intervention or by degree of urgency.
    b. It maps the inspected buildings according to their posting classification as the operation progress.
    c. it provides information on buildings for any combination of user-defined attributes recorded in the EDIF (Earthquake Damage inspection Form).

The Greek system of post-earthquake structural assessment provides this thesis with some very clear guidance on how, at what stage and to what extent different stakeholder groups can be engaged in the process. For the Iranian system analysis, this thesis will seek evidence of the extent to which these “opportunities” for engagement are included in the post-earthquake structural assessment process.

2.5.2 Post-earthquake structural assessment in reinforced concrete framed structures

As this thesis cannot cover the entire spectrum of structural typologies, this research study will focus on buildings with reinforced concrete frames. The rationale for that condition is that, in Iran, the most common "engineered" structure is a type with a reinforced concrete frame. Further to the system for conducting post-earthquake structural assessment, as outlined in Section 2.3.1, Engineers engaged in the task of assessing earthquake damaged structures will need training in post-earthquake damage survey assessment in order to arrive at a final judgement about a building's safety. In this section, a technique is introduced for assessing the residual seismic capacity of reinforced concrete structures, first proposed by Bunni and Meada (2001), but subsequently revised and improved by Maeda and Kan (2009), Bao, Matsukawa and Maeda (2010) and Maeda, Matsukawa and Ito (2014) is evaluated for use in Iran.

The residual seismic capacity assessment method for analysing earthquake damaged reinforced concrete structures builds on the damage evaluation system described in Section 2.3.1, by providing a further refinement in the classification of damage to structures (Table 2.6). The classification system is based on a visual assessment but focusses the Engineers attention on the extent of cracking, spalling and reinforcement deformation in critical structural elements. Maeda, Matsukawa, and Ito (2014) augmented the descriptive table of damage classes with a set of images that could be used by Engineers when determining the appropriate class for a damaged structure (Figure 2.11). After the visual classification, abuilding requires a deeper analysis of damage to the building foundations and to the building superstructure (Nakano, Kuramoto, and Murakami, 2004).

Table 2.6 Post-earthquake damage classes for reinforced concrete structures (Meada and Kang, 2009).

Damage Class	Description of Damage
I	- Visible narrow cracks on concrete surface (Crack width is less than 0.2 mm)
II	- Visible clear cracks on concrete surface (Crack width is about 0.2 -1.0 mm)
III	- Local crush of concrete cover - Remarkable wide cracks (Crack width is about 1.0 - 2.0 mm)
IV	- Remarkable crush of concrete with exposed reinforcing bars - Spalling off of concrete cover (Crack width is more than 2.0 mm)
V	- Buckling of reinforcing bars - Cracks in core concrete - Visible vertical and/or lateral deformation in columns and/or walls - Visible settlement and/or leaning of the building

Figure 2.11 Images of earthquake damaged structures with Damage Classification.

(Source: Maeda, Matsukawa and Ito 2014)

Nakano, Kuramoto and Murakami (2004) identified two types of post-earthquake foundation damage that needs to be assessed:

1. Foundation leaning (θ)
2. Building settlement (S).

The degree of foundation leaning (θ), is calculated using the tilting angle in each X and Y directions of super structure. Equation 1 is used to calculate leaning angle: (Nakano, Kuramoto and Murakami, 2004).

$$\theta = \sqrt{\theta_x^2 + \theta_y^2} \qquad \text{Equation 1}$$

The foundation leaning angle (Θ) is then combined with an assessment of building settlement (S) to arrive at a classification of damage, spanning "None" to "Heavy" damage Table 2.7. (Nakano, Kuramoto and Murakami, 2004) proposed that, when assessing building foundations, a distinction needs to be made between piled foundation and footing and mat foundations, with piled foundations having more rigorous criteria relating to leaning angle and footing and mat foundations having more stringent cut-offs for settlement.

Table 2.7 Assessment of foundation damage to earthquake affected structures.

(Source: Nakano, Kuramoto and Murakami, 2004).

(a) Pile Foundations

θ (rad.) \ Settlement S (m)	0	0.1	0.3	
Tilting 1/300	None	Light	Moderate	*
1/150	Light	Moderate	Moderate	Heavy
1/75	Moderate	Moderate	Heavy	Heavy
	Heavy	Heavy	Heavy	Heavy

(b) Footing and Mat Foundations

θ (rad.) \ Settlement S (m)	0.05	0.1	0.3	
Tilting 1/150	None	Light	*	*
1/75	Light	Moderate	Moderate	*
1/30	Moderate	Moderate	Heavy	Heavy
	Heavy	Heavy	Heavy	Heavy

When assessing the building superstructure, (Bao, Matsukawa, and Maeda, 2010), proposed that two types of structural collapse mechanism need to be analysed. First is a story collapse mechanism and second is a total collapse mechanism Figure 2.12.

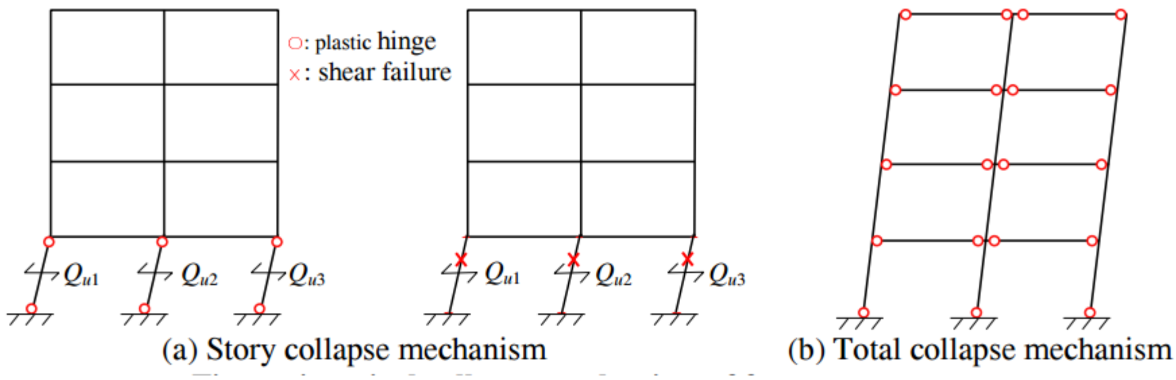


Figure 2.12 Two types of collapse mechanism in the residual seismic capacity assessment method Bao, Matsukawa, and Maeda (2010).

Equations 2 through to 16 in this chapter are all derived from the study by Maeda, Matsukawa and Ito (2014).

Central to the residual seismic capacity assessment method, is the calculation of the residual seismic capacity index (R). Maeda, Matsukawa and Ito (2014) stated that the value of R is the best indication of the how safe is the damage building is after the earthquake. The R index represents the ratio of post-earthquake residual seismic capacity to original capacity before the earthquake and is judged to be of most benefit when analysing the story collapse mechanism (Equation 2).

$$R = \frac{D^{Is}}{Is} \times 100\ (\%) \qquad \text{Equation 2}$$

From Equation 2, D^{Is} stands for seismic capacity of the reinforced concrete structure after the earthquake damage. While, I_s stands for seismic capacity of the reinforced concrete before the earthquake damage.

I_s the original seismic capacity of the building can be calculated from lateral resistance and deformation ductility of the structural members.

The relationship between the load capacity and deflection for columns for different damage classes for ductile and brittle member is shown in the Figure 2.13 below.

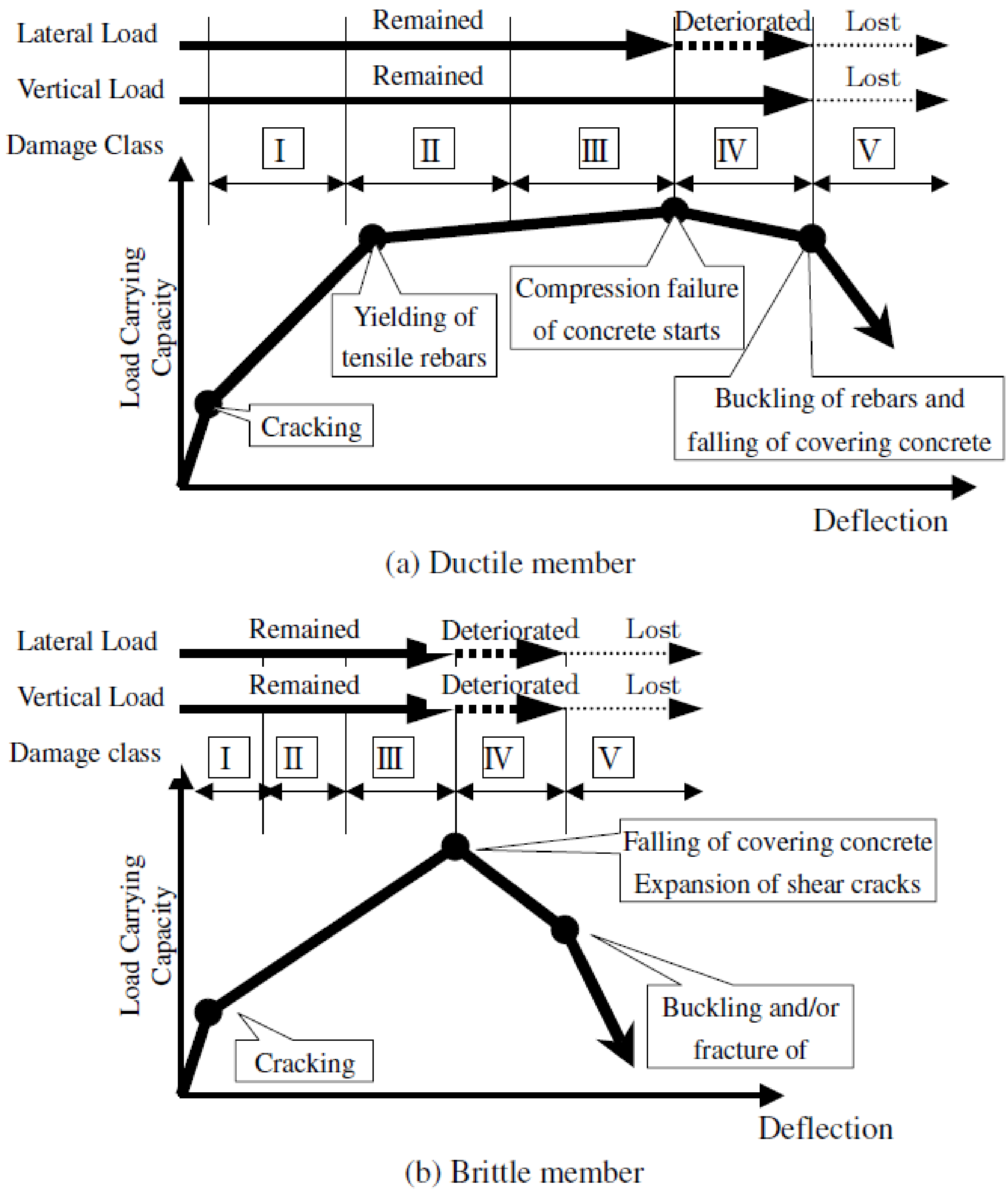


Figure 2.12 Idealized lateral force-displacement relationship and damage class (Maeda, Matsukawa, and Ito, 2014).

Seismic Capacity of Reduction Factor can be calculated from the formula below:

$$\eta = \frac{E_r}{E_t} \qquad \text{Equation 3}$$

ɳ can be defined as the ratio of residual energy dissipation capacity, E_r stands for residual absorbable energy and E_t stands for entire absorbable energy ($E_t = E_d + E_r$) and E_d stands for dissipated energy

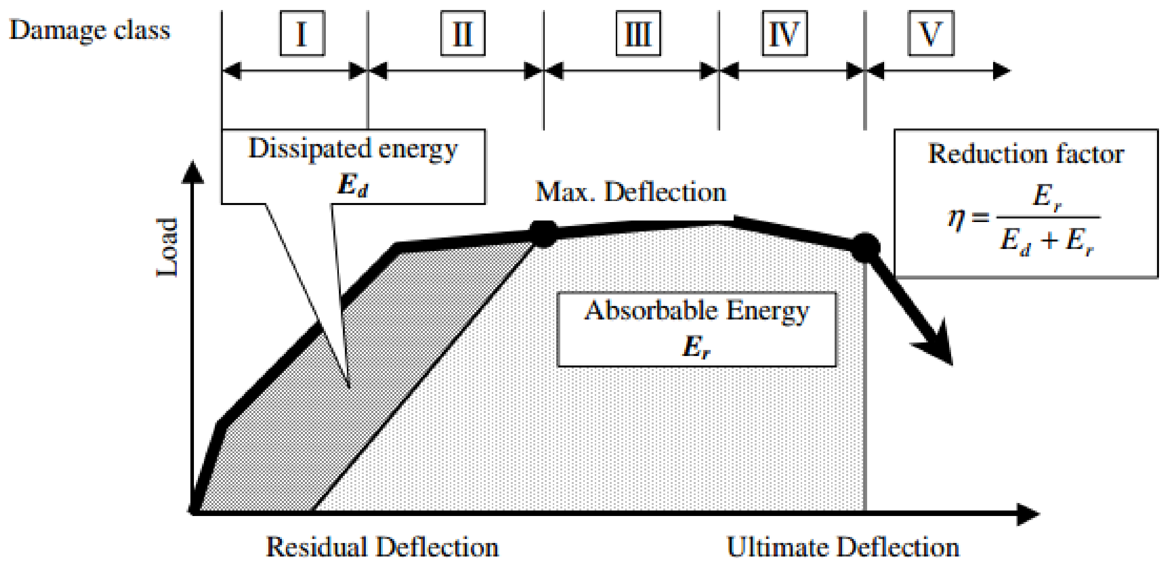


Figure2.13 Seismic capacity reduction factor with relevant damage classes (Maeda, Matsukawa and Ito, 2014).

The flexural deformation can be calculated from the formula below (R_f).

$$R_f = \frac{\sum W_f}{D} \qquad \text{Equation 4}$$

ΣW_f stands for total flexural crack widths and D stands for width of the building.

Shear deformation caused by shear cracks can be calculated from the formula below (R_s):

$$R_S = \frac{\sum W_S \times \sin\theta}{h_0} \qquad \text{Equation 5}$$

From Equation 5, H_0 stands for clear span height of a column and ϴ stands for angle of shear crack to the horizontal plane.

Residual Deformation of a Column:

The residual deformation of the column can be calculated from the formula below:

$$R_0 = R_{0f} + R_{0S} = \frac{\sum W_f}{D} + \frac{\sum W_S \times \sin\theta}{h_0} \qquad \text{Equation 6}$$

By rearranging the equation of residual deformation of a column we could calculate the maximum residual crack, residual deformation of the column and the ratio of flexural deformation α and the ratio of total crack width to maximum crack width.

$$maxW_{0f} = \frac{\alpha.D}{n_f} R_0 \qquad \text{Equation 7}$$

$$maxW_{0S} = \frac{(1-\alpha)h_0}{n_S \sin\theta} R_0 \qquad \text{Equation 8}$$

$$where, \alpha = \frac{R_{0f}}{R_0}, n_f = \frac{\sum W_f}{maxW_{0f}}, n_S = \frac{\sum W_S}{max^{W_{0S}}} \qquad \text{Equation 9}$$

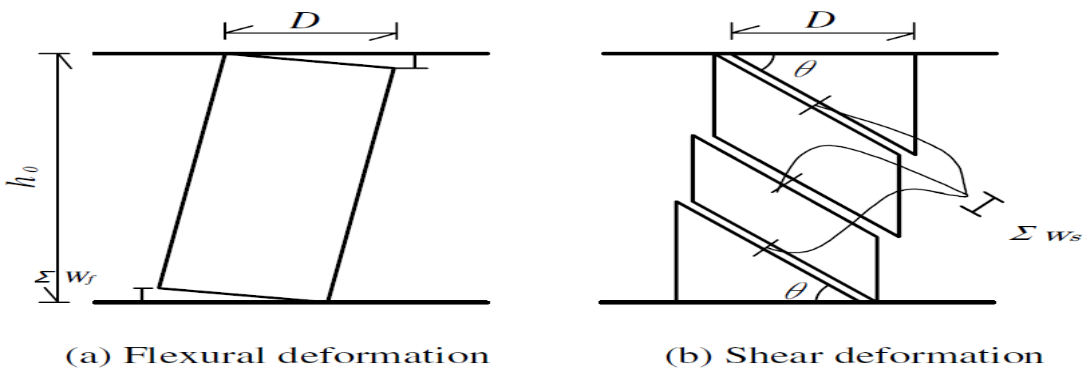


Figure 2.14 Different factor for flexural deformation and shear deformation (Maeda, Matsukawa, and Ito 2014).

If the max residual crack width plotted against seismic capacity reduction factor for ductile member and brittle member the damage level could show in figure below.

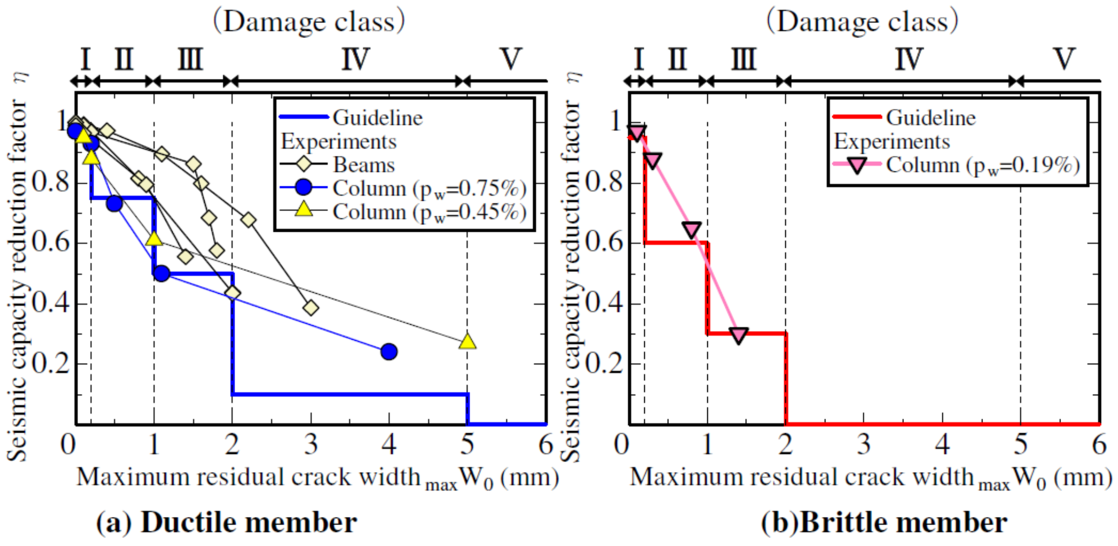


Figure2.15 seismic capacity reduction factor for ductile member and brittle member (Maeda, Matsukawa, and Ito 2014).

Table 2.8 Analytical results of the experiment (Maeda, Matsukawa and Ito 2014).

Damage class	column			beam		shear wall	
	ductile	quasi-ductile	brittle	ductile	brittle	ductile	brittle
I	0.95	0.95	0.95	0.95	0.95	0.95	0.95
II	0.75	0.7	0.6	0.75	0.7	0.7	0.6
III	0.5	0.4	0.3	0.5	0.4	0.4	0.3
IV	0.2	0.1	0	0.2	0.1	0.1	0
V	0	0	0	0	0	0	0

The main aim of the post-earthquake damage survey assessment is to assess the residual seismic capacity of the building as quick as possible and for this purpose the best and most effective way is to divide the evaluation in two different levels of procedure: 1. The first level is to consider the sectional area of columns and walls and the concrete strength.2. The second level of procedure the ultimate lateral load carrying capacity of vertical members is evaluated using material and sectional properties together with reinforcing details based on the field inspections and structural drawing.

Seismic performance Index of the Building (I_s)

The seismic performance index can be calculated from the formula below:

$$I_s = E_o\, S_D\, T \qquad \text{Equation 10}$$

From Equation 10, E_o stands for basic structural seismic capacity index which could be calculated from the product of strength index ©, ductility index (F) and story index (Ø) at each direction when a story or building reaches at the ultimate limit state due to lateral force. Such that, $E_0 = \emptyset \times C \times F$.

S_D stands for factor to modify E_0 index due to stiffness discontinuity along stories, eccentric distribution of stiffness in plan, irregularity and/or complexity of structural configuration, basically ranging from 0.4 to 1.0 .

T stands for the reduction factor to allow for the deterioration of strength and ductility due to age after construction, fire and/or uneven settlement of foundation, ranging from 0.5 to 1.0 .

Index Story of Shear Distribution during Earthquake Ø

The Story of Shear Distribution (Ø) can be calculated from the formula below:

$$\emptyset = \frac{n+1}{n+i} \qquad \text{Equation 11}$$

From Equation 11, i stands for story level of an n-storied building by assuming inverted triangular shaped deformation distribution and uniform mass distribution.

As most of the fatal collapsing damages could be found in vertical member and the story collapse mechanism, the formula below is more concerned about the columns and walls rather than beams so the residual seismic capacity (R index) can be calculated based on story shear and assume the ductility index is uniform in all the vertical elements in the story from the formula below.

$$R = \Sigma[\frac{Q_{ui}}{\Sigma Q_{ui}} \times \eta_i] \qquad \text{Equation 12}$$

Q_{ui} stands for lateral strength of vertical structural members (columns and walls) and η_i stands for seismic capacity reduction factor of each member.

The formula can be used for total collapse failure which happens in ductile failure pattern and beam yielding.

The seismic capacity (R index) for **total collapse mechanism** can be calculated from the formula below:

$$R = \Sigma[\frac{M_{ui}}{\Sigma M_{ui}} \times \eta_i] \qquad \text{Equation 13}$$

M_{ui} stands for ultimate flexural moment at yielding hinge.

In other words, the seismic index is to represent the capacity of the building story being analysed to absorb energy.

Ductility Index of the columns (F) can be calculated from the formula below:

$$F = \emptyset\sqrt{2\mu - 1} \qquad \text{Equation 14}$$

μ is stand for ductility factor

$$\emptyset = \frac{1}{0.75(1+0.05\mu)} \qquad \text{Equation 15}$$

Ultimate Flexural Capacity of Beams

The ultimate flexural capacity of the reinforcement concrete beams can be calculated from the formula below:

$$M_u = A_S f_Y[d - \frac{a}{2}] \qquad \text{Equation 16}$$

M_u ultimate capacity moment, A_s area of cross section, F_y characteristic of tensile strength in steel bar, d depth of concrete beam and a depth of natural axis.

Turkish post-earthquake damage survey assessment form consists of the following calculation, which is very suitable for Iran.

The total number of damaged elements is calculated from the formula below:

H=I+2xII+III+2xIV

I stand for number of heavily damaged columns, II stands for number of heavily damaged walls, III stands for number of moderate damaged columns, IV stands for number of heavily damaged walls.

The damage ratio (HO) is calculated from the formula below:

$$HO=(H/C) \text{ or } (H/F)$$

H stands for number of damaged structural elements

The C coefficient can be calculated from the formula below:

$$C = A+2xB$$

A total number of columns and B total number of walls.

The F coefficient can be calculated from the formula below:

$$F=D+2xE$$

D represents the total number of inspected columns, E stand for total number of inspected walls.

The total damage ratio (THO) can be calculated from the formula below:

$$THO=Ho \times 1.2 + HK$$

HK is the overall damage contribution and can be calculated from the formula below:

$$HK= 0.0125x(N1+N2+N3+N4)$$

N1 represents for the damage to non-structural element (roof and gable) and if there is a damage it takes as 1 and if there is no damage it takes as 0.

N2 stands for damage to non-structural element (stairs) and if there is a damage it takes as 1 and if there is no damage it takes as 0.

N3 stands for damage to non-structural element (chimney and parapet) and if there is a damage it takes as 1 and if there is no damage it takes as 0.

N4 stands for damage to non-structural element (partition walls) and if there is a damage it takes as 1 and if there is no damage it takes as 0.

Lastly, the overall structural damage is classified into four categories:

THOx100(%) ≥ 40 (Heavy Damage)

40<THOx100(%) ≤20 (Moderate Damage)

20<THOx100(%) ≤5 (Slight Damage)

THOx100(%) < 5 (No Damage)

2.6 Summary

As part of this literature review, the author sought publicly available data on the Iranian post-earthquake damage survey assessment system. He learned that some forms do exist, but they are not in public circulation. This research will seek to find examples of the forms used and subject them to scrutiny, based the good practices outlined above.

1. Is data collected before, during and after an earthquake event?
2. Analyse the data collected to assess risk, vulnerability and impact.
3. Learn lessons from prior events.
4. Dose the system Describe how post-earthquake structural survey assessment events will be planned, managed and monitored?
5. Dose the Iranian disaster management system Include short- and long-term planning?
6. Dose the Iranian earthquake Information management system (EIMS) collect and disseminate the post-earthquake damage survey assessment?
7. Who, when and how are different stakeholder group engaged in the post-earthquake structural assessment system reviewed?

Chapter 3 - Methodology

This chapter will outline a data collection and analysis philosophy that will support the achievement of the aim and objectives of this research. The chapter will start by explaining the broad context of the research methods to be used. That is done within a philosophical tradition associated with social science research, using phenomenological and ethnographic methods. It will then explore specific methodological considerations relevant to conducting research on this project, including the nature of the data to be collected, the selection of the study sample, ethical issues that may arise and finally systems for analysing the collected data. The final section will review the success of the methods used to collect and analyse the data.

3.1 The research philosophy

This research fits within a tradition of exploratory and inductive social scientific research, from which it is possible to identify the philosophical grounding upon which further data collection and analysis will be based. In particular, the aim and objectives of this research align well with the philosophies of phenomenological and ethnographic research, both of which will be explained in more detail in this section. The explanation will be augmented with details about how the phenomenological and ethnographic research philosophies will be applied in this thesis.

3.1.1 Phenomenological aspects of the research

According to Christensen (2001), phenomenology is one of the oldest methods of qualitative research and is often used to explain the conscious feeling or experience of an object, which is called the "phenomenon". Importantly for this research, Howitt (2016) described how phenomenology can be effective in the study of ordinary people in their everyday lives or in special situations. For Willing (2013), phenomenology is interested in the world as it is experienced by human being, in particular contexts and at particular times, rather than in abstract statements about the nature of the world in general. Within the larger framework of approaches to phenomenological research, Smith, Flowers, and Larkin (2009) described a refinement of the method, called IPA. IPA is often used to examine how people make sense of their major life experiences, such as a disaster. More recently, Lyons and Coyle (2016) stated that IPA can be applied to the study of individual personal and lived experience, especially the experience of difficult situations, and helps to examine how individuals make sense of the situation. With the above understanding of phenomenological research, the author considered that IPA approach would be appropriate for this study and this section will elaborate on how that philosophy will be applied.

In this research earthquakes are the phenomena around which the study is based. This research will explore some specific features about earthquakes and their management in Iran.

A complete exploration of the post-earthquake management system in Iran is beyond the scope of this thesis, so the research will focus on earthquake information management system in Iran. A further sub-division of the earthquake phenomenon and the post-earthquake management system is proposed. That sub-division will focus on the damage survey assessment part of the system. What this research will be most interested in analysing is the role and functional effectiveness of educational and engagement elements within the earthquake information management system. Thou the phenomenological approach adopted for this project will be divided into four research areas:

1. The Iranian Earthquake Information Management Systems (EIMS).
2. Post-earthquake damage survey assessment within the Iranian EIMS.
3. Post-earthquake damage survey assessment education.
4. Post-earthquake damage survey assessment engagement.

The Interpretative Phenomenological Analysis (IPA) approach will be used to critically analyse data collected, with a view to revelling a range of “lived” experiences of research participant in relation to the earthquake management system in Iran.

1. The lived experiences of research participants in relation to the Iranian earthquake information management system (EIMS).
2. The lived experiences of research participants in relation to the post-earthquake damage survey assessment system within the Iranian EIMS.
3. The lived experience of research participants in relation to the post-earthquake damage survey assessment system of **education.**
4. The lived experience of research participants in relation to the post-earthquake damage survey assessment system of **engagement.**

3.1.2 Ethnographic aspects of the research

For this research, the author wanted to gain deeper insight about earthquake management system in Iran. To achieve that deeper understanding, he chose to augment the research philosophy with a layer of ethnographic analysis. In contrast to phenomenology, ethnographic research tries to describe and interpret the culture of a group of people (Christensen, 2001). Howitt (2016) ethnography as the close study of cultural reality, where the result of the research aligns with the culture of the participants. In ethnographic research, the researcher studies how individuals theorise about their own behaviour, rather than imposing theory onto the behaviour Parker (2005). The ethnographic approach is based on the idea that social life is a product of actions. According to Breakwell, Hammond and Fife-Schaw (1995), there are four issues that the researcher needs to consider in ethnographic research:

1. The goal of the research should be to represent the group of people or participants under investigation worldwide.
2. Ethnographic research should study the behaviour of participants in their own world without the interference of the researcher.
3. The ethnographic research should represent most of the population being studied.
4. The ethnographic research does not focus on a single solution for a problem but recognised that for any problem there is multiple solutions.

For Howitt (2016), in simple terms, ethnography is the study of people's culture and customs. In general, it suits groups of people who live together, have the same culture, exhibit similar pattern of behaviour, and share the same customs. In such cases, ethnography tries to understand the "way of life" within those groups of people. As such, ethnographic researchers often use interview techniques, with groups or individuals to generate a rich level of qualitative data about the subjects. When the researcher becomes part of the group of people being studied, to get inside knowledge of that group of people and as part of the process of analysing and understanding them better, then participant observation is a preferred approach, with the researcher actively participating in the investigation.

According to Giles (2004) explained that, in order to observe and understand a community, the ethnographic researcher needs to travel to the area where he wants to do his research and collect his data. Forshaw (2012) reinforced that view, stating that ethnographic research is more about experiencing and being involved in a community or and becoming one of them, rather than simply observing them (which may be acceptable in a purely phenomenological study). Parker (2005) suggested that ethnographic research can help to describe the self-representations a community assumes in its relations with others, which seemed appropriate for this research, as the author wanted to compare the view, behaviours, and opinions of several different community groups.

The ethnographic element of this research will ultimately focus on one case study community in Iran, the community in Tehran. Within that community the research will focus on three sub-groups of the community, namely:

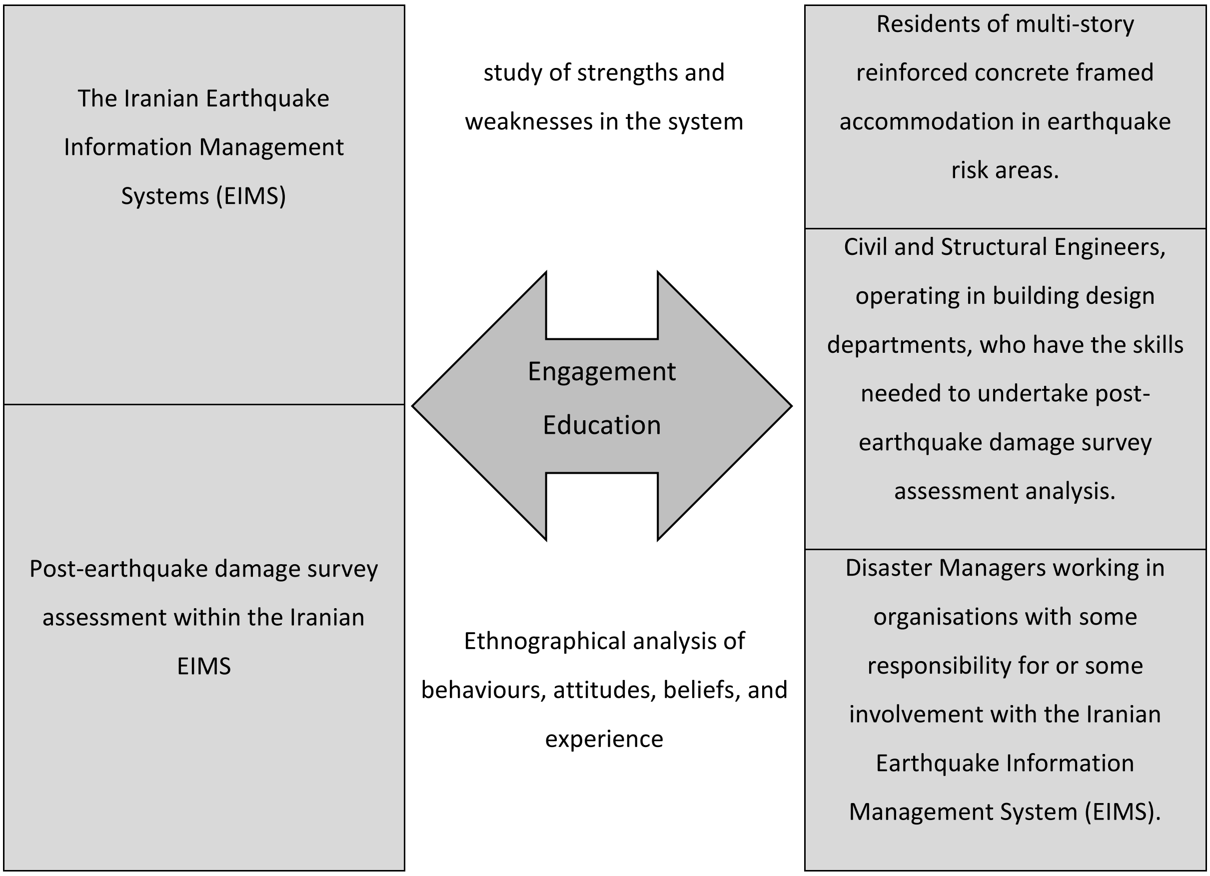
1. Residents of multi-story reinforced concrete framed accommodation in earthquake risk areas.
2. Civil and Structural Engineers, operating in building design departments, who have the skills needed to undertake post-earthquake damage survey assessment analysis.
3. Disaster Managers working in organisations with some responsibility for or some involvement with the Iranian Earthquake Information Management System (EIMS).

In accordance with suggested good practice, the author travelled to Tehran in 2018 and lived within the local community for a period of six weeks. During that time, he collected ethnographical data from and about the three sub-subgroups of the Tehran community. Data collected aimed to:

- Define the culture of the community, by cataloguing:
    - Patterns of behaviour related to the research phenomena
    - Attitudes towards the research phenomena
    - Beliefs about the research phenomena
- Observe how the community represents itself to others in the context of the research phenomena.
- Detailing experiences that the communities have had when interacting with the research phenomena.

Table 3.1 below provides an overview of how the overarching philosophical approach adopted by this research was applied in a practical methodology.

Table 3.1 Philosophical structure of research method



3.2 Other Methodological considerations

According to Moore (2006), quantitative and qualitative research is generally characterised by the approach used to analyse the data gathered. For Partington (2002) quantitative research lends itself to numerical and statistical analysis whereas qualitative research is lending itself to thematic and interpretive analysis. From a social science perspective, Partington (2002) also stated that quantitative research often involves a questionnaire survey, whereas qualitative research may involve interviews and observation. These methods are the most common ways to generate information about a group of people. For this research the author adopted a mixed methodology, using both quantitative and qualitative methods.

Oakshott (2001) described data sampling as the process of collecting information about a small subset of the population. In statistics, data sampling refers to all groups or items being surveyed. Data sampling can give you a surprisingly accurate result if carried out properly. If not carried out correctly the result can, at best, be unreliable and at the worst misleading. According to Moore (2006), all research needs to be done in a way that ensures the results obtaining are not the production of random chance, but are the characteristics of the subjects that are being studied, the samples should be taken from groups that share similar characteristics. In this research, and in order to collect data about the "lived" experience of communities exposed to a shared earthquake event, the author was able to include data on two case study earthquakes. In that respect the sample included 100% of recent events that coincided with the author's data collection trip to Iran.

According to Elmes, Kantowitz and Roediger (2011), bias in research can occur when the project does not accept or consider a wide range of viewpoints. Biased research tends to take sides and does not have a neutral view. Biased ideas can indirectly come from the cultural settings or bias in the sampling. The latter can occur if ideas only come from groups of people who share a single view. Elmes, Kantowitz and Roediger (2011), explained that in the process of finding a solution for a problem the researcher must avoid his personal ideas, religious attachments, taking sides of any groups of people. The solution should be without any personal reason and should focus on the solution to take things forward and make it better. The resident sample was restricted to a number that was practically achievable within the time and resource constraints of the project. Severe constraints were imposed on the author by governing authorities in Tehran, who dictated which suburbs and building residents could be contacted. As such, although the study did successfully sample a relevant sector of Tehran residents living in reinforced concrete framed buildings, there is a chance that the governing authorities may have biased the sample.

For the engineers and disaster managers a shortlist of potential subjects was developed and as many contacted as possible. The original intention was to interview the engineers and disaster managers, but fear of speaking directly to the author meant that the interviews were replaced with survey responses. The interviews would have provided more detailed qualitative data than the survey was planned to capture. To address the problem encountered during the data collection exercise, the author modified the survey to include qualitative questions from the interviews. The limitation in that regard was that the author was unable to cross examine survey respondents or determine deeper meaning to the words expressed in the survey responses. Using the revised survey format, response rate from engineers and disaster managers improved considerably, but the sample is biased to those who were able to over the fear that led them to disengage from the interview process.

The sample of observational material included in the research is much more difficult to quantify, as it is strictly limited to the opportunities presented to the author as the sole researcher in this project. That said, the author was able to describe a wide range of observational material both directly and indirectly linked to the research project.

Oakshott (2001) suggested that many decisions made by business and the Government are the result of information obtained from sample data, as it is often too costly or impractical to collect data on the whole population. Data may already exist, or it may need to be collected. When researchers collect their own data, it is referred to as primary data, but when it already exists, as in government statistics, it is considered to be secondary data. For this research, the cases study data was mostly secondary, whereas all other observational, survey and interview data are primary data. Some secondary data was referred to in the engagement sections of the observational accounts that data mostly relates to projects that the author was involved with during this thesis study programme.

As most of the primary data was collected from human participants, Punch (2001) and Giles (2004) reminded the author that ethical and commercial confidentiality are important considerations. For Willing (2013), ethical considerations defined the way that the researcher treats participants in both qualitative and quantitative studies. Lyons and Coyle (2016) added that the most important issue in social science research is the well-being of participants and welfare of participant must be protected. Before collecting data for this project, the author sought and received ethical clearance for the study from the university (See appendix 06). However, as described above, then travelling to the research area and when trying to implement the data collection methods, ethical concerns forced the author to change the methodology. The change from using mixed survey and interview methods to only survey methods was a direct consequence of the need to address ethical concerns expressed by research participants in the field.

That leads to the question about the position of the researcher in the data collection and analysis process. According to Davies and Harre (1999) positionality is used to help the researcher understand his “location” within the structure of the study. As this research included an ethnographic element, the author was very aware that his position in the research was potentially highly significant, in three ways. First, was in the interpretation of the language used by research participants. Second was in understanding the culture of the communities being surveyed. Third was his ability to decipher lesson from the technical field of study, post-earthquake structural assessment. In relation to the first and second ways, the author's position was strong, as an ethnic Iranian himself with family living in the study area, he was uniquely positioned to interpret qualitative data gathered by the study. In relation to the third way, the author possessed a high level of education in Civil/Structural engineering, enabling him not just to interpret technical material but also to act as a role model/active participant in the education and engagement elements of the research. All of the features about the author combined in appositive way in the context of disaster management, His interest, study and engagement in disaster management enabled him to be accepted by and gain access to the professional disaster management community in Iran.

3.3 The research method for this project

In this section the author will explain how he applied the research philosophy and practical consideration of research methods to collect data for the thesis.

3.3.1 Earthquake case studies

As explained above, just before the author visited Tehran for his main data collection activity, two earthquake events happened in the country in 2017 and 2018. One was very close to Tehran and the other close to the Iraq border in the city of Sar-e-Pol Zahab, Kermanshah province. The two events provided the author with an opportunity to observe the reaction to the events by the three main study groups included in the research: residents, engineers, and disaster managers. Observation of the two events, helped to reveal details of coordination efforts between the different groups and helped the author to assess how much each community understood about the earthquake management process. Before the Sar-e-pol Zahab Kermanshah earthquake there was very little other opportunity available to the author to collect primary data about the Iranian post-earthquake response and management system. The Tehran earthquake provided the author the opportunity to engage directly in the event response himself.

The Tehran earthquake happened on the same day that the author arrived in the city to conduct his main data collection activity (20/12/2017). Over the following two months, he was able to observe directly how people and authorities responded to the event. The Sar-e-Pol Zahab earthquake happened on 12/11/2017, three weeks before the author arrived. The author was able to travel to Sar-e-Pol Zahab and witness the destruction caused by the earthquake. In both locations the author met local people who expressed their worries about their day-to-day life (food, shelter and medicine), their belongings and fears about the safety of buildings. The author's observations also revealed some of the details about the levels of education and engagement there had been between the disaster managers, engineers, and resident communities. In both case study areas, the author encountered some difficulties getting permission to visit sites and to talk with individuals in the different communities. The Tehran case study helped to reveal how the disaster management system in Iran works, whereas the Sar-e-Pol Zahab earthquake revealed details of the structural assessment process.

Details from the case study observation are used in all four of the discussion chapters 4 and 5. Each chapter starts with an extract from the author's own reflective account of his visit to Iran. Those "scenarios" are used in each chapter to help interpret lessons learned from the research and reveal now contributions by the research to understanding of the phenomena being studied. In Chapter 5, much of the Sar-e-Pol Zahab earthquake data is presented to help illustrate new understanding about the post-earthquake damage survey assessment process.

3.3.2 Engineer and Disaster Manager Interviews

For the engineer interviews, a UK-based desk study internet search enabled the author to create a list of structural engineering businesses and disaster management authorities in Tehran. Prior to the commencement of the data collection trip to Tehran, the author contacted all the companies and authorities on the list by email to make interview appointments, but the response rate was very poor. After his arrival in Tehran to conduct the data collection exercise, the author again contacted the organisations but this time by telephone. Again, the response rate was very poor, but the author was able to gather some evidence as to the reason why. Several organisations stated that, for security reasons, they could not do an interview, but they were willing to complete the questionnaire on condition that their anonymity was maintained. Eventually, one disaster manager agreed to help, but insisted that some of the questions in the questionnaire were changed and that permission from the Government was received before issuing the questionnaire survey. With the support of the disaster manager and then using a snowballing technique (interview by recommendation of participants) the author was able to interview several disaster managers and engineers. However, interviewees did not agree to open interviews and stuck to only answering the survey questions. One of the engineers was involved in the post-earthquake damage survey assessment process in Kermanshah. The author was allowed to accompany a team visiting the city and collect observational data (See Chapter 5).

3.3.3 Resident survey

Tehran is divided into 20 districts, all of which have a similar threat from earthquake damage. Some of the districts are largely commercial and others largely industrial. Prior to departure from the UK to Tehran for the data collection trip, the author had planned to issue his community questionnaire in three districts of the city. His plan was to cover districts with low, moderate- and high-income communities and districts with old and new residential buildings. However, as mentioned in the previous section, after arrival in Tehran the disaster management authorities placed severe restrictions on the author, limiting permission for the survey to just one district.

For this research, the author was allowed to target District 5 (Figure 3.1). District 5 is located northwest of Tehran and located in the western Alborz Mountains. District 5 has a population of 700000 and due to high migration, it is known as the development zone of Tehran. District 5 has been faced with growing construction of residential units. District 5 is the main gate for the entrance of passengers from west of Tehran into the city and has been turned into an academic point of Tehran due to the accumulation of universities. The biggest sports complex in Iran is located in district 5. District 5 also has the largest number of religious sites in the country and many residents of the capital pay pilgrimage to these sites.

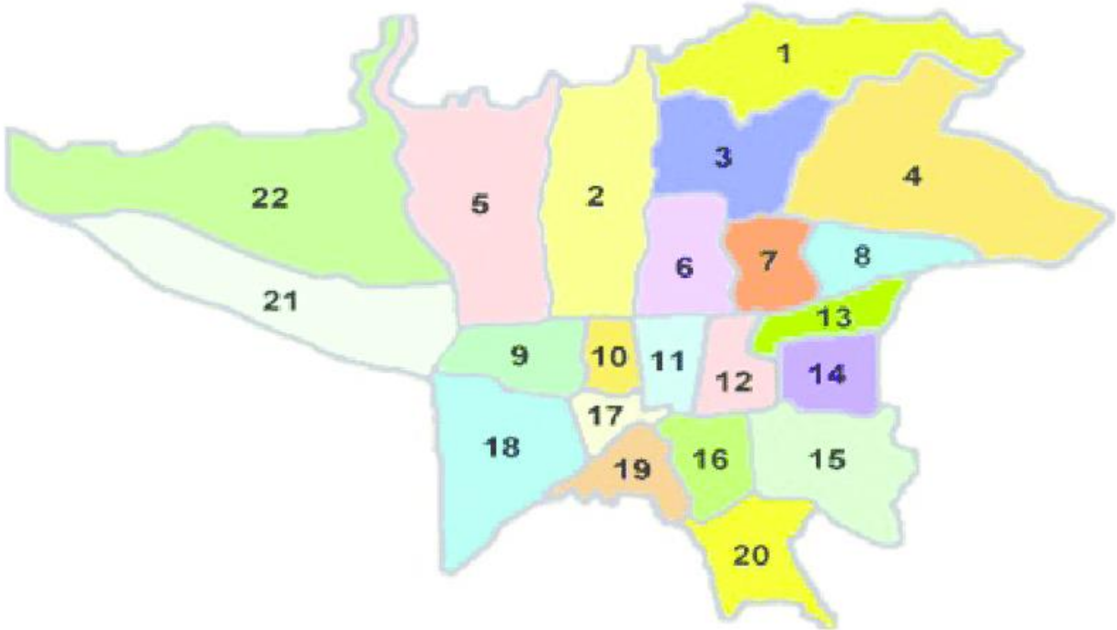


Figure 3.1 District map of Tehran (researchgate.net 2018).

The survey questionnaire was divided in four sections.

1. Section 1: Background information about the respondent
2. Section 2: Questions about the respondent's awareness of the Iranian system for managing the earthquake.
3. Section 3: Questions about post-earthquake damage survey assessment education
4. Section 4: Questions about post-earthquake damage survey assessment engagement

A copy of the questionnaire survey can be found in Appendix 01.

For the survey, the language used was an important barrier to overcome. So, the author had the questions professionally translated it to Persian (Farsi) to ensure it was understood by the local recipients. Logistically distribution and collection of the forms was a bit of a challenge. For the main period during which the survey was conducted, the author was mostly resident in a city neighbouring Tehran, called Zanjan. As such, the distribution of the survey was spread over several weeks, to coincide with the authors visits to Tehran. In the end the author managed to distribute 500 survey questionnaires and received 177 back. From the literature about questionnaire surveys, the author judged that the return rate of 35.2% was very good.

3.4 Data analysis and structure of the discussion

In total 175 survey responses were collects from the three different surveyed communities. Responses from the surveyed groups were coded as:

1=Community residents

2=Engineers

3=Disaster managers

Additional coding was then conducted to define sub-groups based on gender, education, and awareness levels of the Iranian earthquake management systems.

Gender Coding:

1=Male

2=Female

Education coding:

1= School Diploma

2= Undergraduate

3= Postgraduate

Awareness level coding:

1= Low Awareness

2= Moderate Awareness

3= High Awareness

The coding system enabled each respondent to be allocated a four-digit identifier. For example:

1131 = community resident, male, post-graduate education and low awareness

2222 = Engineer, female, undergraduate education, and moderate awareness

3133 = Disaster manager, male, post-graduate education, high awareness

Appendix 03 shows the distribution of the 177 respondents in each coding category.

Questions with easily quantifiable answers, like: YES, NO, do not know were analysed using simple frequency analysis. Data from the analysis was either presented in the form of histograms or data tables with numbers of responses for each category shown. Questions that required respondents to qualitatively rank their response to a question (Questions 11, 15 and 19) were analysed using a statistical calculation of the mean ranked response. Deeper meaning and insights were then gained by analysing the results for the different sub-groups of respondents. Several questions allowed "open" answers, where respondents could include text data to reveal details of their behaviours, attitudes and beliefs about different topics being researched. When analysing those responses, the four-digit identifier discussed above was used to cluster responses into groups that allowed the author to differentiate views from the different sub-groups. In terms of presenting the data in the discussion chapters, the quantitative data is first presented and analysed, followed then by the qualitative data and analysis.

3.5 Reflective overview of the methodological approach used for the research

The author considers that the case studies he analysed were very helpful. They provided him with useful scenarios from which he could translate his understanding the research material into contexts that he hopes readers of the thesis would be able to engage effectively. Perhaps one limitation of the case studies was the small amount of technical data that the author was able to collect about each event while he was in Iran. That challenge was difficult to overcome, as at the time of the author's visit to Iran, detailed studies of the two events had not been published. After his return to the UK to complete this study, further research details of the two events were difficult to find, as they were not significantly large events to feature in any internationally published research.

By adopting an ethnographic approach in the research methodology, the author was encouraged to reflect and observe as part of his data collection and analysis. That process was more revealing than the author expected and was applied extensively in the first part of four discussion chapters. The observational activity helped the author learn and see where problems areas arose in the study topics, rather than simply relying on reading material. He was also able to observe how his own background and experience could serve as useful illustrations of how to interpret new data and understanding derived from this project.

One potential failure in the data collection plan was the interviews. The author encountered considerable difficulty securing open interviews. The author often made an appoint with a potential interviewee but was required to wait weeks for a response and many cancelled at the last minute. Most people interviewed would not answer open questions and did not agree to their voice being recorded. The best that the author could achieve was to send the questionnaire survey to the interviewee in advance of a meeting and then limit the discussion to the survey questions. As such, all the interview data with engineers and disaster managers is included in the survey response data set.

In the end, the author considers that the blended data collection activity, including case studies, observation, survey, and interviews did provide a sufficiently broad and detailed data set for this thesis study programme.

Chapter 4 – Strengths and weaknesses in the Iranian Earthquake Information Management Systems (EIMS)

This research will be used to demonstrate new insights developed from this thesis research project about strengths and weaknesses in the current EIMS used by Iranian authorities. The chapter will apply the blended phenomenological and ethnographical approach to the study of the Earthquake Information Management System (EIMS) in Iran and then develop proposals that may be used to enhance the current system. The analysis starts with a personal reflective assessment of the author's own evolving understanding of best practice in EIMS operation, before turning to the quantitative and qualitative analysis of survey data.

4.1 Early reflective insights about good practice in EIMS development and operation

The author had witnessed numerous earthquakes and other natural disasters while living in Iran and his personal experience made him aware of the existence of some form of EIMS in Iran, but not the detail of how the system operated.

The Bam earthquake was a particularly concerning and motivating event for the author. The experience left him thinking, "how I can help my country to reduce the number of casualties and help Iranian people to be prepared for the next earthquake?" The outcome was a decision to seek more research needed to understand how the EIMS system in Iran operated. With that in mind, his BSc dissertation studied the Iranian post-earthquake management system Razaghi-Kashani (2008). In that research he assessed several elements of the Iranian system. The BSc thesis found that, due to the unfamiliarity with early warning systems and aftershocks, resident populations were adversely affected by the Bam earthquake. In addition, due to poor mapping of the area, agencies responding to the Bam earthquake had difficulties finding their way around and that led to hindrance of rescue operations. He also assessed that there were weaknesses in the educational aspects of the Iranian EIMS, specifically in the training of civil engineers and town planners on how to monitor major active faults and how to produce risk maps. The author proposed that improvement efforts focus on high population areas and provide general education about early warning systems and the effects of earthquake aftershocks. His proposals to improve the EIMS in Iran included:

- Increasing the scientific knowledge required for earthquake risk reduction,
- Reducing structural vulnerability and improving construction standards,
- Raising public awareness of seismic hazards and promoting a culture of risk reduction, and
- Developing plans for rapid reaction and disaster mitigation

The undergraduate research was helping him understand more clearly what essential components an EIMS must include to have an effective structural assessment system. For example, in the case of a post-earthquake structural failure, the EIMS must collect data about the method of design and construction, material quality and as far as possible, evidence of quality control processes during construction. As well as deepening his technical understanding of structural design methods, the author's MSc dissertation provided a further opportunity to understand ways of mitigating the impact of earthquakes on tall buildings.

In relation to the scenario at the start of this chapter, the lessons outlined in this section help to reveal some useful insights about the observations. Firstly, it is reassuring to observe that Iran has well qualified engineers with the forensic capability to collect and analyse data needed to judge the extent of damage in earthquake affected buildings. That may be an improvement from when the author conducted his survey of the response to the 2004 Bam earthquake. However, one area that does not seem to have improved is in learning lessons from past earthquakes. The EIMS is under pressure and important opportunities to learn lessons from each earthquake event are being missed. That said, the picture is not as bleak as it could be, because there is also evidence that disaster managers are keen to learn how to make the system better.

4.2 Deeper insights about good practice in the development and operation of an EIMS

As an academic researcher, the author is aware that dissemination of research is an important learning activity. It not only helps to spread news of results from the latest research, but also enables opportunities for researchers to be able to question new theories and concepts. In addition, it enables people with similar interests to meet and to build networks of contacts that may be useful in further research projects. With that in mind, the author's first EIMS dissemination activity was to present details of his research plan at the International Disaster Risk Conference (IDRC) in Davos 2016 Razaghi-Kashani, Fox and Easterbrook (2016). The author presented a paper with the title "Post-earthquake disaster management and structural assessment". As part of the presentation, he provided some insights he had gained about how best to add value to an EIMS system, with the aim of enhancing urban resilience. He explained that his research revealed that disaster management authorities have been aware that to enhance urban resilience to earthquakes it is important local disaster management authorities have a risk management system capable of recording data about earthquake events and how past events were managed Seismological Bureau of Yunnan Province (2001). Previous research also established how such systems have been used to learn lessons about past events and to help lawmakers make better decisions when developing plan to monitor and manage future earthquake events (Ajani, Fatahi and Moradi, 2006; Lippeveld *et al.*, 2000). The systems used are often referred to as Earthquake Information Management Systems (EIMSs). In Japan, the EIMS is managed by the Prime Minister's office and other National Government ministries, but data for the EIMS is gathered by independent experts, government departments and non-governmental organizations (Ajani *et al.*, 2006). The Japan system is good example of an effective and integrated risk management system, and it also has an interesting resilience enhancing component. To enhance resilience of vulnerable communities, the Japanese EIMS makes important seismic information publicly available (Hyogo Framework for Action 2005-2015). The author explained that he discovered a general sense from the published research material, that Iran lacks an effective EIMS (Ajani *et al.*, 2006, Ajani, Fatahi and Moradi, 2006).

In his paper, the author judged that the disparity between the level of development of the Iranian EIMS system and the system running in Japan presented challenge for his research, as comparisons might lead to recommendations for change that would prove impossible to implement without fundamental and widespread change in the Iranian management structure. The authors judged that Turkey offered more opportunities than Japan to learn lessons that can be quickly and easily applied in Iran. Turkey has a seismic risk, geography, and level of development that are comparable to Iran. Furthermore, for more than a decade Turkey has been working to establish an EIMS, called AFAYBIS (Eraslan *et al*., 2004). As with Iran, Turkey has a number of active earthquake zones and the country is growing at a fast pace, so Turkey's need for a clear and effective EIMS is similar to Iran (Eraslan *et al*., 2004); Ajani, Fatahi and Moradi, 2006). For Iran, Ajani, Fatahi and Moradi (2006) judged that considerable challenges existed if it chose to follow the Turkish model, as in Iran there have historically been many government agencies involved in earthquake management and the planning process was never clearly defined. In 2004, there was evidence of an emerging IEMS system in Iran, but it is focused on data collection during and immediately after an earthquake and was not designed to the address the needs of different regional and local areas within Iran. In addition, there was no proper classification of the information from an earthquake information management's point of view and, therefore, Iran's IEMS was judged to be weak, or at best, insufficient at that time. This research will seek to up-date the assessment of the Iranian EIMS, looking specifically at how it collects earthquakes information and how effective it is at publishes data at the right time and making it accessible to organizations and the wider public.

At the Davos conference the author met with a delegation that had come from Iran. The Iranian delegation was very interested in his research and helped him identify important areas where his research into the Iranian EIMS should focus. Some members of the Iran delegation invited the author to include some of those ideas in a paper for a conference to be held in Iran. The conference was the Integrated Disaster Risk Management (IDRiM) Society conference, to be held in (Isfahan, Iran). The IDRiM paper provided insights that the derived from a study by Movahedi (2003), who found that the EIMS in Iran is insufficient because of the following reasons:

1. Insufficient information and skills in disaster preparedness and management: there is not enough media coverage on how to engage the community with training. The local people are not familiar with disaster management facilities in the local area. Most of the information and training are irrelevant as they are very technical and theoretical.
2. Insufficient attention towards vulnerability reduction: after all the effort that the Iranian organizations have done there is still not enough information in some vulnerable parts of Iran due to that reason most people living in these areas are not careful about the labour quality, structural code and suitable material. There is other issue that needs to be mentioned is that there are many old buildings in Tehran that has been repaired or made fit for the new purpose which there is no plan and action for these areas due to the lack of management and budget distribution. Even if the Iranians had the best code of practice for new build houses and the best methods of construction, it still would not be enough. Due to those reasons Iranian organisations realised how important the public engagement in these areas is.
3. Low level of collaboration among the community members and local government: in some parts of Tehran's north the people are not concerned about their neighbours due to the change of lifestyle and this makes the rescue operation post-earthquake more difficult as the neighbours are the first people arriving to the scene and this problem is growing through the whole of the capital. There other problem is that the districts cities do not have a good relationship with their local governments as their needs have not been fulfilled, as a result these communities have been getting cut off from any local government exercise for earthquake preparedness.

He also added that, according to Okano (2005) there are barely any non-governmental organizations who deal with disaster mitigation and disaster management in Iran. According to Hosseini (2009) the Iranian plan consists of two parts: 1. public awareness which is been done through campaigns, seminars, workshop and mass media. 2. Disaster preparedness education which has been done through schools. With reference to Izadkhah (2009) there is no regular training for rescue and relief, first aid, firefighting and evacuation in case of an earthquake and paper posters need to be made in a way that everyone from different backgrounds and different levels of education can understand. As such, the identified that issues which need to be addressed include:

- Employees in governmental organizations need additional training to be ready in case of a disaster.
- Students need education about earthquakes and their consequences and they the right response in emergency situations.
- The public need to be informed about earthquake risk and earthquake preparedness plans.
- Disabled people, elderly and people with special needs need to be considered in earthquake preparedness planning.

After the conference presentations, the author was able to engage as part of the research team in a project called ''Post-Earthquake Structural Health Monitoring System (PE-SMS)''. The project provided opportunities to explore much specialised aspect of information collection in an EIMS. The project involved the development of wireless sensor technology to monitor the health of buildings damaged by earthquakes, which was very much at the forefront of current research and required very advanced training and education. Another aspect of the project was to pool resources from across the world to in order to ensure the right skills were included in the project. The author's contribution was to help define how the Internet of thing (IoT) monitoring system could fit within an existing EIMS and to advise on the testing of the system in reinforced concrete structures. This activity provided valuable insights about challenge of designing and implementing activities within an EIMS system. It was important to ensure that the new systems proposed were compatible with the existing EIMS. This project encountered challenges when the Philippine disaster management authorities suggested that they may not have the expertise or technology to manage the new IoT monitoring system.

Following the PE-SMS project the author had the opportunity to engage with a large international project funded by the Horizon 2020 Framework Programme for Research and Innovation (2014-2020). The project was called, Reliability and Safety Engineering and Technology (RESET) and as part of the project the author was allowed to undertake a research placement at Mahadol University in Thailand. The author initially sought to explore the system used to manage the structural assessment of reinforced concrete buildings that were damaged by extreme environmental hazards. However, during the research placement, the

Mahadol team encouraged him to look instead at the EIMS in Thailand, how communities in southern Thailand are trained to be ready for future tsunami events. Unfortunately, the placement was cut short before the new plan could be implemented. But an extremely important lesson was learned, namely that people with a detailed understanding of the local system must be involved at an early stage in the design of a research programme. That is particularly important in EIMS research programmes, where the subject matter can be highly technical and the stakeholder community highly diverse.

After engaging with the RESET project, the author secured a Research Associate position on a project funded by the Global Research Challenge Fund (GCRF). This project was a water technology project and acted as an opportunity to apply lessons learned from the Philippines (PE-SMS) and Thailand (RESET). The project did not have an EIMS or even an earthquake focus, instead it aimed to tackle the lack of progress in creating conducive environments for development and economic transformation across Africa. Where the author was able to see parallels with his own research project, was in the need expressed in the aim of the project to develop technical higher-level skills for the engineering sector in Kenya. In addition, the project promoted strengthening linkages between industry and training institutions, recognising that transformations can only occur if the workforce is healthy and secure, all of which had strong parallels with EIMS research. The project involved collaboration between universities in the UK and Africa, as well as private sector organisations, a model that fitted very well with a collaboration aiming to create a strong EIMS. The author's main duty was to plan and implement an international workshop in the UK, involving invited delegates from across the UK and Africa. Important lessons from the author's engagement with this project are discussed more fully in Chapter 6. An important lesson drawn by the author for this project, was how important it is to have an effective management system in place to managing teams in highly distributed locations.

Finally, the author undertook a four-month internship at UNECO headquarter in Paris. The internship was in the "Earth science and geo-hazard risk reduction" part of the "Disaster risk reduction section". Disaster risk reduction at UNESCO operates at the interface between natural and social sciences, education, culture, and communication plays a vital role in constructing a global culture of resilient communities. UNESCO assists countries to build their capacities in managing disaster and climate risk. The Organization provides a forum for governments to work and engage together and it provides essential scientific and practical advice in disaster risk reduction. At UNESCO the author was involved in many projects. One involved a project which was to build capacity for disaster risk reduction in the built environment against earthquake across Latin America. This project involved the countries of Mexico, Guatemala, Cuba, The Dominican Republic, and Peru. The author was involved in the process of supporting each country outcome, but mainly engaged with Mexico. Another project was to create a "Chatbot" to engage communities with earthquake education. Yet another project the author got involved with was the Equipment for earthquake Early Warning System (EQ EWS) in schools. The author helped to research the countries where this programme was best suited and most needed. He also helped to define how to keep children engaged with the earthquake early warning system and keep the schools engaged in the programme.

Form this structured series of research activities, the author gained significant new insight that helped to reveal important lessons in relation to the scenario at the start of this chapter. First and foremost was the fact that several researchers had already investigated aspects of the EIMS in Iran and revealed numerous weaknesses in the system. Consequently, disaster management authorities in Iran were becoming more aware of deficiencies in their EIMS, which could explain their willingness to learn lessons about how to improve the system. An important part of the improvement process is to learn lessons from past events and the IDRiM conference in Isfahan was a good demonstration of efforts being made in that direction. But perhaps the pessimistic view of the engineers and resident communities was a sign that too much of the learning was focussed on to narrow a group of people. In that regard, the author's own project experience helps to demonstrate that in earthquake management, education and engagement needs to include a wide range of stakeholder groups (both local and international) and cover a wide range of subjects, from the simplest messages to school children to technical know-how to engineers and disaster managers across Iran. What the scenario appears to show is that wide ranging education and engagement effort is not happening in Iran.

From the PE-SMS project, the author has researched how to test the pro-type of a post-earthquake crack monitoring system to improve the post-earthquake damage survey assessment. He also did his pilot study for his questionnaire at the Philippine Saint Carlos University.

In Thailand (Mahidol University) from the Reset project the author has done some research on post-Tsunamis structural assessment education and engagement programmes within the community in the tsunami-affected area.

Finally, during the internship at UNESCO, the author has done some research Sendai Framework for Disaster Risk Reduction 2015-2030. This outlines seven clear targets and four priorities for action to prevent new risks and to reduce existing disaster risks. These are:

(i) Understanding disaster risk;
(ii) Strengthening disaster risk governance to manage disaster risk;
(iii) Investing in disaster reduction for resilience and;
(iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

The author's research at UNESCO was involved in a school safety program (VISUS multi-hazard methodology). The author has done research on the adoption and implementation for assessing the safety of schools after an earthquake. In addition, the author was involved in researching insulting earthquake early warning systems in countries most need including Afghanistan and Iran.

4.3 Quantitative analysis of strengths and weaknesses in the EIMS of Iran

Previous research, by Ajmani (2009), found very little evidence of an EIMS in Iran. Earlier research, by Bamdad (2005) stated that, even though Iran has a national system for managing disasters, there is no department named as ‘’The Department of Earthquake Information Management’’. At the time of the previous research a great deal of earthquake information was recorded, but there is no place to store the date and there is no system to learn lessons from earthquake events, as a means of improving the system (Ajmani, 2009). As such, the first step in this research was to up-date the evidence about the existence or otherwise of an EIMS in Iran. Question 9a of survey asked respondents to state if they were aware of an EIMS in Iran. Table 4.1 shows the responses to question 9a for the three main survey groups (Community Residents, Structural Engineers and Disaster Mangers)

Table 4.1 Survey responses to survey question 9a “is there an EIMS in “Iran”.

	YES	NO	Do not know	Total Number (N)
Residents	35 (24%)	51 (35%)	58 (41%)	144 (100%)
Engineers	3 (16%)	11 (58%)	5 (26%)	19 (100%)
Disaster Managers	4 (100%)	0	0	4 (100%)
All respondents	42	62	63	167

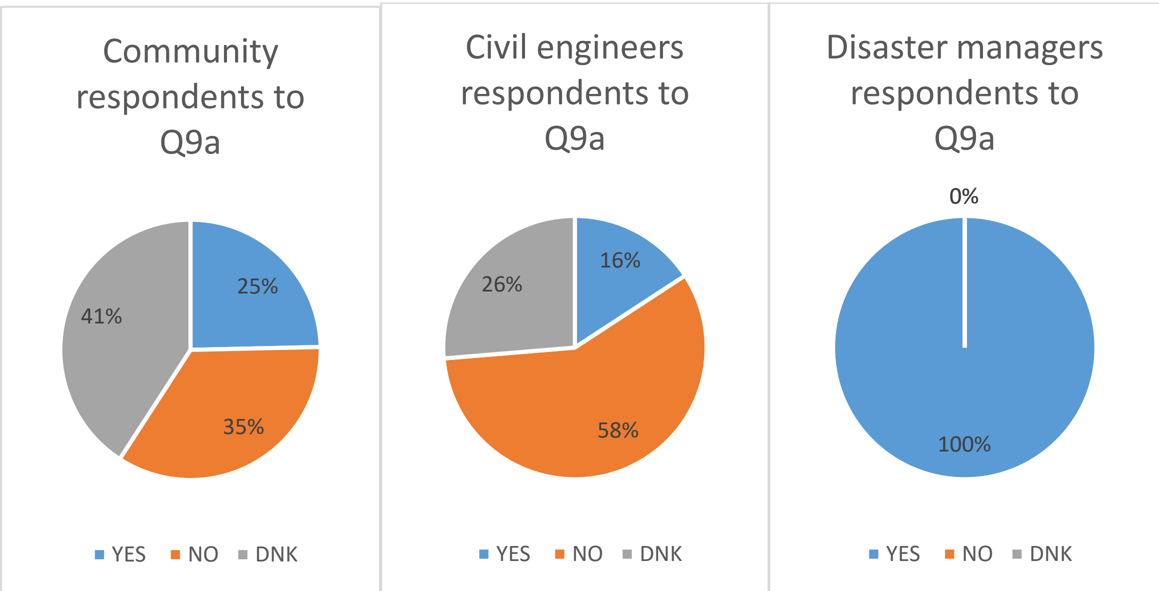


Figure 4.1 Profile of the respondents to Q9a.

The response to Q9a provided an important finding for this research. Specifically, 100% of the disaster managers sampled agreed that Iran does have and EIMS. Although a small sample, the results from the disaster managers is important, as any recommendation to improve the EIMS in Iran will be much easier if one already exists in the country. However, the views of the disaster managers were not shared by the engineers. In another surprise result, only 16% of engineers considered that Iran has an EIMS. The results also suggest that the response is not based on ignorance of the system, as only 26% responded do not know. A significant majority of the engineers were very clear, that in their view Iran did not have an EIMS (58%). For the resident sample, Table 4.1 shows that residents were quite split on whether Iran had an EIMS. Only 25% or residents considered that there is an EIMS in Iran. The remaining responses were evenly divided between NO (35%) and Do Not Know (41%). The resident responses were further broken down based on gender, education level and level of awareness of the disaster management system in Iran (Table 4.2).

Table 4.2 Breakdown of resident responses to survey question 9a “is there an EIMS in “Iran”.

	YES	NO	Do not know	Total Number (N)
Male	16 (24%)	25 (38%)	25 (38%)	66 (100%)
Female	19 (24%)	26 (33%)	33 (43%)	78 (100%)
Sub-total	**35**	**51**	**58**	**144**
School Diploma	17 (36%)	12 (26%)	18 (38%)	47 (100%)
UG Degree	15 (25%)	22 (36%)	24 (39%)	61 (100%)
PG Degree	3 (8%)	17 (47%)	16 (45%)	36 (100%)
Sub-total	**35**	**51**	**58**	**144**
High Awareness	18 (42%)	17 (40%)	8 (18%)	43 (100%)
Moderate Awareness	8 (21%)	13 (34%)	17 (45%)	38 (100%)
Low Awareness	9 (14%)	21 (33%)	33 (53%)	63 (100%)
Sub-total	**35**	**51**	**58**	**144**

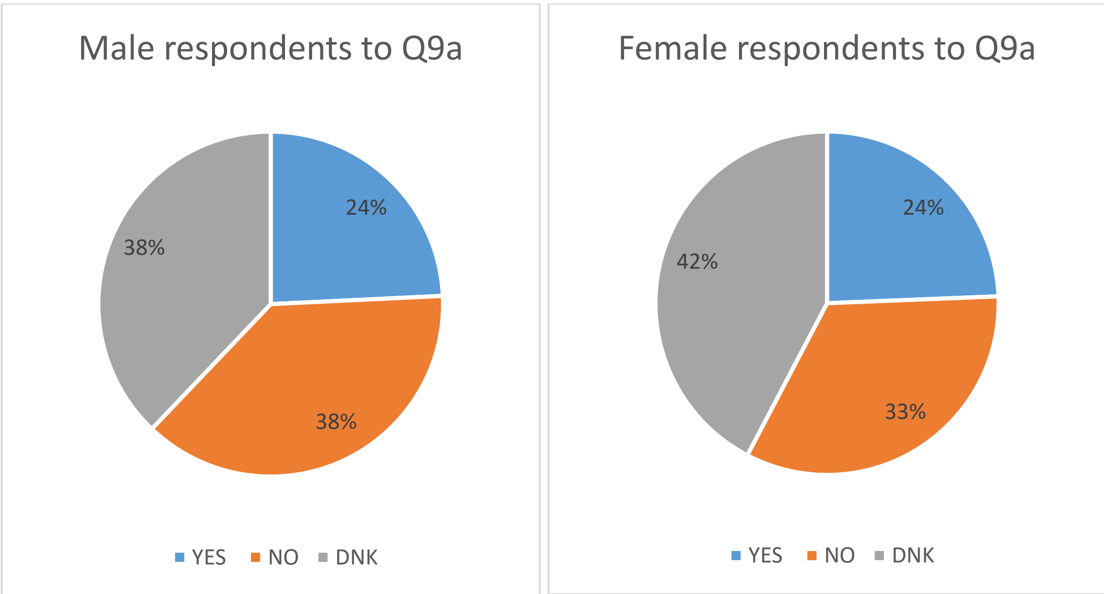


Figure 4.2 Gender to respondents to Q9a.

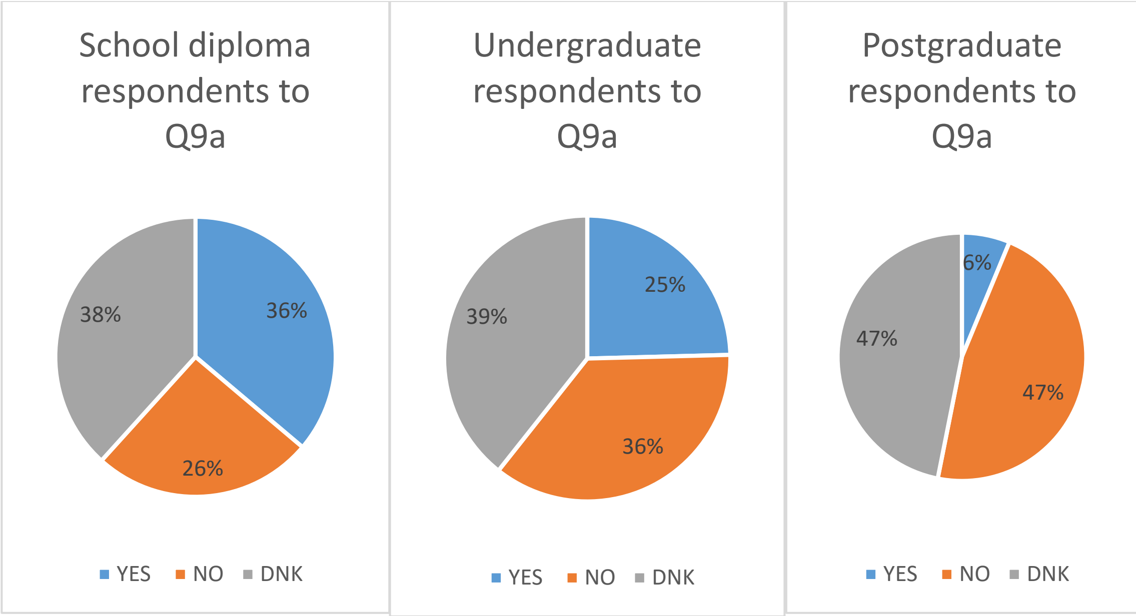


Figure 4.3 Academic qualifications of the respondents to Q9a.

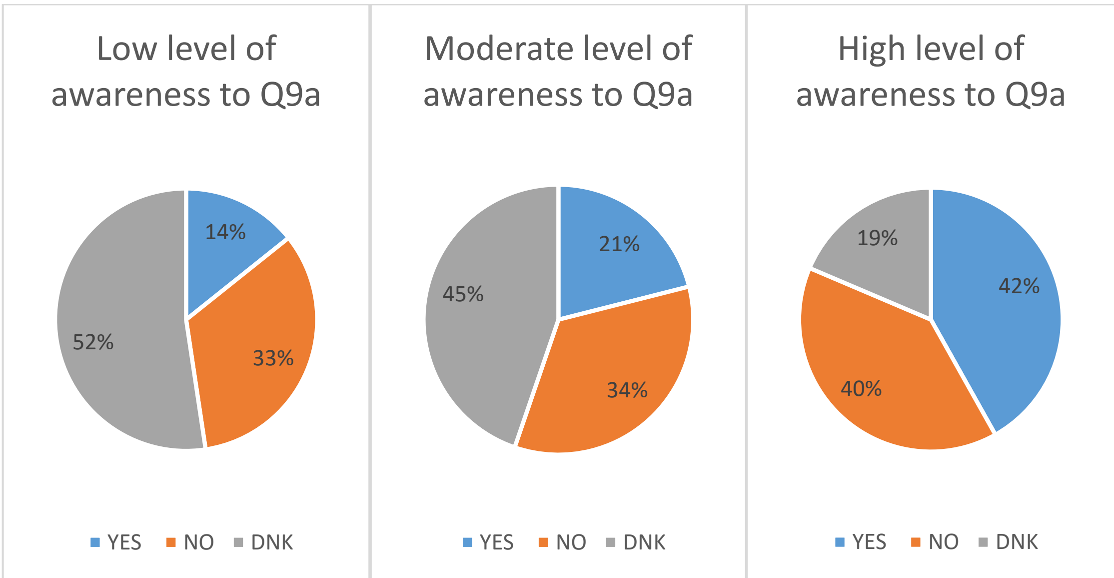


Figure 4.4 Level of Awareness of the respondents to Q9a.

Table 4.2 also shows that the views of male and female residents about the existence of an EIMS in Iran are broadly the same. Males were slightly less optimistic with more saying "NO" rather than "Do not know" compared to the female respondents. In relation to education levels a clearer pattern emerged. Those with school diploma education were significantly more likely to answer "YES" than those with very high levels of education. In the same way, those with very high education were most likely to say "NO", and those with school diploma education were the least likely to response "No". The level of awareness of the disaster management system in Tehran, also showed a clear pattern of results. Those with high levels of awareness who were much more likely to responded “YES” to Q9a, compared to those with low levels of awareness. One curious result from the survey was that the responses from residents with high levels of awareness was much divided between YES (42%) and NO (40%). On balance, that may be an apt summary of all the answers to Q9a. The fact that responses were not all unanimous and either clearly YES or clearly NO suggests that a lot of work needs to be done to raise awareness and understanding of the EIMS in Iran.

To help learn what features of the Iranian EIMS need effort to improve awareness and understanding, the literature in Chapter 2 was used to compile a list of features that the author considered the Iranian EIMS should include. What was clear in the literature, was that an EIMS is a mechanism to records, collects, keep, retrieves and analysis information to produce a report (Ajmani and Fattahi, 2009). But, collecting earthquake information on its own is not enough, the EIMS needs to be used in response planning and for learning lessons to improve the system for the next earthquake (Ajmani and Fattahi, 2009). At its most fundamental, the EIMS should facilitate the estimation of damage to the physical and social infrastructure (Ajmani and Fattahi, 2009). From the published research of EIMS systems across the world, the author was able to describe a series of processes that effectively defined current best practice in earthquake information management. Table 4.3 below includes the list of those processes that the author deemed important, in the context of the aims and objectives for this research that the Iranian EIMS should include.

Table 4.3 The list of processes that should be included in an Iranian EIMS.

Assess wider regional damage
Undertake short-term usability assessment
Calculate economic losses
Calculate funding needed for reconstruction
Estimate the social impact of the earthquake
Assess emergency management needs
Assess the long-term usability of buildings
Record the location of damaged buildings
Identify additional hazards around buildings
Identify a safe zone around damaged building
Assess the need to improve the system
Add information to a central database
Collect data from the public and other bodies
Disseminate data to public and other bodies

Question 11 (Do you know if the Iranian earthquake management system includes a process to manage post-earthquake structural assessment) in the main survey listed the EIMS processes and asked respondents to score each one on a three-point scale. A score value of 1 indicated that the process was included after every earthquake event and a score of 3 indicated that the process was never included. For the analysis, the mean score given by each of the three main communities (Residents, Engineers, and Disaster Managers) was calculated and then the mean of means was used to rank each of the processes, giving equal weighting to each of the three groups. Table 4.5 below shows the results of that analysis. Importantly for this research, the Iranian system was judged to have a good coverage of the process areas. No process received a mean score close to 3. However, what is highly significant for this research is that the process of “Estimate the social impact of the earthquake”, was the lowest ranked by almost every group. By a small margin the residents ranked “Assess the need to improve the system” as the weakest element in the Iranian EIMS (analysed in more detail below).

For most of the processes (all except the lowest ranked process) the three disaster managers who responded to this question were unanimous, recording that all processes were addressed all the time. As the disaster managers in Iran are the group that should be most aware of all elements in the EIMS, the inference derived from this result is that Iran does have an excellent EIMS. That would be a very significant finding from this research, being at odds with previous research findings. It would also provide a good starting point from which this thesis could propose ways of enhancing the EIMS in Iran, with engagement and education activities that aim to raise awareness and understanding of all the processes in the system (for that discussion see chapters 6 and 7).

Table 4.4 Results from survey Q11 showing ranking of EIMS topics in "Iran".

			Mean Score		
Rank	Topic	Mean of Means	Residents	Engineers	Disaster Managers
1	Record the location of damaged buildings	1.33	1.70	1.29	1.00
2	Identify a safe zone around damaged buildings	1.36	1.65	1.43	1.00
3	Assess wider regional damage	1.41	1.65	1.57	1.00
4	Identify additional hazards around buildings	1.42	1.82	1.43	1.00
5	Calculate economic losses	1.42	1.69	1.57	1.00
6	Assess emergency management needs	1.43	1.72	1.57	1.00
7	Assess the need to improve the system	1.45	1.92	1.43	1.00
8	Disseminate data to public and other bodies	1.48	1.71	1.71	1.00
9	Collect data from the public and other bodies	1.48	1.74	1.71	1.00
10	Assess the long-term usability of buildings	1.49	1.89	1.57	1.00
11	Undertake short-term usability assessment	1.52	1.85	1.71	1.00
12	Add information to a central database	1.55	1.79	1.86	1.00
13	Calculate funding needed for reconstruction	1.58	1.88	1.86	1.00
14	Estimate the social impact of the earthquake	1.86	1.91	2.00	1.67

Data from the survey enabled the views of disaster managers to be compared with residents and engineers. Looking closely at the results for the engineers, the author noted that the response was heavily weighted in favour of the views of the male engineers, with 6 of the 7 responses to Q11 coming from male respondents. From a gender perspective, a female view in relation to Q11 was derived from the resident responses (analysed below). Broadly speaking the engineers agreed with the overall ranking of the topic areas. Where they disagreed was in relation to the topics of "Identify additional hazards around buildings", "Assessing the need to improve the system" and the "Assessing the long-term usability of buildings". In these three areas the engineers were more positive, judging that these topics were addressed more frequently than the overall ranking suggested.

The resident community responses ranged from N= 33 to 37. As mentioned above, the one major difference in their responses was ranking of the process to “Assess the need to improve the system”. This process they ranked as the weakest part of the Iranian EIMS. The residents were also less optimistic than the engineers about the frequency at which topics of “Record the location of damaged buildings”, “Identify additional hazards around buildings” and the “Assessing the long-term usability of buildings” were undertaken. That discrepancy may have arisen because engineers are more familiar with those topics and more likely to be engaged in those activities, hence engineers are more likely to be aware that the processes are undertaken. On the other hand, residents were more optimistic than engineers in believing that the topic of “Add information to a central database” was undertaken more frequently than its ranking suggests. It is not clear why residents would consider that the process happens more frequently than engineers think it does and it could simply be that the residents think it “should” happen.

Looking in more detail at the resident responses, 20 of the responses were female and 12 were males. Table 4.6 shows how the male and female responses to Q11 varied in relation to the overall survey means. Both groups included respondents will all levels of education and awareness of the earthquake management system. The number of responses in the education and awareness categories was too low to detect any discernible pattern. What is clear from the gender split is that the low score for the topic “Assess the need to improve the system” clearly came from the male residents. That does not mean that the female residents disagreed, just that they did not rate the topic quite a low as the male residents. It is difficult to detect any other pattern in the results, other than the fact that female residents were more likely to agree with the top half of the ranked topics and the male residents were more likely to agree with the lower ranked topics.

Table 4.5 Results from survey Q11 showing ranking of EIMS topics in Iran for Male and Female Residents.

Rank	Topic	Mean of Means	Mean Score All Residents	Mean Score Male Residents	Mean Score Female Residents
1	Record the location of damaged buildings	1.33	1.70	1.86	1.61
2	Identify a safe zone around damaged buildings	1.36	1.65	1.79	1.57
3	Assess wider regional damage	1.41	1.65	1.62	1.67
4	Identify additional hazards around buildings	1.42	1.82	1.85	1.80
5	Calculate economic losses	1.42	1.69	1.77	1.65
6	Assess emergency management needs	1.43	1.72	1.92	1.61
7	Assess the need to improve the system	1.45	1.92	2.15	1.78
8	Disseminate data to public and other bodies	1.48	1.71	1.79	1.67
9	Collect data from the public and other bodies	1.48	1.74	1.77	1.71
10	Assess the long-term usability of buildings	1.49	1.89	2.00	1.82
11	Undertake short-term usability assessment	1.52	1.85	2.08	1.73
12	Add information to a central database	1.55	1.79	1.93	1.70
13	Calculate funding needed for reconstruction	1.58	1.88	1.83	1.90
14	Estimate the social impact of the earthquake	1.86	1.91	2.00	1.86

The scenario at the start of this chapter helps to put findings from this analysis into context. Q9a of the study reveals hopeful signs that Iranian disaster management authorities have created the basis for a good and strong EIMS. However, the scenario demonstrates clearly that trust in the new EIMS is low. Although not clear in the scenario, Q11 from the survey included in this research would suggest that the whole element of the community would recognise some of the elements of the new EIMS and agree that those elements were working well. However, there are also clear areas that either residents or engineers would advocate improvement, either at the public engagement level or at the technical specialist level. Q11 revealed strengths in the following areas:

- Record the location of damaged buildings.
- Identify a safe zone around damaged building.
- Assess wider regional damage.
- Identify additional hazards around buildings.
- Calculate economic losses.
- Assess emergency management needs.

The weaker parts of the system include:

- Disseminate data to public and other bodies.
- Collect data from the public and other bodies.

- Assess the long-term usability of buildings.
- Undertake short-term usability assessment.
- Add information to a central database.
- Calculate funding needed for reconstruction.

Almost all groups agreed that the weakest part of the system was:

- Estimate the social impact of the earthquake.

In relation to where to place the topic “assessing the need to improve the system”, the response was less clear. Views on this were quite divided, with engineers and disaster managers placing in the list of strengths in the system but residents considering it to be a weakness.

4.4 Qualitative analysis of strengths and weaknesses in the EIMS of Iran

Question 9a of survey asked respondents to state if they were aware of an EIMS in Iran. In part 9b, 27 respondents provided additional Information to explain their answers. In this section the responses are analysed based on the subgroup (Disaster manager, Engineer, Resident), the gender of the respondent (Male and Female), the respondent’s level of education (PG Education, UG Education or School Diploma) and finally level of awareness of the Iranian disaster management system (High, Moderate or Low).

Disaster Manager Beliefs

Two male disaster managers with high levels (Postgraduate education level) of education and awareness provided a qualitative response to question 9b. They both confirmed that studies into the Iranian disaster management system have been conducted and, if not yet complete, plans to enhance the system have been prepared.

> *“Numerous studies have been done in disaster management and good plan of action in this field has been prepared.” (Respondent 172, 3111).*

> *“Good studies have been done and I hope a good programme has been prepared.” (Respondent 174, 3111)*

Engineer beliefs

Nine engineers provided comments in relation to the EIMS in Iran, all were male and seven had high levels of education and high or moderate levels of awareness of the system. All the highly educated engineers agreed that either the EIMS in Iran was at best weak or at worst non-existent. They suggested that if it does exist it does not function well and that has led some to speculate that disaster managers lack competence in implementing the system.

> *"In light of the circumstances of recent earthquakes and mismanagement in crisis time, it is felt that there is no comprehensive disaster management programme in Iran or if it does exist it cannot function." (Respondent 169, 2111)*

> *"There is no earthquake management system in Tehran or any other cities in Iran but they are trying to create something." (Respondent 154, 2111)*

> *"No, an EIMS does not exist in Iran. There is no action done by relevant organisations." (Respondent 164, 2111)*

> *"I am not sure there is any earthquake information management system in Iran but I know there is programme between the city of Tehran council and JICA to reduce the post-earthquake damage." (Respondent 171, 2112)*

> *"In light of recent earthquake in Kermanshah, disaster management is very weak." (Respondent 168, 2112)*

> *"With regards to where Tehran is geographically, as far as earthquake are concerned and evident lack of training and preparedness post-earthquake or when earthquake happens, they all point to incompetence of disaster mangers." (Respondent 165, 2112)*

> *"The disaster management in Iran is very weak." (Respondent 152, 2112)*

The two engineers with undergraduate level education had either high or moderate levels of awareness of the system. Interestingly the one with higher awareness suggested that they had not information or experience to respond. The other was positive that EIMS activity was happening at the city council level.

"I have no information and experience in disaster management system in Iran." (Respondent 156, 2121)

"Disaster management is done active through the council in every Iranian city." (Respondent 167, 2122)

Resident beliefs

In total 40 residents provided qualitative feedback (16 males and 24 female respondents).

Males responses (N=16)

The first eleven male residents had high or undergraduate level education and range of awareness levels. Their responses were all negative either thinking that there is no EIMS in Iran or that the system was not adequate.

"GIS research through to companies (one Japanese, one Persian) was done in Tehran in 1384 and 1389 and the results are devastating, despite this there has been no planning in this field." (Respondent 92, 1111)

"No, as we no Management neither a comprehensive plan to deal with recent disasters." (Respondent 135, 1111)

"I, as a volunteer, am active in disaster management, and currently I am not aware of any disaster management programmes." (Respondent 21, 1111)

"I think it does not exist and if it does information is not accurate at all." (Respondent 103, 1112)

"I am not aware of the answer to this question as I have not followed up on it and the information has not been put out accurately." (Respondent 1, 1112)

"There is neither planning nor solutions." (Respondent 124, 1121)

"No, there is no disaster management in Iran. Relevant organization are in crisis when disaster happens." (Respondent 57, 1121)

“I have not seen any disaster management programmes anywhere in Iran.” (Respondent 143, 1122)

“No, given the weak action regarding recent earthquake, no comprehensive plan exists.” (Respondent 137, 1123)

“My information is only limited to the media so I am sure if it is accurate.” (Respondent 134, 1123)

“We do not know how to manage earthquake.” (Respondent 69, 1123)

The remaining 5 male resident respondents all had school diploma levels of education and a range of awareness levels. Generally, the views were also negative about any EIMS in Iran. Just one respondent, with high awareness suggested that performed EIMS functions when needed.

“Management equals zero.” (Respondent 116, 1131)

“As far as I know, disaster management does not exist.” (Respondent 17, 1131)

“The disaster management organization as well as passive defence organization performed earthquake management rules when needed.” (Respondent 3, 1131)

“I know that there is an organization called ''disaster management'' but I do not know if they are active in earthquake.” (Respondent 19, 1132)

“My information is very limited which is through mass media and is incomplete and censored.” (Respondent 15, 1132)

<u>Female responses (N=24)</u>

The first fourteenth female respondents all had high or undergraduate level of education and a range of levels of awareness of the Earthquake Information Management System. As with the male respondents, the female respondents were all negative either thinking that there is no EIMS in Iran or that the system was not adequate.

"Disaster management is very weak, raising awareness is incomplete, media is censored, and in my opinion, there is no order and management." (Respondent 113, 1212)

"An agreement has been signed with Japan which allows Iran use a system that gives warning just before earthquake." (Respondent 46, 1212)

"There is some training given to the people of the community through DVAM NGO's in Tehran." (Respondent 34, 1212)

"Not enough information is available." (Respondent 38, 1213)

"There is no comprehensive information available and in light of recent earthquake, it is unlikely any plans would be practical." (Respondent 33, 1213)

"It is very weak in Tehran so it must be weak in Iran." (Respondent 28, 1221)

"The only information available that I know are ones that is given through mass media." (Respondent 51, 1221)

"Such a programme or training does not exist." (Respondent 16, 1221)

"If it exists it is just for show and has no practicalities." (Respondent 104, 1222)

"In light of recent earthquake there is no earthquake management." (Respondent 62, 1222)

"With reference to the recent earthquake there is no planning for the future." (Respondent 45, 1222)

"Form recent earthquake in Kermanshah it can be seen that there is clear lack of management system." (Respondent 130, 1223)

"I have no knowledge of disaster management in Tehran." (Respondent 25, 1223)

"Disaster managements meetings only take place post-earthquake in Iran." (Respondent 20, 1223)

The remaining 10 female respondents all had school diploma levels of education and a range of awareness levels. Generally, the views were more positive suggesting that some elements of the EIMS do exist in Iran but it needs to give more information to the public.

> *"There are certain provinces in Iran which are designed to help Tehran if there was an earthquake in the capital." (Respondent 6, 1231)*
>
> *"I know there are organizations, however; giving information to public is not sufficient." (Respondent 114, 1232)*
>
> *"There is no public awareness in this field by mass media and there is no specific place for it." (Respondent 60, 1232)*
>
> *"Lack of raising awareness from mass media and relevant government organization." (Respondent 59, 1232)*
>
> *"Yes, there are different forces active and under training in this field." (Respondent 41, 1233)*
>
> *"It exists, however; it is not comprehensive and more needs to be done." (Respondent 18, 1233)*
>
> *"Very weak." (Respondent 12,123x)*
>
> *"The council has trained specific people in case of disaster." (Respondent 58, 1232)*
>
> *"Iran is prone to earthquake but people got no information about it." (Respondent 61, 1233)*
>
> *"Crisis management organization exist in Tehran which they get together in case of a disaster anywhere in the country." (Respondent 9, 12xx)*

The responses to Q9b revealed that, if there is an EIMS in Iran, the resident community are not aware of the system and think negatively about what they do know of it. That negative message spanned both genders, all levels of education and all levels of awareness. The almost unanimously negative response from the resident sample reveals an important lesson, specifically, this research has found something very wrong with the public engagement aspect of the Iranian EIMS. The response from the engineers was a bit more positive, but not overwhelmingly so. The engineers' view could be summarised, as if an EIMS does exist in Iran it does not function well and that has led some to speculate that disaster managers lack competence in the implementation of the system. Perhaps in recognition of the deep distrust of the Iranian EIMS, the disaster managers conceded that studies into the Iranian disaster management system have been conducted and, if not yet complete, plans to enhance the system being prepared.

<u>Q10a – Plans to develop an EIMS in Iran</u>

Following on from Q9 in the survey, Q10 asked respondents if there is any plan to develop an earthquake Information management System (EIMS) in Iran. Table 4.7 shows the responses to question 10a for the three main survey groups (Community Residents, Structural Engineers, and Disaster Mangers)

Table 4.6 Survey responses to survey question 10a "is there a plan to develop an EIMS in "Iran".

	YES	NO	Do not know	Total Number (N)
Residents	22 (16%)	46 (33%)	73 (52%)	141 (100%)
Engineers	4 (21%)	4 (21%)	11 (58%)	19 (100%)
Disaster Managers	4 (100%)	0	0	4 (100%)
All respondents	30	50	84	164

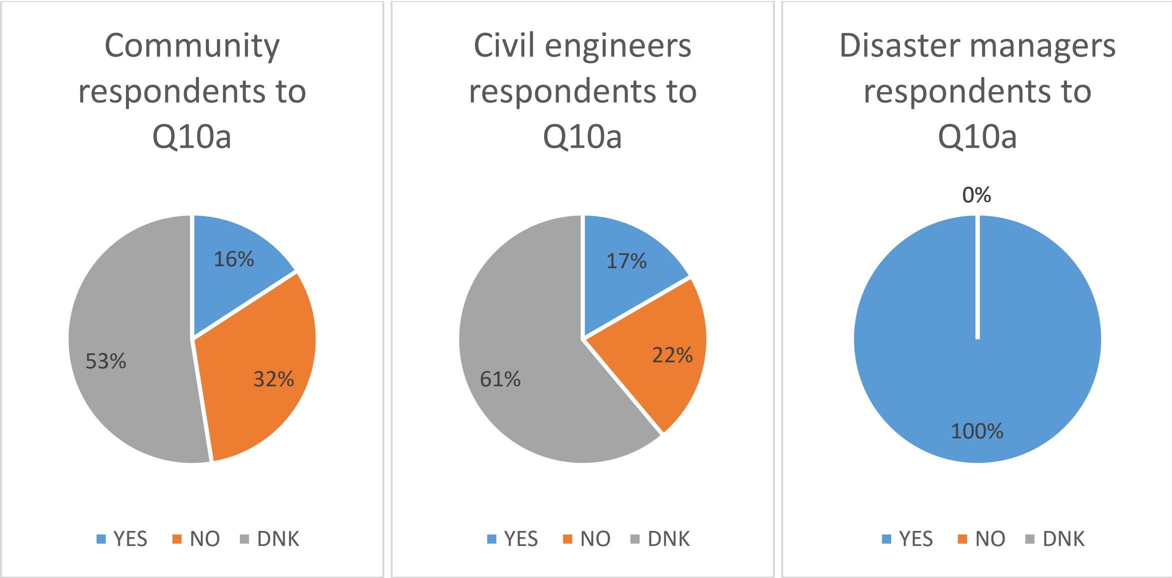


Figure 4.5 Profile of the respondents to Q10a.

The response to Q10a provided another important finding for this research. Specifically, 100% of the disaster managers sampled agreed that Iran does have a plan to develop its EIMS. As with Q9a, the results from the disaster managers are important, as any recommendation to improve the EIMS in Iran will be much easier if there is already a plan in place to improve the current system. However, the views of the disaster managers were not shared by the other two groups. A high proportion of engineers and residents admitted that they did not know if there was a plan to develop an EIMS in Iran. Engineers that did give a definite response were equally divided between “TES” and “NO”. The residents who gave a definitive response were slightly in favour of a “NO” response. The resident responses were further broken down based on gender, education level and level of awareness of the disaster management system in Iran (Table 4.8).

Table 4.7 Breakdown of resident responses to survey question 10a “is there a plan to develop an EIMS in Iran?”.

	YES	NO	Do not know	Total Number (N)
Male	11 (17%)	20 (30%)	35 (53%)	66 (100%)
Female	11 (15%)	26 (35%)	38 (50%)	75 (100%)
Sub-total	**22**	**46**	**73**	**141**
School Diploma	7 (15%)	17 (37%)	22 (48%)	46 (100%)
UG Degree	12 (20%)	17 (28%)	32 (52%)	61 (100%)
PG Degree	3 (10%)	11 (37%)	16 (53%)	30 (100%)
Sub-total	**22**	**45**	**70**	**137**
High Awareness	12 (29%)	10 (24%)	20 (47%)	42 (100%)
Moderate Awareness	2 (5%)	15 (38%)	22 (56%)	39 (100%)
Low Awareness	6 (12%)	17 (35%)	26 (53%)	49 (100%)
Sub-total	**20**	**42**	**68**	**130**

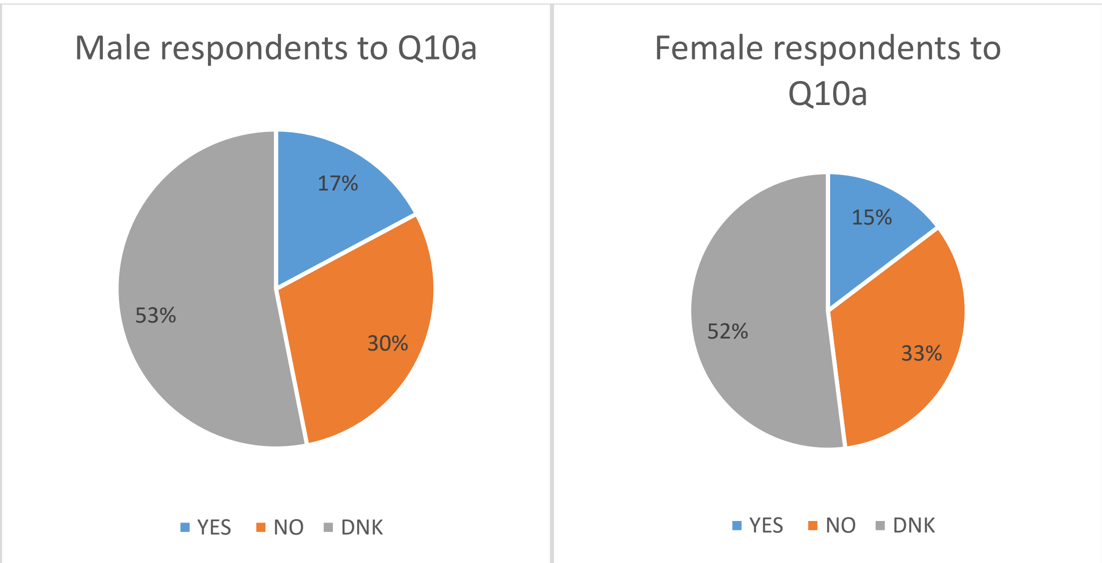


Figure 4.6 Gender of respondents to Q10a.

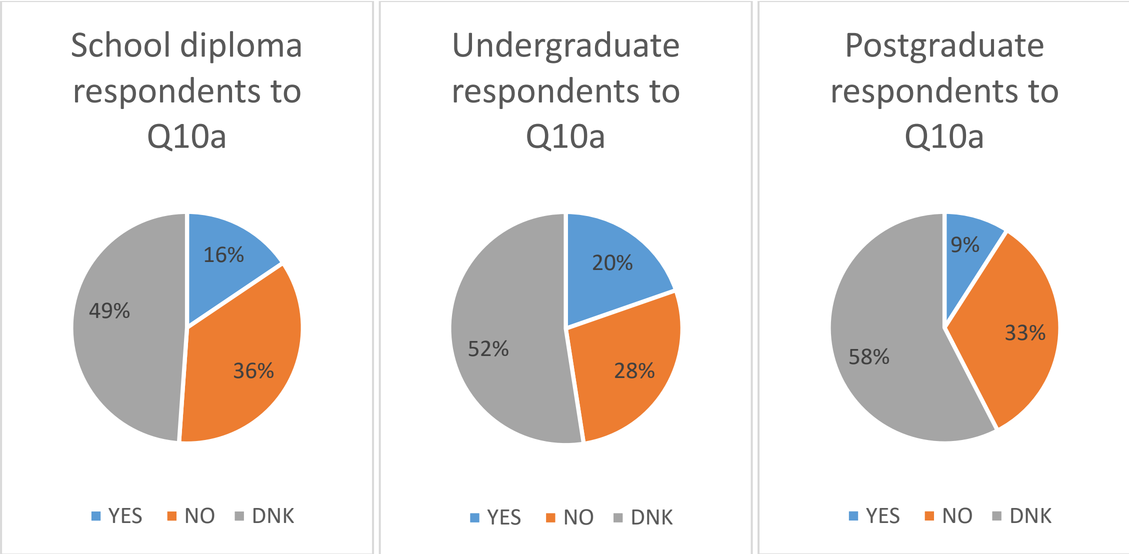


Figure 4.7 Academic qualifications of respondents to Q10a.

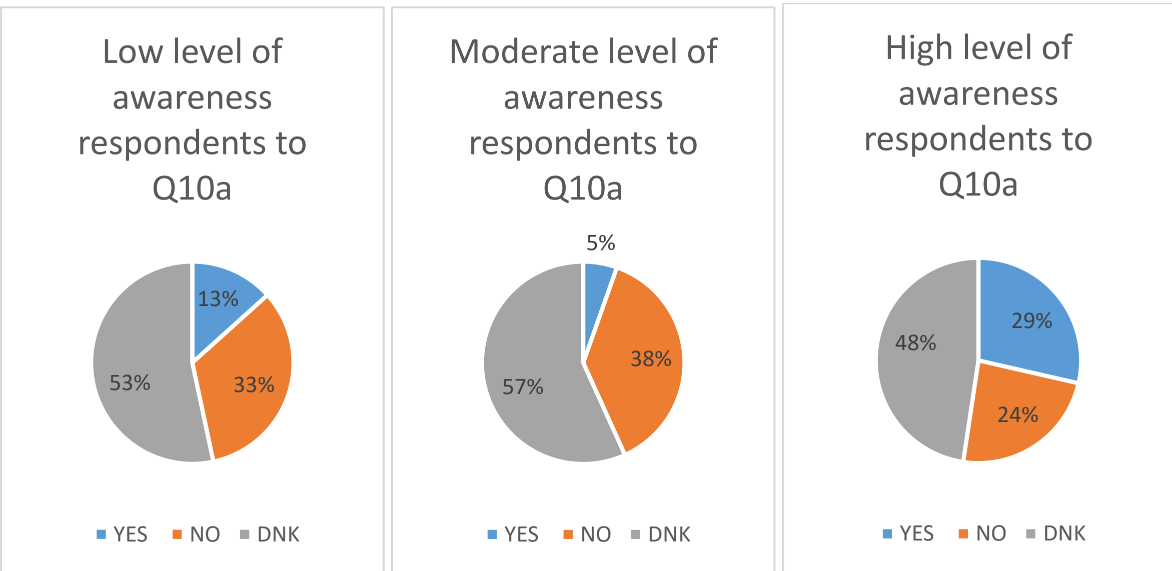


Figure 4.8 Level of awareness of respondents to Q10a.

Table 4.8 also shows that the views of male and female residents about plans to develop and EIMS in Iran are broadly the same. The majority of both groups replied, “Do not know”. Both groups were also slightly pessimistic, with more saying “NO”. That pattern of responses was flowed by respondents at all levels of education and those with low or moderate awareness of the disaster management system in Iran. Just one group, those with decisive responses in the high levels of awareness category, were slightly more inclined to say “YES”.

In summary Q10a has revealed that, despite 100% of disaster managers suggesting that there is a plan to develop the EIMS in Iran, there is a considerable lack of awareness of that plan in the wider community. Only those with the highest levels of awareness of the system were willing to believe that such a plan existed, but of that group an almost equal number doubted that such a plan existed.

To gain deeper insights into the results from Q10a, Q10b asked respondent to provide some qualitative feedback on reasons for their answer.

Disaster Manager Beliefs

Only one disaster manager provided any qualitative feedback, stating that plans had already been drawn up.

> *"Comprehensive plans have been drawn up in this field." (Respondent 172,3111)*

Engineer beliefs

Eight male engineers provided some additional insight, of which three had high levels of education and awareness levels. The opinion of the three engineers was equally divided, one positive, one negative and one ambiguous.

> *"There is programme for improving and creating the disaster management system has been set with universities and government agencies." (Respondent 154, 2111)*
>
> *"Using the past experience and planning for post-earthquake." (Respondent 153, 2111)*
>
> *"There is not a plan." (Respondent 164, 2111)*

Three more engineers had high level education and moderate levels of awareness. All three were quite pessimistic in their views, thinking that it was unlikely that such a plan existed.

> *"I do not know even if it exists." (Respondent 168, 2112)*
>
> *"It's highly unlikely that there is a comprehensive plan as the first step is training people which is non-existent and if it exists it is very weak at school levels." (Respondent 165, 2112)*
>
> *"There is no effort." (Respondent 152, 2112)*

The remaining two engineers had undergraduate education and high to moderate levels of awareness of the system. One was uncertain about the existence of a plan, but the other was more positive.

> *"Because there is no Education, workshop for disaster management so I have no Information about the disaster management system in Iran." (Respondent 156, 2121)*

> *"In all Iranian Cities specifically, the ones that are more vulnerable to earthquakes/natural disasters, there is a disaster management plan and a team who are available to help people." (Respondent 167, 2122)*

<u>Resident beliefs</u>

In total 29 residents provided qualitative feedback (15 males and 14 female respondents).

<u>Male responses (N=15)</u>

The first eight male residents with high or undergraduate level education and range of awareness levels. Their responses were very negative, almost all the respondents thought that there is no plan to develop an EIMS in Iran.

> *"Very little with limited expertise have been done." (Respondent 92, 1111)*

> *"Tehran is far from having an ideal and acceptable disaster management programme, however; improvements are being made in this field." (Respondent 21, 1111)*

> *"I think it does not exist and if it does information is not accurate at all." (Respondent 103, 1112)*

> *"It seems as though as the efforts have been made however it is still unknown that they have come to fruition." (Respondent 1, 1112)*

> *"There is no Planning." (Respondent 124, 1121)*

> *"My information is only the one I have through the media." (Respondent 134, 1123)*

> *"I only heard on the news." (Respondent 93, 1123)*

"Disaster management meetings only take place after the earthquake, there is no planning and organization before the disaster." (Respondent 75, 112x)

The remaining 7 resident male respondents all had school diploma levels of education and a range of awareness levels. Generally, the views were negative or ambiguous about any plan to develop an EIMS in Iran

"I have no accurate information." (Respondent 116, 1131)

"Red Cross is trained to help people on disaster days." (Respondent 17, 1131)

"I am not aware of it." (Respondent 3, 1131)

"I have not heard anything regarding this." (Respondent 19, 1132)

"Of course, it is possible however it will only be a piece of paper and will not be put in practice." (Respondent 15, 1132)

"I have no information." (Respondent 112, 1133)

"Lack of management." (Respondent 31, 113x)

Female responses (N=14)

The first 9 female respondents all had high or undergraduate level of education and a range of levels of awareness. Here again the responses were overwhelmingly negative, believing that there is no plan to develop an EIMS in Iran.

"Unfortunately, nothing is ongoing and everything is forgotten post disaster and I do not think any comprehensive planning is in place." (Respondent 113, 1212)

"I have no explanation for it." (Respondent 39, 1213)

"Apparently yes but in reality, no, given the recent earthquake and the inaction faced by the earthquake affected people." (Respondent 38, 1213)

"There is no comprehensive information available and in light of recent earthquake, it is unlikely any plans would be practical." (Respondent 33, 1213)

"Iran is trying to improve earthquake management." (Respondent 28, 1221)

“I have not heard such a programme.” (Respondent 16, 1221)

“It shows after the Kermanshah Earthquake it shows that there is no Planning.” (Respondent 62, 1222)

“There is no planning.” (Respondent 45, 1222)

“There is no Plan to develop EIMS in Iran.” (Respondent 20, 1223)

The remaining 5 female respondents all had school diploma levels of education and a range of awareness levels. Generally, the views were also negative about any plan to develop an EIMS in Iran.

“No, since there is no information available in this field, there cannot be a plan.” (Respondent 60, 1232)

“I do not know as if there was the recent disaster would have been managed more efficiently.” (Respondent 59, 1232)

“No, as there is no media that raises awareness.” (Respondent 122. 1233)

“For improvement they need to have a comprehensive information system. Most of information should be available online.” (Respondent 13, 123x)

“I have got very little information from my city council.” (Respondent 61, 1233)

The responses to Q10b, were almost uniformly negative, from all sectors of the survey sample. Most of the disaster managers did not respond to this question, which may be taken as an indication that there is some basis to the belief that there is no effective plan to develop the EIMS in Iran. This is a very significant and problematic finding by this research, which could potentially undermine some of the other findings and any proposal to improve the EIMS in Iran.

Taken together the findings from the analysis in this section provide some new and important insights in relation to the scenario presented at the start of the chapter. The previous section ended on a positive note, identifying evidence of an EIMS in Iran and revealing strengths as well as weaknesses in the system. What this section reveals are the depth of feeling in relation to some of the weaknesses in the system, which are very powerfully felt by residents and a good proportion of engineers. The negative and pessimistic views expressed in the scenario seem to stem from a belief that if an EIMS does exist in Iran it does not function well and that has led some to speculate that disaster managers lack competence in the implementation of the system. Even more widespread and possibly reaching into the disaster management community is a belief that there is no effective plan to improve the EIMS.

4.5 Summarising findings from the analysis of strengths and weaknesses in the Iranian EIMS

This chapter started by drawing lessons from the authors early observations of the study communities in Iran. That observation started positively, with the judgement that Iran has a developing and well qualified body of engineers with the forensic capability to collect and analyse data needed to judge the extent of damage in earthquake affected buildings. However, the early lessons indicated that the EIMS in Iran is under pressure and important opportunities to learn lessons from each earthquake event are being missed. But there was also evidence that disaster managers are keen to learn how to make the system better.

The author's own direct engagement with a structured series of research activities, new insights that helped to reveal further important lessons. First and foremost was the fact that several researchers had already investigated aspects of the EIMS in Iran and revealed numerous weaknesses in the system. Therefore, disaster management authorities in Iran were becoming more aware of deficiencies in their EIMS, which could explain their willingness to learn lessons about how to improve the system. An important part of the improvement process is to learn lessons from past events and the IDRiM conference in Isfahan was a good demonstration of efforts being made in that direction. But perhaps the pessimistic view of the engineers and resident communities was a sign that too much of the learning was focussed on to narrow a group of people. In that regard, the author's own project experience helps to demonstrate that in earthquake management, education and engagement needs to include a wide range of stakeholder groups (both local and international) and cover a wide range of subjects, from the simplest messages to school children to technical know-how to engineers and disaster managers across Iran. What the scenario appears to show is that wide ranging education and engagement effort is not happening in Iran.

Q9a of the questionnaire survey revealed signs that Iranian disaster management authorities have created the basis for a good and strong EIMS. Q11 revealed strengths in the following areas:

- Record the location of damaged buildings.
- Identify a safe zone around damaged building.
- Assess wider regional damage.
- Identify additional hazards around buildings.
- Calculate economic losses.
- Assess emergency management needs.

The weaker part of the system includes:

- Disseminate data to public and other bodies.
- Collect data from the public and other bodies.
- Assess the long-term usability of buildings.
- Undertake short-term usability assessment.
- Add information to a central database.
- Calculate funding needed for reconstruction.

Almost all groups agreed that the weakest part of the system was:

- Estimate the social impact of the earthquake.

The topic "assessing the need to improve the system" proved difficult to place in the system, with views quite divided. Engineers and disaster managers were willing to place the topic in the list of strengths in the system but residents considering it to be a weakness. However, the last section revealed the depth of feeling in relation to the weaknesses in the system, which were very powerfully felt by residents and a good proportion of engineers. This research has revealed that the negative and pessimistic views expressed in the scenario at the start of the chapter stem from a belief that if an EIMS does exist in Iran it does not function well and that has led some to speculate that disaster managers lack competence in the implementation of the system. More importantly and even more widespread (possibly reaching into the disaster management community) is a belief that there is no effective plan to improve the EIMS.

Despite the deeply felt negative views about the weaknesses in the Iranian EIMS, the author proposes that by working on the weaknesses revealed in the system (listed above), disaster manager can rebuild trust in the system. Discussions in chapter 6 and 7 will elaborate further on how that process can be implemented.

Chapter 5 – Strengths and weaknesses in the Iranian Post-Earthquake damage survey Assessment system

This chapter will be studying of the initial post-earthquake usability damage survey assessment system in Iran. The scenario will be used to demonstrate new insights developed from this thesis research project about strengths and weaknesses in the current of the initial post-earthquake damage survey assessment system used by Iranian authorities. The chapter will apply the blended phenomenological and ethnographical approach to the study of the post-earthquake structural assessment system and then develop proposals that may be used to enhance the current system. The analysis starts with a personal reflective assessment of my own evolving understanding of best practice in the post-earthquake structural assessment, before turning to the quantitative and qualitative analysis of survey and interview data.

5.1 Good practice in post-earthquake damage survey assessment

To summarise, what this section has revealed is that not every member of the public will have the necessary skills to understand the different elements of a post-earthquake damage survey assessment system. People without basic civil engineering skills will have to undertake some further education to prepare them for involvement in the process. In addition, graduate civil engineers will possess a good depth of knowledge in several subjects that are important for the analysis of buildings damaged by earthquakes, but they are unlikely to have applied that knowledge for post-earthquake damage survey assessment purposes. Engineers wanting to get involved in post-earthquake damage survey assessment will need further specialist training to show them how to apply their skills in this area of investigation. Finally, disaster managers need to understand how important a post-earthquake damage survey assessment system is to achieve an effective EIMS.

Reflecting on the scenario at the start of this chapter, the author was pleased to find evidence that disaster management authorities had recognised the need to have specialist engineers involved in the assessment of buildings damaged by earthquakes in Iran. The fact that each region in Iran has a local association of structural engineers, with teams who have received some training in post-earthquake damage survey assessment is another positive finding. Where the author found less evidence of good practice was in the observation of the new building in Tehran. On the construction site there seemed to be very little specialist engineering oversight of the building process. Consequently, it was possible that features in the design of the structure, which were supposed to increase its earthquake resistance, might have been left out during the construction process. Finally, there was little or no evidence of teams of people from the community getting engaged in the post-earthquake damage survey assessment process.

5.2 Deeper insights about good practice in the development and operation of effective post-earthquake damage survey assessment system for Iran

Attending the 6th International Disaster and Risk Conference IDRC, Davos, Switzerland and the 7th International Conference on Integrated Disaster Risk Management, Isfahan, Iran helps me to formulate my ideas about best practice in post-earthquake damage survey assessment. In the papers I submitted to the conferences, I assessed how best to include post-earthquake damage assessment within an EIMS, lessons were drawn from practice in Italy, Japan, Turkey and Greece. In Italy, the post-earthquake damage survey assessment systems have traditionally been triggered by requests from property's owners, with inspection results sent to the local government administrative offices and subsequently a national body for classification (Goretti, 2002). In Japan the post-earthquake damage survey assessment system was only used on multi-owner buildings and the results would form the basis for a suggested plan of action to the owners of the building (Ajani *et al*., 2006). In Greece the post-earthquake damage survey assessment system was done on all buildings in the area classified as the epicentre of the earthquake and only at the request of building owners/occupiers in areas outside the epicentre Anagnostopoulos and (Moretti, 2006). Since 2001 the Italian department for National Civil Protection (NCP) and the National Seismic Survey (SSN) decided to use a unified standard classification procedure for usability and damage assessment in all the regions in Italy Goretti (2002). The Italian procedure follows two steps. First buildings are classified based on the post-earthquake reconstruction aim: short term usability assessment, economic loss and the funding need for reconstruction, social impact assessment and emergency management. Second, buildings are classified by subject disciplines for after earthquake reconstruction: The methods that Italy and Greece employ are divided in to four categories. Pre-event assessments, based on quick visual inspections. First post-event assessments normally conducted 2 to 3 days after the event. Second post-event, conducted 3 to 60 days after the event, focussing more on usability of buildings. Third post-event: assessment, conducted up to 1+ years after the event and focussing on long-term usability of the buildings (Building Research Institute,2002; Anagnostopoulos, Petrovski and Bouwkamp, 1989; Anagnostopoulos *et al*., 2004). In Greece the post-earthquake damage survey assessment system divides buildings into three states; safe for use, unsafe for use and dangerous for use and the damage assessment of the building would be done by two experience or well-trained structural engineers (Anagnostopoulos 1997; Anagnostopoulos and Moretti, 2006). The main aim of rapid post-earthquake damage survey inspection would be to distinguish safe buildings from unsafe buildings as quick as possible. In rapid inspection the structural engineers would assess the outside of the building and if it is safe, they would check the ground floor of the building, taking no more than 10-30 minutes for each building assessment Dandoulaki, Panoutsopoulou and (Ioannides, 1998). What this brief review of post-earthquake structural assessments provides to the reader is that an EIMS that has post-earthquake structural assessment integrated within it will need to allow input from expert engineers, but also the community of building owner/occupiers. Allowing input from expert engineers and the wider community will only be effective in enhancing urban resilience if the EIMS also provides a facility to educate engineers and the community in both the methods for interacting with the EIMS and the methods for conducting post-earthquake damage survey assessments.

Working on the Post-Earthquake Structural Health Monitoring System (PE-SMS) project in Philippines, I was introduced to a subject that I had very little prior knowledge of, namely the use of sensors to monitor buildings. In this project I helped in the design and testing of a prototype structural crack monitoring system. The project was led by Coventry University and involved the University of Plymouth and the University of San Carlos in the Philippines. A post-earthquake structural health monitoring system is an evolution beyond traditional seismic early warning systems. Li, Zhang, and Zhu (2007) stated that pre-seismic event structural health monitoring can be used to assess if a building can survive an earthquake tremor. More often, the use of structural health monitoring systems is for disaster and emergency management, helping managers and decision makers make the rescue and relief operation faster and more efficient. To check a building is stable and safe cracks in structural elements need to be identified and monitored. A structural health monitoring system is distinct from a seismic early warning system. The seismic early warning system consists of series of intelligent network of seismic sensor for recording the real time data which is the important factor for risk management purposes (Heaton, 1985). The structural health monitoring system from the civil engineering viewpoint is not only about the detection of sudden or progressive damage but also are concerned about monitoring of their performance under operational condition (Mufti, 2001). Fujino and Abe (2001) described the main aim of the structural health monitoring system in the earthquake affected area is to do the field assessment of the earthquake resistance of a building and, at the same time, to provide checks of its serviceability in operational condition. There are different types of sensors commonly used in structural health monitoring systems, these include: Strain gages, accelerometers, Fiber Bragg Gratings (FBG) sensors, and temperature sensors (Rainieri, Fabbrocino and Cosenza, 2010). Experiments in Naples, Italy, showed that two types of accelerometers should be considered. Uniaxial force-balanced accelerometers and uniaxial piezoelectric accelerometers, installed at the top of the building and tri-axial force balanced accelerometers placed at the base of the building. Accelerometers positioned in that way enable monitoring of translational and torsional modes of vibration in the structure (Rainieri, Fabbrocino and Cosenza, 2010).

An important element of my contribution to the PE-SMS project was to design a testing procedure for prototype sensors prior to dispatch to the Philippines. Figure 5.1 shows the apparatus that I helped to design and test the sensors in the structure’s laboratory at the University of Plymouth.

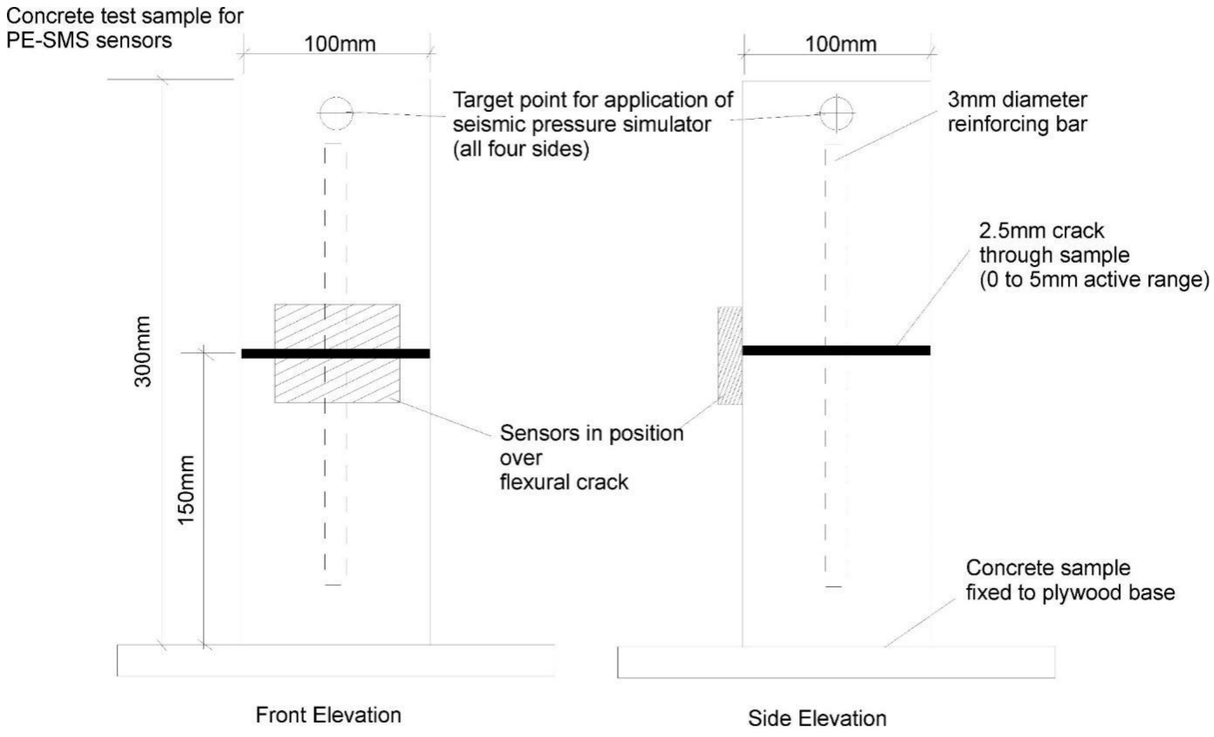


Figure 5.1 Concrete test sample for strain gauge testing.

The strain gauge was fixed across the crack and connected to a processor unit. The processor unit included a circuit board, which relayed the sensor signal to a Raspberry Pi computer located in Plymouth (Figure 5.2). The Raspberry Pi computer then transmitted sensor data to a server located in Coventry via the internet.

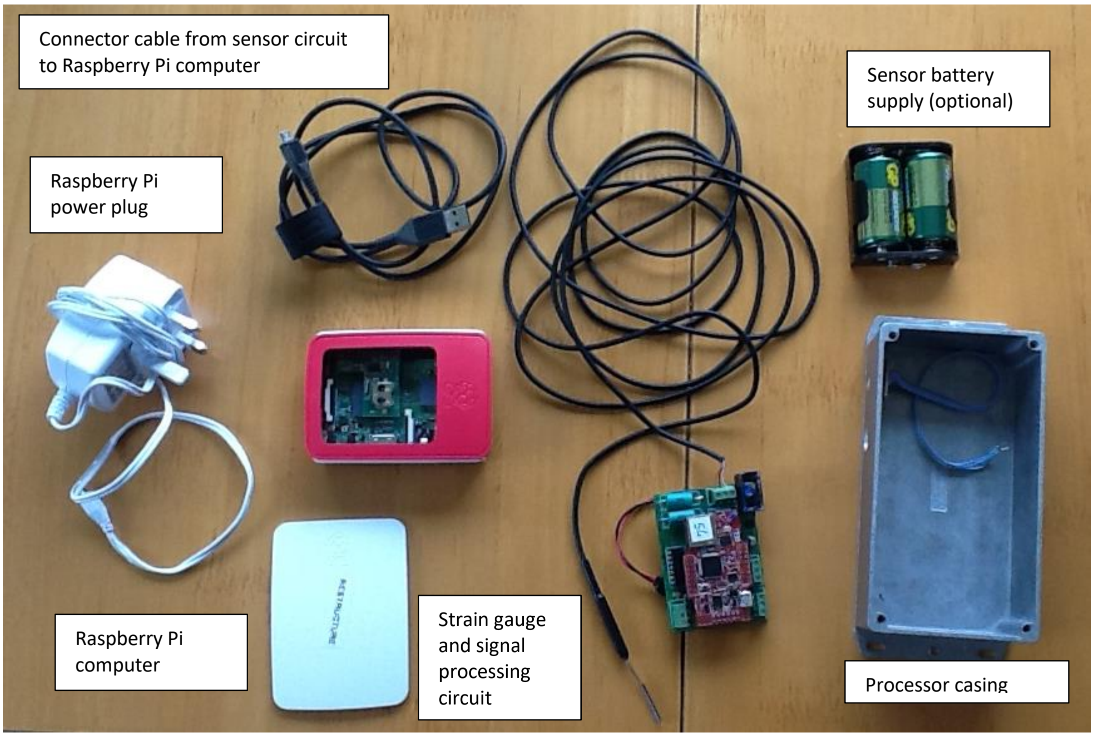


Figure 5.2 Strain gauge and signal processor unit.

When activated the sensor circuit recorded a strain gauge reading every 1 second.

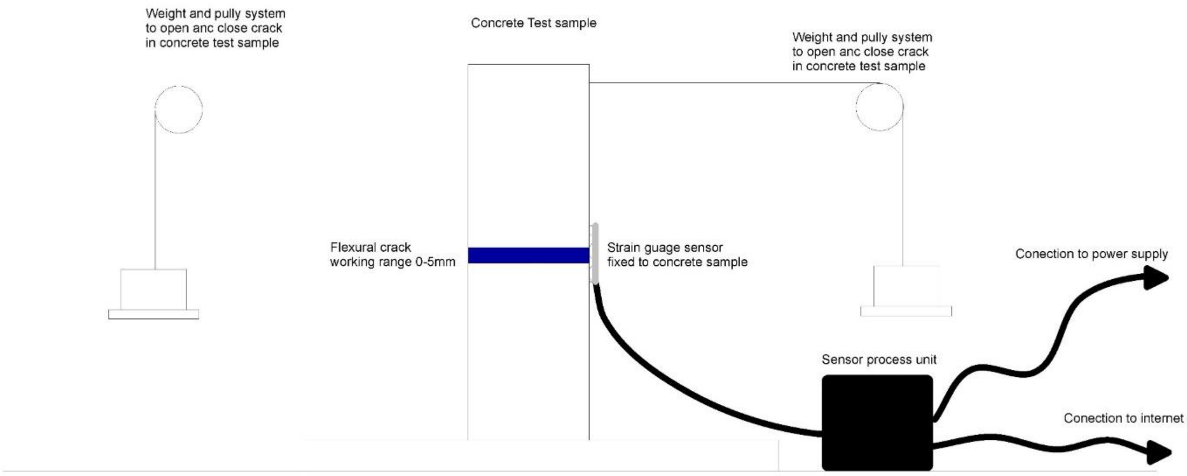


Figure 5.3 Strain gauge test sample rig.

Table 5.1 Sampler strain gauge log file.

Time (s)	Acceleration (mm/s^2)	Displacements (mm)	Inclination
1496659937	3250.25	10.20	-4.5312
1496659938	3250.5	10.20	-4.75
1496659939	3249	10.19	-4.9062
1496659940	3250.5	10.19	-5.0625
1496659941	3250.25	10.20	-5.0625
1496660612	3226.5	10.20	-4.2188
1496660613	3225.5	10.20	-3.9375
1496660614	3226.5	10.20	-3.9062
1496660615	3227.25	10.20	-3.75
1496660616	3227.25	10.20	-3.4062
1496660617	3226.75	10.20	-2.9688
1496660618	3227.25	10.20	-3.375
1496660619	3228.25	10.20	-3.5938
1496660620	3229	10.19	-3.9375

Table 5.1 shows the strain gauge log file from the part of the damaged building in The Philippines. Early experiments with the system in the lab at Plymouth University, revealed that the strain gauge was not suitable for use over the range of crack widths built into the test sample. A decision was made to change the strain sensor for a displacement sensor. A spring return linear actuation conductive plastic position sensor was chosen to replace the strain gauge. The displacement sensor had a mechanical travel of 14mm and worked well with the crack width working range. A fixing system was designed, using an angle bracket that incorporated an adjusting screw. The adjusting screw had a recessed head, which was used to receive the sensor slider. A lock nut was included to secure the screw when the sensor reading has been adjusted to a zero reading (Figure 5.5).

Figure 5.5 Displacement sensor arrangement (Source: Nirvan Razaghi-Kashani).

With the decision to move away from strain monitoring to crack displacement monitoring the Plymouth University team advised deploying sensors over flexural cracks only. The rational here was that shear cracks, if detected in an earthquake damaged building are much more likely to result from “heavy damage” after the earthquake event. The PE-SMS system is more likely to be deployed in building with “light damage”, where only flexural cracks are observed. With the decision to deploy sensors to monitor flexural cracks, the Plymouth team also advised that the building sensor system could comprise five sensors – one accelerometer, three flexural crack monitoring sensors and one inclinometer. The displacement sensors could be set to take readings every 10 minutes, moving into a rapid reading mode if changes between two successive readings exceeded 1mm. The rapid reading rate may be set to take readings every second for a period of 5 minutes and issue an alarm if successive reading continues vary by 1mm. The accelerometer and inclinometer would be used to trigger a more rapid displacement sensor reading rate if they detected vibrations or changes in the inclination of the building. The Plymouth team also advised on the deployment of the sensors system throughout the building. They advised that the accelerometer be placed at the lowest level in the building. The three displacement sensors be deployed over flexural cracks in high load bearing columns and beams, usually found at the ground floor and lower floor levels. The inclinometer is best placed at the highest level of the building.

When determining suitable sites for the displacement sensors in buildings, columns and beams are important areas to look for suitable sensor deployment opportunities. For this project suitable sites are flexural cracks in columns or beams, and not shear cracks. Shear cracks are distinguished from flexural cracks, by the fact that they often run at a 45degree angle across the plane of the structural element. Flexural cracks generally run horizontally or vertically at right angles from edge to edge in a column or beam. Columns with simple “pin” jointed end connections are most likely to demonstrate shear cracks, with no flexural cracks. Columns with full moment connections may display horizontal flexural cracks close to the connection. Beams with simply supported ends are most likely to display flexural cracks on the underside of the beam at mid-span. Beams with full moment connections at beam-column nodes may display a vertical flexural crack on the side of the beam, close to the connection. In reinforced concrete framed structures, pin-jointed connections are most likely to be found in buildings with pre-cast elements. Images from a potential case study building in the Philippines, show details that are common in in-situ cast concrete framed buildings, with columns and beams having full moment connections. Figure 5.6 shows the typical in-situ concrete construction with arrows indicating where to look for flexural cracks.

The shear crack is a type of crack found in concrete beams due to an increase in shear stress, which appears near the supports such as walls or columns.

The beams are subjected to bending moments and shear forces when it is loaded.

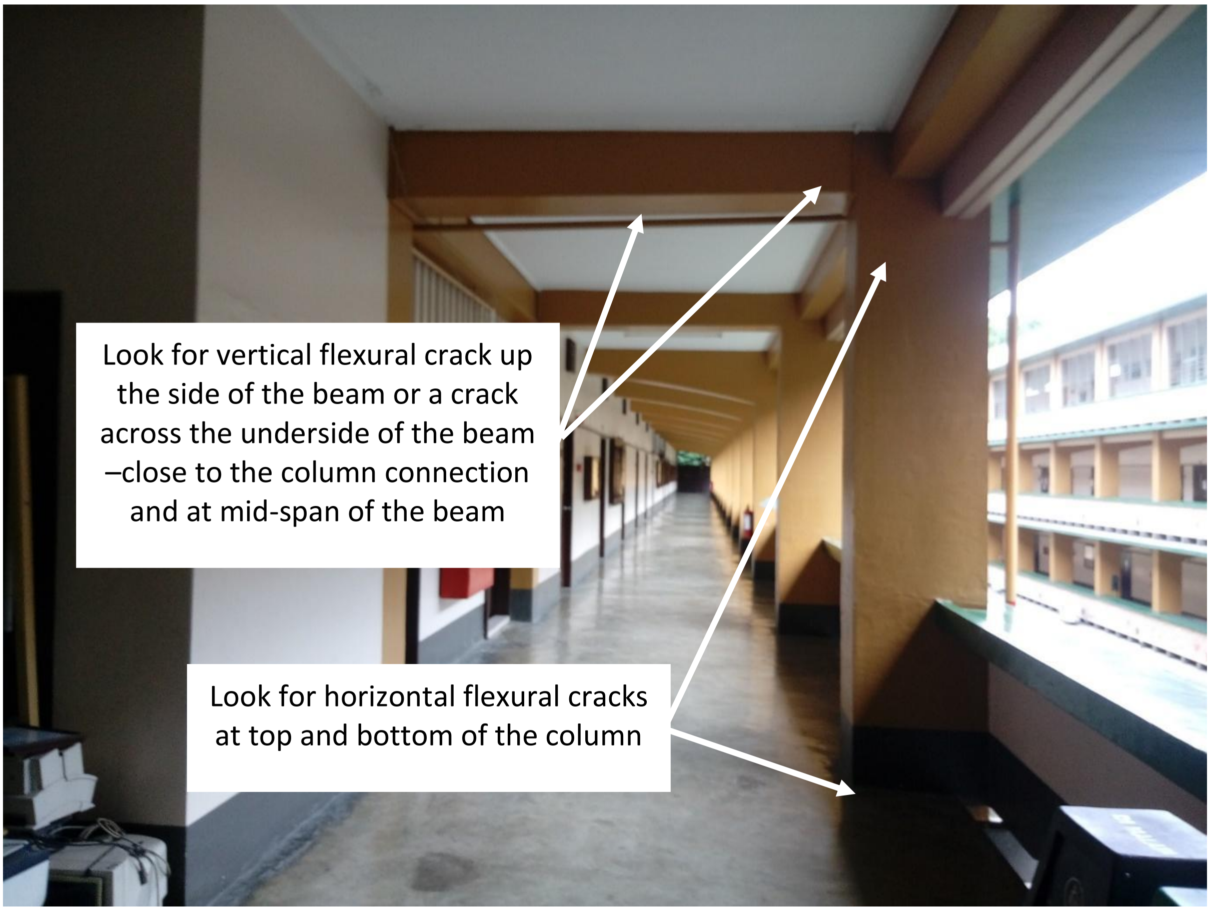


Figure 5.6 Typical in-situ concrete frame construction with full moment connections between columns and beams.

(Source: Rabuya, 2017)

The proof-of-concept Internet of Thing (IoT) based data collection system, was developed at CU, tested at PU, and field-tested at USC. The system has the facility to collect data regarding the tilt of a building and the movement of flexural cracks. The network included a series of displacement sensors connected to a common server unit, wirelessly transmitting data about crack movement to the server.

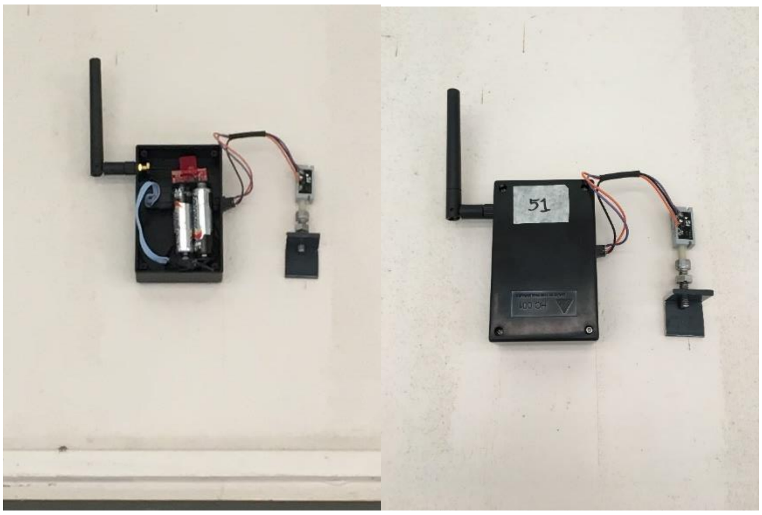


Figure 5.7 Details of sensor units deployed in Philippines (Source: Rabuya, 2017).

Figure 5.8 Sensors in position at different locations at USC, Cebu, Philippines (Source: Rabuya, 2017).

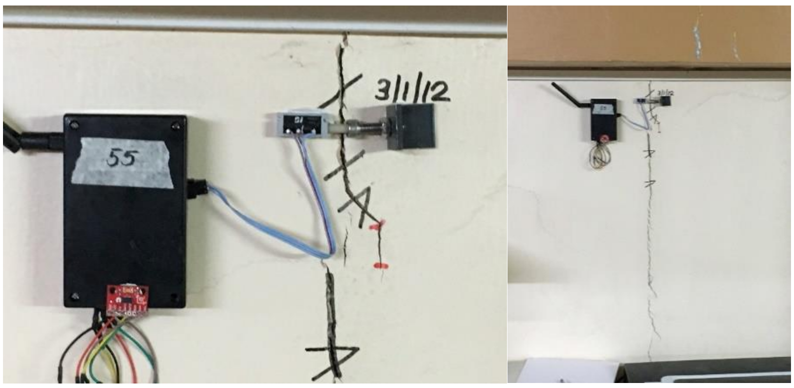


Figure 5.9 Detail of displacement sensor overactive crack (Source: Rabuya, 2017).

The main lessons from working in Thailand was that the disaster management system there was not working perfectly, as their system suffered a disconnect between engineers and community residents. That problem was illustrated by the 2004 Tsunami, where there was plenty of education material available on non-structural response issues, but there was not enough education and engagement to help communities undertake post event structural assessment. When working at UNESCO, the main lesson that I learned was how important communities are in an earthquake response. With right education and engagement programme, they can play a major role in the post-earthquake disaster management cycle.

To summarise, important lessons to take from this section are that any EIMS that has post-earthquake damage survey assessment integrated within it will need to allow input from expert engineers, but also the community of building owner/occupiers. Allowing input from expert engineers and the wider community will only be effective in enhancing urban resilience if the EIMS also provides a facility to educate engineers and the community in both the methods for interacting with the EIMS and the methods for conducting post-earthquake damage survey assessments. As technology continues to improve, it is becoming increasingly easy to enhance post-earthquake damage survey assessment systems by incorporating a structural health monitoring system. A structural health monitoring system does not just enable the detection of sudden or progressive damage but also aids in monitoring the performance of damaged building under operational conditions. Such a system may greatly enhance the efficiency of post-earthquake damage survey assessment operations and speed up the process of recovery from earthquake events.

Reflecting on the status of post-earthquake structural assessment in Iran, the scenario at the start of this chapter, suggested to the author that the concept and practical application of structural health monitoring systems was not common. The team of specialist engineers who visited Kermanshah did not go equipped with sensors to deploy in damaged buildings. Similarly, the new building being constructed in Tehran did not have any structural sensors embedded in its structural framework. Also, there was no evidence during the visit to Kermanshah of the team of engineers actively working with the community of building owner and occupiers to complete post-earthquake structural assessments. Both cases provide early indicators of where this thesis research could identify areas in which the system could be improved and where the more detailed analysis will help to explain why and how the system needs such improvement, as well as the benefits that would be achieved if those improvements were made.

5.3 Observational data analysis of strengths and weaknesses in the Iranian post-earthquake damage survey assessment system within the Iranian

Tehran Observational Field Data

On Saturday 26th December 2017 at 21.30hrs. Local time an earthquake with the magnitude of 5.2 took place in Meshkin Dasht (Figure 5.10). The epicentre was 50 km west of Tehran the capital of Iran at Meshkin Dasht the province of Alborz. According to the Iranian news IIEES (2017) the earthquake was felt quite strongly in Karaj, located 20 km west of Tehran. Qom also felt the quake, located 125 km south of Tehran, as did residents in Qazvin which is located 150 km north-west of Tehran and Arak, which is located 260 km south-west of Tehran.

Figure 5.10 The epicentre was at Meshkin Dasht in Alborz Province, 50 km west of Tehran, (Source: IIEES, 2017).

The event was very personal for the author, happening on the first night he arrived at Tehran to conduct his data collection activity. The author was witness to the news of the event as it was broadcast on the news. In total 117 people were injured in Tehran and a neighbouring city and 2 people died due to the shock and heart attack from the earthquake (IIEES, 2017).

Nothing was reported in terms of structural collapse or major structural damage in Tehran. Some cracks were observed on houses in the city of Tehran, but inspectors reported nothing to be worried about. Outside Tehran, there were some reports that rocks had fallen onto the Karaj-Chalus motorway, but no accident or injury were reported. Telecommunications did get interrupted for a short while. In the author's mind, what the whole experience confirmed was that an effective post-earthquake damage survey assessment system was essential if Tehran was to have any chance of mitigating the effects of the next big earthquake to hit Tehran.

One thing that the literature is full of, is how structural damage from earthquakes can be dramatically reduced by effective design and good quality construction. To help understand how that process works in Iran, the author arranged to interview several structural engineers. However, the author also had the opportunity to observe one reinforced concrete structure being constructed, which was typical of the typology that this research project is focussed on. I was allowed to take several photographs, showing many stages of the construction process and in this section will show how that kind of data can be used as part of an education and engagement system to help improve a post-earthquake damage survey assessment system.

Foundations

The foundations of a building are most important to maintain its stability. They are rarely seen after they are constructed, but they serve a crucial role in transferring loads from the building into the ground. In that respect, it is important that the foundations distribute the loads of the building to the soil in a way that ensures the capacity of the ground to carry the load is not exceeded. To achieve their purpose, foundation of a building is constructed in direct contact with the ground and the ground conditions must be assessed by a qualified geotechnical engineer to ensure that it is capable to carry the structure loads. As this thesis is concerned with earthquakes, it is useful to understand that the loads imposed on foundations resulting from an earthquake are derived from horizontal and vertical forces. Those derive from pressure waves (p-waves) and shear waves (s-waves). Either of these forces can cause a building to fail, either by breaking the foundation or by reducing the capacity of the ground to carry the structure. Previous research has revealed 5 ways that engineers can make the building earthquake resistant (Tomlinson, 2001):

1. Split the foundations and structure, allowing different parts of the building to move without damaging each other.
2. Design flexibility into the structure by using earthquake resistant materials such as steel, wood and even bamboo. These materials are highly ductile and can absorb a lot of the tension and deformation generated by an earthquake.
3. Install vibration a control device on the building, such as a tune mass damper.
4. Prevent vibrations in the foundations extending up into the building structure by installing elastomeric bearings at the foundation/structure interface.
5. Strengthen the building structure, with shear walls, diaphragms and a moment resisting frame.

It is very important to choose right type of foundation for a building and that choice is determined by the type of ground, the building size and shape and the building usage (Tomlinson, 2001). Building foundations generally fall into two types:

1. Shallow foundation
2. Deep foundation

Shallow foundation is the most common type of foundation, usually used for small and medium sized buildings and where the ground conditions are good (Tomlinson, 2001). There are 3 type of shallow foundation which are as follows:

1. Pad foundation - a rectangular or square base that supporting a single point load, such as a column.
2. Strip foundation - a trench under the structure generally filled with concrete (reinforced or unreinforced with steel bars) and onto which load bearing elements of the building are constructed.
3. Raft foundation - a reinforced concrete slab covering the whole area under a structure, on top of which the structure is built.

The deep foundations are generally used for taller buildings or on sites where the ground conditions are poor (Tomlinson, 2001). There are 2 type of deep foundation which are as follows:

1. Piled foundation – where a pre-made pile is driven into the ground until the pile can resist a certain load.
2. Caissons or drilled shaft foundation - where a hole is drilled into the ground and then filled with a non-compressible fill (normally concrete or stone).

Images 01 and 02 below show an excavation for the foundations of a new building in Tehran. The images show that the ground is dry and very compact. The fact that the sides of the excavation are vertical and do not need any support, suggests that the soil is very compact and acts like a soft rock. For that reason, the building is designed with shallow foundations. The foundations themselves are formed of strips of steel reinforced concrete and the images show the steel bars that will be cast into the concrete. This type of foundation is very common in earthquake areas and will help to ensure that the building remains stable if an earthquake event happens.

Image O1:

Foundation reinforcement 1

Source: Nirvan Razaghi-Kashani

Date: 01/12/2017

Location: Tehran

It can be seen from this image that the digging by JCB has been done and the foundation bar has been laid out and they are waiting for the concrete to deliver on site.

Image O2:

Foundation reinforcement 2

Source: Nirvan Razaghi-Kashani

Date: 01/12/2017

Location: Tehran

It can be seen from this image that the builders are busy tying the foundation bar and as it can be seen that there no health and safety regulation in this site. Builders do not wear safety hat or boots and no hi viz vests

Figure 5.11 Images of building foundations in Tehran.

To form the foundations, the steel cages are flooded with a liquid concrete mixture. Image 03 and 04 show temporary shutters placed around the steel bars to hold the liquid concrete in place before it sets hard.

Image O3:

Column reinforcement 1

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that the alum steel and foundation steel to be tied properly to avoid joint cracks

Image O4:

Column reinforcement 2

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that the reinforcement bar shall be as per bending schedule according to drawing

Figure 5.12 Images of shuttering to building foundations in Tehran, (source: Nirvan Razaghi-Kashani).

Images 15 and 16 (refer to Figure 5.13) shows the concrete in the foundation after it has set and the shutters removed prior to backfill being added to bury the foundation.

Image 15:

Concrete in foundations 1

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that the column bar are ready to be linked and put the frame around it and pour the concrete

Image 16:

Concrete in foundations 2

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that the column bar are ready to be linked and put the frame around it and pour the concrete.

Figure 5.13 Images of finished concrete building foundations in Tehran, (source: Nirvan Razaghi-Kashani).

Structural Framework

The structural framework of a building includes all the elements that are essential to withstand imposed loads and to transfer loads from the structure into the foundations. An important role of the framework elements is to connect all the sections of the building together. In multistore buildings the structural framework is often made up of the foundation, columns, beams, and floor slabs. The structural framework can be made from a range of different materials, but for this research the building typology that is the focus for the post-earthquake damage survey assessment analysis has a structural framework made up of reinforced concrete. In simple terms, there are two type of reinforced concrete construction methods (McKenzie, 2004):

1. Precast – elements of the structural framework are made off site and then brought to the building location and connected.
2. In situ − elements of the structural framework are fabricated on site.

Images 05 and 06 below shows preparations for an in situ reinforced concrete floor slab. Floors like those in the images, for the upper storeys of a building are often referred to as “suspended slabs” and must be supported from underneath until they are strong enough to carry their own dead load and some live loads.

Image 05:

Suspended slab and beam reinforcement 1

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that suspended slab are above the ground level slabs did put in place. They are used to create floors for the upper storeys of houses.

Image 06:

Suspended slab and beam reinforcement 1

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that suspended slab from different angle.

Figure 5.14 Images of suspended floor slab ready for concrete in Tehran, (source: Nirvan Razaghi-Kashani).

Images 07 and 08 shows the support needed to hold up the suspended floor when the wet concrete to be poured in. The temporary support props are removed after the concrete has set and the floor has gained sufficient strength.

Image 07:

Suspended slab and beam support 1

Source: Nirvan Razaghi-Kashani

Date: Dec 2017

Location: Tehran

It can be seen from this image that how they are getting floor plan ready for the concrete to be poured for the first floor celling

Image 08:

Suspended slab and beam support 2

Source: Nirvan Razaghi-Kashani

Date: Dec 2017|

Location: Tehran

It can be seen from this image that how make floor plan ready for the first second floor celling.

Figure 5.15 Images of support to suspended floor in Tehran, source (Nirvan Razaghi-Kashani).

Images 09 and 10 shows how the reinforced concrete structural framework is constructed as floors to a new building are added. In particular, the images show the columns and beams that are used to collect the loads and transfer them down the building and into the foundations.

Image 09:

Multiple floor construction 1

Source: Nirvan Razaghi-Kashani

Date: Jan 2018

Location: Tehran

It can be seen from this picture that when the ground floor and first floor is ready and getting ready to get the second floor celling concrete to pour in.

Image 10:

Multiple floor construction 2

Source: Nirvan Razaghi-Kashani

Date: Jan 2018

Location: Tehran

It can be seen from this picture that when the ground floor and first floor is ready and getting ready to get the third floor celling concrete to pour in.

Figure 5.16 Images of columns and beams in the structural framework on a building in Tehran, (source: Nirvan Razaghi-Kashani).

Image 11 and 12 shows how the suspended slabs in the reinforced concrete structural framework the beams and columns together. The image also shows wet concrete is pumped to the higher levels of the building.

Image 11:

Multiple floor construction 3

Source: Nirvan Razaghi-Kashani

Date: Feb 2018

Location: Tehran

It can be seen from this image that the superstructure is almost done.it can be seen that the crane is pumping the concrete for the next floor.

Image 12:

Multiple floor construction 4

Source: Nirvan Razaghi-Kashani

Date: Feb 2018

Location: Tehran

It can be seen from this image that the superstructure from different angle.

Figure 5.17 Images of a complete reinforced concrete structural framework on a building in Tehran, (source: Nirvan Razaghi-Kashani).

Non-structural elements

Non-structural elements of a building are all parts that are included in the building but are not essential for the integrity of the structural framework. These may include partition walls, external cladding, windows and all the furniture and equipment needed to make the building functional Sullivan (2020). It is not always clear which elements in a building are part of the structural framework and with parts are non-structural that is a task that needs careful assessment by a qualified structural engineer. In terms of post-earthquake damage survey assessment, it is important to inspect and record damage to non-structural elements, as they could fall off the building and cause injury or death, or they could make the building non-functional.

Images 13 and 14 shows non-structural brick infill wall panels. The brick panels are constructed between structural framework reinforced concrete columns and are also constructed to divide spaces within the building, creating different rooms for the occupants of the building.

Image 13:

Infil panel construction 1

Source: Nirvan Razaghi-Kashani

Date: Jan 2018

Location: Tehran

It can be seen from this picture the infill panel construction. The infill panel are used as internal separating wall.

Image 14:

Infil panel construction 2

Source: Nirvan Razaghi-Kashani

Date: Jan 2018

Location: Tehran

It can be seen from this picture the infill panel construction. The infill panel are non-load-bearing panel and they are used as internal separating wall.

Figure 5.18 Images of a non-structural brick panels in a building in Tehran, (source: Nirvan Razaghi-Kashani).

The poor construction methods, information, and inadequate application of building codes are responsible for 80% of casualties and death after the earthquake in Iran. As shown in the photos above, poor information about the building, the method of construction, and other factors to include from the figures above include lack of skilled labour, lack of or poor construction machinery; lack of availability of details/information; lack of availability of experienced contractors.

The school building is significantly important so that learning continuity is assured, and children are protected from an earthquake risk. This research study will help Iran to secure learning facilities, develop school disaster management, and improve education for disaster risk reduction.

<u>Quality control</u>

To ensure that any building behaves as it is designed to do when subject to loading, effective quality control is essential. That quality control must be maintaining through the whole lifecycle of a building, from the design of the structure, through its construction and during its operation (Cartlidge, 2015). Quality control during the design stage, is important to ensure that the building is designed correctly. The design must ensure that the correct loads have been calculated and their potential impact on the structure of the building rigorously assessed. A good quality control system for the design of a building will include the production of detailed drawings and calculations. Those records will be essential to help engineers involved in a post-earthquake damage survey assessment of the building.

During the construction of a building many events can happened that may undermine the integrity of a building, so high levels of quality control are essential. It may be possible that a building is well designed to accommodate loads imposed by an earthquake, but if the building is not constructed exactly in accordance with the design specification, then the structure may not be as strong as it needs to be (Cartlidge, 2015). Accurate records of all aspects of the construction process need to be kept to evidence that the building has been constructed in accordance with the design specification. Failure to keep accurate and detailed records will make the process of post-earthquake damage survey assessment much more difficult and time consuming.

To prevent deterioration of the structure during its occupation and use, a good quality control system should be implemented. Regular inspection, maintenance, and repair of the building structure during its use will ensure that the building structure does not deteriorate and that it will continue to function as it is designed to do (Cartlidge, 2015). Here again, a good quality control system will generate a set of records detailing all the inspections, maintenance and repairs undertaken. If kept and made accessible to engineers, those records will make the process of post-earthquake damage survey assessment much easier.

In relation to the post-earthquake assessment, the observational data adds valuable insight about current construction practices in Iran and helps to highlight why and how the system needs improving. Specifically, the images collected for this thesis research illustrate how the collection of quality control data during the construction process can be an asset in the post-earthquake structural assessment process. Armed with such images, an engineer could make faster and more effective judgement about the level of potential damage caused by an earthquake event. However, this research suggests that the current system in Iran does not have effective means to collect such data about the quality of a building's construction. The observational data was clear about how well supervised operations on the site were, who inspected the steel before the concrete was poured and who tested the concrete to make sure it was of the correct quality, etc. That data would be of great assistance to a post-earthquake structural assessor. Finally, one good way to tell if a site has a good quality control system is by the signage on the entrance to the site. Signage on a construction project normally identifies what type of building it is, the name and contact details of the company that designed the building, the name and contact details of the company that is building the structure and possibly also the client's details. Signage provides traceability to persons responsible for the design and construction of the building, which are important people to trace in the event that the building is damaged by an earthquake. This data should be available in the Iranian EIMS, which engineers can access and edit when conducting post-earthquake structural assessments.

Analysis of a form used in Iran for post-earthquake damage survey assessment

In this research the author set out with a goal to find out ways of improving the Iranian post-earthquake damage survey assessment system. And an important part of that system is the damage survey form used by assessors when inspecting buildings. The author acknowledges that the behaviour of structures in an earthquake is directly related its design and material used for its construction (masonry, concrete, steel, timber etc.). As such, an effective EIMS will need several different forms for different type of structures. In this research, the author has limited himself to only considering forms relevant to the assessment of reinforced concrete framed structures. In that respect and after studying forms from several different countries, the author determined that, for the initial assessment, post-earthquake damage survey assessment forms should be:

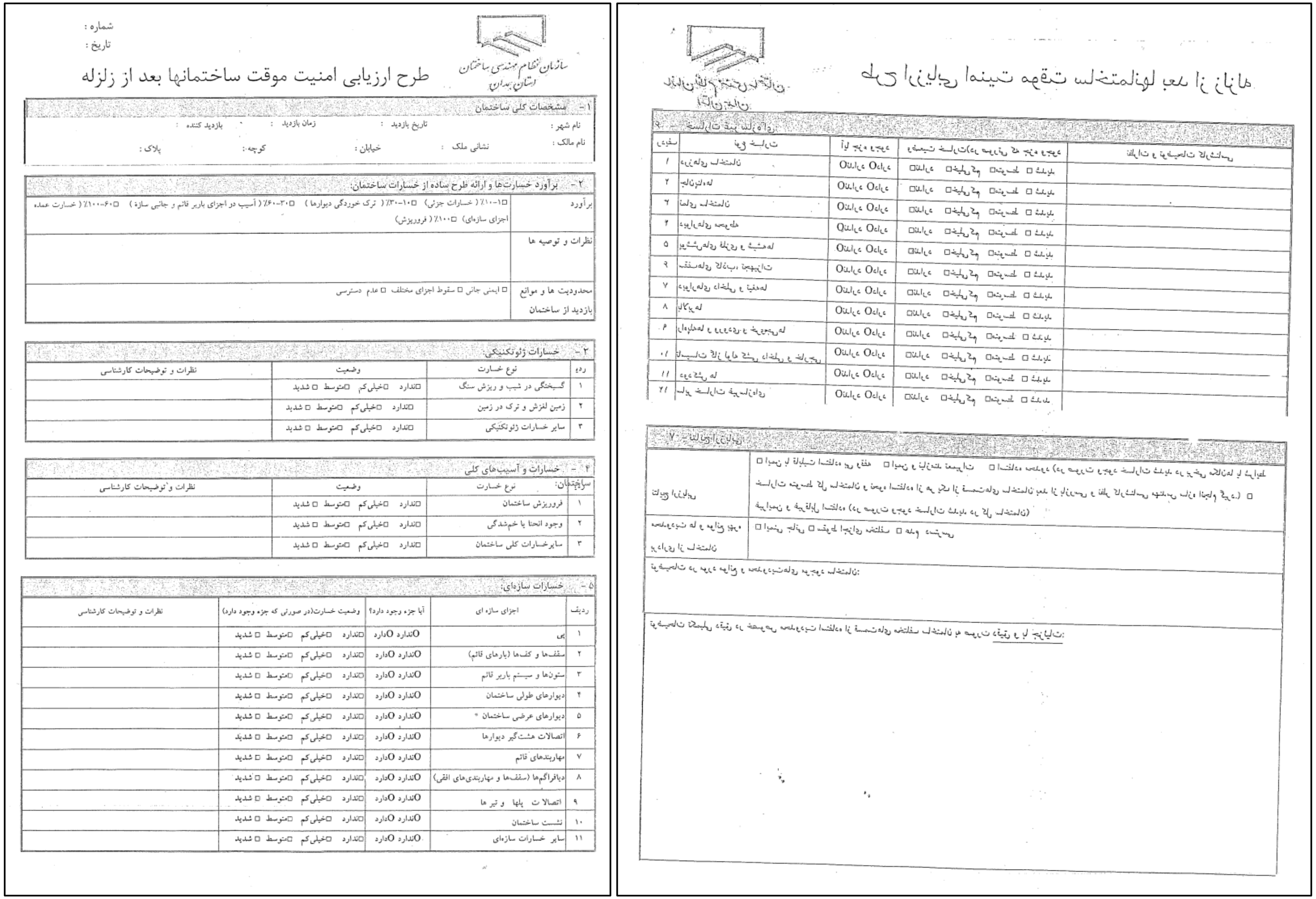
1. **Quick to complete** - A maximum two pages.
2. **Easy to complete** - All the questions should be clear and concise and avoid ambiguity and avoid subjective judgements as much as possible (stick to reporting information).
3. **As well as structural information, include ownership and occupancy data** - The assessment should contain the information of the owner so they can benefit from the government incentive and the government knows who gets what.
4. **Be applied consistently** - To ensure uniformity of data collection and ease of data transfer and analysis.

5. **Be linked to an online database** – Ideally the data uploaded onto a database via an internet-connected mobile device, in real-time as the surveyor enters it.

During his data collection visit to Iran, the author learned that Iran has no single definitive post-earthquake damage survey assessment form, the author was able to acquire details of one such form (see Figure 5.19 and the English translation in Figure 5.20). The survey form is used to collect information about earthquake damaged building as well as record judgements about the level of the damage. The form is mainly used to help Iranian authorities estimate the financial impact of an earthquake event.

The Iranian form allows for the collection of the following data:

1. The date and time of inspection and the name of inspector.
2. Information about the structure and its location.
3. An assessment of damage visible on the outside of the building.
4. An assessment of the building foundations.
5. Details of damage to structural elements.
6. Details of damage to non-structural elements.
7. A judgement on the level of overall damage to the building.



شماره :
تاریخ :

سازمان نظام مهندسی ساختمان استان همدان

طرح ارزیابی امنیت موقت ساختمانها بعد از زلزله

۱ – مشخصات کلی ساختمان

نام شهر : تاریخ بازدید : زمان بازدید : بازدید کننده :
نام مالک : نشانی ملک : خیابان : کوچه: پلاک :

۲ – برآورد خسارت‌ها و ارائه طرح ساده از خسارات ساختمان:

برآورد	□۱-۱۰٪ (خسارات جزئی) □۱۰-۳۰٪ (ترک خوردگی دیوارها) □۳۰-۶۰٪ (آسیب در اجزای باربر قائم و جانبی سازة) □۶۰-۱۰۰٪ (خسارت عمده اجزای سازه‌ای) □۱۰۰٪ (فروریزش)
نظرات و توصیه ها	
محدودیت ها و موانع بازدید از ساختمان	□ ایمنی جانی □ سقوط اجزای مختلف □ عدم دسترسی

۳ – خسارات ژئوتکنیکی:

ردیف	نوع خسارت	وضعیت	نظرات و توضیحات کارشناسی
۱	گسیختگی در شیب و ریزش سنگ	□ندارد □خیلی‌کم □متوسط □ شدید	
۲	زمین لغزش و ترک در زمین	□ندارد □خیلی‌کم □متوسط □ شدید	
۳	سایر خسارات ژئوتکنیکی	□ندارد □خیلی‌کم □متوسط □ شدید	

۴ – خسارات و آسیب‌های کلی ساختمان:

ردیف	نوع خسارت	وضعیت	نظرات و توضیحات کارشناسی
۱	فروریزش ساختمان	□ندارد □خیلی‌کم □متوسط □ شدید	
۲	وجود انحنا یا خم‌شدگی	□ندارد □خیلی‌کم □متوسط □ شدید	
۳	سایرخسارات کلی ساختمان	□ندارد □خیلی‌کم □متوسط □ شدید	

۵ – خسارات سازه‌ای:

ردیف	اجزای سازه ای	آیا جزء وجود دارد؟	وضعیت خسارت(در صورتی که جزء وجود دارد)	نظرات و توضیحات کارشناسی
۱	پی	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۲	سقف‌ها و کف‌ها (بارهای قائم)	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۳	ستون‌ها و سیستم باربر قائم	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۴	دیوارهای طولی ساختمان	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۵	دیوارهای عرضی ساختمان *	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۶	اتصالات هشت‌گیر دیوارها	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۷	مهاربندهای قائم	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۸	دیافراگم‌ها (سقف‌ها و مهاربندی‌های افقی)	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۹	اتصالات پلها و تیر ها	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۱۰	نشست ساختمان	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	
۱۱	سایر خسارات سازه‌ای	Oندارد Oدارد	□ندارد □خیلی‌کم □متوسط □ شدید	

Figure 5.19 Example of a post-earthquake damage survey assessment form used in Iran.

1.Information About The Building				
Name of the City:	Date of Inspection:	Time of Inspection:	Name of Inspector:	
Name of the Owner:	Address of the Owner:	Street:	Alley:	House Number:

2. Simple damage assessment to the building	
Estimation:	1. (Small Damage) 1-10%. 2. (Cracks on the walls) 10-30% .3. (Damage to the Loadbearing walls) 30-60% .4. (Major damage to the Structural Elements) 60-100%.5. (Falling) 100%
Comments and Recommendations	
Limitation and Obstacles in Assessing the building	1. Life Safety. 2. Falling objects. 3. Lack of access

3. Geotechnical Damage		
Type of Damage	Damage Condition	Comments and Recommendations of Expert
Rupture on the Slope and stone falling	No Damage, slightly damaged, Moderately damaged, highly damaged	
Landslide and Cracks on the Ground	No Damage, slightly damaged, Moderately damaged, highly damaged	
Other geotechnical damages	No Damage, slightly damaged, Moderately damaged, highly damaged	

4. Overall Damage		
Type of Damage	Damage Condition	Comments and Recommendations of Expert
The Collapse of the Building	No Damage, slightly damaged, Moderately damaged, highly damaged	
Presence of Curvature and Bending	No Damage, slightly damaged, Moderately damaged, highly damaged	
Other Building damages	No Damage, slightly damaged, Moderately damaged, highly damaged	

5. Structural Damage				
No	Structural Component	Is There Any Damage?	Damage Condition(if there is any damage)	Comments and Recommendations of Expert
1	Foundation	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
2	Ceiling and Floor (Vertical Loads)	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
3	Columns and Vertical Barrier System	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
4	The Vertical Walls of the Building	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
5	The Horizontal walls of the Building	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
6	Wall ....Connections	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
7	Vertical Bracing Bracket	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
8	Diaphragms(Ceilings and Horizontal Bracing)	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
9	Steps Connection and Beams	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
10	Settlement of the Building	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
11	Other damages to the Structure	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	

6. Non-Structural Damage				
No	Damage Type	Is There Any Damage?	Damage Condition(if there is any damage)	Comments and Recommendations of Expert
1	Building Cracks	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
2	Shelters	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
3	Building Facades	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
4	Enclosure Walls	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
5	Metal Coatings and Glasses	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
6	..... Celling and Equipment	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
7	Internal Walls and	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
8	Lifts	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
9	Internal and External Staircases	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
10	Internal and External Gas Pipe Installations	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
11	Chimneys	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	
12	Other Non-Structural damages	YES, NO	No Damage, slightly damaged, Moderately damaged, highly damaged	

7.Assessment Results	
Results of Assessment	Safe and Usable Building, Safe but Repair required, Limited use of building, unsafe building not to be used due to safety
Limitations and obstacles of using the Building	Life Safety, Falling of Various Components, Building Inaccessibility
Explanation of Existing Limitation and Obstacles in Building	
Precise Completing explanation with regards to limitation of building usage in a comprehensive manner :	

Figure 5.20 Translation of the post-earthquake damage survey assessment form used in Iran.

Based on the literature reviewed for this thesis, the author was able to synthesise a set of data that an initial assessment form should include. When comparing the author's data set against the Iranian form, the two correlated very well. That is a positive finding from this research but is just the first stage in the assessment process. To enhance the Iranian EIMS system, data from the initial assessment needs to be fed into the EIMS and used to help guide structural engineering resources to areas where they are most needed and where they will have maximum effect in speeding up the recovery process and in preventing any further disaster (structural, social, and environmental). To enhance the current Iranian post-earthquake damage survey assessment system, the author suggests that the form above could be improved as follows:

- Include photographs to show details of the type of damage suffered by the structure (to help engineers understand the nature of the problem they must analyse)
- As well as the address, include GPS coordinates of the structure (to help re-locate the structure)
- Provide information about the building geometry, shape, and height (to help quantify scale of further analysis needed)
- Include information about the building occupancy, usage, purpose, and loss of life (to help quantify the social impact of damage to the structure)
- Identify the main structural design system (to help identify the expertise needed for the detailed assessment)
- Identify which floor has the most damage (the focus for further detailed analysis)
- Describe potential negative effects of any further collapse of the building (structural, social, and environmental risks)
- Include an estimate of the age of the structure (to help reveal standards used for the design)

To summarise lessons learned from this section, without good quality supervision and management essential records for effective post-earthquake damage survey assessment will not be collected. In that regard, the effectiveness of the enhanced post-earthquake damage survey assessment form would be limited. The link between quality management during construction and the effectiveness of post-earthquake damage survey assessment would be limited. The link between quality management during construction and effectiveness of post-earthquake damage survey assessment is not something that the author encountered in the literature and was not a topic at the forefront of this research project. However, the lack of effective construction management in Iran, with the specific aim to aid post-earthquake damage survey assessment has been revealed by this research as an important area in need of improvement.

The importance of comprehensive and detailed design and construction management records for the post-earthquake damage survey assessment system is well illustrated by the scenario at the start of this chapter. If the records existed and were accessible to the team of structural engineers who went to Kermanshah, then they would have been able to understand much more clearly how to analyse the buildings they were looking at. With good design records they would have known exactly which elements of the structure needed the closest examination on site. With good construction management records, they could quickly assess high risk issues, like construction compliance with design specifications. Both these important features of an effective post-earthquake damage survey assessment system were missing from the data gathered and when I accompanied the assessment team to Kermanshah.

5.4 Quantitative survey data analysis of strengths and weaknesses in the Iranian post-earthquake damage survey assessment system within the Iranian disaster management system

Question 11a of the survey asked respondents if the Iranian Earthquake Information Management System (EIMS) includes a process to manage post-earthquake damage survey assessment programme. Of the 168 definitive responses, 133 (76%) answered NO and 40 (29%) answered YES. Figure 5.23 shows that the split in responses, which was quite consistent across all sub-groups, except for the disaster managers. 75% of the disaster managers (3 of 4) in the survey answered YES.

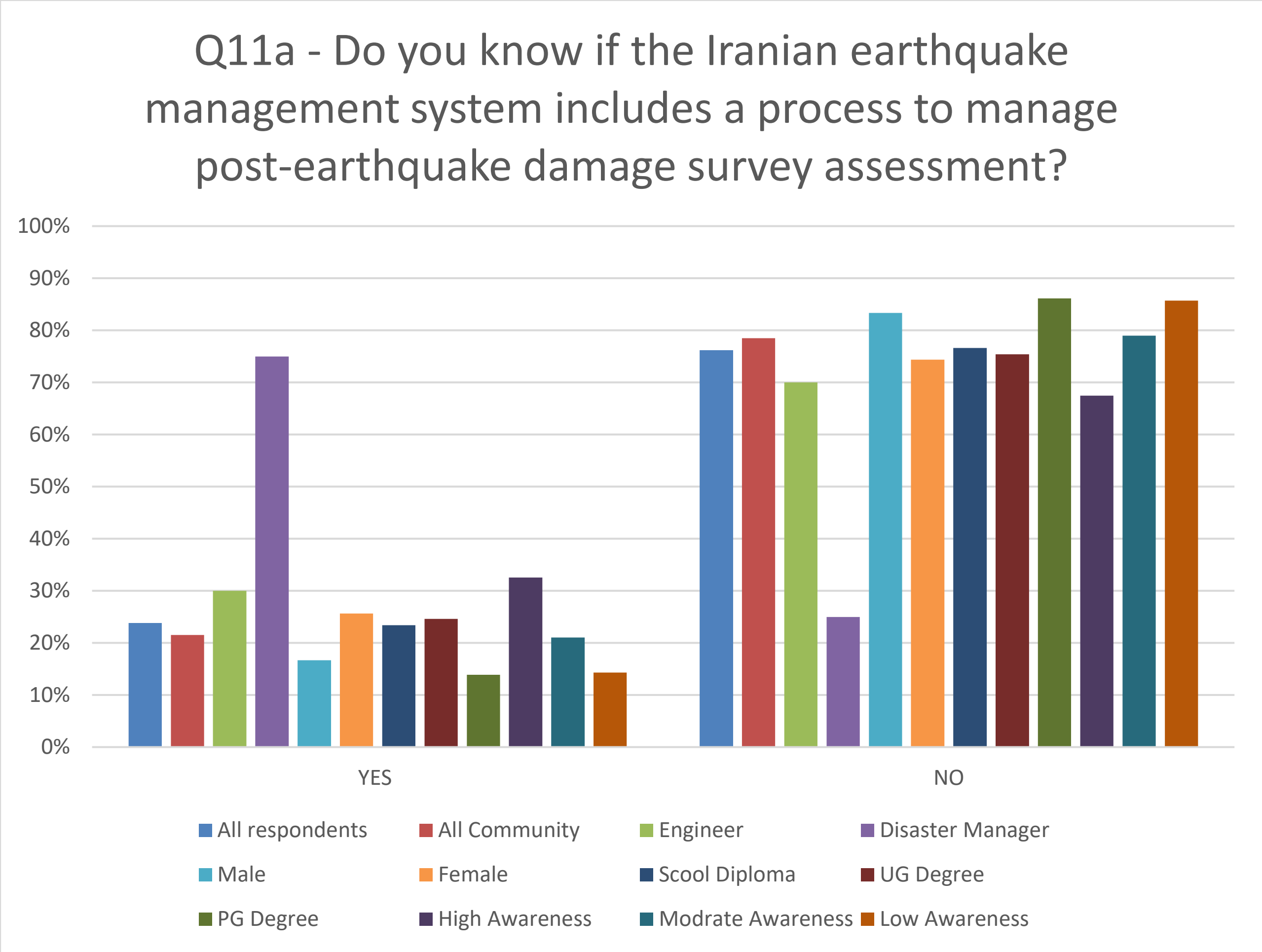


Figure 5.21 Respondents if the Iranian EIMS includes a post-earthquake damage survey assessment programme.

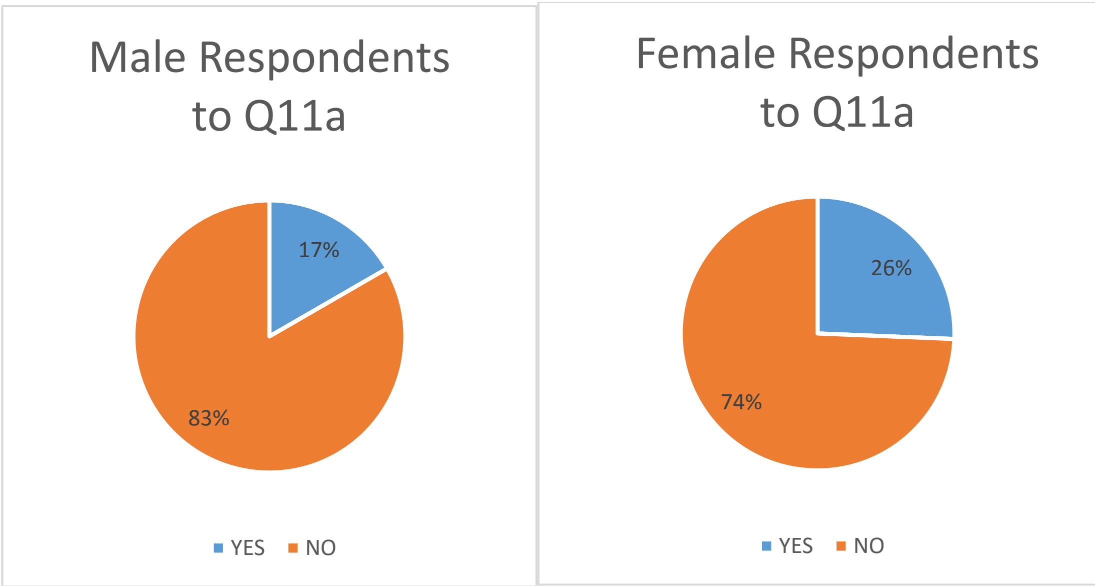


Figure 5.22 Gender of respondents to Q11a

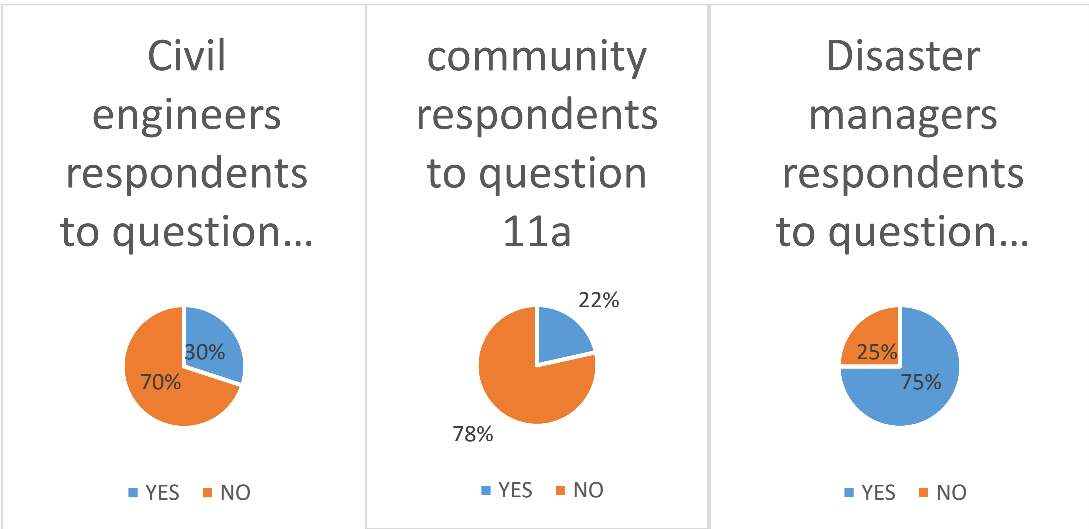


Figure 5.23 Profile of respondents to Q11a

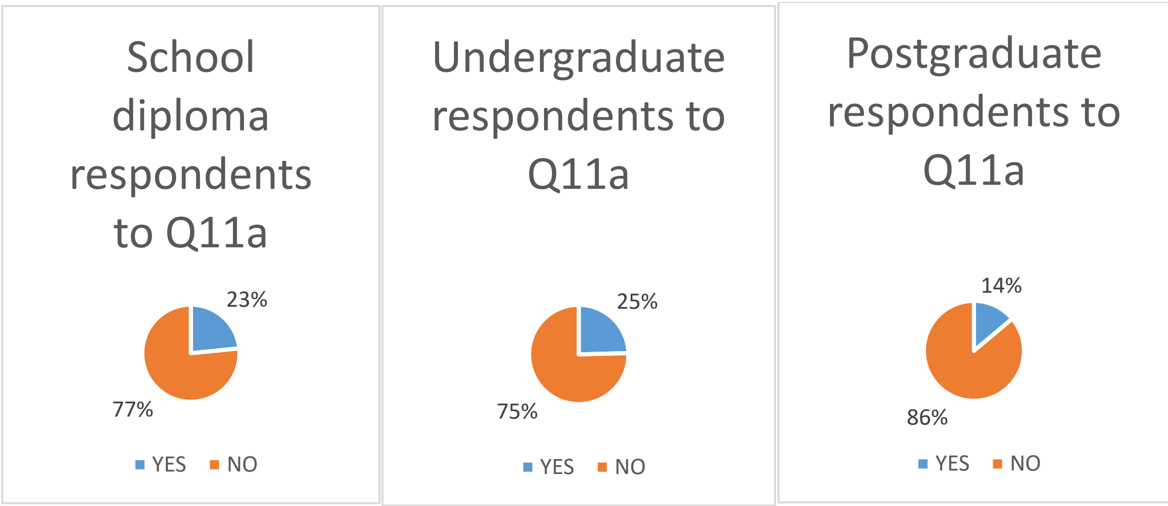


Figure 5.24 Academic qualifications of respondents to Q11a

Importantly to this research, the engineers were also very negative, with 70% responding that they do not know if the Iranian earthquake management system includes a process to manage post-earthquake damage survey assessment. This result shows that efforts to improve the post-earthquake damage survey assessment within the Iranian management system is very necessary and it needs to be done as soon as possible. Male respondents were very negative about the system, with 83% responding that they do not know if the Iranian earthquake management system includes a process to manage post-earthquake damage survey assessment, and Female respondents were very similar to the male respondent, with 72% responding that they do not know if the Iranian earthquake management system includes a process to manage post-earthquake damage survey assessment. Regarding levels of education and awareness the response was very negative, with those having higher education and a high level of awareness were very negative, with 86% respondent with high level of education and 67% of respondent with high level of awareness think that they do not know if the Iranian earthquake management system includes a process to manage post-earthquake damage survey assessment.

The response to Q11a, is a powerful and clear indication that, in Iran, there is significant need to improve post-earthquake damage survey assessment. The fact that the view provided by disaster managers is so different to all the other sub-groups hints to a potential problem. Engineers should be the key custodians and operators of the post-earthquake damage survey assessment system. As such, if the disaster managers consider that post-earthquake damage survey assessment is adequate and 70% of engineers think opposite, then it might be a problem and it needs further investigation. What the survey question did not reveal is whether disaster managers were aware that their views differ by such a margin from other groups in Iranian society. Further analysis below will help to improve that understanding.

The responses to Q11a, were almost uniformly negative, from all sectors of the survey sample. Which may be taken as an indication that there is some basis to the belief that there is no effective post-earthquake damage survey assessment in Iran. This is a very significant and problematic finding by this research, which could potentially undermine some of the other findings and any proposal to improve the post-earthquake damage survey assessment in Iran. From the literature review the author was able to list several important topics that a post-earthquake damage survey assessment system should include. Table 5.2 below includes the list of topics.

Table 5.2 Processes that should be included in a post-earthquake structural assessment system (Source: Nirvan Razaghi-Kashani).

Steps	**Actions**
Step 1	Assess materials used in building construction
Step 2	Record how the buildings are being used
Step 3	Record method used for building construction
Step 5	Used of a standard system to record damage
Step 6	Undertake a quick/rapid visual inspection
Step 7	Undertake a detailed damage assessment
Step 8	Assess the condition of structural elements
Step 9	Evaluate the overall building condition
Step 10	Classify the level of damage to each building
Step 11	Identify damage to non-structural elements
Step 12	Measure the dimensions of damaged building
Step 13	Count the number of floors in building
Step 14	Record any foundation damage in buildings
Step 15	Calculate the residual strength of buildings

Question 11b in the main survey listed the damage survey assessment processes and asked respondents to score each one on a three-point scale. A score of 1 indicated that the process was included after every earthquake event and a score of 3 indicated that the process was never included. For the analysis, the mean score given by each of the three main communities (Residents Engineers and Disaster Managers) was calculated and then the mean of means was used to rank of the processes, giving equal weighting to each of the three groups.

Table 5.3 below shows the results of that analysis. Importantly for this research, the Iranian system was judged to have a good post-earthquake damage survey assessment system as no process received a mean score close to 3. However, what is highly significant for this research is that the process of "Assess the Material used in building construction" and "Record method used for building construction" was the two lowest ranked by almost every group.

The community residents ranked "Assess condition of structural element", "Identify damage to non-structural elements", "evaluate the overall building condition" and "count the number of floors in buildings" as the weakest elements in the Iranian post-earthquake damage survey assessment.

The three disaster mangers who responded to this question ranked "Record method used for building construction", "Assess materials used in building construction" and "Record how the buildings are being used" as the weakest elements in the Iranian post-earthquake damage survey assessment but apart from that they think the system exist and working perfectly.

The engineers ranked "Undertake a quick/rapid visual inspection" and "Count the number of floors in building" as the weakest elements in the Iranian post-earthquake damage survey assessment and they think there is room for improvement in "classify the level of damage to each building", "use the standard system to record damage", "Record any foundation damage in building" and "Record method used for building construction".

Table 5.3 Breakdown of responses to survey question 11b.

			Mena Score		
Rank	Topic	Mean of Means	Residents	Engineers	Disaster Managers
1	Undertake a detailed damage assessment	1.40	1.78	1.43	1.00
2	Measure the dimensions of damaged building	1.41	1.81	1.43	1.00
3	Calculate the residual strength of buildings	1.43	1.86	1.43	1.00
4	Classify the level of damage to each building	1.43	1.73	1.57	1.00
5	Evaluate the overall building condition	1.44	1.89	1.43	1.00
6	Use of a standard system to record damage	1.45	1.79	1.57	1.00
7	Record any foundation damage in buildings	1.48	1.86	1.57	1.00
8	Assess condition of structural elements	1.48	2.00	1.43	1.00
9	Undertake a quick/rapid visual inspection	1.48	1.72	1.71	1.00
10	Identify damage to non-structural elements	1.49	1.91	1.57	1.00
11	Count the number of floors in buildings	1.55	1.94	1.71	1.00
12	Record how the buildings are being used	1.58	1.78	1.29	1.67
13	Assess materials used in building construction	1.64	1.84	1.43	1.67
14	Record method used for building construction	1.70	1.85	1.57	1.67

Data from the survey enabled the views of disaster managers to be compared with residents and engineers. Looking closely at the results for the engineers, I noted that the response was heavily weighted in favour of the views of the male engineers, with 6 of the 7 responses to Q11b coming from male respondents. From a gender perspective, a female view in relation to Q11b was derived from the resident responses. Broadly speaking the engineers agreed with the overall ranking of the topic areas. Where the community resident and engineers disagreed was in relation to the topics of "Assess condition of structural elements" and "Undertake a quick/rapid visual inspection". In these two areas the engineers and the community resident have some disagreement and further research needs to be done to analysis these issues in more detail.

Table 5.4 Breakdown of resident responses to survey question 12a "do you believe that having an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information management systems (EIMS) is achievable?".

	YES	NO	Do not know	Total Number (N)
Male	19 (31%)	7 (11%)	35 (57%)	61 (100%)
Female	30 (42%)	5 (7%)	37 (51%)	72 (100%)
Sub-total	**49**	**12**	**72**	**133**
School Diploma	15 (35%)	0 (0%)	28 (65%)	43 (100%)
UG Degree	20 (36%)	7 (13%)	29 (59%)	56 (100%)
PG Degree	14 (41%)	5 (15%)	15 (44%)	34 (100%)
Sub-total	**49**	**12**	**72**	**133**
High Awareness	16 (41%)	5 (13%)	18 (46%)	39 (100%)
Moderate Awareness	14 (40%)	2 (6%)	19 (54%)	35 (100%)
Low Awareness	19 (32%)	5 (8%)	35 (59%)	59 (100%)
Sub-total	**49**	**12**	**72**	**133**

Table 5.4 also shows that having an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information Management System (EIMS) is achievable are broadly the same most woman did say that it is achievable. The majority of both groups replied, "Do not know". Both groups were also slightly pessimistic, with more saying "Do not know".

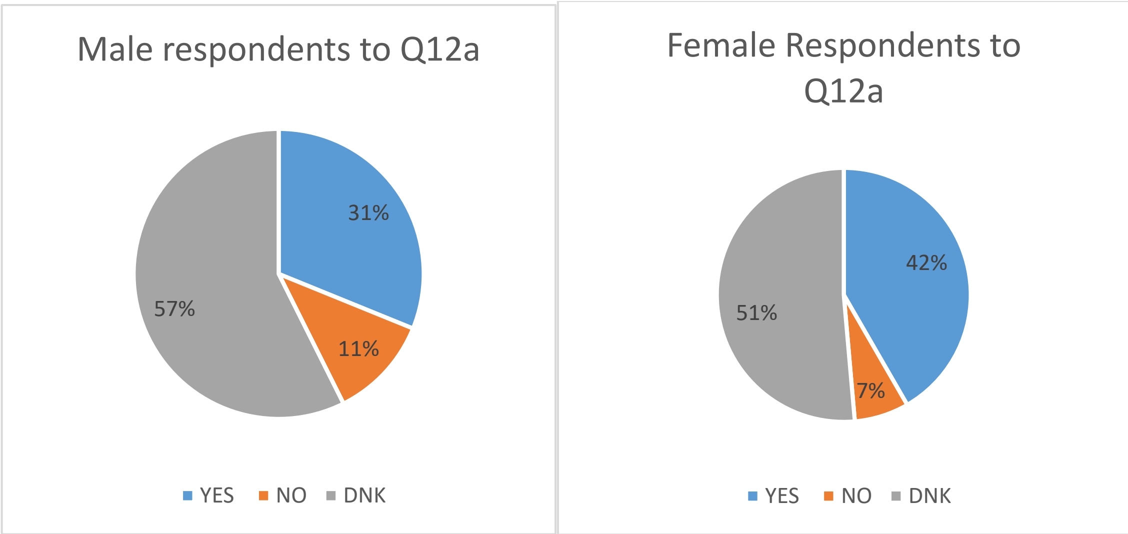


Figure 5.25 Gender of respondents to Q12a.

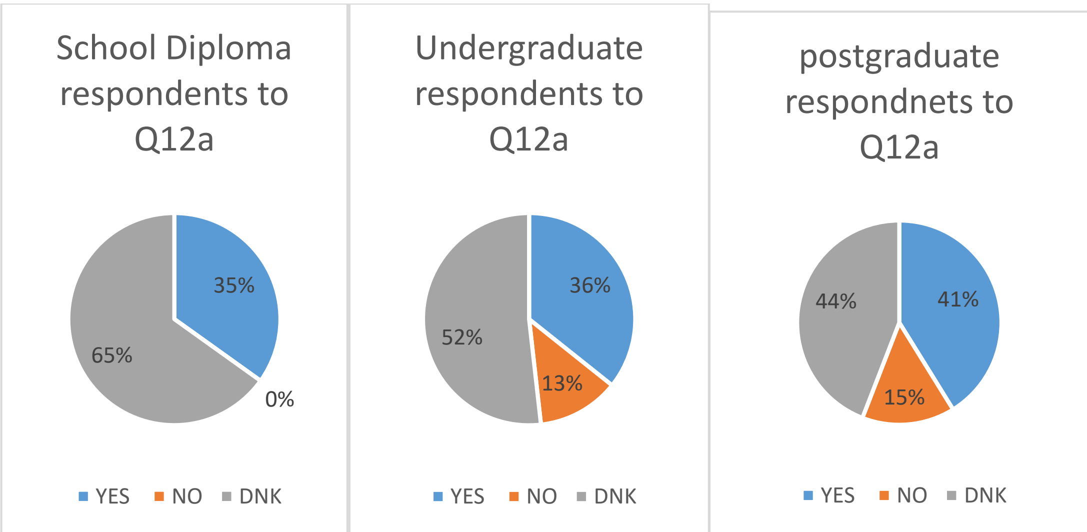


Figure 5.26 Academic qualifications of respondents to Q12a.

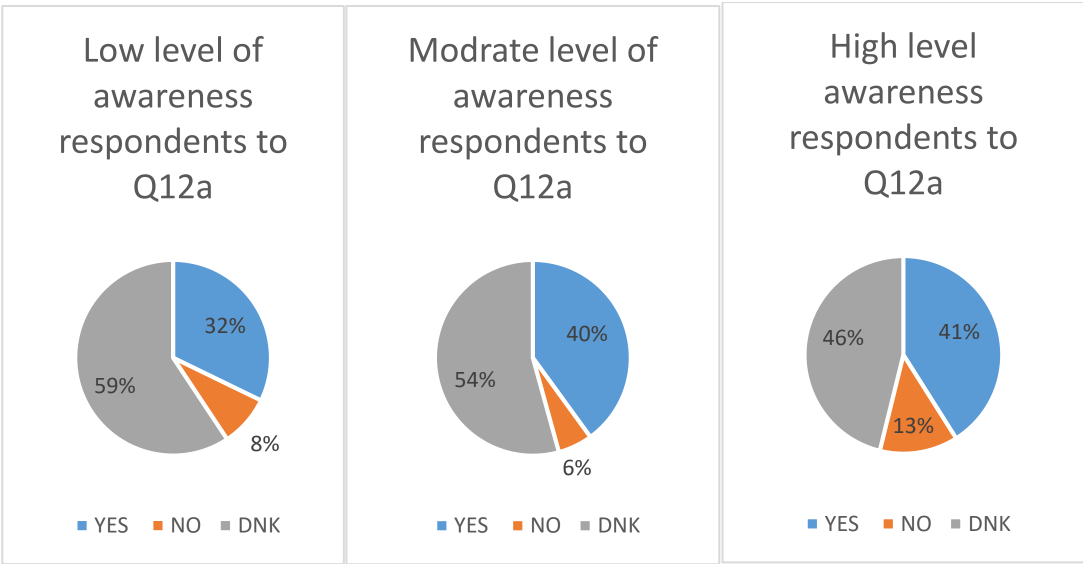


Figure 5.27 Level of awareness to respondents to Q12a.

That pattern of respondents from different levels of education shows that the majority of them do not know if this system is achievable in Iran and again those with low or moderate and high awareness do not know that this system is achievable in Iran.

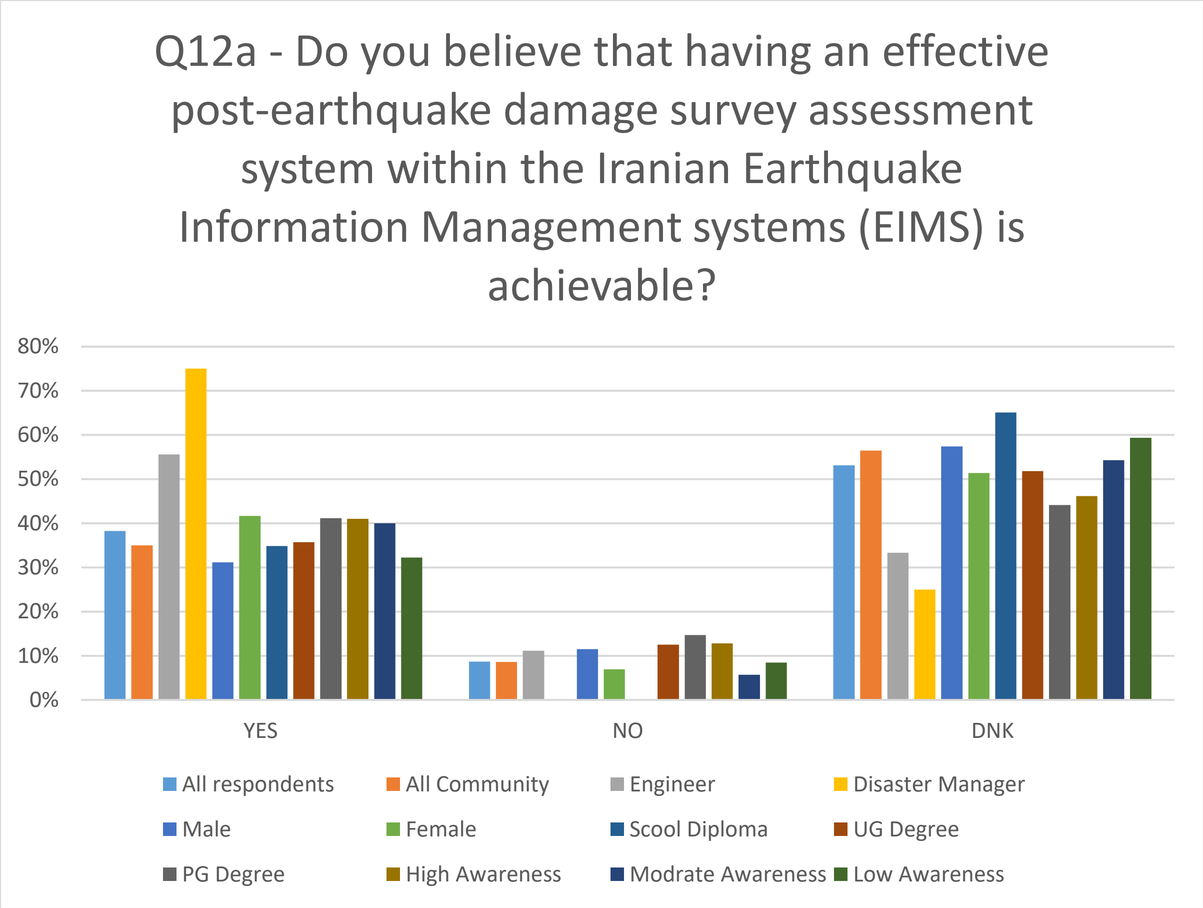


Figure 5.28 Summary of respondents to Q12a (if they believed that an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information Management System EIMS is achievable).

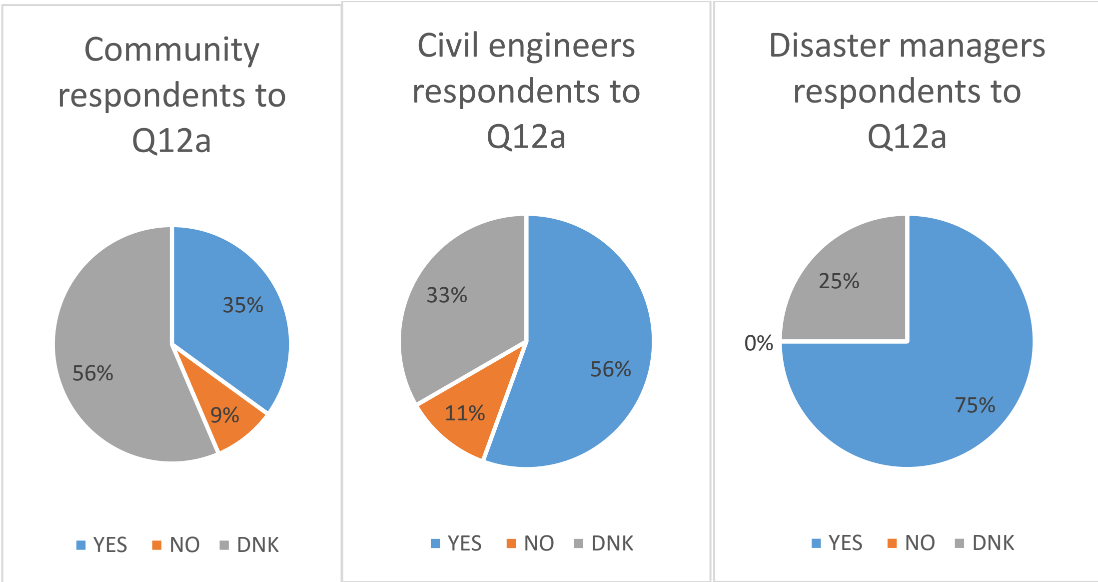


Figure 5.29 Profile of respondents to Q12a.

Importantly to this research, the engineers were also very positive, with 56% responding that an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information management system is achievable in Iran. This result shows that efforts to improve the post-earthquake damage survey assessment within EIMS may receive a positive response from the engineering community. Male respondents were divided between YES and DOT KNOW, and Female respondents were much more divided between YES and DOT KNOW. Regarding to levels of education and awareness the response was mixed, with those having higher education and a high level of awareness were divided between YES and DOT KNOW.

Table 5.5 Breakdown of resident responses to survey question 14a “do you think that the strength and weaknesses of a post-earthquake damage survey assessment system within the Iranian Earthquake Information Management systems (EIMS) analysed?”

	Every year	Once every five years	Never	Total Number (N)
Male	10 (25%)	5 (13%)	25 (63%)	40 (100%)
Female	19 (39%)	9 (18%)	21 (43%)	49 (100%)
Sub-total	**29**	**14**	**46**	**89**
School Diploma	7 (25%)	7 (25%)	14 (50%)	28 (100%)
UG Degree	13 (33%)	3 (8%)	24 (60%)	40 (100%)
PG Degree	9 (43%)	4 (19%)	8 (38%)	21 (100%)
Sub-total	**29**	**14**	**46**	**89**
High Awareness	8 (26%)	6 (19%)	17 (55%)	31 (100%)
Moderate Awareness	6 (27%)	4 (18%)	12 (55%)	22 (100%)
Low Awareness	15 (42%)	4 (11%)	17 (47%)	36 (100%)
Sub-total	**29**	**14**	**46**	**89**

Table 5.5 also shows how often they think that strength and weaknesses of a post-earthquake damage survey assessment system within the Iranian Earthquake Information Management System (EIMS) analysed, that the strength and weaknesses are NEVER being analysis within the EIMS.

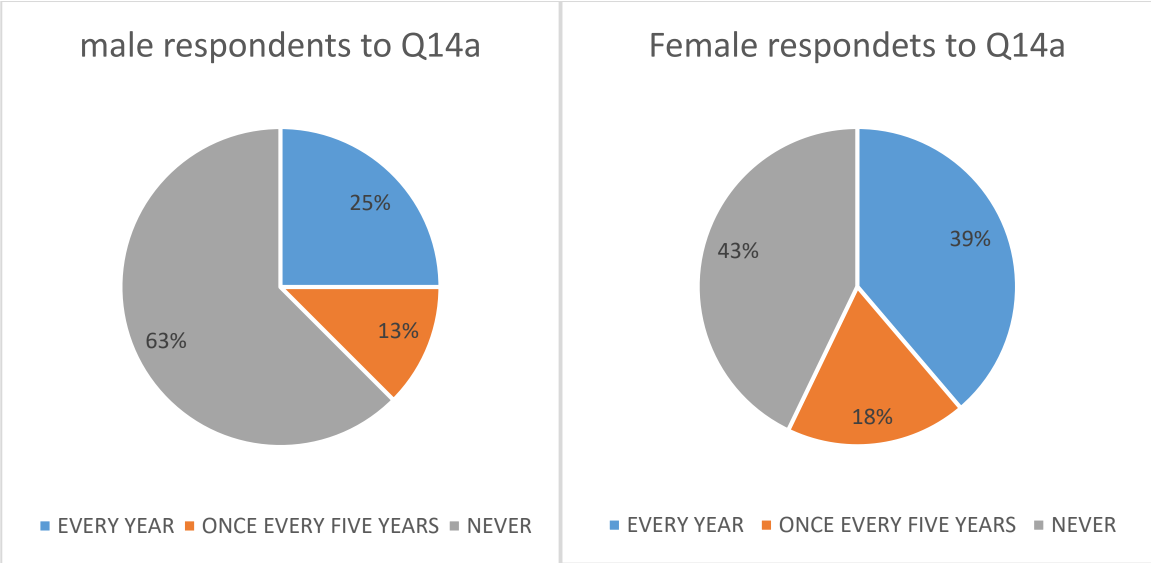


Figure 5.30 Gender of respondents to Q14a.

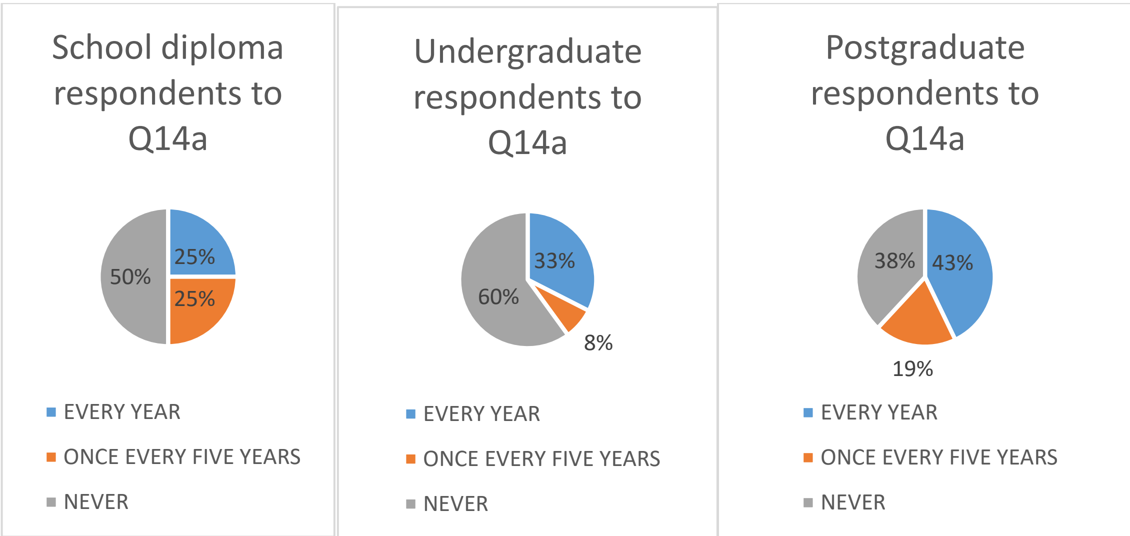


Figure 5.31 Academic qualifications of respondents to Q14a.

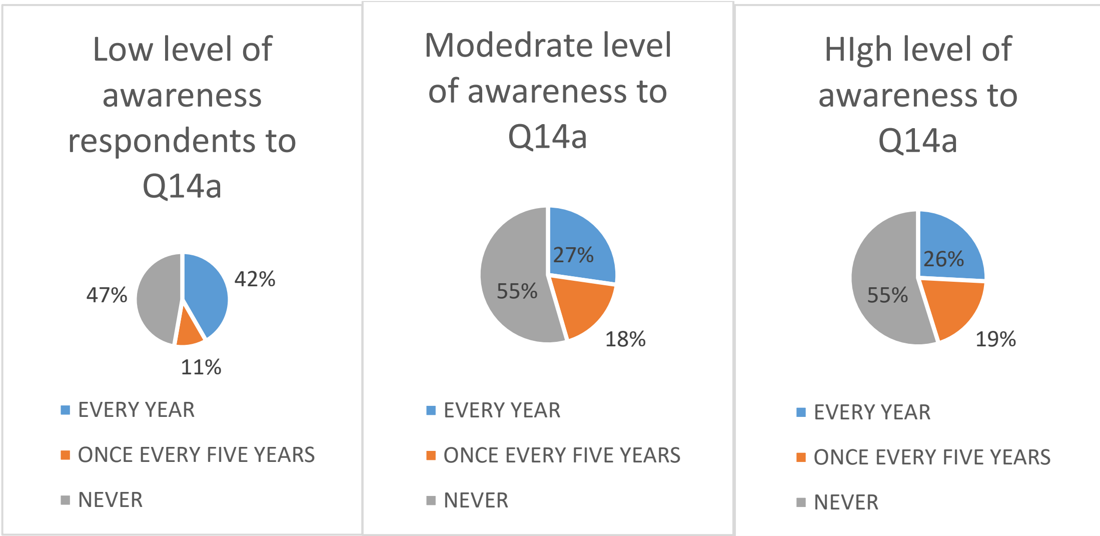


Figure 5.32 Level of awareness of respondents to Q14a.

That pattern of respondents from different levels of education and awareness, shows that the majority of them think that the strength and weaknesses of damage survey assessment within the EIMS has never been analysed.

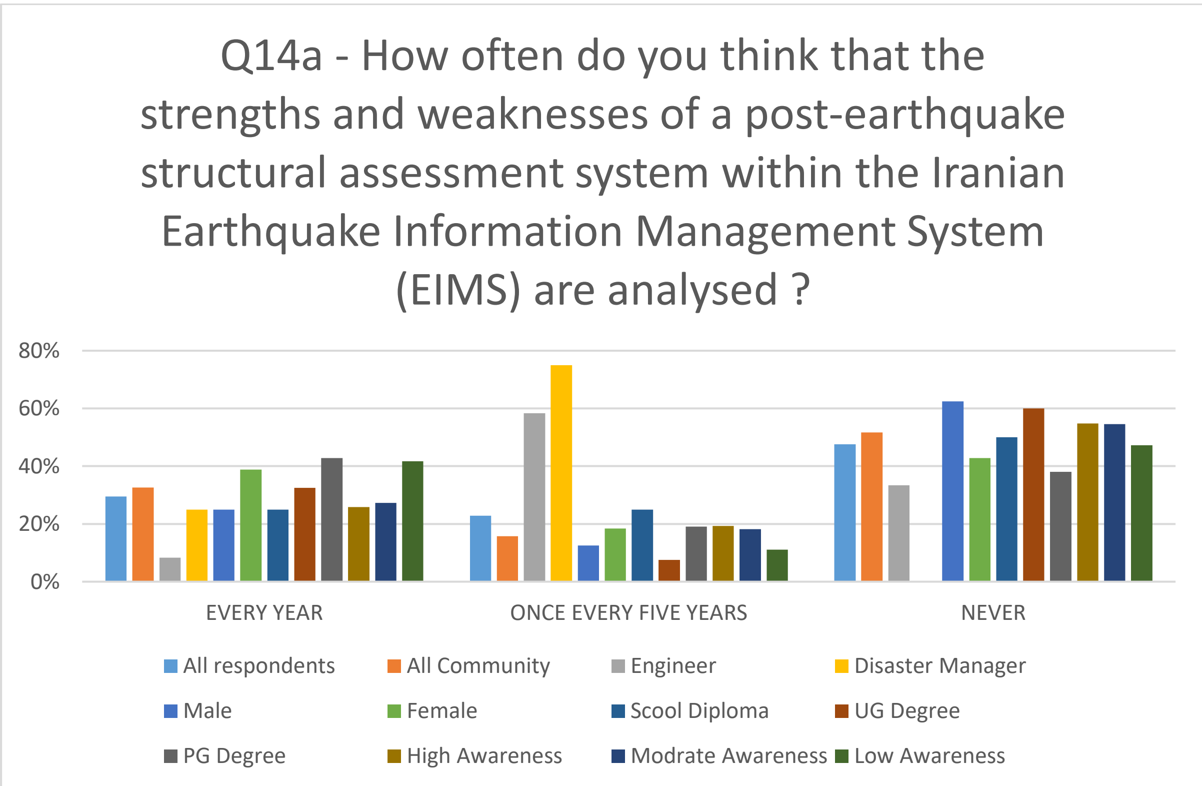


Figure 5.33 Summary of respondents to Q14a (how often the strength and weaknesses of a post-earthquake damage survey assessment system within the Iranian EIMS are analysed).

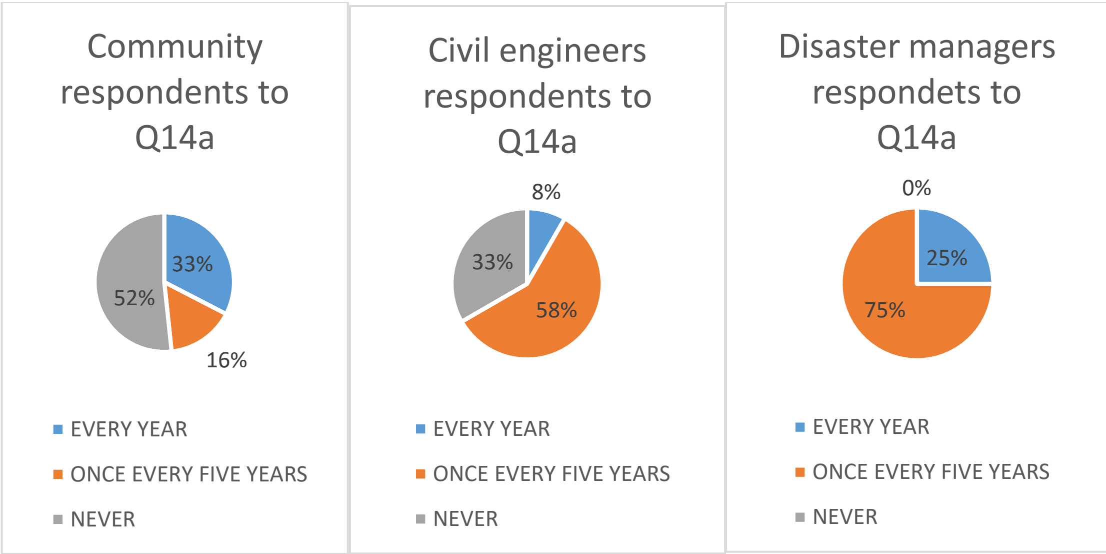


Figure 5.34 Profile of respondents to Q14a.

Importantly to this research, the engineers thought that the strength and weaknesses of post-earthquake damage survey assessment system within the Iranian Earthquake Information Management System (EIMS) is analysed once every five years, with 58% responding that an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information management (EIMS) should be analysed once every five years. This result shows that, in Iran, engineers and disaster managers know how important regular assessment of the post-earthquake damage survey assessment system is within and EIMS. However, that review process is not well understood or recognised by the wider community, who think it is either reviewed every year or not at all. In this respect, this research has revealed that greater awareness of the review process in Iran is needed. That will greatly assist in improving knowledge and understanding of the system, but also raise trust amongst the wider public of the system used in Iran.

In summary, the main finding from the quantitative survey investigation of the post-earthquake damage survey assessment system in Iran shows that the 76% of participants did not think that the Iranian EIMS included an effective system. However, detailed questioning in Q11b did reveal that all elements of an effective system to exist in the country. This research was also able to identify strengths and weaknesses in the system. Specifically, this Thesis study has revealed that the best practice in post-earthquake damage survey assessment in Iran is weakest in relation to “assessing materials used in building construction” and “Record methods used for building construction”. That said, most sector of the population surveyed were shown to be very keen to see development of a post-earthquake damage survey assessment within the EIMS. However, the major concern in Iran was that communities believe the strength and weakness of the system are rarely analysed.

From author’s trip to Iran and what he observed when visiting Kermanshah, he developed the impression that a structured, comprehensive, and uniformly applied post-earthquake damage survey assessment system in Iran does not exist. Clearly, the damage survey assessment team visiting Kermanshah did have a rudimentary system to work with, but the results from the survey suggest that the system does not always function properly. I did not detect evidence from the Kermanshah damage survey assessment team that they had spent time learning lessons from past earthquakes, and this was evident in the attitude of residents, who tired of seeing Iranian disaster management authorities making the same mistake repeatedly.

5.5 Qualitative analysis of beliefs, attitudes, and behaviours towards the Iranian post-earthquake structural assessment system

Question 12a of survey asked respondents to state if they believe that having an effective post-earthquake damage survey assessment system within the Iranian Earthquake Information Management Systems (EIMS) is achievable. In part 12b, 39 respondents provided additional Information to explain their answers. In this section, the responses are analysed based on the subgroup (Disaster manager, Engineer, Resident), the gender of the respondent (Male and Female), the respondent’s level of education (PG Education, UG Education or School Diploma) and finally level of awareness of the Iranian disaster management system (High, Moderate or Low).

Disaster Manager Belief

None of the disaster managers answered question 12b. Which is very surprising as the disaster manager always agree with everything, and they think everything is perfect in their system. Maybe this question will be something to think about with the disaster mangers and more research needs to be done in this area.

Engineer belief

Eight male engineers provided some additional insight, of which three had high levels of education and awareness levels. The opinion of the three engineers was sort of positive but need more work in this field.

> *"Basically, if a structure is built according to the rules and regulation, yes of course it can be assessed, otherwise the post-earthquake assessment is not possible as a structure could be completely damaged." (Respondent 169, 2111)*

> *"It is doable if we do collect data after earthquake, do lab test on structural elements and compare them with the previous earthquake." (Respondent 154, 2111)*

> *"Personally, I believe we need to do these points to achieve post-earthquake structural assessment within EIMS: 1. More action less talk.2. Do not let politics come into disaster management.3. There must be a person or an organisation who is responsible and accountable in time of a disaster.4. Clarity on budgets and spending in these field.5. The country goals for improvements in the field of disaster management must be clearly defined." (Respondent 164, 2111)*

> *"I do not know anything about EIMS. The information regarding earthquake in Iran gets published by two organisations: 1. one is based in Tehran University and the second is the international research centre in Iran. These two organisations are research centres and they cannot assess the post-earthquake damage." (Respondent 171, 2112)*

> *"Damage assessment from earthquakes and identifying weaknesses in buildings structures can be done through having an effective post-earthquake structural assessment system." (Respondent 168, 2112)*

> *"It is achievable through attracting competent and experienced workforce in this field as well as comprehensive planning and training for all people." (Respondent 165, 2112)*

"Yes, this is achievable through better management and more accurate information and structure assessment, post-earthquake." (Respondent 167, 2122)

"Yes, if we learn our lessons from past earthquakes and actually not making the same mistakes for the future." (Respondent 166, 2123)

Most of the male engineers with high level awareness and post-graduate qualification think that there are some issues with method of construction in Iran which rules and regulation in construction and no body record the method of construction and the government agencies have no record from the building in case of an earthquake. The other issue that the engineer raise is that there is no record from the past earthquake damage so they can build back better for the next earthquake. The other engineer thought that there no single government organization who is responsible for post-earthquake damage survey assessment. Other engineer thinks that Iran can have post-earthquake damage survey within the EIMS if they use experienced engineers in this field and plan everything in advance.

<u>Resident Belief</u>

<u>Male</u>

"No, as there is mismanagement and inappropriate activities." (Respondent 92, 1111)

"Yes, however; like many other disaster management programmes it will be far from ideal." (Respondent 21, 1111)

"No, as the country cannot manage disasters consequently it cannot achieve EIMS. "(Respondent 124, 1121)

"Every building must be assessed to see how earthquake resistance they are and how this could be improved." (Respondent 30, 1121)

"No, as there is systematic problem in Iran." (Respondent 57, 1121)

"No, given the foundation of the current building in Iranian cities." (Respondent 143, 1122)

"Yes, if we get help and use experience of countries such as Japan." (Respondent 137, 1123)

“No, as most do not think about disaster management and everything is done only at talk level and theories.” (Respondent 134, 1123)

“Yes, it helps solving problems post- earthquake structural assessment, as well as decreasing losses/damages.” (Respondent 136, 1131)

“Pre-earthquake building assessment is not done and post-earthquake assessments is not good.” (Respondent 19, 1132)

“It can be achieved provided that professionals and experts are used as hands of organizations who can deal with architects and big contractors.” (Respondent 15, 1132)

“As we are so behind from view point of the systematic management.” (Respondent 112,1133)

Female

The first 12 female respondents all had high or undergraduate level of education and a range of levels of awareness. Here again the responses were a bit more positive, but we have some negative response as well. The positive respondent believing that it is possible having post-earthquake structural assessment within EIMS if there is better disaster management plan to develop an EIMS in Iran. The negative respondent indicating about the recent earthquake and lack management and fund for the system.

“Yes, but we need better management at every organization.” (Respondent 113, 1212)

“Yes, it could be very beneficial and this weakness has caused major damage.” (Respondent 98, 1213)

“It is achievable in Iran, as it needs very good computer system and an even stronger data bank. (Respondent 109, 1211)

“It is necessity however nothing has been done so far.” (Respondent 46, 1212)

“No, due to the lack of attention to the problems in Iran.” (Respondent 38, 1213)

“As Iran prone to earthquake, I think it must be a necessity for Iran to make the system achievable.” (Respondent 28, 1221)

“The way a building gets damaged shows how good/bad the foundation is, in some cases the foundation is very low quality and there is lack of bracing.” (Respondent 51, 1221)

“Fundamental training is required to achieve this.” (Respondent 16, 1221)

“There are organization that can do this, however this requires very efficient planning and management.” (Respondent 7, 1221)

“Yes, provided that the council in every area directly involved in building houses….and every building is certified by the council of that area. (Respondent 144, 1223)

“It is possible if there enough financial support available.” (Respondent 48, 1223)

“No, given the lack of planning in Iranian management systems.” (Respondent 20, 1223)

The female resident with low level of education with range of level of awareness

“No, suppose this system did exist, would it be any good for all buildings? This system is good for new builds if it is done correctly.” (Respondent 60, 1232)

“Yes, we can try to make the system better through using expert and professionals as well as advances in the engineering field.” (Respondent 59, 1232)

“Giving information and making the public aware as well as buildings assessment is very important.” (Respondent 4, 1232)

“Yes, and there are legal problems as well as lack of equipment in this field.” (Respondent 41, 1233)

“As our management system is not competent.” (Respondent 122, 1233)

“It is possible only if the right people manage and are in charge.” (Respondent 18, 1233)

“I have no information but if there is anything I could not see it.” (Respondent 61, 1233)

Women respondent with high or undergraduate level of education and a range of levels of awareness are being positive and the issues that they think it is important to achieve effective post-earthquake damage survey assessment within the EIMS system are as follows: 1. Better disaster management system in Iran. 2. Weakness in post-earthquake damage survey assessment within the EIMS make Iran suffer a lot from the post-earthquake structural failure. 3. Some women are complaining about the construction method in Iran, the evidence from the recent earthquake in Kermanshah. 4. Lack of efficient management in Iran and planning in advance is most important issue in Iranian disaster management system especially in post-earthquake structural assessment system. 5. More careful monitoring is needed from city council in Iran as some contractors make mistakes in their construction project and city council either they fine them for small amount of money or ignore the faulty building and let the contractor will carry on. Sometimes the bribe within the system is the big issues and we must put an end in this culture.

In question 13 of the survey, respondents were asked if, assuming that the Iranian Earthquake Information Management system (EIMS) dose includes a post-earthquake damage survey assessment education programme within it, “what do you believe needs to be done to raise awareness of the system?”

Disaster Manager Beliefs

Two disaster managers provided a qualitative response to question 13. The disaster manager responses were extremely positive for this research, clearly stating that post-earthquake damage survey assessment education programmes are being implemented in Iran. However, there was some acknowledgement that more could be done to educate structural engineers, especially in advance of an earthquake event.

“*Iran has a system for post-earthquake damage survey assessment but it needs to be strengthened.” (Respondent 172, 3111)*

“Iran has post-earthquake damage survey assessment system but it needs to use its neighbouring country’s’ experience.” (Respondent 174, 3111)

It clears from the disaster managers' comment that there are some issues with post-earthquake damage survey assessment but they cannot collaborate more about the problems. They know that we could improve our system by using more advance countries experience to have better and more efficient system.

Engineer beliefs

All engineer respondents were male and four had post-graduate qualifications and a high level of awareness of the earthquake management system (matching the Disaster Manager profile). Overall, the responses from this group were very positive, including a range of suggestions for more and up to date equipment and better and real and honest information is needed to improve the system, educating the public about the system. Train more engineer who will capable enough to do the post-earthquake damage survey assessment. They suggest that we need a system to collect and retrieve information about the structure to see if it built according to the regulation (EIMS structural assessment). Universities needs to be more active in case of educating their student about the system and raising awareness about the EIMS structural assessment system. The other engineer indicate that the structural engineers need to be involved more in case of post-earthquake damage survey assessment and the training needs to be provided for them to do the initial post-earthquake damage survey assessment as quick as possible.

> *"Firstly, the increase in equipment's is very necessary, secondly real true information must be given to the public as far as the building regulations are concerned which sometimes the information and the facts do not correspond to each other." (Respondent 170, 2111)*
>
> *"1. Establishing trained groups for post-earthquake assessment.2. Preparation post-earthquake.3. Investigating if structures have been built according to rules and regulations." (Respondent 169, 2111)*
>
> *"I think all the people involves in disaster management have to cooperate with people in education such as universities and research department, the mass media should transfer the information to people." (Respondent 154, 2111)*

"Information gathering from reliable sources could be a start in raising awareness." (Respondent 164, 2111)

The rest of engineers with various education and different level of awareness think that we need to get better use of the structural engineers capacities to have better post-earthquake damage survey assessment, using post-earthquake damage survey assessment system within the disaster management cycle, better trained more competent disaster managers in this field, better trained and more professional people in post-earthquake damage survey assessment field and using the structural engineers in the post-earthquake damage survey assessment. More research and collaboration between Iranian researchers and foreign expert and attending more conferences and workshop in this field. Using the experience of other countries that they are more advance than Iran in this field.

"The ''Association of Engineers'' capabilities must be put to a greater use. A group of engineers must be selected and trained in order to assess the post-earthquake damage and destruction." (Respondent 171, 2112)

"Using up to date technologies and equipment in this field, use of trained experts for damage assessment post-earthquake, and if necessary changing the law's in this field." (Respondent 168, 2112)

"I believe that firstly the disaster management workforce needs to undergo more training and then when they are properly trained they can transfer their knowledge to the public. The other aspect is to put competent managers at high level management jobs." (Respondent 165, 2112)

"Having structural engineers on the site after the earthquake.2. Taking picture from the effected building." (Respondent 160, 2121)

"1. Having professional disaster managers in the organization.2. Having professional workforce in the Organization.3. Educating and breeding the professional workforce.4. Visiting the disaster effected area after the long post-event.5. Using the professional foreign expert for conferences." (Respondent 156, 2121)

“Through accurate planning and spending on research through universities which are the best in this field, we can raise awareness and achieve better results.” (Respondent 167, 2122)

“Raising awareness can be done through attracting specialists and experts in this field and passing on their experience and knowledge to the public.” (Respondent 166, 2123)

<u>**Resident beliefs**</u>

In total, 67 residents provided qualitative feedback (32 males and 35 female respondents).

Male residents

Three male resident respondents had high education levels and high awareness. They suggested that we need management team with right expertise in post-earthquake damage survey assessment to lead in the field and proper training in this field is necessary and all the building around the fault line needs to checked before the earthquake and more monitoring is needed on the new construction to make sure that they follow the code of practice and data needs to be gathered before the earthquake so make post-earthquake structural assessment easier.

“There must be high level of management with the right expertise in place.” (Respondent 92, 1111)

“The training in this field must be given.” (Respondent 91, 1111)

“All the assessment must be done pre-earthquake as post-earthquakes this task is impossible because there are other problems.” (Respondent 135, 1111)

“Building assessments must be established and supported but we can have an understanding of the situation by sampling buildings and data gathering.” (Respondent 21, 1111)

“Relevant organizations need to train experts in this field.” (Respondent 148, 1121)

“Through the use of mass media.” (Respondent 124, 1121)

"1. Laying the foundation for better post-earthquake mangement.2. Giving relevant information to public.3. Training to be given to architects as well as engineers." (Respondent 27, 1121)

"Having approved certified certificate from engineers for building plans and method of construction." (Respondent 143, 1122)

"Discussion and co-operation amongst countries prone to earthquakes." (Respondent 139, 1123)

"Updating the system and re-education." (Respondent 137, 1123)

"We need to give disaster management role to competent expert people." (Respondent 134, 1123)

"In my personal opinion, up to date equipment must be used." (Respondent 115, 1123)

"There must be a separate department established who would work under the disaster management and this organization must have clear planning." (Respondent 116, 1131)

"In my personal opinion, the most advanced equipment's must be used." (Respondent 17, 1131)

"Training and using experience of other countries." (Respondent 136, 1131)

"Our system should be up to date according to the international standards." (Respondent 64, 1132)

"We can achieve this through learning lessons from countries which are advanced in this field such as Japan." (Respondent 15, 1132)

"The public wants training and awareness raising from the people who are in charge." (Respondent 133, 1133)

"We need general information regarding earthquakes from countries such as Japan, the US, etc." (Respondent 112, 1133)

"Making the organization responsible and accountable." (Respondent 65, 1133)

Female residents

The female resident indicates that the trust between the government organization and people in the community is broken as the community heard lots of dishonest truth from the government agencies and they think the government should repair that so the people trust the government rather than other source of information such as Instagram, Facebook or some other fake news agencies. The female participant believe that the organizations need to be in cooperation with each other rather and competing with each other.

> *"All the disaster managers and organization with absolute honestly must make the public aware of the situation and this does not seem to be the case." (Respondent 113, 1212)*
>
> *"Through establishing trusted on-line resources, raising awareness could be achieved." (Respondent 98, 1213)*
>
> *"Co-operation between relevant organizations is very important and these organizations must feel the need for such a system and make themselves familiarise with it." (Respondent 109, 1211)*
>
> *"Re-educating and training of engineers with up to date global system." (Respondent 95, 1212)*
>
> *"The training needs to be given in every organization." (Respondent 46, 1212)*
>
> *"Trained engineers must be used." (Respondent 96, 1213)*
>
> *"Training through broadcasting (TV and Radio)." (Respondent 52, 1213)*
>
> *"1. Advertisement.2. National broadcast." (Respondent 39, 1213)*
>
> *"1. enough attention must be giving to the subject .2. Establishing a budget for training and giving information." (Respondent 38, 1213)*

"Prevention is the best policy, reviewing building regulation and improving it is very important." (Respondent 51, 1221)

"Not receiving bribes and having responsible engineers before any disaster." (Respondent 36, 1221)

"Organizational shake up in disaster management is required as well as use of experts and professionals." (Respondent 16, 1221)

"1. Increased level of research, getting help from researchers from various countries in this field.2. Sending Iranian students/academics to other countries for training and research." (Respondent 141, 1222)

"1. having sufficient equipment.2. Having experts as disaster managers." (Respondent 104, 1222)

"1. Management .2. Review and research.3. Planning and order.4. Enforcement." (Respondent 62, 1222)

"1. having educational classes on disaster management.2. Raising awareness through media (TV, Radio)." (Respondent 47, 1222)

"All the fundamental planning and activities must be done initially." (Respondent 45, 1222)

"1. Traning.2. Using experience of countries such as Japan." (Respondent 144, 1223)

"Yes, provided that, there are practical steps taken by relevant organization." (Respondent 48, 1223)

"Updating the information of disaster organization and people when disaster happen." (Respondent 145, 1223)

"I have no information about EIMS.I think they will need to show some more information and advertisement from broad casting organization (TV and Radio)." (Respondent 25, 1223)

"Fundamental appropriate training." (Respondent 20, 1223)

“Building assessment pre-earthquake in all areas as well as the population in all areas.” (Respondent 6, 1231)

“Positive action must be taken in this field.” (Respondent 114, 1232)

“Iran needs to cooperate with advanced countries in this field such as Japan.” (Respondent 60, 1232)

“Using updated technologies and research in this field, damage from earthquake could be limited. Through research the unwanted factors caused by earthquakes could be manage better too.” (Respondent 59, 1232)

“Updating information by researchers and having equipment as well as using available international information.” (Respondent 41, 1233)

“We need to get information from countries such as Japan and the US.” (Respondent 122, 1233)

“Due to the lack of assessment system in Iran, assessment system must be established post-earthquake in order to minimise losses and damage.” (Respondent 108, 1233)

“Like advanced countries we need to give equipment and facilities to managers in order to have better assessment.” (Respondent 107, 1233)

“Making people familiarise with the system through TVs.” (Respondent 55, 1233)

“I do not know exactly, but I think capable and complete people who are in charge can increase the level of EIMS awareness.” (Respondent 18, 1233)

“Giving information to people before the earthquake and building our structures according to earthquake code of practice.” (Respondent 61, 1233)

“Assessment of buildings which are prone to earthquake must be done prior to earthquake as well as giving information regarding the resistance level of building to the public.” (Respondent 9, 12xx)

Question 14a of survey asked respondents to state that how often they think that the strength and weaknesses of a post-earthquake damage survey assessment system within the Iranian

Earthquake Information Management Systems (EIMS) are analysed. In part 14b, 39 respondents provided additional Information to explain their answers. In this section, the responses are analysed based on the subgroup (Disaster manager, Engineer, Resident), the gender of the respondent (Male and Female), the respondent's level of education (PG Education, UG Education or School Diploma) and finally level of awareness of the Iranian disaster management system (High, Moderate or Low).

Disaster Manager Beliefs

No one from the disaster mangers group answered part (b) of question 14.

Engineer beliefs

Three engineers provided comments in relation to how often they think that the strength and weaknesses of a post-earthquake damage survey assessment system within the Iranian Earthquake Information Management Systems (EIMS) are analysed. All the highly educate and high awareness engineers believe that the strength and weaknesses of post-earthquake damage survey assessment needs analysed after every earthquake and one engineer think that there lack of knowledge in this field, and it needs to be addressed as quick as possible.

> *"This is done post-earthquake in Iran." (Respondent 170, 2111)*

> *"After every earthquake." (Respondent 154, 2111)*

> *"Research and development in this field needs knowledge and training which is non-existent by managers in this field, and if this happens it is very weak and dose not function." (Respondent 165, 2112)*

Resident beliefs

Male resident

The first eight male residents had high or undergraduate level of education and range of awareness levels. Their responses were all negative either they think that do have enough information or the system does not exist.

> *"I have doubts whether there is accurate information available." (Respondent 21, 1111)*

“I do not have any information.” (Respondent 1, 1112)

“Raising awareness in this field is very weak or non-existent.” (Respondent 148, 1121)

“If there was analysis, the building would be built correctly.” (Respondent 124, 1121)

“It never comes under review and assessment.” (Respondent 72, 1121)

“Whenever there is major fatality.” (Respondent 139, 1123)

“Whenever a major earthquake takes place.” (Respondent 137, 1123)

“The analysis is done only after an earthquake/disaster which caused enormous amount of damage.” (Respondent 75, 112x)

The remaining 6 male resident respondents all had school diploma levels of education and a range of awareness level. The views were also negative about any post-earthquake structural assessment let alone analysing the strength and weakness of the system with EIMS.

“I do not know how frequently this is done, however; it must come under review at least once a year.” (Respondent 17, 1131)

“After a major earthquake.” (Respondent 136, 1131)

“Structural assessments information has not been communicated and I have no information on it.” (Respondent 19, 1132)

“Only when a major earthquake happens.” (Respondent 133, 1133)

“It only happens for two days after the earthquake and on the 3rd day it looks as though nothing has happened.” (Respondent 112, 1133)

“When the earthquake happens.” (Respondent 65, 1133)

Female resident

The first five female respondents all had high or undergraduate level of education and range of level of awareness. The female respondents were all negative either thinking that the system does not exist with reference to the recent earthquake in Iran.

"This system is currently not in existence in Iran." (Respondent 109, 1211)

"It could potentially happen post disaster." (Respondent 95, 1212)

"Nothing comes under review and analysis in Iran, as long as there is no major disaster." (Respondent 94, 1213)

"This can be given greater attention in light of recent earthquakes." (Respondent 7, 1221)

"The reviews and assessments are performed only in the case of the big disaster." (Respondent 145, 1223)

The remaining 4 female respondents all had school diploma levels of education and range of awareness levels. They respondents also negative, it mentioned that in light of the recent earthquake, it seems like there no system to collect data to analyse the strength and weakness of the Iranian post-earthquake structural assessment within EIMS.

"Unfortunately, the review and analysis only take place in Iran when major disaster happens." (Respondent 97, 1231)

"I do not know, however; through watching how disasters are managed, even if it is reviewed it has no usefulness or practicalities and the data in this field is not used at all if there is any data." (Respondent 59, 1232)

"When disaster happens for the next 3 days people are in the state of anxiety and then it is normal." (Respondent 122, 1233)

"It is no good if it is not done once a year." (Respondent 18, 1233)

To summarise, the engineering point of view in Iran indicates that there are some issues with methods of construction in Iran, which are to do with rules and regulation in construction. Specifically, nobody records the method of construction and the government agencies have no "as built" records about building, which can be used to assess a building after an earthquake. The other issue that the engineers raise is that Iran has no system for keeping records of damage to structures from the past earthquake, which would be helpful in the assessment of building subject to further earthquake shocks. Some engineers in Iran think that there is no single organization responsible for post-earthquake damage survey assessment in the country. That is a problem, because every organization involved has their own system of recording damage and method for undertaking post-earthquake damage survey assessment. That makes it hard to compile all the data in one comprehensive EIMS. Overall, the engineers provided many suggestions on how to improve the system:

1. Collect better and more accurate information about building design and construction.
2. Invest in better and more advanced equipment for post-earthquake damage survey assessment.
3. Educate and engage the public in initial post-earthquake inspections.
4. Train more civil engineer in post-earthquake structural analysis.
5. Improve the EIMS system to collect and retrieve post-earthquake damage survey assessment data.
6. Involve Universities in the education and training programmes relating post-earthquake damage survey assessment and the Iranian EIMS.
7. Involve more engineers in the post-earthquake damage survey assessment system.
8. Improve training of disaster mangers in how to integrate a post-earthquake damage survey assessment system into an EIMS.
9. Create more collaboration and more workshops with other countries in this field.

From the male and female resident point of view, the main point raised was about the competence of disaster mangers. There was widespread feeling that better monitoring of the design and construction of buildings before an earthquake was needed. The community response also suggested that more cooperation, rather than competition, between organisations involved in a disaster response was needed in Iran. The survey found a difference between male and female views on the Iranian post-earthquake damage survey assessment system. Woman were more positive in their belief that a better post-earthquake damage survey assessment system could be developed in Iran. The women were also willing to suggest ways of improving the system, by addressing the following issues:

1. Creating a better disaster management system generally in Iran.
2. Assessing weakness in the post-earthquake damage survey assessment within the EIMS.

3. Sorting out deficiencies in construction methods used in Iran.
4. Having better management plans for before, during and after an earthquake.
5. Having a more effective system to punish contractors who breaking construction law.
6. Enhance control and monitoring of new building construction.
7. Stop bribery and corruption in the building regulation process.

Taken together the findings from the analysis in this section provide some new and important insights in relation to the scenario presented at the start of the chapter. What this section reveals are the depth of feeling in relation to some of the weaknesses in the system, which are very powerfully felt by residents and a good proportion of engineers. The negative and pessimistic views expressed in the scenario seem to stem from a belief that if a post-earthquake damage survey assessment does exist in Iran it does not function well and that has led some to speculate that disaster managers lack competence in the implementation of the system. Even more widespread and possibly reaching into the disaster management community is a belief that there is no effective plan to improve to make the rapid post-earthquake damage survey assessment better and from the recent earthquake in Kermanshah the community are getting very disappointed.

5.6 Summarising findings from the analysis of strengths and weaknesses in the Iranian post-earthquake structural assessment system

This chapter set out to provide new insights about post-earthquake damage survey assessment within the post-earthquake disaster management, using the system in Iran as a case study. Data from an observational visit, a variety of engagement activities undertaken and from a survey conducted in Tehran were analysed in order to reveal insights. Many of the insights relate directly to the Iran context, but some can be generalised to apply in a broader context.

In section 5.1, I revealed is that not every member of the public will have the necessary skills to understand the different elements of a post-earthquake damage survey assessment system. People without basic maths and science skills will have to undertake some further education to prepare them for involvement in the process. In addition, graduate civil engineers will possess a good depth of knowledge in several subjects that are important for the analysis of buildings damaged by earthquakes, but they are unlikely to have applied that knowledge for post-earthquake damage survey assessment purposes. Engineers wanting to get involved in post-earthquake damage survey assessment will need further specialist training to show them how to apply their skills in this area of investigation. Finally, disaster managers need to understand how important a post-earthquake damage survey assessment system is to achieve an effective EIMS.

Section 5.2 revealed that any EIMS that has post-earthquake damage survey assessment integrated within it would need to allow input from expert engineers, but also the community of building owner/occupiers. Allowing input from expert engineers and the wider community will only be effective in enhancing urban resilience if the EIMS also provides a facility to educate engineers and the community in both the methods for interacting with the EIMS and the methods for conducting post-earthquake damage survey assessments. As technology continues to improve, it is becoming increasingly easy to enhance post-earthquake damage survey assessment systems by incorporating a structural health monitoring system. A structural health monitoring system does not just enable the detection of sudden or progressive damage but also aids in monitoring the performance of damaged building under operational conditions. Such a system may greatly enhance the efficiency of post-earthquake damage survey assessment operations and speed up the process of recovery from earthquake events.

Section 5.3 revealed that the quality of construction in Iran is very poor, and it needs to be reviewed and corrected as soon as possible before the next earthquake. Without good quality supervision and management essential records for effective post-earthquake damage survey assessment will not be collected. In relation to that point, I reviewed a post-earthquake damage survey assessment form used in Iran and recommended important improvement. The effectiveness of the enhanced post-earthquake damage survey assessment form would be limited without good quality construction records. The link between quality management during construction and the effectiveness of post-earthquake damage survey assessment is not something that the author encountered in the literature and was not a topic at the forefront of this research project. However, the lack of effective construction management in Iran, with the specific aim to aid post-earthquake damage survey assessment, has been revealed by this research as an important area in need of further investigation.

Section 5.4 revealed that majority of structure engineers do not think that here post-earthquake damage survey assessment within the disaster management system in Iran which very worrying as the structural engineers in Iran did not aware of any post-earthquake damage survey assessment system. In this section the structural engineer's opinion is very important as they are playing key role on post-earthquake damage survey assessment. When the present the list of post-earthquake damage survey assessment items the engineers think the weakest in the Iranian system is "undertake a quick/rapid visual inspection" which is this research can be useful and based on the Iranian post-earthquake damage survey assessment form and the research has been done on other countries we can improve this form and save more life and reduce the economic loss. The engineers ranked "Undertake a quick/rapid visual inspection" and "Count the number of floors in building" as the weakest elements in the Iranian post-earthquake damage survey assessment and they think there is room for improvement in "classify the level of damage to each building", "use the standard system to record damage", "Record any foundation damage in building" and "Record method used for building construction". Quantitative findings from this section of the thesis reinforce the findings in Section 5.3, that the collection and retention of good design and construction records in Iran is a serious weakness in the system and needs further research.

Finally, in Section 5.5, qualitative survey data revealed the engineering point of view in Iran, which indicated that there are some issues with methods of construction in Iran, which are to do with rules and regulation in construction. Specifically, nobody records the method of construction and the government agencies have no "as built" records about building, which can be used to assess a building after an earthquake. The other issue that the engineers raised was that Iran has no system for keeping records of damage to structures from the past earthquake, which would be helpful in the assessment of building subject to further earthquake shocks. Some engineers in Iran thought that there was no single organization responsible for post-earthquake damage survey assessment in the country. That was a problem, because every organization involved has their own system of recording damage and method for undertaking post-earthquake damage survey assessment. That makes it hard to compile all the data in one comprehensive EIMS. Overall, the engineers provided many suggestions on how to improve the system:

1. Collect better and more accurate information about building design and construction.
2. Invest in better and more advanced equipment for post-earthquake damage survey assessment.
3. Educate and engage the public in initial post-earthquake damage inspections.
4. Train more civil engineer in post-earthquake damage survey analysis.
5. Improve the EIMS system to collect and retrieve post-earthquake damage survey assessment data.
6. Involve Universities in the education and training programmes relating post-earthquake damage survey assessment and the Iranian EIMS.
7. Involve more engineers in the post-earthquake damage survey assessment system.
8. Improve training of disaster mangers in how to integrate a post-earthquake damage survey assessment system into and EIMS.
9. Create more collaboration and more workshops with other countries in this field.

From the male and female resident point of view, the main points raised were about the competence of disaster mangers. There was widespread feeling that better monitoring of the design and construction of buildings before an earthquake was needed. The community response also suggested that more cooperation, rather than competition, between organisations involved in a disaster response was needed in Iran. The survey also found a difference between male and female views on the Iranian post-earthquake damage survey assessment system. Woman were more positive in their belief that a better post-earthquake damage survey assessment system could be developed in Iran. The women were also willing to suggest ways of improving the system, by addressing the following issues:

- Creating a better disaster management system generally in Iran.
- Assessing weakness in the post-earthquake damage survey assessment within the EIMS.
- Sorting out deficiencies in construction methods used in Iran.
- Having better management plans for before, during and after an earthquake.
- Having a more effective system to punish contractors who breaking construction law.
- Enhance control and monitoring of new building construction.

- Stop bribery and corruption in the building regulation process.

Taken together the findings from the analysis in this section provide some new and important insights in relation to the scenario presented at the start of the chapter. What this section reveals are the depth of feeling in relation to some of the weaknesses in the system, which are very powerfully felt by residents and a good proportion of engineers. The negative and pessimistic views expressed in the scenario seem to stem from a belief that if a post-earthquake damage survey assessment does exist in Iran, but it does not function well and that has led some to speculate that disaster managers lack competence in the implementation of the system. Even more widespread and possibly reaching into the disaster management community is a belief that there is no effective plan to improve to make the rapid post-earthquake damage survey assessment better and from the recent earthquake in Kermanshah the community are getting very disappointed.

Chapter 6 - Engagement in post-earthquake disaster management and damage survey assessment in Iran

On 20th November 2017 I travelled to Iran (Tehran) to collect my data. A few weeks before I arrived, a powerful earthquake with magnitude of 7.3 hit Western Iran. It occurred in the region of Sar-e-Pole Zahab, in Kermanshah, near Iran-Iraq border and many thousands of people were victims of the destruction that it caused. The earthquake had featured in a lot of the media before I set off from the UK to Iran. Then, just a few hours prior to my arrival in Tehran, a moderate earthquake with the magnitude of 5.1 shook the region of Malard-Meshkindasht, in Alborz province. This region is located not very far to the West of Tehran. Even though there was no damage in Tehran, I as I travelled into the city, I witnessed people on the road, many were queuing to fill their cars with fuel.

> *As I arrived at the house of my grandmother, where I was to stay for the next six weeks, I saw more people in the roads. Although it was late at night, in my grandmother's apartment block, all the residents were awake and ready to go outside if they felt any shaking. They were all worried and did seem to know what to do. Some people were sleeping in their cars, as they thought it would be safer. Others were sleeping in a park close to my grandmother's house and some travelled in their cars to somewhere outside the capital where they thought they would be safe. The trouble seemed to be that there was different news about the epicentre and the magnitude of the earthquake. So, people were worried and trying to find out more, mainly via social media, about the earthquake.*
>
> *Over the next few days, I learned that government organizations and some specialist non-governmental organization had sent search and rescue team to the affected area. In addition, many members of the public (including famous celebrities) and community groups (including religious groups linked to local Mosques) collected money to buy essentials supplies and took them to the affected area. The public effort seemed to occur without coordination with government authorities. Indeed, some people told me that they did not trust government agencies, so they took matters into their own hands and travelled to the affected area. The result was traffic jams, which hindered all*

parties trying to reach to the affected area and delayed vital rescue efforts. Several weeks later, it was realised that many collected essentials and equipment was not needed and much of it was left unused in warehouses.

In social science research especially research with elements of an ethnographical approach, a story-telling style of writing is often used to help convey the meaning and understanding of the subject matter.

Storytelling in social science research provides a theoretical mechanism for strengthening community natural disaster resilience. This enables people to unite and build a network, promoting resilience (Nagamatsu, Fukasawa and Kobayashi, 2020).
Moreover, storytelling in social science is a tool to reflect the public memory and their experiences. Also, it is a good tool to create a disaster-resilience community (Nagamatsu, Fukasawa and Kobayashi, 2020).
When researching the phenomenon of "engagement" in the disaster management system of Iran, the author found that the ethnographic techniques imbedded into the methodology was particularly useful. As stated in the Methodology (Chapter 3), for this research, the author wanted to gain deeper insights about the earthquake management system in Iran and to achieve that deeper understanding. The author chose to augment the research philosophy with a layer of ethnographic analysis. Studies by Parker(2005) and Howitt (2016) found that ethnographic research requires the researcher to study how individuals theorise about their own behaviour, culture, and customs. To ensure insights, ideas and innovative findings form this thesis are meaningful, the author felt he must first demonstrate his deep personal understanding of the communities and cultures being studied. In this section, the author applied the reflective ethnographic analysis to his own position in the research, thereby helping to define where his insights can be interpreted from a position of strength and where his theories may be a bit more speculative.

Giles (2004) explained that in order to observe and understand a community, the ethnographic researcher needs to travel to the area where the author wants to do his research and collect his data. Forshaw (2012) reinforced that view, stating that ethnographic research is more about experiencing and being involved in a community and becoming one of them, rather than simply observing them (which may be acceptable in a purely phenomenological study).

The author was member of the project called ‘’Post-Earthquake Structural Health Monitoring System (PE-SMS)’’. This project was supported by the Royal Academy of Engineering Frontiers of Engineering - Seed funding scheme (Wilkins, Fox, Razaghi-Kashani, Rabuya, Cabildo, 2017). The author will focus on the engagement aspect of the project. To start with the project engaged a multidisciplinary team of software, electrical and civil engineering experts. That core team worked to develop wireless sensor technology to monitor the health of buildings damaged by earthquakes. The second aspect of the project’s engagement activity was to pool resources from across the world to in order to ensure the right skills were included in the project. Software and civil engineering expertise were sourced from the UK, while earthquake management and electrical engineering expertise were sourced from the Philippines. The author’s own contribution was in the fields of earthquake and civil engineering expertise. The author helped to provide structural engineering and post-earthquake structural assessment advice to other non-expert team members. The author assisted in developing the specification for the sensor technology, that was tailored to monitoring cracks I structural elements of reinforced concrete framed buildings. The author helped to test prototype sensors in a laboratory at the University of Plymouth. Finally, the author helped to organise and run a multi-day workshop in the Philippines, where lessons from the project were evaluated. At the workshop, the author engaged with local engineers and disaster managers and complete a survey exercise, which acted as a “pilot study” for a larger survey to be conducted in Iran. Lessons learned from the PE-SMS project were used to refine the design of the later data collection exercise in Iran. This project revelled to the author the importance of how the post-earthquake structural health monitoring can be done remotely. Damaged buildings can be remotely monitored by structural engineers and, if the crack on the main beam and columns start to grow, the structural engineers raise an alarm to evacuate the building and saves lives. In this way structural engineers can effectively monitor many buildings. Okano (2005) stated that there are barely any non-governmental organizations engaged with disaster mitigation and disaster management in Iran. So, the PE-SMS project was interested to the author, as it provided an example of how Iranian authorities could use technology to get the community interested and get them engaged in the post-earthquake disaster management system.

In October 2019 the author commenced a six-month internship at UNECO headquarter in Paris. The internship was in the "Earth science and geo-hazard risk reduction" part of the "Disaster risk reduction section". Disaster risk reduction at UNESCO operates at the interface between natural and social sciences, education, culture, and communication plays a vital role in constructing a global culture of resilient communities. UNESCO assists countries to build their capacities in managing disaster and climate risk. The Organization provides a forum for governments to work and engage together and it provides essential scientific and practical advice in disaster risk reduction. At UNESCO the author was involved in many projects. One involved a project which was to build capacity for disaster risk reduction in the built environment against earthquake across Latin America. This project involved the countries of Mexico, Guatemala, Cuba, The Dominican Republic, and Peru. The author was involved in the process of supporting each country outcome, but mainly engaged with Mexico. Another project was to create a "Chatbot" to engage communities with earthquake education. Yet another project the author got involved with was the Equipment for earthquake Early Warning System (EQ EWS) in schools. The author helped to research the countries where this programme was best suited and most needed. The author also helped to define how to keep children engaged with the earthquake early warning system and keep the schools engaged in the programme. From the author work as intern at UNESCO headquarter in Paris, the author learned how engaging neighbouring countries in a disaster management programme can help reduce the effect of a disaster and improve the overall management system. By engaging different countries in disaster risk reduction efforts, they mutually benefit from the experience and can undertake many joint disaster planning exercises. They can also learn how to share limited specialist resources. Another lesson that author learned, was that there a range of methods for engaging communities. Like, asking one effected community to tell their story to people in a different community, of how a disaster affected them personally. Other lessons were about how highly developed countries can be engaging in education programme in the less well-developed countries, to improve their management systems and share ideas about the best use of new technology. That said, the author stresses the need to involve all layers of people in society in all these efforts. This research found the point that would be important to this thesis are as follows:

- The importance of engagement between the neighbouring countries and benefit from their experience
- Different ways to engage the disaster community with other community through different way such as interviews the effected community resident and let then to explain in their word what happened and just show them in the other community.
- Using technology to engage community and school children about the earthquake such as chatbot and early warning system.
- Engaging more advanced countries to educate and engage with less advanced countries about their experience and their new technology.
- Engage the school children in poor community about the disaster risk reduction (VISUS).

The UNESCO experience provided valuable insights on Iranian authorities could enhance engagement in the post-earthquake disaster management system, thus addressing many of the long-term shortcoming in the system identified by many researchers (Movahedi, 2003; Okano, 2005; Hosseini,2009; Izadkhah, 2009).

From this structured series of ethnographic research activities, the author gained significant new insight that helped to reveal important lessons in relation to the scenario at the start of this chapter. First and foremost was the fact that not too many researchers had investigated aspects of the engagement in post-earthquake structural assessment in Iran and revealed numerous weaknesses in the system (Movahedi,2003; Okano, 2005; Hosseini, 2009; Izadkhah, 2009). As a consequence, disaster management authorities in Iran were becoming more aware of deficiencies in their engagement in post-earthquake structural assessment in Iran, which could explain their willingness to learn lessons about how to improve their system. Building on the approach advocated by Giles (2004) and (Forshaw (2012), the author was able to define an important part of the improvement process is to learn lessons from past events. But the ethnographic analysis might suggest that the pessimistic view of the engineers and resident communities was a sign that too much of the learning was focussed on to narrow a group of people. In that regard, the author’s own project experience helps to demonstrate that in earthquake management, education and engagement needs to include a wide range of stakeholder groups (both local and international) and cover a wide range of subjects, from the simplest messages to school children to technical know-how to engineers and disaster managers across Iran.

According to the World Disaster Report Iran have the highest number of earthquakes with the magnitude over 5.5 Richter and among the countries with highest number of the casualties from the post-earthquake building failures. Iran is located in the alpine-Himalayan seismic belt which is one most active and dangerous tectonic regions of the world.

Earthquake management in Iran have not paid any attention toward the community engagement (Jahangiri, Izadkhah, Montazeri, 2010).

Tehran is the capital city of Iran with a population of 8.3 million and had population density of 146 people per hectares one the dense city in the (world Betaud, 2003).

The earthquake engagement programme is one of the most effective plans in earthquake preparedness (Jamshdi, Majzadeh, Saberi Namin, Ardalan, Seydali, 2016)

This research also finds that community engagement with disaster management allow the disaster managers to apply methods that are well-suited to the culture of the local communities which helps to make safer disaster-resilient communities (Jamshdi, Majzadeh, Saberi Namin, Ardalan, Seydali, 2016).

Post-earthquake damage survey assessment and reconstruction is a multi-agency task. The cost of reconstruction is heavy so many countries are relying on post-earthquake detailed damage survey assessment or repair to avoid the heavy cost of reconstruction. Community engagement in post-earthquake damage survey assessment is one of effective solution in post-earthquake disaster management cycle (Reed, 2008).

The community participation within the post-earthquake disaster management cycle would be affected by political and economic condition of the countries (Darabi, Zafari and Milani, 2015).

The past earthquake in Iran shows that the community engagement in the reconstruction process and rehabilitation did decrease the cost and had the result that is more effective within the disaster management. Community engagement is accepted as effective framework in disaster management recovery cycle (Darabi, Zafari and Milani, 2015).

Better strategies need to be employed for more community engagement in natural disaster in Iran to make the disaster management more effective (Darabi, Zafari and Milani, 2015).

The community engagement programme should be more effective and empowering the community, be clearer in decision making and social integration, more partnership, better access to resources and basic services, sustainability of reconstruction and most importantly build a culture of safety (Cleaver, 1999; Lizarrald, Johnsonet, 2010; Mahfuzar and Chowdhury, 2011).

The post-earthquake community engagement is an empowerment process of community in a way to enable them to control causes that affects their lives (Darabi, Zafari and Milani, 2015).

The main issues with community engagement divided in four group: 1. General issues such as lack of information, lack of resources, lack of motivation within the community and lack of interest or time lack of community needs assessment.2. Issues with agencies developer agencies are as follows: 2.1 lack of awareness of community need and cultural misunderstanding, lack of skills, culture of communities and lack of experience within the field of community engagement.2.2 lack of trust between the government agencies and communities.2.3 issues with timing and political pressure.

3. Issues with government are as follows: 3.1 decision making procedure .3.2 unsuitable policies 3.3 focus their plan on short term solution rather than long term solution.3.4 difficulties to integrate the community in the disaster management process. 4. Issues with local communities are as follows: 4.1 tension between the community resident.4.2 disbelief and distrust.4.3 lack of confidence within the community 4.4 lack of cooperation between the stakeholders 4.5 limited access to information .4.6 diversity of participant’s interests.

There are two main areas that needs to be studies in post-earthquake disaster management engagement programme:

1. Organizational sub system which is “who is to do what”.

2. Technical subsystem which is “how to use the resources (Lizarrald *et al*., 2008).

The action and activities that needs to be done in post-earthquake disaster management life cycle and reconstruction system are:

1. communication with public continually.

2. Providing temporary shelter and long-term housing.

3. Post-earthquake initial damage survey assessment.

4. Detail damage survey assessment to see which building should be demolished.

5. Clearance of debris.
6. Inspection and repair of the damaged building.
7. Social rehabilitation programme.
8. Creating employment opportunities.
9. Compensation for property losses.
10. Reassessment of the hazard risk.

11. Rehabilitation of the injured Darabi, Zafari and Milani (2015).

In Iran the post-earthquake reconstruction process focus on reconstruction of only houses and the disaster management cycle is different from one earthquake to anther earthquake (Darabi, Zafari and Milani, 2015).

This Thesis try to find out the behaviour and attitude level of post-earthquake damage survey assessment in Iran and how much the community know about the programme and how engaging is it? (Darabi, Zafari and Milani, 2015).

The community engagement in post-earthquake disaster management is very important but it has been ignored by disaster management cycle in Iran (Darabi, Zafari and Milani 2015).

The post-earthquake disaster management engagement system in Iran did not design in a way to interact between the social and economic habits of the affected people (Darabi, Zafari and Milani, 2015).

Post-earthquake initial damage survey assessment team dose exists in Iran, the civil engineers' team only responsible for construction of new housing units (Darabi, Zafari and Milani, 2015).

Due to the psychological condition of the affected community after the earthquake, any physical engagement activities could be very useful psychological rehabilitation (Zafari, Darabi, 2012).

Disaster management system in Iran needs to encourage more local structural engineering company to engage more in post-earthquake damage survey assessment and providing more educational opportunities to prevent the use of improper construction materials in the building (Omidvar, Zafari *et al*., 2009)

The construction material quality control is another issue that the community can be engage after the earthquake. In this task the government can make a check point and run by the effected community to make sure that the standard construction material will deliver to the site as in Iran after the earthquake too much low-quality construction martial will deliver to the site for quick profit (Zafari and Jodi, 2009).

There are three steps in every successful post-earthquake damage survey assessment and reconstruction programme: 1. Decision making.2. Decision taking.3. Planning (Darabi, Zafari and Milani, 2015).

The post-earthquake damage survey assessment engagement program within the community in Iran makes the job of disaster management and the government much easier (Darabi, Zafari, and Milani, 2015).

In Iran there is shortage of post-earthquake damage survey assessment community-based engagement programme. There are some NGOs and CBOs (community-based organizations) but there mostly colleting charitable money for effected communities, but they have no information or skills in post-earthquake disaster risk reduction (Amini Hosseini, Hosseini, O. Izaddkhah, Mansouri and Shaw, 2014).

In this Thesis I have decided to analysis the community participation in post-earthquake damage survey assessment within the disaster management system in Iran.

6.1 Quantitative data analysis of engagement practices linked to disaster management and post-earthquake structural assessment in Iran

Moving away from the ethnographic analysis, this section presents quantitative data, analysed in a manner more closely aligned with the phenomenological approach adopted by this research. Question 19a of the survey asked respondents if the Iranian Earthquake Information Management System (EIMS) includes a post-earthquake damage survey assessment engagement programme. Of the 160 definitive responses, 133 (83.1%) answered NO and 27 (16.9%) answered YES. Figure 6.1 shows that the split in responses, which was quite consistent across all sub-groups, except for the disaster managers. 75% of the disaster managers (3 of 4) in the survey answered YES.

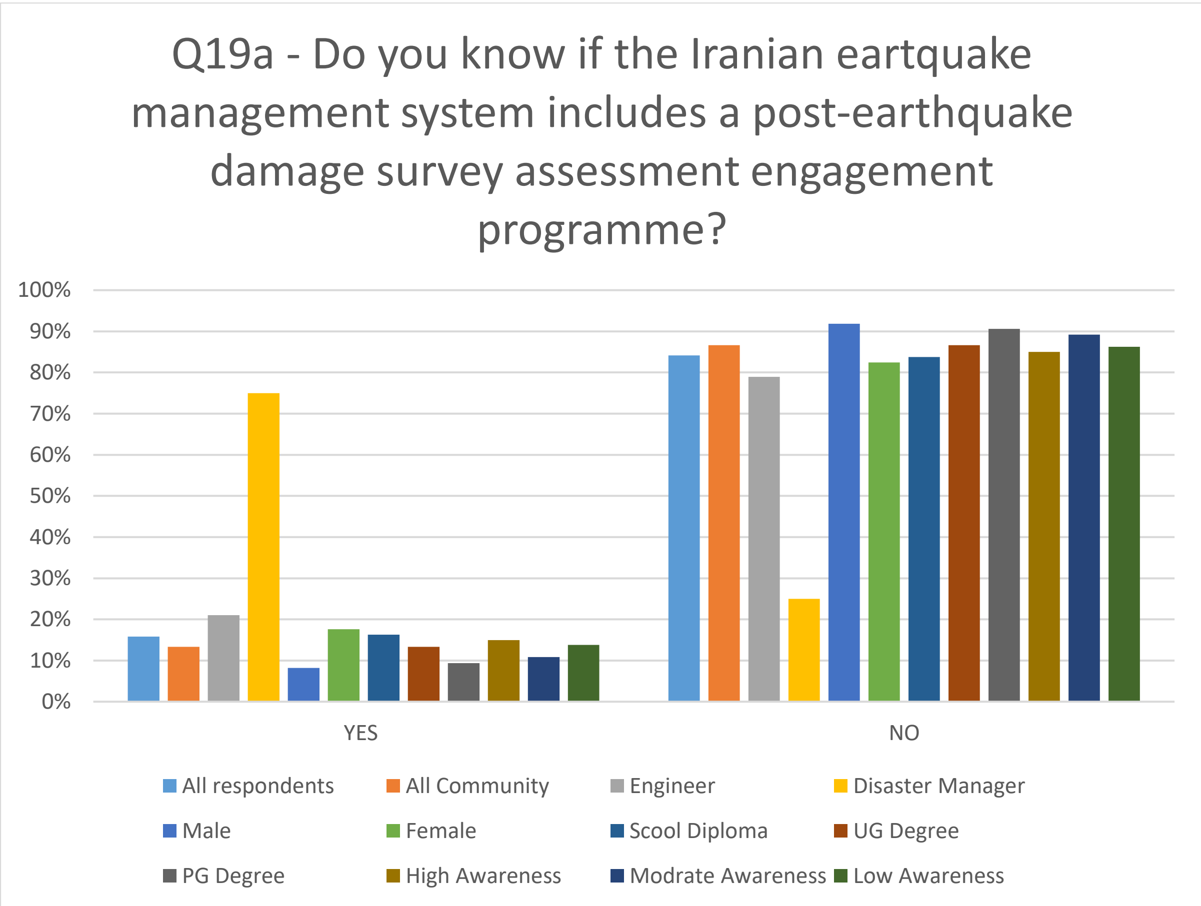


Figure 6.1 Summary of respondents to Q19a (if the Iranian EIMS includes a post-earthquake damage survey assessment engagement programme).

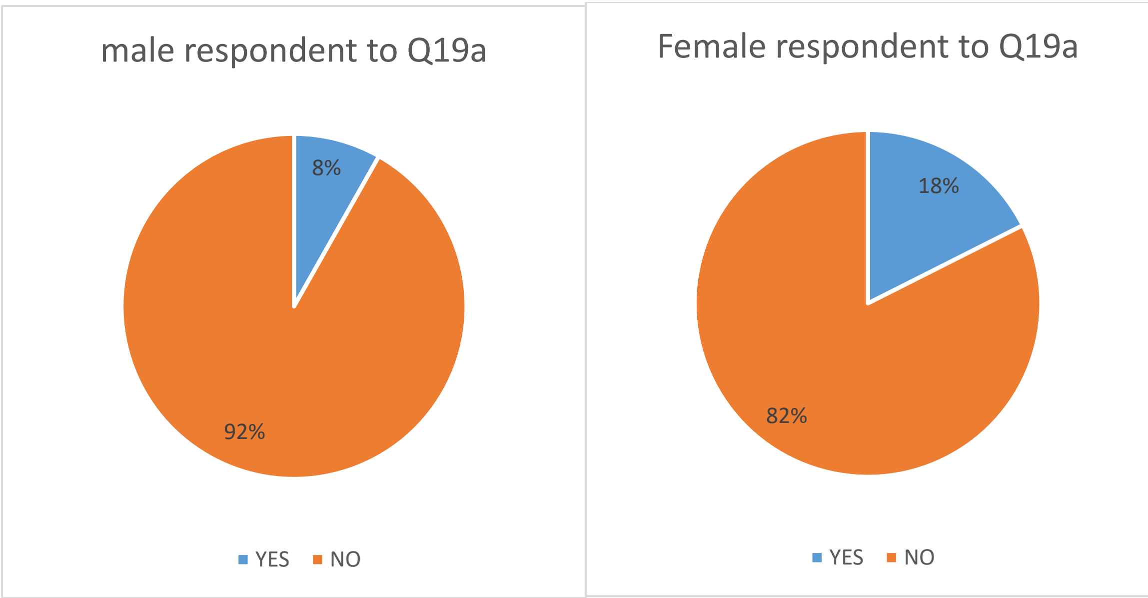


Figure 6.2 Gender of respondents to Q19a.

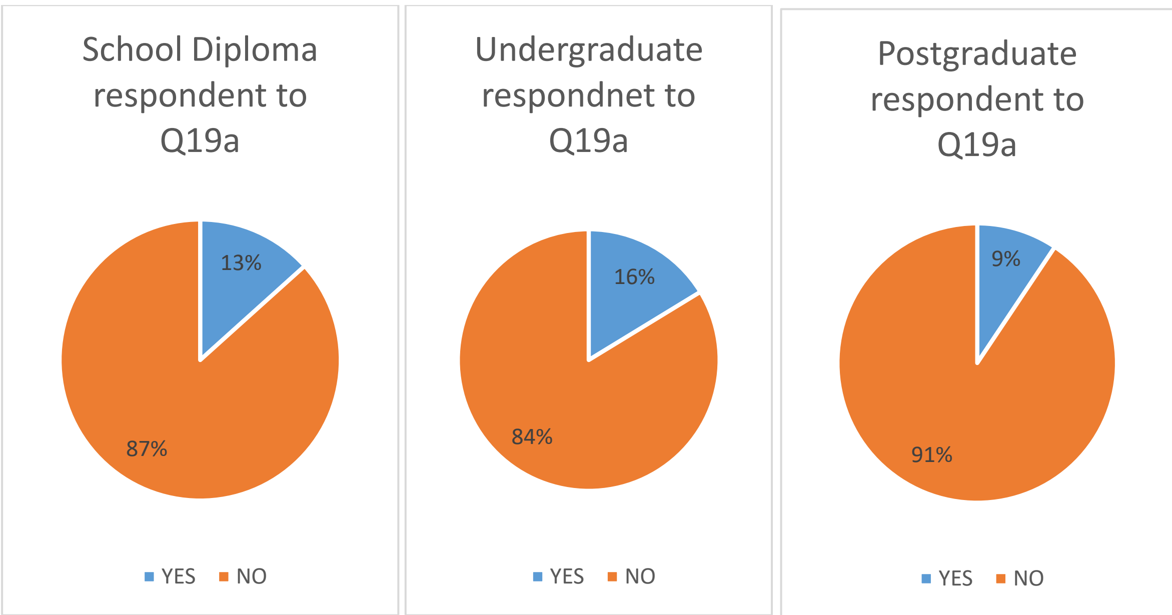


Figure 6.3 Academic qualifications of respondents to Q19a.

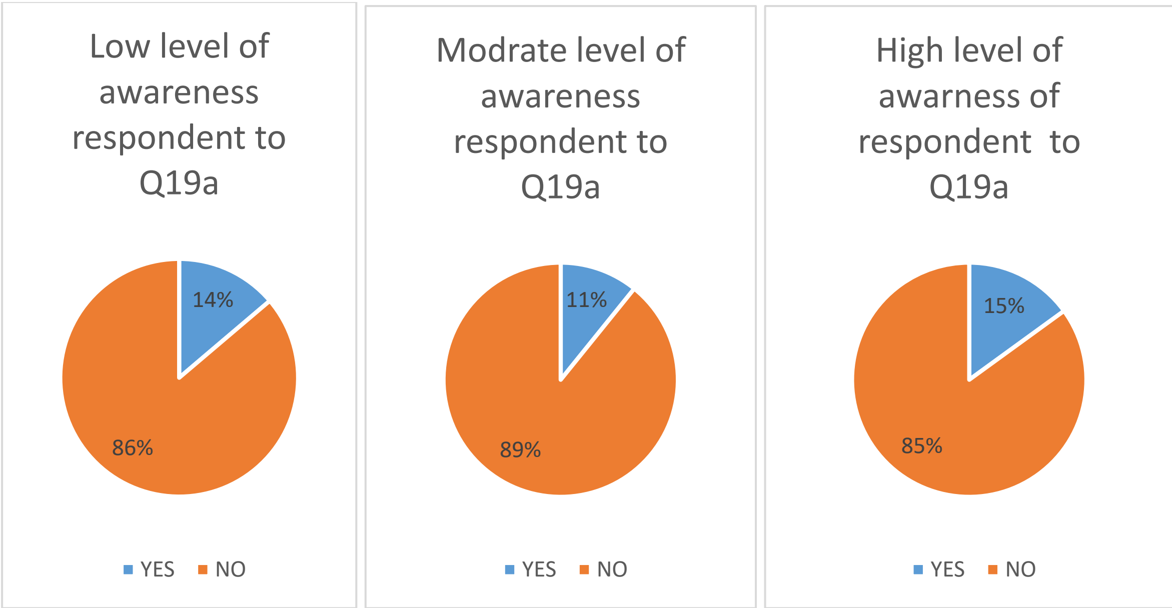


Figure 6.4 Level of awareness of respondents to Q19a.

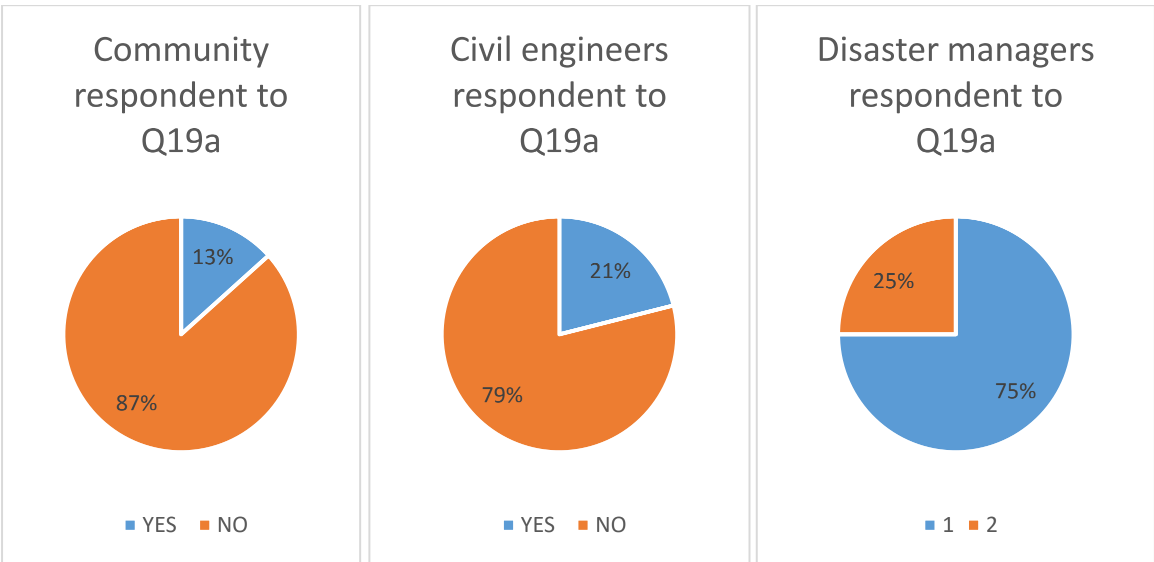


Figure 6.5 Profile of respondents to Q19a.

The response to Q19a, aligned very closely with previous research Movahedi (2003), Okano (2005), Hosseini (2009), Izadkhah (2009) and is a powerful and clear indication that, in Iran, there is significant need to improve post-earthquake disaster management engagement programme. The fact that the view provided by disaster managers is so different to all the other sub-groups hints to a potential problem, one that previous research has not found. Disaster managers are the key custodians and operators of the EIMS system, within which engagement activity must be managed Ajmani (2009). As such, if the disaster managers consider that engagement activity is adequate, then they might resist proposals to do more. This is an important potential finding from this research. What Q19a did not reveal is whether disaster managers were aware that their views differ by such a margin from other groups in Iranian society. Further analysis below will help to improve that understanding.

To up-date finding from previous research Movahedi (2003), Okano (2005), Hosseini (2009), Izadkhah (2009). The author compiled a list that communities could be engaged in the post-earthquake damage survey assessment system. In the survey, question 19b listed those communities and asked respondents to score each one on a three-point scale. A score value of 1 indicated that the group was always engaged and a score value of 3 indicated that the group was never engaged. No previous research has provided a detailed analysis of the level of engagement of different communities in the Iranian disaster management system.

For the analysis, the mean score given to each community by each sub-group in the survey sample, was calculated. Then the list of communities was ranked by the overall mean of means score. A lower mean score represented a higher level of engagement of each community (Table 6.1).

Table 6.1, individual results were colour shaded, with results closest to 1, shaded green and results closest to 3 shaded red. The colour shading helps to highlight one important finding linked to the results for Q19a, namely that the disaster managers' answers are at odds with all other samples. 3 out of the 4-disaster manager completed this section of the survey and they almost unanimously scored the level of engagement at 1 for all communities. Just one disaster manager considered that disabled and vulnerable groups, international disaster relief agencies and emergency services were sometimes engaged (score 2). The fact that no other sub-group had a similar set of results suggests a serious disconnect between the disaster management authorities and the rest of the population. If the disaster managers are correct, then they may only be working with a small group of the population, who were not represented in the survey sample for this thesis. Further analysis of qualitative data would be needed to add clarity to this important finding.

Table 6.1 Answers to the question 19b asking respondents to indicate how often the post-earthquake structural assessment programme in Iran engages with each entity.

			Mean score for each sub-group										
Rank	Description	Mean of means	Residents	Engineers	Disaster Managers	Males	Females	School Diploma	UG Degree	PG Degree	High Awareness	Moderate Awareness	Low Awareness
1	Disabled and vulnerable groups	1.55	2.13	1.57	1.33	1.40	1.63	1.44	1.56	1.67	1.57	1.25	1.46
2	School children	1.62	2.00	1.57	1.00	1.80	1.61	1.56	1.89	1.60	1.50	1.50	1.85
3	Disaster managers	1.63	1.65	1.71	1.00	1.80	1.79	1.56	1.89	2.00	1.80	1.00	1.77
4	International disaster relief agencies	1.70	1.68	1.71	1.33	2.00	1.59	1.78	2.13	1.40	1.83	1.75	1.46
5	Local Government organisations	1.72	1.71	1.71	1.00	1.80	1.93	1.75	1.88	1.75	2.20	1.25	1.92
6	Emergency services	1.73	1.45	1.57	1.33	2.00	1.88	1.88	1.78	2.17	2.25	1.00	1.77
7	Building inspectors	1.74	1.79	1.86	1.00	2.00	1.65	1.67	1.56	1.80	2.00	2.00	1.82
8	Religious groups	1.75	2.32	1.71	1.00	1.40	1.79	2.00	2.13	1.20	1.80	1.50	2.38
9	Health professionals	1.75	1.68	1.57	1.00	1.80	1.47	1.86	1.88	2.17	2.60	1.25	2.00
10	Engineers	1.76	1.83	1.71	1.00	2.60	2.11	1.89	2.13	1.50	1.80	1.00	1.75
11	National Government ministries	1.77	1.90	2.00	1.00	2.20	2.06	1.60	1.50	1.80	2.33	1.40	1.64
12	Neighbouring communities	1.79	1.85	1.86	1.00	1.80	2.06	1.88	1.67	1.40	2.14	2.00	2.00
13	Volunteer groups	1.82	1.70	1.86	1.00	2.00	1.69	1.67	1.78	1.80	2.00	2.50	2.00
14	Non-Governmental Organisations	1.84	2.00	1.86	1.00	1.83	1.76	1.78	2.38	2.00	2.00	2.00	1.64
15	The victim community	1.88	1.71	1.71	1.00	1.60	1.72	1.88	1.88	2.80	2.67	1.75	1.92
16	Transport authorities	1.88	1.74	2.00	1.00	1.80	2.24	2.00	2.33	2.00	1.83	2.00	1.75

Rank value 1 (always) to 3 (never)

Colour shading shows the top ranked element in green and the lowest ranked element in red, for each survey sub-group

Further detailed analysis of the results presented in Table 6.2, was conducted using a theoretical ranking of the communities. The theoretical rank order was developed by the author, based on my research into engagement practices (Section 2.2.4), my understanding of EIMSs and analysis of the EIMS in Iran (Chapter 4) and my knowledge of post-earthquake damage survey assessment (Chapter 5). Table 6.2 shows that my theoretical rank order for the engagement of different community groups and the actual ranking each community achieved based in analysis of the survey data. In table 6.2 communities were grouped into four clusters. Cluster 1 includes communities that must be engaged after every earthquake. Cluster 2 includes groups that may be engaged after every earthquake. Cluster 3 includes groups that should be supporting the engagement activity of cluster 1 and 2 communities after every earthquake. Cluster 4 are communities that are only likely to be engaged if there are insufficient resources provided by cluster 1 and 2 communities.

Table 6.2 Theoretical ranking of community groups for engagement in a post-earthquake structural assessment programme.

Cluster Level	Theoretical Ranking	Actual Ranking	Description
1	1	10	Engineers
	2	7	Building inspectors
	3	3	Disaster managers
	4	4	International disaster relief agencies
2	5	6	Emergency services
	6	12	Neighbouring communities
	7	13	Volunteer groups
	8	14	Non-Governmental Organisations
3	9	5	Local Government organisations
	10	11	National Government ministries
	11	16	Transport authorities
4	12	8	Religious groups
	13	9	Health professionals
	14	2	School children
	15	1	Disabled and vulnerable groups
	16	15	The victim community

The colour coding of the “Actual Ranking” column in table 6.2 shows how well the ranking relates to the theoretical rank. Green is good correlation, with community in the right cluster. Orange is moderate correlation, with community in the wrong cluster but given a higher rank than in the theoretical order. Red is poor correlation, with community in incorrect cluster and rank lower than in the theoretical order. This coding allows strengths and weaknesses in the results to be assessed.

Starting with the strengths in the efforts by Iranian authorities to engage communities in post-earthquake damage survey assessment activity, this research can reveal that 4 community groups are currently being engaged at an appropriate level. Within Cluster 1, the ranking suggests that Disaster Managers and International Disaster Relief Agencies are engaged very often. In cluster 2, Emergency Services are also engaged at an appropriate level. In cluster 3, National Government Ministries are engaged at an appropriate level and finally, in cluster 4, the victim community is the last community to seek engagement from and is appropriately ranked.

Five community groups had a moderate level of correlation with the theoretical ranking. One community in cluster 3, the Local Government Organisations, is engaged at a higher level than the theoretical ranking. This could be a unique feature of the Iran system; whereby local government organisations have a more important role in post-earthquake damage survey assessment. On that basis, this result could be interpreted as an additional strength in the Iranian system. The remaining four communities were all in cluster 4 and achieved a significantly higher ranking than the theory would suggest is wise. The results suggested that religious groups, Health professionals, School children and disabled and vulnerable groups were frequently engaged. I did not interpret their higher level of engagement as a strength in the Iranian system, rather their engagement could be the result of a weakness in the level of engagement by other, better suited community groups.

Looking at the weaknesses suggested by the ranking system, the results identify six communities that are not engaged as much as they need to be. Two communities in cluster 1 had a low correlation with their theoretical ranking, Engineers, and Building Inspectors. This points to serious and fundamental weakness in the Iranian post-earthquake damage survey assessment system, as both engineers and building inspectors play a crucial role in that system. In cluster 2, three of the four communities are poorly correlated with their theoretical ranking. Neighbourhood communities, volunteer groups and non-governmental organisations all have the potential to provide valuable resources for a post-earthquake damage survey assessment programme, but their engagement seems too much less than they should be. It is possibly the poor level of engagement by these communities that may explain why religious groups, health professionals, school children and disabled and vulnerable groups were more frequently engaged (as discussed above). The final poorly correlated community is in cluster 3 and is the Transport authorities. This community is important in a post-earthquake response, as transport infrastructure is crucial to maintain an effective response, so their lack of engagement is a problem for the Iranian system.

At this stage it may be useful to pause and blend the results of the phenomenological analysis with the ethnographic analysis, to reveal important insights about the Iranian disaster management system derived from this research. What this research has found, is that Disaster Management, National Governmental agencies, and emergency services were evident in their engagement in post-earthquake activity, exactly as the survey predicted. No international disaster relief agencies were evident, but then the event was too small for such a response. There was also evidence of the engagement of religious groups, again, as predicted by the phenomenological analysis, but at the expense of engagement by more organised and better qualified communities of engineers and building inspectors. The survey also predicted that Neighbourhood communities, volunteer groups and non-governmental organisations would be less engaged, but the scenario suggests that is possibly not the case, rather it is that the efforts of those communities was not well organised. One final ethnographical observation that did correlate well with the survey, was that transport authorities were not effectively engaged and that their lack of engagement did hamper post-earthquake relief efforts. Previous research has not provided this level of insight about the system in Iran.

6.2 Qualitative deepening of understanding about engagement practices linked to disaster management and post-earthquake damage survey assessment in Iran

In the survey, the author asked respondents if they believe that an effective post-earthquake damage survey assessment engagement system is achievable in Iran (question 20a). The responses were not overly positive, as the largest proportion (48%) replied “Do not know”. That said, of other 52%, more were positive, responding “Yes” (32%) compared to those who were negative, responding “No” (20%) (Figure 6.2).

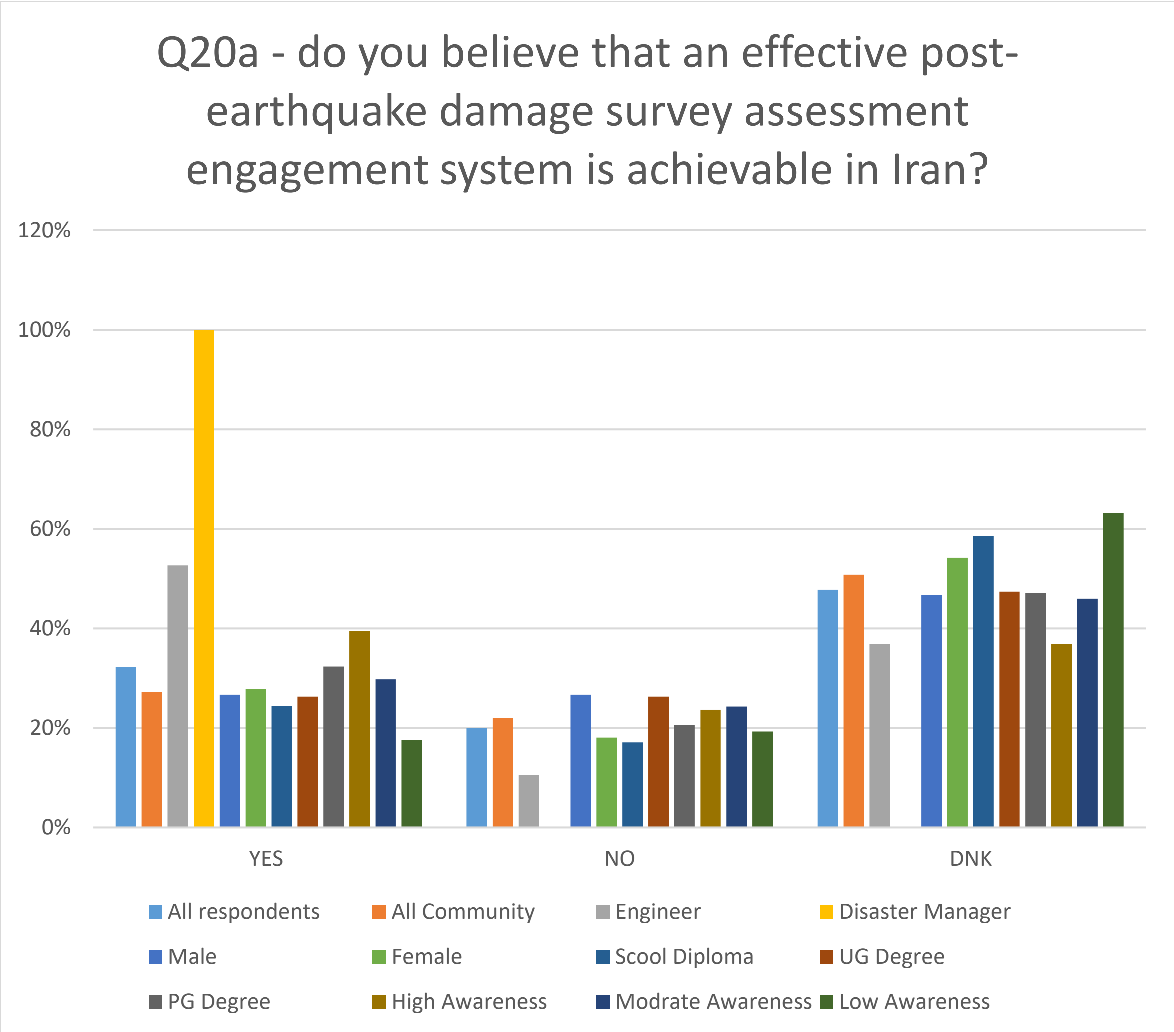


Figure 6.6 Summary of respondents to Q20a (if they believed that an effective post-earthquake damage survey assessment engagement system is achievable in Iran).

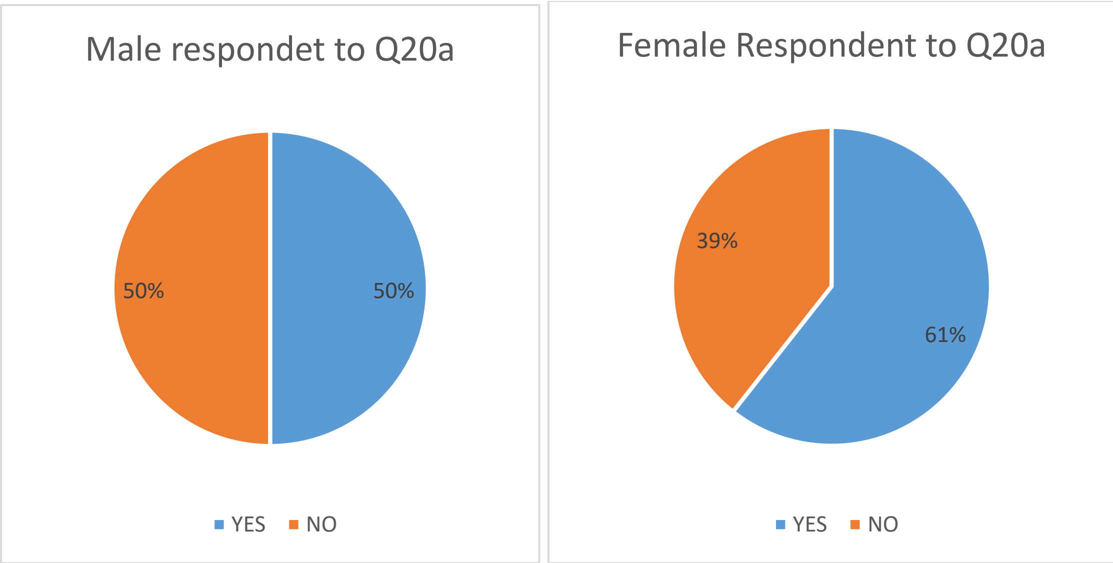


Figure 6.7 Gender of respondents to Q20a.

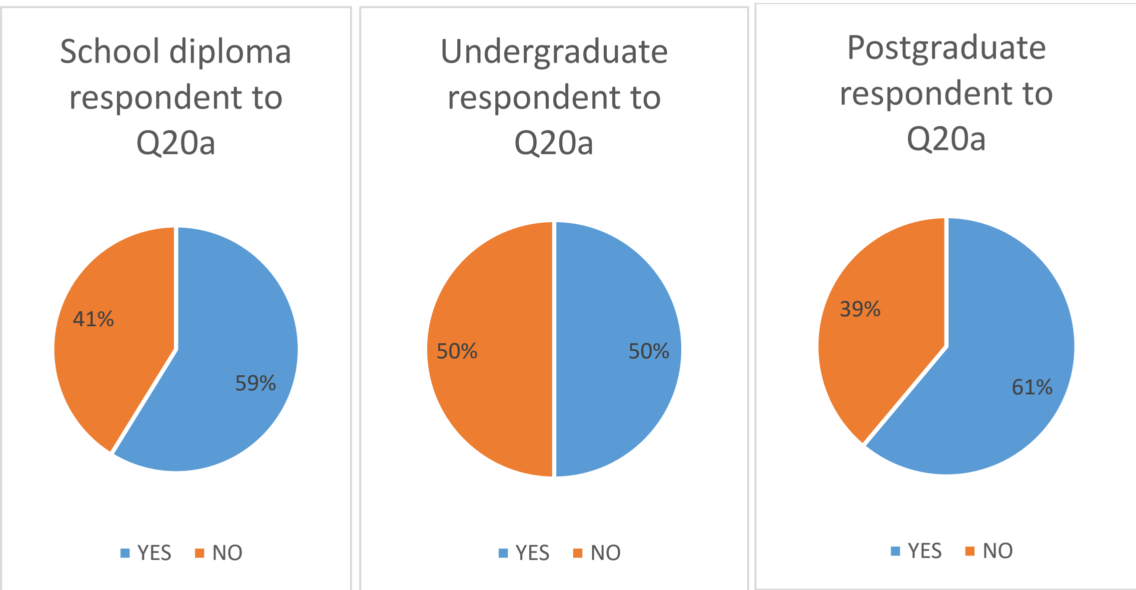


Figure 6.8 Academic qualifications of respondents to Q20a.

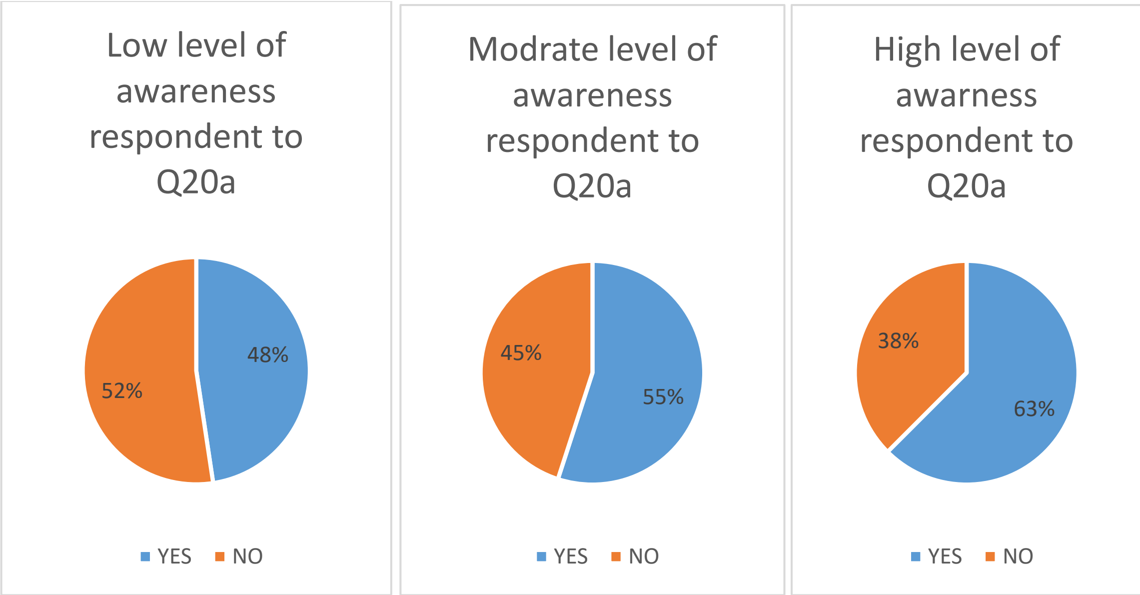


Figure 6.9 Level of awareness of respondents to Q20a.

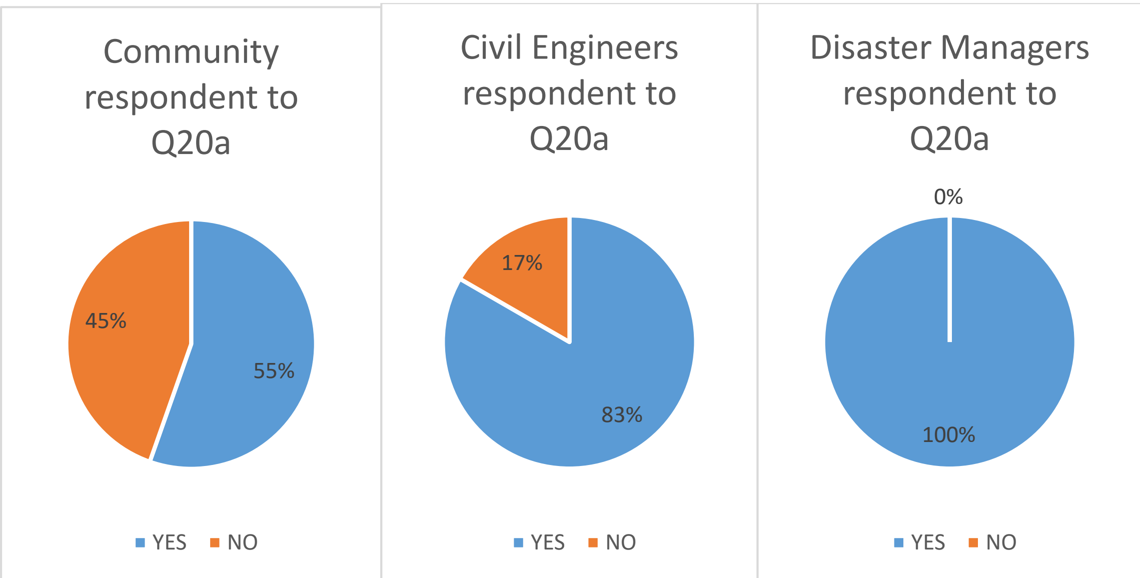


Figure 6.10 Profile of respondents to Q20a.

As in the previous section above, the Disaster Managers again distinguished themselves as being at odds with the rest of the survey sample, with 100% replying YES. Importantly this research, the engineers were also very positive, with 53% responding that an effective post-earthquake damage survey assessment engagement system is achievable in Iran. This is a very positive finding, as in the previous section above, the finding was that engineers were not as engaged as they should be. This result shows that efforts to improve their level of engagement may receive a positive response. Another affirming response was that the higher the level of awareness, the more likely the respondents were to think that an effective post-earthquake damage survey assessment engagement system is achievable in Iran (39% responding YES). Male respondents were equally divided between YES and NO, but Female respondents were more likely to say YES. As with the level of awareness, there was evidence that as the respondent's level of education increased, so their level of optimism also increased, with more highly qualified respondents responding YES compared to those with just a School Diploma. This last point will be explored in more detail in the Chapter 6, which will focus on education issues.

The second part of Question 20 (Q20b) asked respondents to provide a brief explanation their answer to the first part that was analysed above (Q20a). Answers to Q20b are analysed below.

Disaster Manager Beliefs

Just one disaster manager provided a qualitative response to question 20b.

> *"People do tend to take part in assessing their own building in times of disaster." (Respondent 172, 3111).*

The disaster manager's response was ambiguous and could be interpreted positively or negatively. In a positive interpretation, it suggests that engagement is being done, so proposals to do more could easily be achieved. In a negative light, the response could mean that engagement activities are being done, and no more are wanted.

Engineer beliefs

Responses from engineers could help to judge whether the positive or negative interpretation of the disaster manager response is valid. In total, 9 engineers provided qualitative feedback, interestingly, of those, all were male. All of the female engineers answered "do not know" to this question. Three of the male engineers, had post-graduate qualifications and a high level of awareness of the earthquake management system (matching the Disaster Manager profile), they stated:

> *"According to the Iranian community, giving incentive packages would be a great encouragement" (Respondent 154, 2111).*

"As relevant organisations work in competition and not in co-operation with each other, achieving this seems to be highly unlikely." (Respondent 164, 2111).

"This is possible due, to the sympathetic nature of the Iranian people in times of a disaster." (Respondent 169, 2111).

The statements were split, 2 with a positive interpretation, suggesting engagement actions would be incentivising and encouraging engagement in the aftermath of a disaster. The negative interpretation related to the history of non-cooperation between organisations in a disaster response. Another engineers, with high awareness, but slightly less qualified echoed the pessimistic view, stating:

"According to my experience, executing the plan in disaster management is very difficult as there are a lot of negativities." (Respondent 156, 2121)

The remaining five engineers, had lower levels of awareness of the earthquake management system, but all were much more positive:

"Yes, through encouraging people to be trained by an expert, competent workforce" (Respondent 165, 2112)

"It is achievable, if all the relevant organisations know their responsibilities as well as work collectively and in co-operation with each other" (Respondent 168, 2112.

"Yes, due to the high number of educated people (civil engineers) and the high willingness of people to help, as seen in recent earthquake. It is expected that, through better organizations and co-operation amongst related organisation, this task is achievable" (Respondent 171, 2112)

"Of course, through planning and having up to date knowledge of the world in this field, as well as strong management from disaster management team in every city in Iran" (Respondent 167,2122)

In contrast to the analysis of Q20a, what these responses reveal is that the more aware the engineers were, of the earthquake management system in Iran, the more pessimistic they became about engagement with the process. But there was a belief that engagement in post-earthquake damage survey assessment was not just possible, but that it must be achievable:

"It must be achievable, as it is a necessity" (Respondent 166, 2123)

Resident beliefs

In total, 35 residents provided qualitative feedback (18 males and 17 female respondents).

Male residents

Two male residents matched the disaster manager control group profile, with high qualifications and high awareness of the earthquake management system. Their views were completely opposite to each other. One was positive, but only if financial support was available and the other was negative due to weak management in Iran.

"Yes, very limited provided that the financial support is available" (Respondent 21, 1111)

"No, through weak management or mismanagement, this is not possible in Iran" (Respondent 92, 1111)

Another two male residents, with post-graduate qualifications but only moderate awareness was not very positive. Either claiming no expertise (despite claiming a high level of awareness), or suggesting that that there is currently no such system in Iran.

"I have no expertise in this field" (Respondent 1, 1112)

"No supervision and action are done in this field" (Respondent 103, 1112)

The next two male respondents were less highly qualified but had a high level of awareness of the earthquake management system. Their responses were again, quite unspecific and unclear, but suggested that there was a need to improve engagement activity with the public.

"When an earthquake happens, it creates a lot of problems such as accommodations, food, water, and electricity etc….and these problems do exist for a long-time post-earthquake" (Respondent 124, 1121)

"Yes, we feel the need for raising awareness of the public" (Respondent 148, 1121)

The one male resident with an undergraduate qualification and moderate awareness was again pessimistic, thinking that a post-earthquake damage survey assessment engagement system is not achievable in Iran.

"It is not possible in Iran" (Respondent 99, 1122)

The next four male respondents all had undergraduate qualifications and low awareness. 3 out of the 4 were positive, thinking that the post-earthquake damage survey assessment engagement system is achievable in Iran. On the positive side, the view was it would require ongoing training, hard work and re-education. On the negative side, the view was that current management systems had too many challenges to make it happen.

"We can do this conditional on ongoing training" (Respondent 101, 1123)

"No, as currently the slow management has a lot of challenges in itself, and we have no management in disaster" (Respondent 134, 1123)

"Yes, through hard work and re-education" (Respondent 137, 1123)

"Yes, given the foundation in disaster management this is achievable" (Respondent 139, 1123)

Two male residents had school diplomas and moderate awareness and were split in their response. One not believing that there was a system in place and the other considering that it was possible, if given the right information and training.

"In my personal opinion the system does not exist in Iran" (Respondent 15, 1132)

"It is achievable through giving the right information and training to public. (Respondent 19, 1132)

At the lowest level, two male residents with school diploma and low awareness were also split in their opinion on whether an effective post-earthquake damage survey assessment engagement system is achievable in Iran. No because of management ineffectiveness and yes if training was provided.

"No, as managers do not question anything" (respondent 112, 1133)

“Yes, by offering necessary training” (Respondent 133, 1133)

Three final male resident respondents were not clear on their level of awareness of the earthquake management system in Iran. They were split 2 to 1 in favour of the belief that an engagement system was possible in Iran.

“Yes, through co-operation and planning between disaster management organization and governmental organizations” (Respondent 75,112)

‘’It is achievable giving the experience of engineers and architects in Iran which goes back thousands of years as well as the modern technologies available’’ (Respondent 35, 1)

“Experience has shown group works and discussions have not been taught in Iran properly and it has proven fruitless” (Respondent 132, 1)

Overall, the male resident responses were quite divided, and that divide continued through all levels of education and all levels of awareness of the Iranian earthquake management system. There was potentially a small balance in favour of the belief that an effective post-earthquake damage survey assessment engagement system is achievable in Iran. However, the obstacles to that believe were deeply seated, mainly focussed on a negative view of current earthquake management systems and manager. A lot of work would need to be done to overcome that entrenched view, but enough of the resident population were open to the idea of engaging in new training and re-education to make a small programme of activity quite a viable consideration.

Female residents

One female resident response was from a person matching the control group criteria, with a post-graduate education and high awareness. She had a positive belief, thinking that better cooperation between the structural engineer association and building association was key to achieving better engagement.

“Yes, at the moment management is the responsibility of ''association of engineers'' as well as ''house building association'' and these two must co-operate together for better engagement” (Respondent 109, 1211)

Another two women residents, with post graduate education but only moderate awareness, were also positive. They thought that effective engagement was possible if the expert and professional workforce was willing to put the effort into it.

> *"On going and tireless efforts by the experts and professional workforce in this field" (Respondent 113, 1212)*

> *"Yes, if they wanted to" (Respondent 95, 1212)*

The final female resident with high levels of education had a low level of earthquake management awareness, but she was also positive in her belief:

> *"In some circumstances, possibly" (Respondent 38, 1213)*

Another four female residents with undergraduate qualifications and high awareness were all positive. They suggested that expert help within a broad framework of training would be achievable.

> *"Establishing expert organizations or asking help from volunteer groups" (Respondent 7, 1221)*

> *"Prevention measures must be done for future disasters as post assessment of earthquake is not enough by itself" (Respondent 16, 1221)*

> *"It is achievable through training in council as well as relevant organizations" (Respondent 51, 1221)*

> *"Yes, people like to take part in building assessment" (Respondent 28, 1221)*

Two women with undergraduate qualifications, but with low awareness levels, were similarly positive.

> *"It can be done in Iran" (Respondent 48, 1223)*

> *"Only through public training" (Respondent 144, 1223)*

One woman, who only had a school diploma, but high awareness suggested that cooperation between an expert workforce and non-governmental organisations could facilitate the engagement process.

“Crisis management organization/ red cross could cooperate with expert organizations. Use of an expert workforce” (Respondent 6, 1231)

The five remaining female responses had school education and moderate or low levels of awareness of the earthquake management system. Four of the five were positive, the only negative response reflecting some dissatisfaction with current disaster management authorities.

“Yes, if the people who are in charge do not possess the ''live and let’s hope'' approach. Increase of educational level, as well as cooperation between relevant organizations in order to have efficient assistance network” (Respondent 59, 1232)

“The question is ''have we established such a system yet''??” (Respondent 60, 1232)

“Yes, through discussion and co-operation between people and government at local level and in such places as schools and masques” (Respondent 114, 1232)

“No, As Managers are not responsible and accountable” (Respondent 122, 1233)

“Yes, it is achievable” (Respondent 41, 1233)

On final respondent did not specify her level of awareness, but her view was also positive.

“Public training and giving relevant information to public is very important” (Respondent 9, 12)

What is immediately apparent to the author, is the very different beliefs expressed by female residents, when compared to the male engineers and residents and the one male disaster manager. Overwhelmingly and across all levels of education and at all levels of awareness of the disaster management system, female residents in Tehran positively believed that an effective post-earthquake damage survey assessment engagement system is achievable in Iran. They even provided suggestions about how the process could be started; within a broader training programme, led by a network of experts from the engineering and building sectors. A critical feature of the programme, according to the female respondents was the engagement of experts, perhaps to counteract the distrust of existing disaster management authorities. They also proposed that non-governmental agencies could help in the implementation of the training and involve local schools and mosques. Some women went as far as to suggest that not only is such an engagement activity needed, but it is also actually wanted by residents. This, divergence in views, between genders in Iran is an extremely interesting finding, not evident in previously published research. It is an important contribution by this Thesis to current knowledge and understanding of programmes that seek to engage communities in post-earthquake disaster management.

Here again, it may be helpful to blend the ethnographical and phenomenological analyses to highlight important new learning about the disaster management system in Iran. What seems clear from the research in this thesis is that Disaster Management authorities would not be encouraging engagement in the post-earthquake response, or at least the message was not clear if engagement was wanted or not. Perhaps that lack of a clear message promoted a sense of distrust in the effectiveness of the disaster management authorities. The engineering community did not help the situation, themselves split in their belief about whether engagement would be effective or not. The non-governmental expert communities did not show leadership in the response, failing to help train and engage the resident community. That was possibly because male leaders of the professions were somewhat pessimistic about the outcome. In contrast, the female community residents were very eager for some kind of engagement opportunity, but needing expert guidance from the professional bodies. These insights are new, as the author was unable to find reports of similar research in the published literature.

6.3 Proposals to improve engagement practices linked to disaster management and post-earthquake damage survey assessment in Iran

In question 21 of the survey, respondents were asked if, assuming that the Iranian Earthquake Information Management dose includes a post-earthquake damage survey assessment engagement programme within it, “what do you believe needs to be done to raise awareness of the system?”.

Disaster Manager Beliefs

Just two disaster managers provided a qualitative response to question 21.

“Iran has a comprehensive engagement programme and it also uses the public as well as religious group” (172, 3111)

“[We] give training regarding post-earthquake structural damage to our Structural engineers and basic training to our people with reference to structural assessment” (Respondent 174, 3111).

The disaster manager responses were extremely positive for this research, claiming clearly and that post-earthquake damage survey assessment engagement programmes are being implemented in Iran. In a negative light, their responses are not supported by the observational data or other data collected by this research from the engineer community and the resident communities. This could mean that the post-earthquake engagement programme is quite narrowly focussed and engaged participants that were not included in the sample of respondents for this thesis study. It also suggests that it would be easy to achieve a significant impact and enhance the post-earthquake damage survey assessment system in Iran by simply broadened the existing engagement programme to include a much larger section of the engineering and resident communities.

Engineer beliefs

In total, 11 engineers provided qualitative feedback. As with question 21, all engineers who responded were male. Four of the engineers, had post-graduate qualifications and a high level of awareness of the earthquake management system (matching the Disaster Manager profile). Their suggestions were all positive, advocating a programme of more engagement spanning members of the public, managers, and people in charge of organisations. To incentivise engagement, it was suggested that the programme is built into some kind for legally enforceable requirement.

“Educating the public through mass media” (Respondent 153, 2111)

“We could improve our disaster management system by given an incentive packages to people and the output will be more effective” (Respondent 154, 2111)

“Putting in to action 'the plan' amongst managers and people in charge of relevant organisations” (Respondent 164, 2111)

"1. It must become a law. 2. Every responsibility must be clearly defined, (who is in charge of what). 3. Updating the law so that it stays relevant" (Respondent 170, 2111)

Five other engineers had the same level of education, but a moderate level of awareness. They provided a number of addition and positive suggestions. Those suggestions re-affirmed the proposal to make the programme a legally enforceable requirement, which included mass public education. Some specific points included analysing and publishing findings from the analysis of past earthquake events and engaging experts to help lead education campaigns.

"Record the lessons learnt from the post-earthquake. Print information's, books and advertising" (Respondent 152, 2112)

"Only by education and creating professional disaster managers" (Respondent 156, 2112)

"Firstly, have mass training through schools and the media. Secondly have expert training for all the people and this has to be organised between relevant organisations and responsible people" (Respondent 165, 2112)

"Through Publication of everyone and giving more information to people as well as training by the relevant organisations. Updating of co-operation system and information management between relevant organisations is of absolute necessity" (Respondent 167, 2122)

"Use experts in this field to raise awareness as well as sending these experts with engineers and contractors to effected areas in order to let people know what can be done. Sending these groups of people to international conferences and publishing their experiences could help to raise awareness as well" (Respondent 168, 2112)

"It must become a law so that every organisation knows what they are responsible for, before this step the government must make known to the public what responsibilities each organisation has" (Respondent 171,2112)

The final engineer had an undergraduate education and a low level of awareness. He emphasised the need for some kind of legal foundation for the programme.

"Relevant organisation must plan to raise awareness and eventually it must become a law" (Respondent 166, 2123)

<u>**Resident beliefs**</u>

In total, 55 residents provided qualitative feedback (26 males and 29 female respondents).

Male residents

Three males matched the disaster manager control group, with high qualifications and high levels of awareness. They proposed that training should be compulsory, with a clear foundation, clear lines of responsibility and government supported.

"There must be forces available that are responsible and government-supported who do the assessment task" (Respondent 21, 1111)

"The foundation for assessment must be laid out" (Respondent 91, 1111)

"Compulsory training" (Respondent 92, 1111)

The next two respondents also had high qualifications, but lower levels of awareness. They proposed clear action and modern communication methods to inform the public.

"Decrease in meetings and more action" (Respondent 103. 1112)

"Through using new ways of giving information to the public and increasing the knowledge of the university student through fundamental teaching" (Respondent 86, 1113)

Ten male residents had undergraduate level education, with 4 having high awareness, 2 with moderate awareness and 4 with low levels of awareness of the Iranian earthquake management system. The group with high awareness advocated a public programme, led by capable managers and using modern media methods.

"1. Using different programmes. 2. using competent and capable managers" (Respondent 30, 1121)

"Through the use of the public in a way that at least one person in every family is completely familiar with the system" (Respondent 124, 1121)

“Public awareness raising, having practical training in the country as well as positive use of media such as TV and radio” (Respondent 148, 1121)

“Create programme such as the public can take part in it” (Respondent 149, 1121)

Those with a moderate level of awareness advocated the use of experts to train engineers and council workers.

“The training must be given under the supervision of civil engineering as well as council workers” (Respondent 2, 1122)

“Through using peoples' information and co-operation between people and expert/experienced workforce raising awareness could be increased” (Respondent 143, 1122)

For the group with low awareness, the suggestions included strengthening top level management and using mass media to run a public education campaign.

“1. Education in schools.2. Education through broadcasting and organizations” (Respondent 101, 1123)

“The government must get public more involved and discussions must be made on the topic.” (Respondent 115, 1123)

“Correction of management at top level in the field of natural disasters such as floods and earthquakes” (Respondent 134, 1123)

“Through mass media (Radio, TV) and online resources” (Respondent 137, 1123)

The final eleven male residents all have school diploma level education, 3 with high awareness, 4 with moderate awareness and 4 with low awareness. Those with high levels of awareness advocated mass media for public education and strengthening planning in relevant organizations.

“Necessary training needs to be given” (Respondent 90, 1131)

“1. Training through media (short term).2. Training through very young age (long term)” (Respondent 136, 1131)

“Training and better planning amongst relevant organizations” (Respondent 17, 1131)

Those with moderate levels of awareness echoed many of the previous suggestions – mass media public campaign with participation of experts (potentially international experts) and relevant organisations.

“This system does not exist in Iran, if it does it only serves as misuse of budgets for personal use of relevant bosses” (Respondent 15, 1132)

“Giving the right information and mass media appropriate training with the participation of experts and professionals” (Respondent 19, 1132)

“Expert workforce at an international level must be used in this field. Or use the experience of people who are sent to America and Japan for studying” (Respondent 64, 1132)

“Repeated training programmes must be given and supervised to relevant organizations” (Respondent 138, 1132)

The male residents with school diplomas and low awareness also suggested a public engagement campaign led by experts in the field and supported by relevant organisations.

“1. Using the expert people in this field.2. Using the experience of the more advanced country” (Respondent 65, 1133)

“1. we could achieve our goal if the relevant organization do their duty correctly.2. If we want to get better results we need to use the more advanced country in this field” (Respondent 70, 1133)

“We need to have ''training for managers'' (Respondent 112, 1133)

“Raising awareness and public training” (Respondent 133, 1133)

Overall, the male resident responses were remarkably consistent across all levels of education and awareness of the earthquake management system.

Female Resident

Of the 29 female residents, 8 had high level of education, 10 had undergraduate level education and 11 had school diploma level education.

Females with high education, three had moderate awareness of the earthquake management system and they suggested education and equipment is needed for engineers, other relevant personnel as well as the public. They also advocated learning lessons from other earthquake prone countries.

> *"1. Providing the right equipment and environment.2. Re-education and training of engineers and relevant personnel.3. convincing the managers that they need to learn the right type of management" (Resident 95, 1212)*

> *"Use of experience of the countries that are prone to earthquake" (Resident 113, 1212)*

> *"1. broadcasting.2. Schools" (Resident 46, 1212)*

For the group with lower awareness levels, suggestions included public education programmes linked to other countries.

> *"Training, giving information on earthquakes and the damage that could result from having bad building regulations in case of an earthquake" (Resident 38, 1213)*

> *"Teaching people through education" (Resident 39, 1213)*

> *"Using billboards in order to increase the public information and knowledge through cities" (Resident 52, 1213)*

> *"Educational programme must be used (Resident 96, 1213)*

> *"Co-operation with advanced countries in this field, however; due to Iran's situation in the region this is very difficult and highly likely nothing is done" (Resident 98, 1213)*

In the female group with undergraduate education, three respondents had high awareness levels. These three suggested a modern public education programme is needed.

"EIMS does not exist in Iran and if it does it has no application and neither has any positive impact" (Resident 16, 1221)

"Raising awareness for the public" (Resident 51, 1221)

"The system must be very modern and up to date" (Resident 28, 1221)

Three more female respondents had moderate levels of awareness. They emphasised the need for a public education programme led by internationally recognised experts and competent managers.

"Training must be expanded, and must be given to the public" (Resident 47, 1222)

"1. having sufficient equipment.2. Having experts as disaster managers" (Resident 104, 1222)

"1. Sending Iranian student/academics/researchers to various countries for training and research.2. Having competent managers and long-term planning" (Resident 141, 1222)

The remaining four females in this group had low levels of awareness and they advocated that a public education programme, based on international experiences is regularly repeat using mass media.

"Reviewing prior research in this field as well as training in schools and through mass media can be done in order to raise awareness of the system" (Resident 20, 1223)

"Giving information mass media or giving information through university course or online" (Resident 145, 1223)

"Repeat the system every so often" (Resident 48, 1223)

"Forces that are trained under government programmes and use of other countries and their experiences in this field" (Resident 144, 1223)

The last group of 11 female respondents all had school diploma education. Only one had a high level of awareness and she advocated a public education programme.

"Teaching classes to increase the publics' knowledge and information" (Resident 6, 1231)

Four respondents had a moderate level of awareness. They suggested that the education programme should be compulsory, start in school and run through to university.

"Training must start from high school through to universities" (Respondent 58, 1232)

"1. Having a compulsory programme for everyone in every organization.2. Having a specific budget to plan and perform long term projects in order to raise awareness.3. Less wastages of financial resources as well as human resources in this field" (Resident 59, 1232)

"Increasing the knowledge level of people is very important to raise the awareness of the system" (Resident 60, 1232)

"The people must be discussed as to what the best course of action is" (Resident 114, 1232)

The final six female respondents also advocated public training led by experts and informed form other international experiences.

"Only training can be a help in this field" (Respondent 18, 1233)

"Getting information from experience and competent people" (Resident 41, 1233)

"Training the people" (Respondent 55, 1233)

"We need to raise our levels to advanced countries as well as having better equipment and facilities" (Resident 107, 1233)

"We need to have training in all of the country" (Resident 122, 1233)

"This could lead to save a lot of lives" (Respondent 14, 123x)

As with the male residents, the female resident responses were consistent across all levels of education and awareness of the earthquake management system in Iran. The resident views also correlated well with the views of the engineers. All the suggestions could be summarised as follows:

- An education programme is needed, that focusses on developing knowledge and understanding of the public, engineers, and managers.
- The education programme should be led by experts in the field and be informed through engagement with international studies from other earthquake prone countries.
- Some form of legal framework would be helpful to support its implementation across all levels of education, to make clear how roles and responsibilities are allocated and to explain the frequency with which the education is repeated.

In association with proposals to improve engagement practices linked to disaster management and post-earthquake damage survey assessment in Iran, question 22 asked respondents how often they thought that the strengths and weaknesses in the system are analysed. Figure 6.3 shows the answers to question 22, revealing that the most common response from most respondents was “Never”. As with previous questions, the disaster manager responses were at odds with all other sub-groups, as 100% of disaster managers replied that the system is reviewed every 5 years.

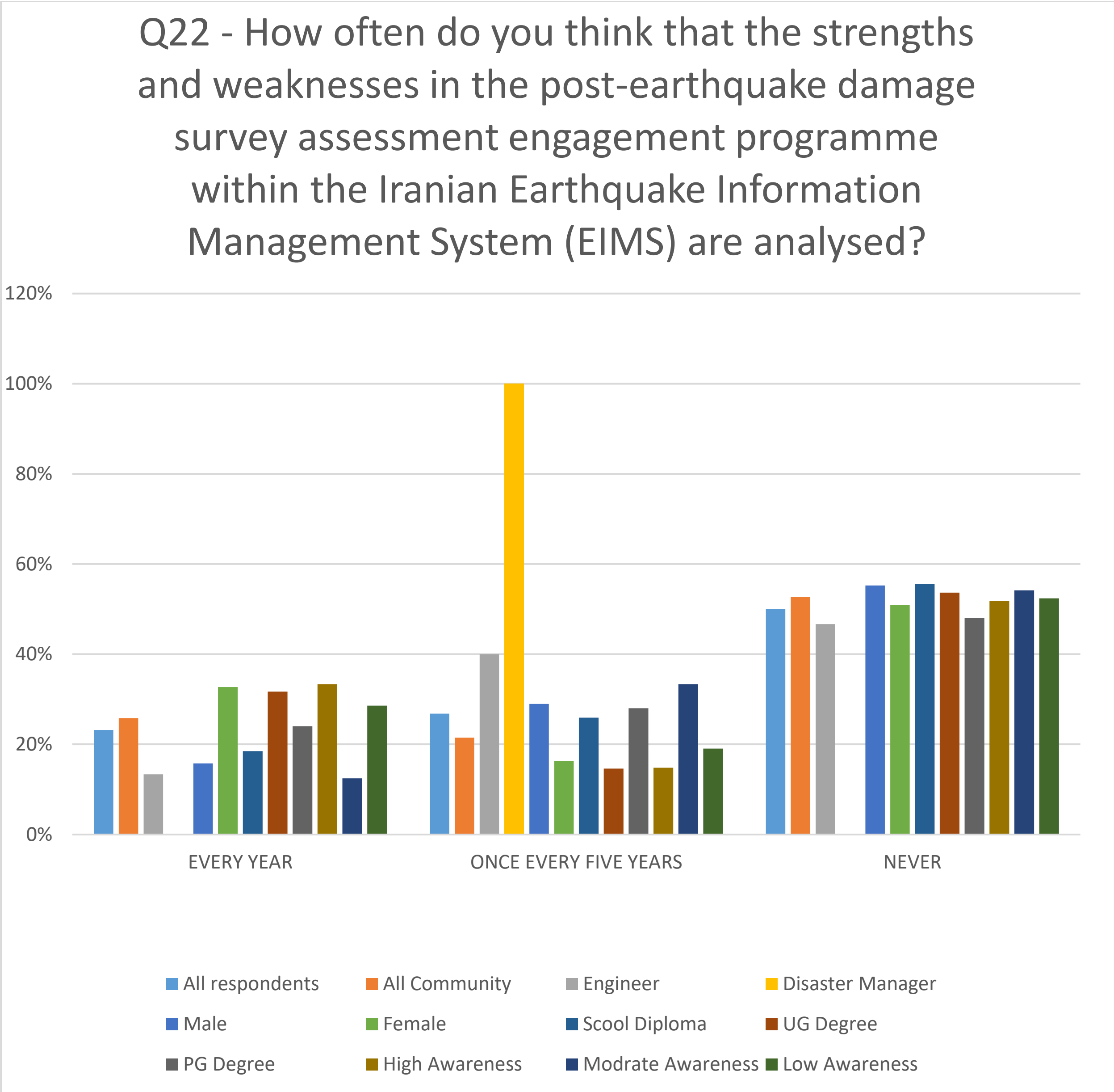


Figure 6.11 Summary of respondents to Q22a (how often strengths and weaknesses in the post-earthquake damage survey assessment engagement programme are analysed).

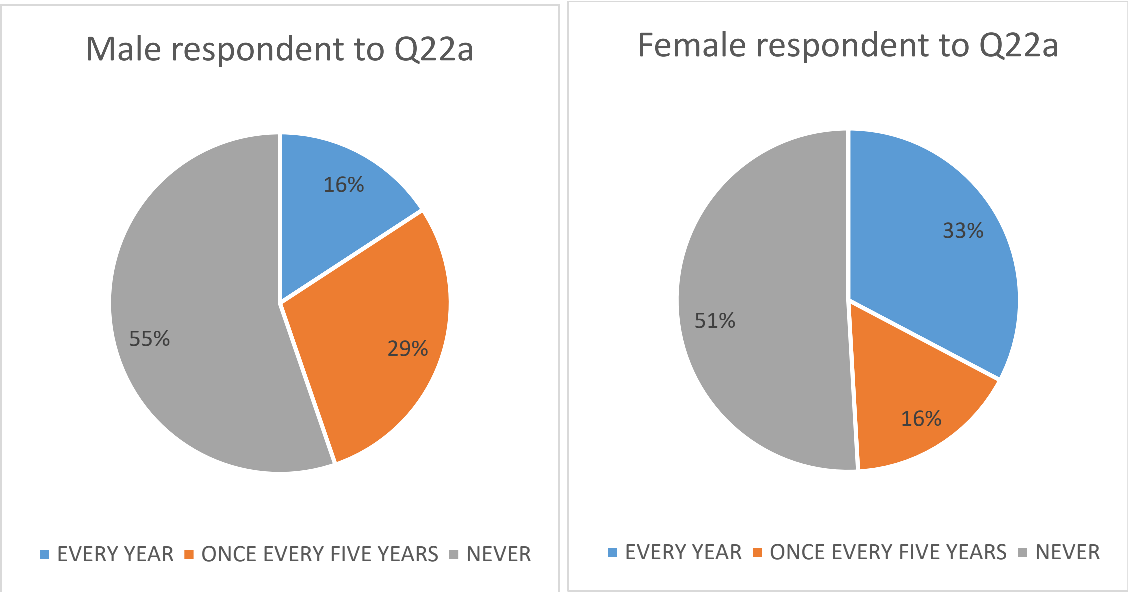


Figure 6.12 Gender of respondents to Q22a.

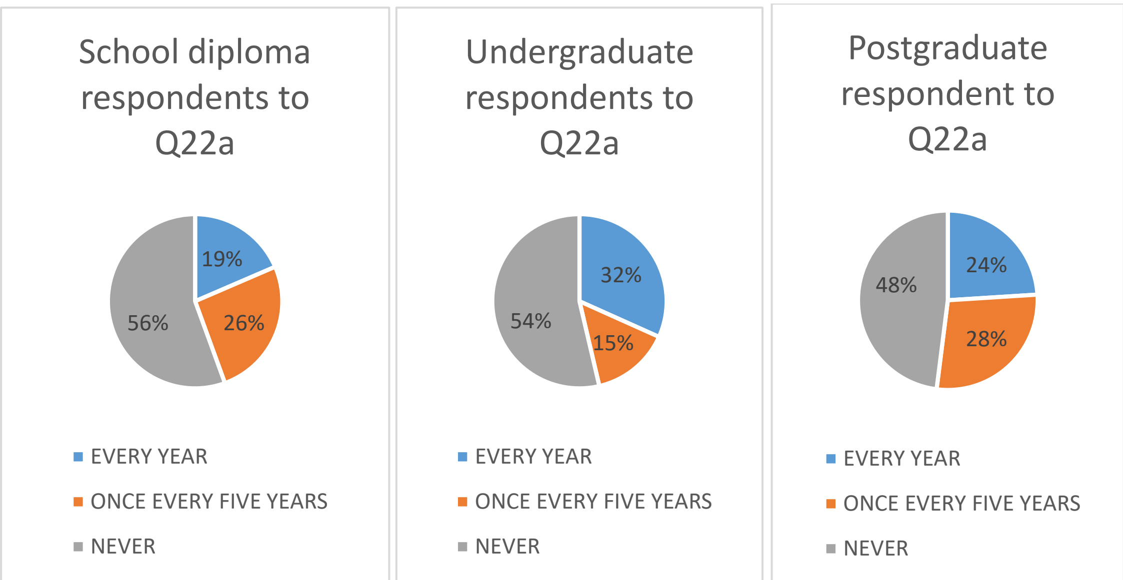


Figure 6.13 Academic qualification of respondents to Q22a.

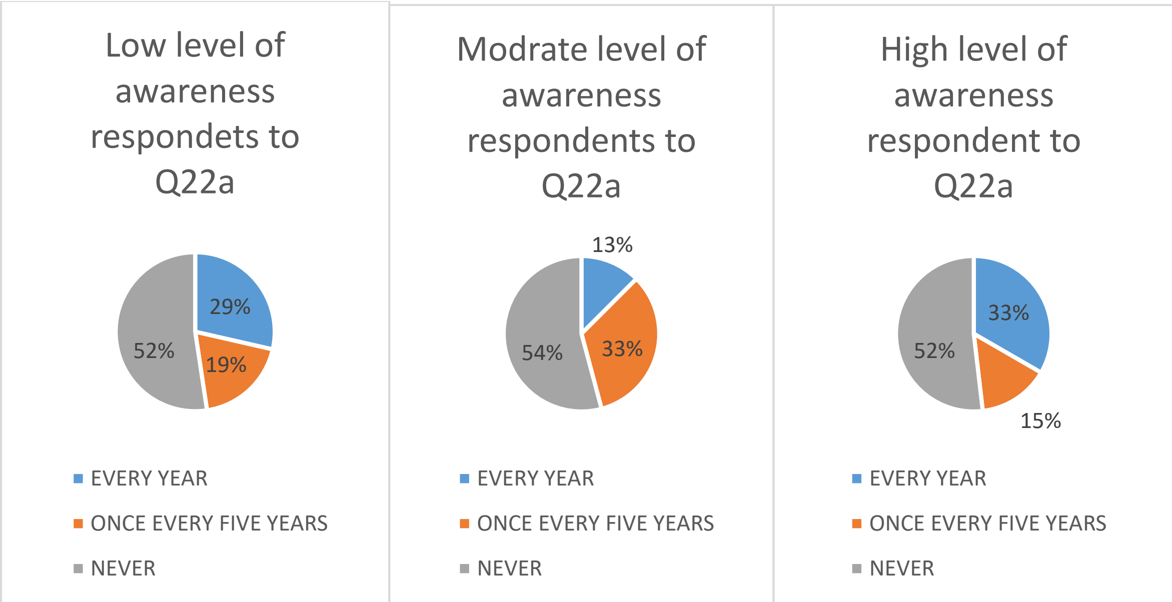


Figure 6.14 Level of awareness of respondents to Q22a.

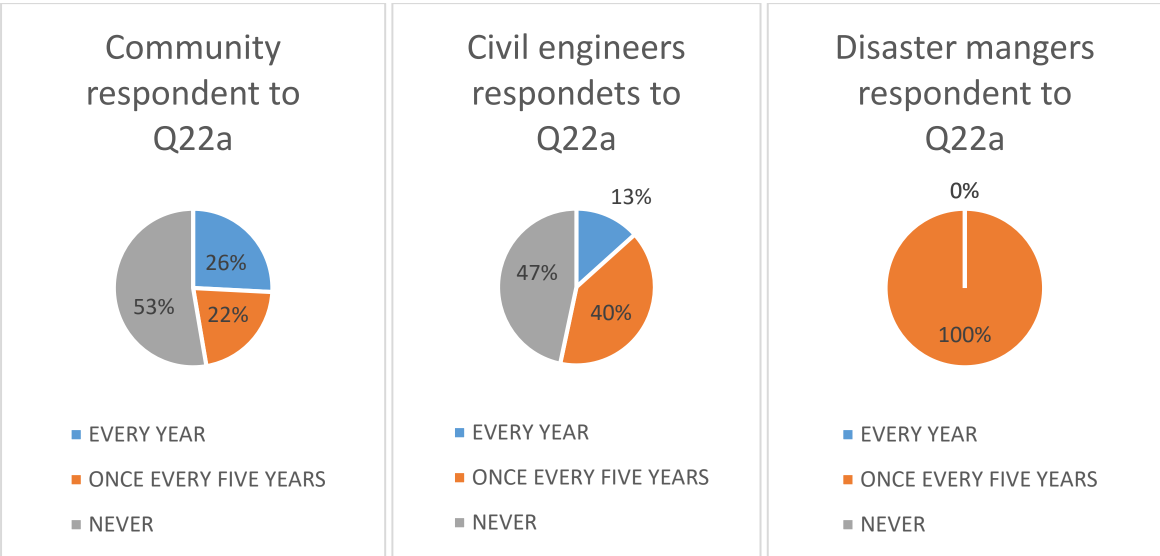


Figure 6.15 Profile of respondents to Q22a.

It is conceivable that the disaster managers in this instance are correct, and the others are wrong. That would be the case if all other sub-groups were not fully engaged in the process, which is possibly true.

Finally, respondent was asked how we often they think that the strengths and weaknesses in the post-earthquake damage survey assessment engagement programme within the Iranian Earthquake Information Management Systems (EIMS) should be analysed.

No disaster managers commented.

Three male engineers commented:

> *"Maybe after every earthquake" (Respondent 154, 2111)*
>
> *"I believe that analysing post-earthquake weaknesses and strengths can help how to build future structures immensely, however, this is not done and every earthquake leaves massive damages and fatalities" (Resident 165,2112)*
>
> *"When the damage is massive and fatalities are very high" (Resident 167, 2122)*

Four male residents commented:

> *"I am not aware of it" (Resident 19, 1132)*
>
> *"Only when disaster takes place" (Resident 133, 1133)*
>
> *"After the big earthquake" (Resident 136, 1131)*
>
> *"No proper information has been given to the public" (Resident 148, 1121)*

Two female residents commented:

> *"I live in the hope that this will be done every year" (Resident 7, 1221)*
>
> *"They would analysis it after the earthquake" (Resident 145, 1223)*

The responses from all sub-groups could be split into two main recommendations. At least some level of review should take place every year and a review should take place after every major earthquake event. That response is at odds with the disaster manager response that the system is only reviewed on a five-yearly pattern. With that pattern, it would take a very long time to implement any significant changes to the way in which the system operates.

To help learn what features of the Iranian post-earthquake damage survey assessment engagement programme need effort to improve awareness and understanding, the literature in Chapter 2 was used to compile a list of features that was considered the Iranian post-earthquake damage survey assessment engagement programme should include. It was clear in the literature that, the buildings were built with no understanding of earthquake code. The heavy traffic, lacking emergency response and preparedness to disaster as well as the Iranian public engagement and awareness make the task of getting the country more prepared against any earthquake much tougher. At its most fundamental, the post-earthquake disaster management system in Iran should facilitate the estimation of damage to the physical and social infrastructure. Non-governmental organization should provide training for effected people in the case disaster in Tehran. From the published research of post-earthquake damage survey assessment engagement programme systems across the world, I was able to describe a series of processes that effectively defined current best practice in post-earthquake damage survey assessment engagement programme.

6.4 Summary and main findings

This chapter set out to provide new insights about engagement in post-earthquake disaster management and damage survey assessment, using the system in Iran as a case study. Data from an observational visit, a variety of engagement activities undertaken by me and from a survey conducted in Tehran was analysed in order to reveal insights. Many of the insights relate directly to the Iran context, but some can be generalised to apply in a broader context.

From the author's research he has found that the post-earthquake disaster management engagement programme in Iran is very weak. Specifically, this research has revealed a lack of cooperation and engagement between the Iranian organizations in disaster management. This adds to findings from previous studies, which had suggested that better collaboration between Iranian organization and NGOs was needed. The author was able to pinpoint specific areas for action, like the need for the disaster management system in Iran to involve architects and civil and structural engineers actively and quickly in their post-earthquake damage survey assessment engagement programme.

Throughout the chapter, the author kept returning to my finding that the disaster management system in Iran needs to include all layer of the community in their programmes. That is needed to reduce the risk of earthquake vulnerability overall, otherwise Iran will continue to suffer badly whenever an earthquake strikes a population centre. To that end, the identified weak points in the Iranian system, namely:

- Iran is lacking cooperation with international disaster relief organizations.

- Iran needs to broaden the existing engagement programme to include the structural engineers and community resident.
- An engagement programme is needed, that focusses on developing knowledge and understanding of the public, engineers, and managers.
- The education programme should be led by experts in the field and be informed through engagement with international studies from other earthquake prone countries.
- Some form of legal framework would be helpful to support its implementation across all levels of education, to make clear how roles and responsibilities are allocated and to explain the frequency with which the education is repeated.

One point that the author has reflected on, based on their direct engagement activity, was that the Disaster Management authorities in Iran do not seem to be encouraging the engagement of architects, civil and structural engineers in the post-earthquake damage survey assessment response, or at least the message was not clear if engagement is needed or not. Perhaps that lack of a clear message has promoted a sense that the structural engineers do not feel that they are needed. However, this research has revealed that there is opportunity and potential within the engineering community to improve the post-earthquake damage survey assessment engagement in Iran. With the structured approach highlighted by my research, authorities can address the missing links between disaster mangers, structural engineers, and the rest of society. To continue working in isolation, as they currently are, is wrong. Instead, the disaster management system in Iran and structural engineering society should work hand in hand to improve engagement with all levels of society in the post-earthquake damage survey assessment. That will have benefits for the whole disaster management system in Iran.

The author has found the weak links in Iranian system are as follows:

- Grassroots voices must have access to higher level of decision making.
- There is lack of common language between disaster manager and disaster management system in Iran.
- Financial help would be good motivation to engage communities in post-earthquake activities.

- More civil engineering's companies and universities have to be involved in post-earthquake damage survey assessment in Iran.
- This research also finds that engaging the community with reconstruction process will reduces the responsibility of the government and disaster management system, and increases the reconstruction speed, workload divided between the organizations which will be less duplication.
- Disaster management system in Iran needs to change from being self-reliant to community protective.
- Post-earthquake disaster management engagement programme in Iran needs to focus on capacity building and empowerment in the long term.
- school teachers can play an important role in post-earthquake disaster management engagement programmes as they have a close relationship with community members and the local authorities so the government should focus on them and train them properly, so in the case of an earthquake they can be effective. Teachers can supply the necessary information for their local communities and manage and monitor the post-earthquake initial damage survey assessment.
- Providing information and images of the past earthquakes to children that they had never experienced earthquakes is very important.

Chapter 7 - New insights about education in post-earthquake disaster management and damage survey assessment in Iran

As I step down from the plane at Tehran airport I am immediately taken back 20years to the time when my family and I left for the UK. I am reminded of my school days in Tehran and plan during my trip to revisit my old school.

As my research visit commences I do get a chance to visit my school, but note that it has changed since I was last there, it is not a school anymore. Talking to people in the community I realise that a lot of other things have also changed. School children now get some formal education in earthquake risk, which did not happen when I was here. Residents also tell me that all neighbourhoods have a community leader that receives training in how to marshal residents to safe areas when an earthquake event happens. The residents say that they used to get help from non-governmental organisations, but in recent years that help has diminished. Instead most resources are directed to helping government agencies.

I also meet with many engineers and they tell me how their education has not prepared them very well for post-earthquake damage survey assessment. Sure, their basic education is very similar to my own. They study applied mathematics, material science, structural analysis and design, soil mechanics and foundation engineering. However, they are not taught much management (and no disaster management) and surveying is not gone into in detail. Certainly, they are not taught the details of forensic engineering, which are much needed in the assessment of damaged structures.

Finally, I meet the disaster managers. They nearly all have the same story. None of them were trained in disaster management before they took up the post. Most came into the role through other governmental administration or management positions. Most of the skills that they have developed were achieved through experience and informal learning.

Reflecting on the scenario presented at the start of this chapter is a helpful way of illustrating how the author own structured education serves as an illustration of the scale and diversity of education needed to effectively integrate education about post-earthquake damage survey assessment into a wider EIMS. That experience may be broken down into three categories relating to education for the General Public, Engineers and Disaster Managers. Specifically:

- **Education for the general public** – As a foundation: Earthquake awareness, the disaster cycle, local disaster risk, disaster preparedness, mitigation and response. Advanced: Disaster management systems, emergency planning, and disaster relief.
- **Education for engineers** – As a foundation: material science, surveying, soils and foundations, structural analysis and design. Advanced studies: seismology, earthquake engineering, and most importantly damage survey assessment.
- **Education for disaster managers** – As a foundation: Disaster cycle, disaster management, EIMS. Advanced studies: Project and programme management, Community engagement, Design and delivery education and training programmes.

7.1 More developed insights about education in disaster management and post-earthquake damage survey assessment

Reflecting on the scenario presented at the start of this chapter, the author contextualises the learning from the experience outlined in this section. Specifically, for educations programmes that are targeting post-earthquake structural assessment:

- **The design of education programmes** – Draw on the latest international research, theory and practice. Contextualise the material to the local system. Research the needs of those being educated. Prepare supporting material at a level appropriate for those being educated. Include educational as well as skills development training elements in the programme.
- **The implementation of education programmes** – Involve experts as well as people with relevant personal experience to deliver the education programme. Choose the people who are to receive the education carefully, to make sure the programme is right for them. Provide a certificate to record and evidence the fact that participants had successfully completed the programme.

Taken together the findings from the analysis in this section provide some new and important insights in relation to the scenario presented at the start of the chapter. This research identifies the link between my training and internship to design an education programme for post-earthquake damage survey assessment. This chapter identified a number of import points in designing and implementing the education programme:

- The educating training programme must be designed according to the need of the local population.
- Experts with understanding of the local system must be involved at an early stage of the designing an education programme.
- Giving basic post-earthquake education training programme to the community can be more effective and lifesaving than giving a detail education programme to small amounts of experts.
- Before I start analysing my data, it needs to highlight the importance role of education in earthquake risk reduction. According to Hyogo Framework for Action (HFA-2005-2015) third priority is about the earthquake education by using knowledge, innovation and education to build the culture of safety and resilience at all levels.
- It needs to mention that a well-informed and well-prepared community can create the culture of safety in their community.
- The past research shows that earthquake hazard education in school and university level and play an important role in helping the community after the earthquake and helping the community to respond to the earthquake better.
- From the prone to earthquake countries around the world shows how powerful earthquake education is to reduce the earthquake risk.
- There has been some attempt through education to improve the earthquake education system in Iran in order to protect the lives and properties (Izadkhah and Hosseini, 2005).
- For example, in USA the Federal Emergency Management agency (FEMA) is responsible for educating the public about natural disaster such as earthquake and ways to reduce the effects of earthquake on communities and their buildings (Lopes, 2001).
- There is lack of priority in earthquake education in Iran and earthquake education needs to be relate to another field (Izadkhah, 2004).

- The earthquake education should be about the discussion and exchange of view and not only about information distribution (Twigg, 2004).
- Disaster risk reduction should be about education to build the culture of safety at all levels (UN, 2000).
- In 2007-2008 UNISDR promote the integration of earthquake risk reduction into government plans and to ensure that school buildings are safe after the earthquake (UNISDR, 2006); UNISDR, 2007).
- UNESCO has long term plan to help make sure that the schools building is safe after the earthquake in developing countries (Petal and Izadkhah, 2008).
- Iran understands the importance of the earthquake education in school and communities. There are enough examples around the world that shows the power of formal and informal earthquake education in disaster risk reduction (Petal and Izadkhah, 2008).
- Iran is located in one of the most active tectonic regions of the world. Iran lack of preparedness usually result in loss of lives and buildings, Iran needs to move from being reactive to proactive approach. The aim of this approach is to educate and train the community and relevant organization for earthquake preparedness (Izadkhah and Hosseini, 2015).
- Earthquake as natural Disaster Risk is an important component of the 2005-2015 Hyogo Framework for action which Education, knowledge and Engagement is the important part of it (Sharpe and Izadkhah, 2013).
- Iran earthquake education system is only focused on school's children to create and develop a culture of safety in their communities and pass the massage and training to their parents. I think because this programmes in Iran include all 3 stages of elementary and secondary and high school, the high school children can involve more in post-earthquake programmes within their communities. The other point from this research is that disaster management system in Iran should not focused on school children, they should reach other members of the community to make their programme well engaged.
- In Iran school's teacher are involved in earthquake information and prepare students for protecting themselves which is very basic. (Izadkhah and Hosseini, 2015). This

search finds that the school's teachers should be more involved in earthquake education as they are very much in touch with their community and their local government, and they know about the community's needs.

- To improve the school preparedness level, in some school in Tehran they have started to form the "School Earthquake Safety Council" whom using the expertise of volunteer parents to provide training for other parents in First aid, fire safety, recovery team, evaluation and support team and information team (Izadkhah and Hosseini, 2015). So, we can be seen that we can include the basic post-earthquake damage survey assessment team in this programme so the community can benefit from it.
- Iran is recently started another project called "Helper "with the help of Iranian Red Crescent Society which provides post-earthquake response to student (Izadkhah and Hosseini, 2015). Again, this research shows that initial post-earthquake damage survey assessment is easily can be done in school as Iran has already running many different programmes to do with earthquake risk reduction.
- In Iran, most earthquake risk reduction education is textbook driven, which is done by the Ministry of education with the help of other governmental organizations. But in Iran, community education by NGOs and voluntary work are not clearly defined in the Iranian disaster management system (Izadkhah and Hosseini, 2015). This is research finds that the gap between the civil and structural engineers and architects with post-earthquake damage survey assessment in Tehran.
- In Iran school's children learn about the causes and effects of the earthquake and how to behave during an earthquake (Izadkhah and Hosseini, 2015). There is no evidence that if there any learning material on post-earthquake and how they can help their parents and communities.
- This research finds that the disabled children and adults are completely forgotten in Iranian earthquake education system, and it is something that needs to be investigated further.
- This research finds that the earthquake education in Iran is only focused on Earthquake itself and what to do during an earthquake for school's children but I do not see any plan for checking building safety or damage survey assessment been conducted on the building see research try to approach the disaster management

system in Iran from the post-earthquake damage survey assessment and see if how can it be improved to from the education point of view and see how the form can improved. It is also needing to mention that there is no evidence that how much the civil and structural universities' students are involved in post-earthquake damage survey assessment from the educational point of view and the duties of NGOs are not clear or it does not exist, and the disabled people are not included in the disaster management education plan in Iran.

- Although Iran is heavily invested in earthquake education in school but there is no quantitative assessment, to see how effective these post-earthquake educations are. (Izadkhah and Hosseini, 2015).
- It needs to be mentioned that there is no documented assessment to shows the effeteness of these earthquake education materials in Iran (Izadkhah and Hosseini, 2015). So, it shows the importance of this research as this research shows how effective these earthquake education materials are with in a community in Tehran.
- In this research the Earthquake education are based on Hyogo Framework for action (2005-2015): "Building the Resilience of Nations and Communities to Earthquake" using Education, knowledge, and innovation to build the culture of safety at all levels (UNISDR, 2005).
- Although Tehran is prone to earthquakes. But because the earthquake has not happened in the capital for a long period of time, it has made people's minds distracted from the phenomenon. It looks like that the people in Tehran does not fully convince about the devastation of the earthquake in the capital. So, the government needs to raise awareness about the earthquake in Tehran (Izadkhah and Hosseini, 2015).
- Most of the Iranian textbook earthquake education material is restricted to disaster-related content with no reference to education and engagement programmes (Izadkhah and Hosseini, 2015).
- The most common disaster in Iran is earthquakes. which are leading to injuries and death through the collapsing building during and after an earthquake, so raising awareness about the building hazard and basic building assessment should be built into the textbooks at all levels. The introduction course regarding building material,

safe construction, basic structural design, the construction quality of the building, and safe buildings can increase the student and public knowledge and it should be included in all textbook levels (Izadkhah and Hosseini, 2015).

- Iran is so vulnerable to earthquakes and threaten by earthquakes all the time, so it needs to understand the importance of post-earthquake damage survey assessment and strengthen the school building as there are 13 million students attending school in 2013 (Izadkhah and Hosseini, 2015).
- This research will also find out about the community earthquake education, understand what they need and how they think about post-earthquake damage survey assessment within the disaster management system in Iran.
- This research tries to understand the earthquake education system in Iran and how this research tries to include the post-earthquake damage survey assessment in Iranian education system and see how much has been done so far regarding the disaster risk reduction in Iran from the earthquake education and damage survey assessment point of view.
- This research will try to find out that after all the research and paper and brochure, booklet that has been published in Iran about the earthquake education in school and communities in Tehran, how effective and how prepared and confident the community in district 5 in Tehran are in case of earthquake in Tehran.
- This research also finds out that the school's teacher can play more effective role within the disaster management system in Iran as they are involved with community and the local government, and they understand the need and the method of disaster risk reduction that is more suitable for their student and their communities.

7.2 Quantitative data analysis of education practices linked to disaster management and post-earthquake damage survey assessment in Iran

Question 15a of the survey asked respondents if the Iranian Earthquake Information Management System (EIMS) includes a post-earthquake damage survey assessment education programme. Of the 162 definitive responses, 133 (82%) answered NO and 29 (18%) answered YES. Figure 7.1 shows that the split in responses, which was quite consistent across all sub-groups, except for the disaster managers. 75% of the disaster managers (3 of 4) in the survey answered YES. Only the female respondents came close to a positive response, with 40% saying YES, but all other subgroups were broadly in line with the overall survey response (less than 29% answering YES).

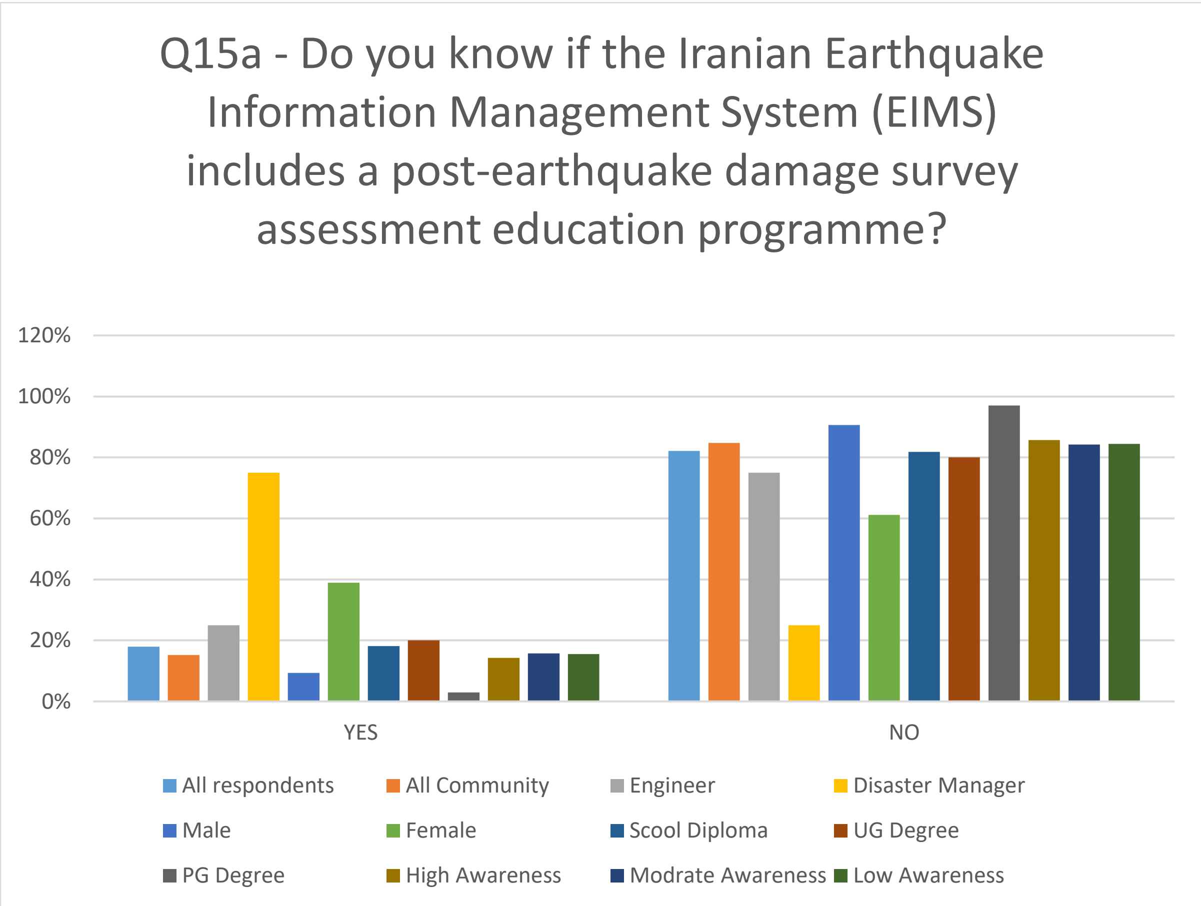


Figure 7.1 Respondents if the Iranian EIMS includes a post-earthquake damage survey assessment education programme.

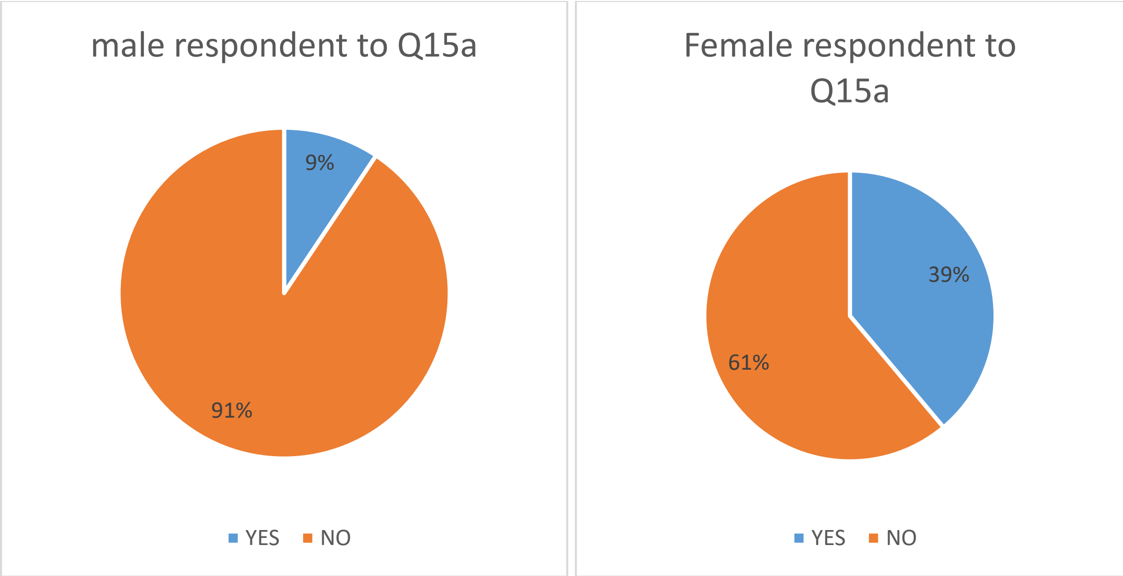


Figure 7.2 Gender of respondents to Q15a.

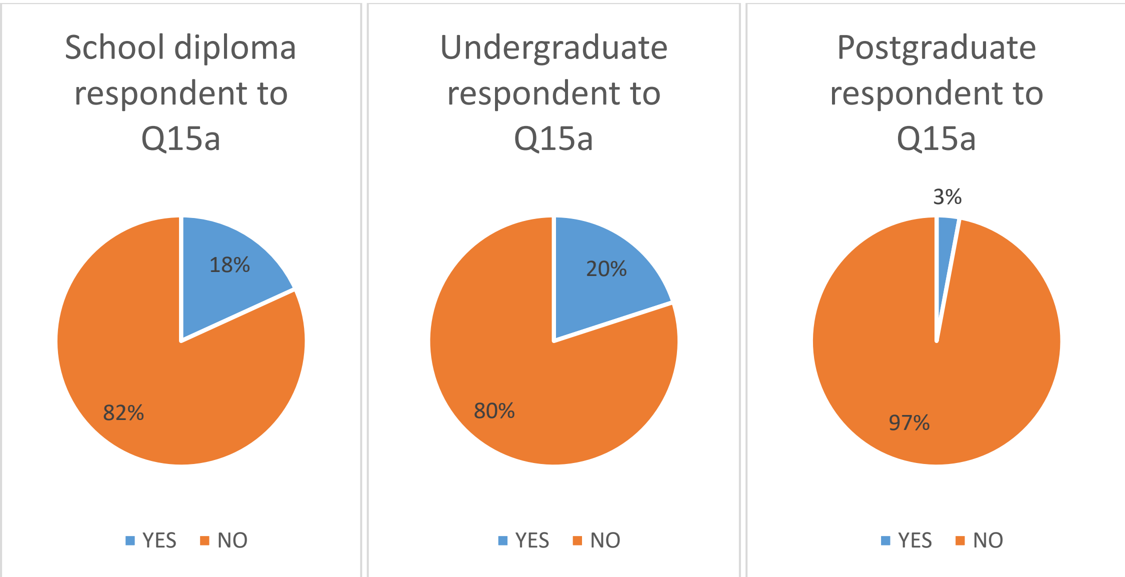


Figure 7.3 Academic qualifications of respondents to Q15a.

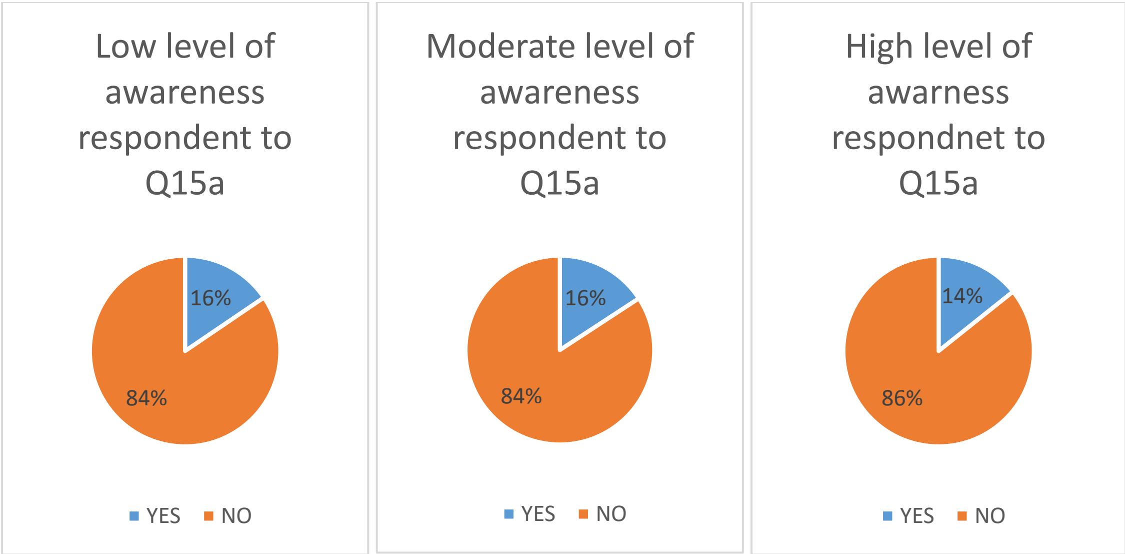


Figure 7.4 Level of awareness of respondents to Q15a.

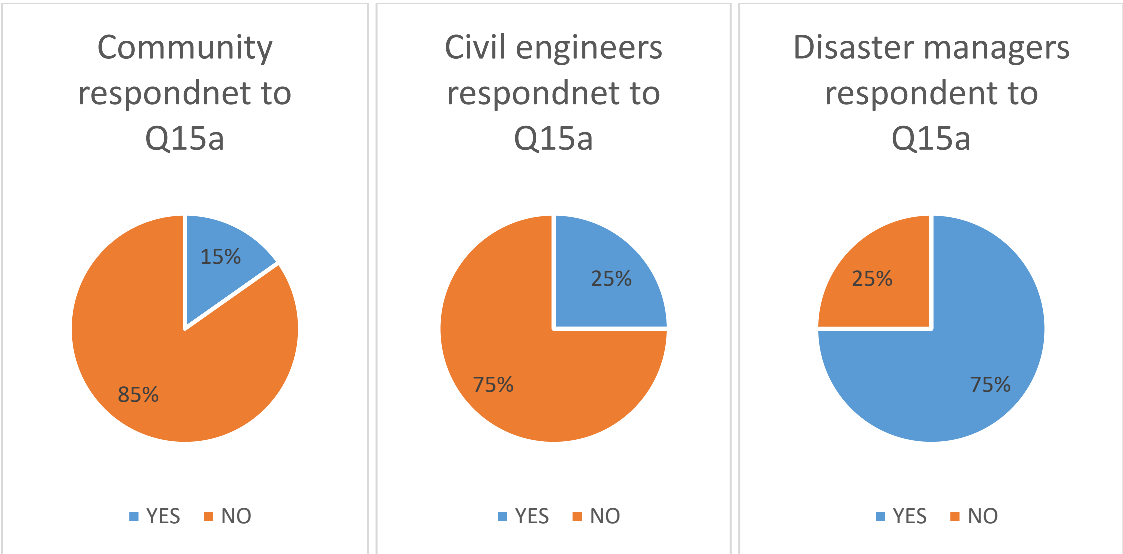


Figure 7.5 Profile of respondents to Q15a.

The response to Q15a, is a powerful and clear indication that, in Iran, there is significant need to improve education. The fact that the view provided by disaster managers is so different to all the other sub-groups hints to a potential problem. Disaster managers are the key custodians and operators of the EIMS system, within which education activity must be managed (Ajani, 2009). As such, if the disaster managers consider that education activity is adequate, then they might resist proposals to do more. What the survey question did not reveal is whether disaster managers were aware that their views differ by such a margin from other groups in Iranian society. Further analysis below will help to improve that understanding.

From the literature review (Section 2.3.1) the author was able to list a number of important topics that a post-earthquake damage survey assessment education system should include. Table 7.1 below includes the list of topics.

Table 7.1 List of education topics to be included in programme related to post-earthquake damage survey assessment.

The local disaster management system
The role of local disaster managers
The role of community residents
The role of structural engineers
Seismic faults in the local area
The local seismic risk
Calculating human and economic loss
Recording building damage
Assessing building damage
Actions to take before an earthquake
Actions to take during an earthquake
Actions to take after an earthquake
Incentives to act
Availability of educational material

Question 15b in the main survey listed the education topics and asked respondents to score each one on a three-point scale. A score value of 1 indicated that the topic was always covered in detail and a score value of 3 indicated that the topic was not included. For the analysis, the mean score given by each of the three main communities (Residents, Engineers, and Disaster Managers) was calculated and then the mean of means was used to rank each of the topics. Table 7.2 below shows the results of that analysis. Importantly for this research, the Iranian system was judged to have a good coverage of the topic areas. No topics received a mean score close to 3. However, what is highly significant for this research is that the topics of

“Assessing building damage”, “Recording building damage” and “The role of structural engineers” were the three lowest ranked topics.

The three disaster managers who responded to this question were unanimous, recording that all topics in the education programme were covered in detail. The inference derived from this result is that disaster managers in Iran do receive a good level of education in all the topic areas. If that inference is correct, it would be an excellent finding from this research and a good starting point from which to expand the programme into the wider community.

Table 7.2 Results from survey Q15b showing ranking of education topics in Iran.

			Mean Score		
Rank	Topic	Mean of Means	Residents	Engineers	Disaster Managers
1	Actions to take during an earthquake	1.36	1.52	1.57	1.00
2	The local disaster management system	1.43	1.73	1.57	1.00
3	Actions to take before an earthquake	1.49	1.60	1.86	1.00
4	The role of community residents	1.53	1.87	1.71	1.00
5	Calculating human and economic loss	1.53	1.87	1.71	1.00
6	Actions to take after an earthquake	1.54	1.63	2.00	1.00
7	The role of local disaster managers	1.54	1.77	1.86	1.00
8	Availability of educational material	1.55	1.64	2.00	1.00
9	Incentives to take action	1.56	1.83	1.86	1.00
10	Seismic faults in the local area	1.59	1.92	1.86	1.00
11	The local seismic risk	1.61	1.83	2.00	1.00
12	Assessing building damage	1.65	1.96	2.00	1.00
13	Recording building damage	1.68	2.04	2.00	1.00
14	The role of structural engineers	1.70	1.96	2.14	1.00

Looking more closely at the results for the engineers, the author can report that the response was heavily weighted in favour of the views of the male engineers, with 6 of the 7 responses to Q15b coming from male engineers. Broadly speaking the engineers agree overall ranking of the topic areas. Where they disagree is in the “Actions to take before an earthquake”, “Actions to take after an earthquake” and the “Availability of education material”. In these three areas the engineers were less optimistic that the topics were always covered in detail. Disappointingly, and again an important finding from this research is that the engineers themselves considered that education about “The role of structural engineers” in post-earthquake damage survey assessment system was the weakest part of the education system in Iran.

The resident community responses ranged from N=26 to N=23. The topic with the fewest responses was “Calculating the human and economic loss”. That said, the resident score mainly differed from the engineers in the topics of “Actions to take before an earthquake”, “Actions to take after an earthquake” and the “Availability of education material”. From all these topics, the residents considered were covered in more detail than suggested by the final ranking. To some extent the resident responses indicated that “The local disaster management system” and the topic of “Seismic faults in the local area” were not covered in as much detail as suggested by the overall ranking. Again, and an important finding from this research is that residents considered the weakest part of the post-earthquake damage survey assessment education system to be “Recording building damage”.

Looking in more detail at the resident responses, of the 26 who provided some response, 7 were males and 19 were females. Both groups included respondents will all levels of education and awareness of the earthquake management system. The number of responses was too low to detect any discernible pattern in the results based on levels of education or awareness.

7.3 Qualitative deepening of understanding about education practices linked to disaster management and post-earthquake damage survey assessment in Iran

As part of the main survey for this thesis, I asked respondents if they believe that an effective post-earthquake damage survey assessment education system is achievable in Iran (question 16a). Overall, the responses were positive, with 47% all respondent replied “Yes”, 20% responding “No” and 33% responding “Do not know” (Figure 7.2). Although this response was positive overall, it was not overwhelmingly positive, as the number responding yes was less than 50% of the total. That general trend was apparent across all sub-groups, other than the Disaster Managers. As with previous answers in the survey, the disaster managers were unanimous and 100% responded “Yes”.

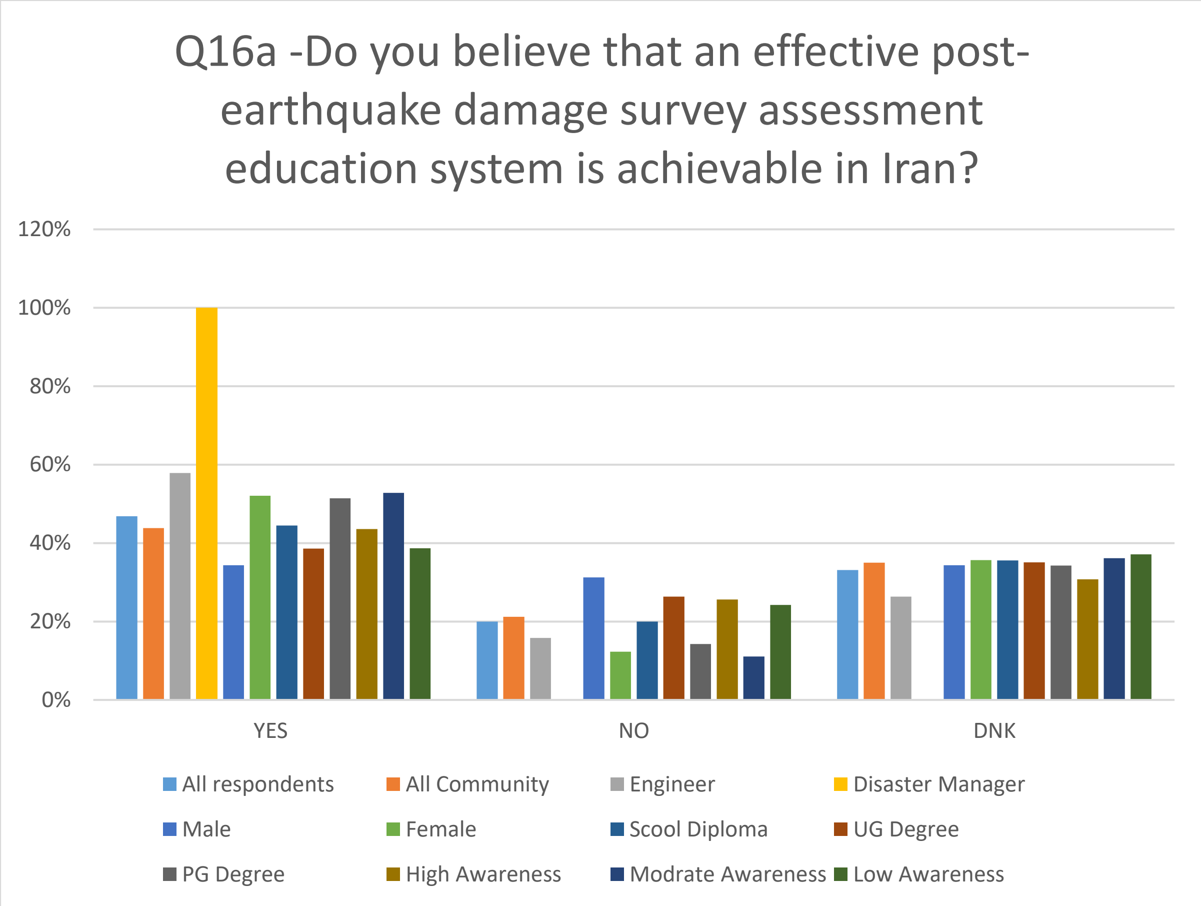


Figure 7.6 Respondents if they believed that an effective post-earthquake damage survey assessment education system is achievable in Iran.

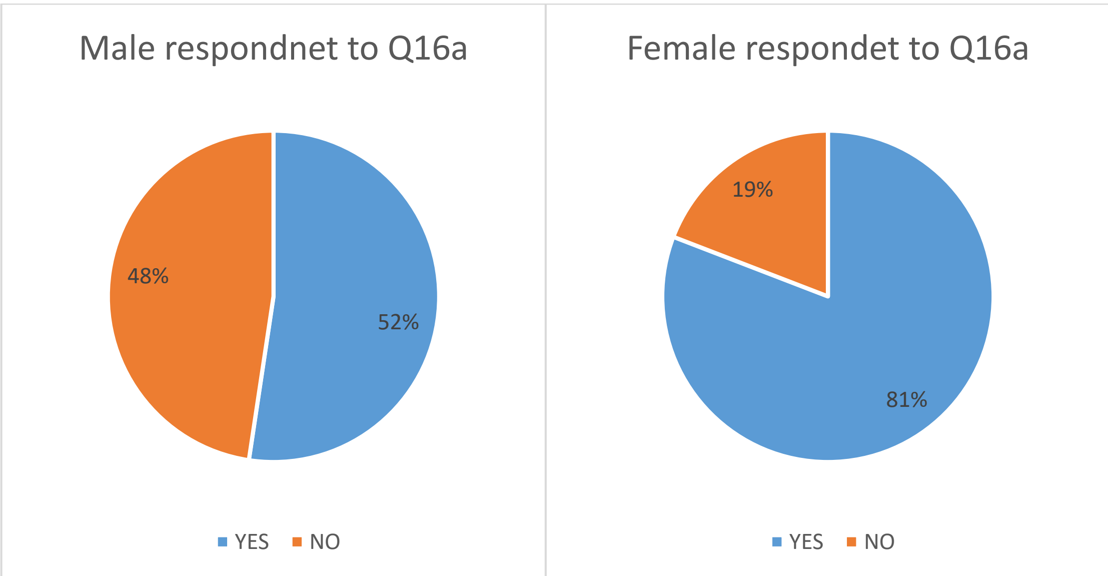


Figure 7.7 Gender of respondents to Q16a.

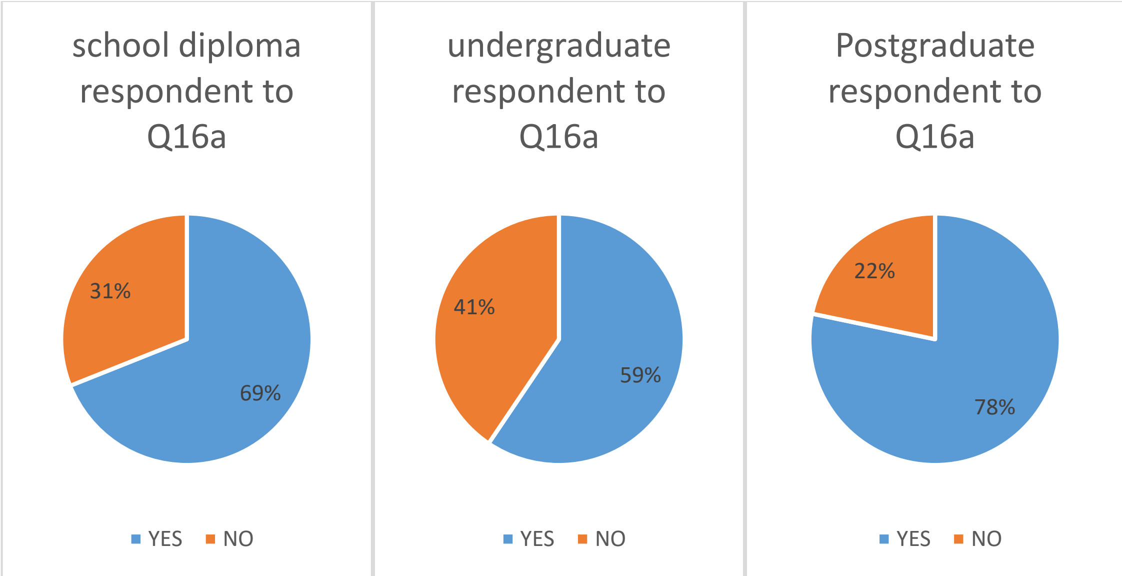


Figure 7.8 Academic qualification of respondents to Q16a.

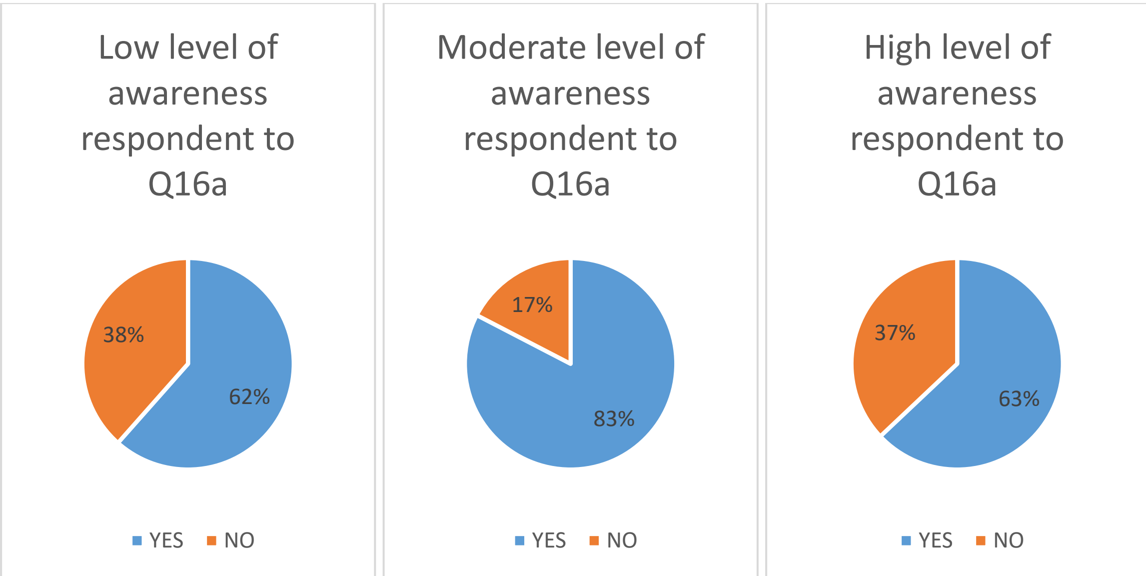


Figure 7.9 Level of awareness of respondents to Q16a.

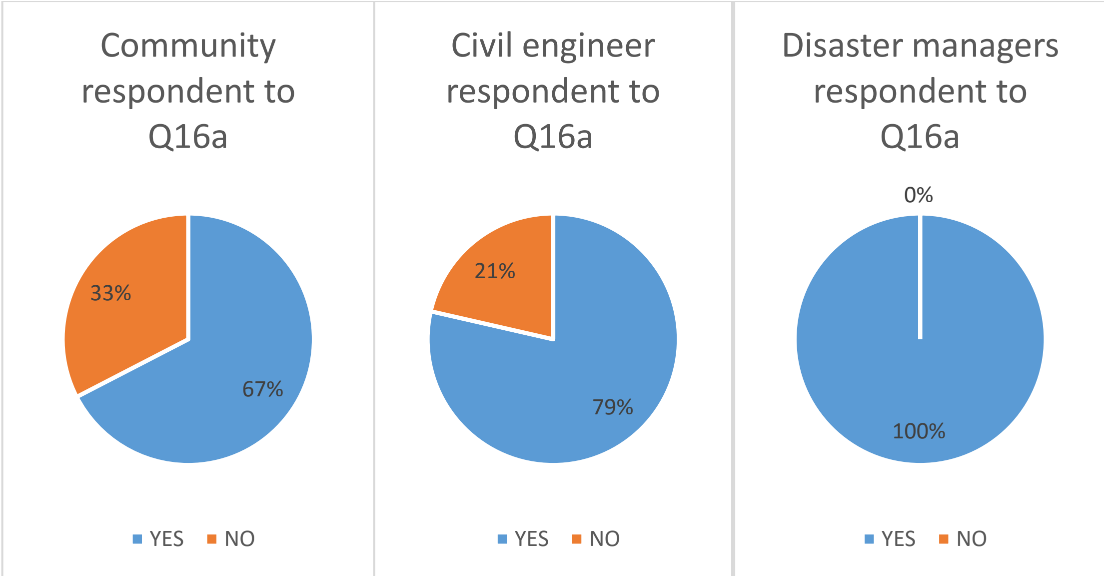


Figure 7.10 Profile of respondents to Q16a.

Importantly to this research, the engineers were also very positive, with 51% responding that an effective post-earthquake damage survey assessment education system is achievable in Iran. This result shows that efforts to improve the post-earthquake damage survey assessment education may receive a positive response from the engineering community. Male respondents were divided between YES and NO, but Female respondents were much more decisive and clearly showed an inclination to say YES. With regard to levels of education and awareness the response was mixed, those having higher education and a moderate level of awareness most likely to answer YES.

The second part of Question 16 (Q16b) asked respondents to provide a brief explanation their answer to the first part that was analysed above (Q16a). Answers to Q16b are analysed below.

<u>Disaster Manager Beliefs</u>

Two disaster managers provided a qualitative response to question 16. One emphasises the fact that demand for training is at a peak when a major event occurs and the other recognised the need to train structural engineers before an event happens.

> *"Training attracts more importance during the disaster." (Respondent 172, 3111).*

> *"We should give training to our structural engineers before the earthquake happens." (Respondent 174, 3111)*

Engineer beliefs

Responses from engineers could help to judge whether the positive or negative interpretation of the disaster manager response is valid. In total, 11 engineers provided qualitative feedback, interestingly, of those, all were male. All female engineers answered "did not answer" to this question. Five of the male engineers, had post-graduate qualifications and a high level of awareness of the earthquake management system (matching the Disaster Manager profile). Their opinions ranged quite widely, from positive to negative and some gave quite ambiguous answers, so it is difficult to draw any clear lessons from their responses.

> *"Advertising and education." (Respondent 153, 2111)*
>
> *"It is achievable if there is any pre-earthquake education and engagement." (Respondent 154, 2111).*
>
> *"No, we cannot achieve this now in the current situation. There is no plan and the politics will not let this be achievable." (Respondent 164, 2111)*
>
> *"With reference to damaged structures in recent earthquakes, the strengths and weaknesses of structures are clearly visible." (Respondent 169, 2111).*
>
> *"Yes, this is done systematically in Iran, every organisation does their own assessment post-earthquake and they do not work collectively." (Respondent 170, 2111).*

Another three engineers had high qualifications, but only moderate levels of awareness of the earthquake management system. Their answers were much more consistent and positive, with some clear and useful suggestions. Essential they considered that an effective post-earthquake management system is achievable, but needed to run at all levels and be led by engineers.

> *"I believe that an effective post-earthquake management system is achievable if it is done through association of engineers at provincial levels." (Respondent 171, 2112)*
>
> *"As Most people who are involved in building constructions are not engineers and do not have academic knowledge and only learned their trades through experience,*

most structure are not built according to rules and regulations, and the weaknesses are very visible post-earthquake, if these issues are addresses positive steps can be taken forward." (Respondent 168, 2112)

"Yes, if we want we can, first we must work hard and secondly use experience of other countries which are ahead of Iran in training and management, in this field through schools, universities and mass media." (Respondent 165, 2112)

The remaining three engineers all had undergraduate education and varying levels of awareness of the earthquake management system. Once again, the overall response was positive, suggesting that some education is already done, but more could be done if professional and academic people were more involved.

"It is doable if we have professional people and having computerised information." (Respondent 156, 2121)

"Currently, post-earthquake damage survey assessment is performed by the disaster management team in every city with assistance from government organisations as well as academics from Iranian universities." (Respondent 167, 2122)

"Yes, as Iran is very vulnerable to earthquake and we have seen huge damages and fatalities, this must be achievable." (Respondent 166, 2123)

<u>Resident beliefs</u>

In total 48 residents provided qualitative feedback (22 males and 26 female respondents).

Male Residents

The first twelve male residents had high or undergraduate level education and range of awareness levels. Their responses were very divided or ambiguous, so no clear lesson could be drawn from them. When expressing negative opinions, it was generally dues to lack of management resources or poor organisation. When expressing positive opinions, it was with caveats that currently if is done but only in a very limited manner.

"No, there is no organization is existence to do this task." (Respondent 92, 1111)

"Yes, however; very limited." (Respondent 21, 1111)

"No, as we have no management in this field." (Respondent 103, 1112)

"I have no expertise in this field." (Respondent 1, 1112)

"No, as far as I know management, this is usually done after the earthquake." (Respondent 124, 1121)

"Yes, the post-earthquake damage survey assessment education system is improving in the country and it seems only in 3rd world countries the true assessment is not done." (Respondent 30, 1121)

"At the moment they review the new building which can be done for post-earthquake as well." (Respondent 27, 1121)

"No, given the post-earthquake chaos and damages, this is not possible in Iran." (Respondent 143, 1122)

"It could be better to train people to the post-earthquake education." (Respondent 101, 1123)

"Due to lack of insufficient facilities." (Respondent 93, 1123)

"Due to the experience of the post-earthquake we need to make plan for the future earthquake." (Respondent 69, 1123)

"Through mass media, online resources, and training conferences." (Respondent 75,112x)

The remaining ten male resident respondents all had school diploma levels of education and a range of awareness levels. Generally, the views were more optimistic, suggesting that an effective post-earthquake damage survey assessment education system is “possible” in Iran. When negative views were expressed, they were often linked to a poor perception of current management in the system.

> *“Yes, Japanese experts must be used in order to solve this problem.” (Respondent 116, 1131)*
>
> *“It is most likely possibly, however; it needs the support of relevant people who are at the top.” (Respondent 17, 1131)*
>
> *“It seems unlikely given the current state of management.” (Respondent 136, 1131)*
>
> *“Unfortunately, due to mismanagement of building regulations, there is no discussion done between relevant organizations.” (Respondent 3, 1131)*
>
> *“It is achievable through information on structures and better post-earthquake management system.” (Respondent 19, 1132)*
>
> *“It is possible conditional on the fact that people in charge must be competent with high level of awareness.” (Respondent 15, 1132)*
>
> *“Yes, only if managers observe the system.” (Respondent 133, 1133)*
>
> *“Yes, as we can minimise losses and damages considerable through this.” (Respondent 112, 1133)*
>
> *“I think there are some activates has been done in some organization and I think they are going to assess the building after the earthquake.” (Respondent 70, 1133)*
>
> *“Management does not exist.” (Respondent 117,113x)*

Female residents

The first eight female resident respondents all had high level of education and a range of levels of awareness of the earthquake management system. The responses were overwhelmingly positive, just one expressing a negative opinion and one ambiguous response. When expressing positive opinions, their views included suggestions that it needed the support or relevant experts and with effective management. The negative view was linked to the perception that current management of the system is poor.

> *"Yes, as this must be established and taught to the experts." (Respondent 109, 1211)*
>
> *"The task is possible to be done through the support of relevant organization." (Respondent 34, 1212)*
>
> *"Yes, could be possible provided that the key points are clear to disaster managers." (Respondent 95, 1212)*
>
> *"Yes, through correct planning, correct use of budgets, and better management." (Respondent 113, 1212)*
>
> *Media and online resources." (Respondent 38, 1213)*
>
> *"I do not know how." (Respondent 39, 1213)*
>
> *"In light of recent disasters, disaster managers are thinking of doing this in the future, however; through incompetency of those managers they will have no effect." (Respondent 94, 1213)*
>
> *"Yes, if experts who put theory in to practice and been successful are used." (Respondent 98, 1213)*

The next eight female resident respondents all had undergraduate education and a range of awareness levels. Their responses were very similar to the previous group, overwhelmingly positive and advocating the use of experts, but also expressing the view that should include the public as well as other organisations. The view that current management of the system is poor was again also evident.

> *"Training requires experts who give the right training. Experienced workforce must be used in this field." (Respondent 16, 1221)*
>
> *"It must be made achievable." (Respondent 28, 1221)*
>
> *"It is achievable if it is done at school levels and training is given through public*
>
> *"Yes, there is an organization that assess the damage to building." (Respondent 51, 1221)*
>
> *"Greater help could be had from the experts, better training and assessment could be performed." (Respondent 7, 1221)*
>
> *"It is achievable if there are some education and planning in schools, universities and organizations." (Respondent 62, 1222)*
>
> *"We can raise awareness through schools and universities as well as media (TV, Radio) and online resources." (Respondent 141, 1222)*
>
> *"Disaster management in Iran is very weak." (Respondent 130, 1223)*
>
> *"Yes, provided that co-operation amongst relevant organizations take place." (Respondent 144, 1223)*

The remaining ten female resident respondents all had school diploma education and a range of awareness levels. Here again, the overwhelming view was a positive one. This group seemed to advocate more clearly the need to involve the public and experts in the field, but echoed again the fear that current management of the system is weak.

> *"This could happen however; due to the incompetence of disaster managers it could take a very long time." (Respondent 97, 1231)*

> *"In my opinion this task needs expertise of architects as well as civil engineers in order to assess the foundations of buildings in order to see how strong they are." (Respondent 6, 1231)*

> *"The government must teach and train the public extensively." (Respondent 114, 1232)*

> *"Yes, if it is only for all topics of builds i.e. old and new, Iran also needs to learn from countries which are advanced in this field." (Respondent 60, 1232)*

> *"Through increased technologies, peoples' use of online resources at every age level we can hope that steps are being taken to achieve this." (Respondent 59, 1232)*

> *"Yes, there are information available on building regulation." (Respondent 41, 1233)*

> *"Yes, as this can decrease losses and damages considerably." (Respondent 122, 1233)*

> *"Yes, it must be achievable considering where geographically Iran is." (Respondent 108, 1233)*

> *"Yes, if the system manages properly." (Respondent 18, 1233)*

"If this system is put in place, it could help the public having better understanding of the crisis and as a result the public could manage and deal with the disaster better." (Respondent 9,12xx)

Overall, when asked if an effective post-earthquake damage survey assessment education system is achievable in Iran, this analysis revealed the disaster managers, engineers and residents all responded positively. However, there were considerable caveats that accompanied the positive response, often linked to a perception that the current management of the system was too weak to make any proposed action effective. Suggestions to strengthen the system included broadening its current application to include the public and a wider range of organisations. There was widespread support for the system to be led by recognised experts in the field, including civil and structural engineers. As with suggestions linked to previous questions, the suggestion in relation to this education programme was that it should embrace modern technological systems in its delivery and operate at all education levels. Finally, and as with other question responses, female resident respondents were found to be much more unified and positive in their views than male respondents.

Reflecting on the scenario presented at the start of this chapter helps me to understand from the experience outlined in this section that the educations programmes that are targeting post-earthquake damage survey assessment in Iran are very weak, but it also revealed that participant are also positive to have a post-earthquake damage survey assessment education programme within the disaster management system. This research also revealed that if the disaster management system in Iran wants to have post-earthquake damage survey assessment within EIMS, they must have more experts in this field and use the experience of more advanced countries and better equipment and learn their lesson from their past educational programmes in this field.

7.4 Proposals to improve education practices linked to disaster management and post-earthquake structural assessment in Iran

In question 17 of the survey, respondents were asked if, assuming that the Iranian Earthquake Information Management dose includes a post-earthquake damage survey assessment education programme within it, "what do you believe needs to be done to raise awareness of the system?"

Disaster Manager Beliefs

Two disaster managers provided a qualitative response to question 17. The disaster manager responses were extremely positive for this research, clearly stating that post-earthquake damage survey assessment education programmes are being implemented in Iran. However, there was some acknowledgement that more could be done to educate structural engineers, especially in advance of an earthquake event.

> *"Iran has Training Programme. Ministry of transport and city planning, municipality and structural engineering society do all the necessity training continuously." (172, 3111)*

> *"We should give training to our structural engineers before the earthquake happens" (Respondent 174, 3111).*

Engineer beliefs

In total, 12 engineers provided qualitative feedback. Only one female engineer answered this question, but her response was neither positive nor negative.

> "I do not know." (Respondent 158, 2223)

All other engineer respondents were male and five had post-graduate qualifications and a high level of awareness of the earthquake management system (matching the Disaster Manager profile). Overall, the responses from this group were very positive, including a range of suggestions for education and engagement of structural engineers and the wider public. Importantly, the suggestions included focussing on information as well as testing equipment.

"It should be done through giving more information to the public and managers and people in charge must do more to achieve this." (Respondent 170, 2111)

"1. Training experts for structural assessment.2. Existence of equipment's and facilities for testing quality of concrete, etc….3. Transfer of relevant information and research to the relevant engineers and engineering students in this field." (Respondent 169, 2111)

"They should provide simple education system for people, having a specific channel on TV for earthquake, having an earthquake's newspaper and having cooperation between the disaster management systems." (Respondent 154, 2111)

"Advertising, publishing and education." (Respondent 153, 2111)

"Information gathering can lead to raising awareness in disaster management." (Respondent 164, 2111)

Three more highly qualified engineers had a moderate level of awareness, and they continued the theme training at different levels for the public, disaster managers and engineers. They also advocated using mass media technology as part of the system.

"1. Training programes.2. Delegation of responsibilities (who is in charge of what).3. Training for different levels i.e. public, engineers, and managers….4. Training must be on going." (Respondent 171, 2112)

"The awareness can be raised through having specialised conferences and publishing the results to the public." (Respondent 168, 2112)

"Raising awareness can be done through various conferences in this field, using mass media specially TV for training and encouraging people for necessary training in this field." (Respondent 165, 2112)

The final three engineers had an undergraduate education and a range of awareness levels. One emphasised using the experience of other advanced countries in this field and using the expert people in post-earthquake education field.

"Having professional people in disaster management system and required equipment." (Respondent 156, 2121)

"Teaching at different levels of communities for all the public especially for students through mass media such as TV, radio and newspaper can help to raise awareness of the public." (Respondent 167, 2122)

"We can use the experience of other countries in this field who are ahead of Iran as well as using an expert workforce." (Respondent 166, 2123)

<u>Resident beliefs</u>

In total, 67 residents provided qualitative feedback (32 males and 35 female respondents).

Male residents

Four male resident respondents had high education levels and high or moderate awareness. They suggested that education supported by good data and research is needed and led by experts in the subject.

"Information through statistical data must be put in use of disaster management cycle/ process." (Respondent 21, 1111)
"Specialist research in this field must be done and the right training must be given." (Respondent 91, 1111)
"On going updating of information and raising awareness." (Respondent 92, 1111)
"1. Change in mangement.2. Use of geniuses in this field." (Respondent 103, 1112)

The next seven male resident respondents had undergraduate level education and high or moderate awareness. Their suggestions included having a specific budget for this system, providing training at a level. Involving the public and again led by experts in the field.

"Having a specific budget for raising awareness of the system." (Respondent 27, 1121)
"Initial training from schools all the way to universities at an ongoing rate must be done, they can be in form of a book or a leaflet." (Respondent 30, 1121)

"Training Iranian (relevant People) with advanced country in this field." (Respondent 72, 1121)

"We need to raise awareness of the public." (Respondent 124, 1121)

"Making successful systems examples such as Japan." (Respondent 148, 1121)

"Given training programme on structural assessment." (Respondent 149, 1121)

"Through using engineering information and expert workforce in foundations." (Respondent 143, 1122)

Five male resident respondents had undergraduate education and low levels of awareness of the earthquake management system. Here again suggestions included a wide range of education for public and professionals, being led by experts in the field.

"Education in schools.2. Education in broadcasting (TV).3. Education in organizations." (Respondent 101, 1123)

"We need to have best plans and systems in order to raise awareness." (Respondent 115, 1123)

"The relevant jobs in this field must be left with relevant people with relevant experience in this field." (Respondent 134, 1123)

"The Iranians must make themselves familiar with up to date knowledge of earthquake management and they must not be left behind." (Respondent 137, 1123)

"1. Training programmes.2. Tougher building regulations are needed." (Respondent 139, 1123)

The final group of sixteen male resident respondents had school diploma education and a range of awareness levels. They echoed previous suggestions, with a system led by experts in the field, build on sound data and research and provided to a wide range of community groups (public and professional).

"Exchange of information amongst relevant organizations as well as private sector investment." (Respondent 3, 1131)

"Given the importance of the task, necessary works must be done." (Respondent 90, 1131)

"1. Training pre-earthquake.2. Using experience of countries such as Japan." (Respondent 136, 1131)

"Training and putting it in practice like the armies for the disaster day." (Respondent 17, 1131)

"1. Training to young people.2. Appropriate use of budgets.3. End of financial corruptions in councils and relevant organizations." (Respondent 15, 1132)

"Experts and professionals can raise awareness of the system through the public media." (Respondent 19, 1132)

"More training courses needed. More international conferences needed every year." (Respondent 64, 1132)

"Accurate information while building such as nationals and ….and post building must be recorded." (Respondent 138, 1132)

"1. Mass public training. On time awareness.2. Training for pre, current and post-earthquake (Respondent 65, 1133)

"I think because earthquake is a disaster, we need to plan to re-educate people through TV, in school and universities (Respondent 70, 1133)

"Training for all." (Respondent 112, 1133)

"1. Practical and scientific education.2. Change attitude toward disaster." (Respondent 126, 1133)

"Raising awareness through mass media and online." (Respondent 133, 1133)

"Through the use of experience of countries that one like Iran and currently use this system." (Respondent 132, 1xxx)

"The city council in every area should give information and training to the people." (Respondent 31,113x)

"1. Being responsible.2. Organizational order.3. Love for the country." (Respondent 117, 113x)

Female Resident

The first group of female resident respondents all had high level education and a range of levels of awareness. Their views coincided well with that of other groups above. Overwhelmingly positive about the need to raise awareness, with a broad training programme based on sound research and led by experts in the field.

> *"Yes, as this must be established and taught to the experts." (Respondent 109, 1211)*

> *"1. Department of education.2. Broadcasting.3. Crisis management." (Respondent 46, 1212)*

> *"Educated experts must be used in relevant posts in disaster management organizations." (Respondent 95, 1212)*

> *"1. Use of expert and professional workforce in this field.2. Having better equipment and facilities for research and making the results practical." (Respondent 113, 1212)*

> *"1. Raising awareness.2. Training." (Respondent 38, 1213)*

> *"Repeated training by relevant organization." (Respondent 39, 1213)*

> *"The up-to-date knowledge, research and exercises in advanced cities that are prone to earthquake must be used." (Respondent 96, 1213)*

> *"In my personal opinion, co-operation with countries such as Japan could be a great effective way to raise awareness of the system." (Respondent 98, 1213)*

The next eleven female resident respondents all had undergraduate level education and a range of levels of awareness. Their views were also positive, advocating training at all levels and across the whole country, delivered using mass media technology.

> *"Giving accurate and on time information to the public." (Respondent 16, 1221)*

> *"Training classes in whole of Iran." (Respondent 36, 1221)*

> *"Possibly, establishing a course in this field for engineering and architecture students." (Respondent 51, 1221)*

“Training people in Tehran Disaster Mitigation and Management Organization by experts.” (Respondent 150, 1221)

“Training classes in whole of Iran.” (Respondent 28, 1221)

“The system must be made known to the public.” (Respondent 47, 1222)

“We should dedicate one module in our education system.” (Respondent 62, 1222)

“Through creating training programmes for children as well as adults.” (Respondent 141, 1222)

“Government should increase the people and organization knowledge through TV, Radio and public places.” (Respondent 145, 1223)

“The training should be given through broadcasting organization, schools and universities.” (Respondent 48, 1223)

“1. Training through TV, schools, universities.2. Compulsory training at schools at every level through to universities and also having a specific university course for this.” (Respondent 144, 1223)

Seven female respondents had school diploma level education and high or moderate levels of awareness of the earthquake management system. This group repeated suggestion of the need to raise awareness and for a broad education programme, with many levels, to be implement, using mass media technology and involving experts in the field.

“1. Increase of the public' knowledge through social messages such as billboards as well as TV messages.2. Building must be assessed pre-earthquake and people need to be told where they can live post-earthquake, i.e. what building are safe.” (Respondent 6, 1231)

“Equipment, sufficient facilities as well as a trained workforce must be in place in order to attract public for teaching them aware of what to do in case of an earthquake.” (Respondent 4, 1232)

“1.use of engineering tools and how they are used to the public.2. Long term planning through the use of expert and professional workforce.3. Use of online resources.” (Respondent 59, 1232)

“Clearly and organization named ''raising awareness'' must be established.” (Respondent 60, 1232)

“Training in schools.” (Respondent 114, 1232)

“Training and re-education through crisis management organization.” (Respondent 123, 1232)

“1. Training through mass media.2. Training in schools and organizations.” (Respondent 20, 1232)

The final group of eleven female resident respondents had school diploma level of education and low awareness of the earthquake management system. Here again, the suggestion of the need to raise aware within a broader disaster management education programme was very clear. It should be supported by experience from other earthquake prone countries.

“We should use the experience of the prone earthquake country.” (Respondent 61, 1233)

“Training and training in this field.” (Respondent 18, 1233)

“Increase the level of educational programme.” (Respondent 55, 1233)

“Co-operation in facilities and equipment with advanced countries and following them where possible in order to be prepared.” (Respondent 107, 1233)

“Right training at every school level pre, current and post-earthquake must be given on compulsory basis.” (Respondent 108, 1233)

“We need to raise awareness and have training.” (Respondent 122, 1233)

“I have no idea as it does not exist.” (Respondent 41, 1233)

“1. Training regarding sheltering.2. Advantages of earthquake training, disadvantages of not having an earthquake training.” (Respondent 14,123x)

“Pre-earthquake building assessment must be performed and steps need to be taken in order to strengthen the building, all those needs to be recorded and mass public, training must be giving too.” (Respondent 9,12)

In association with proposals to improve education practices linked to disaster management and post-earthquake damage survey assessment in Iran, question 18 asked respondents how often they thought that the strengths and weaknesses in the system are analysed. Figure 7.3 shows the answers to question 18, revealing that the most common response from most respondents was “Never”. As with previous questions, the disaster manager responses were at odds with all other sub-groups, as 100% of disaster managers replied that the system is reviewed every 5 years.

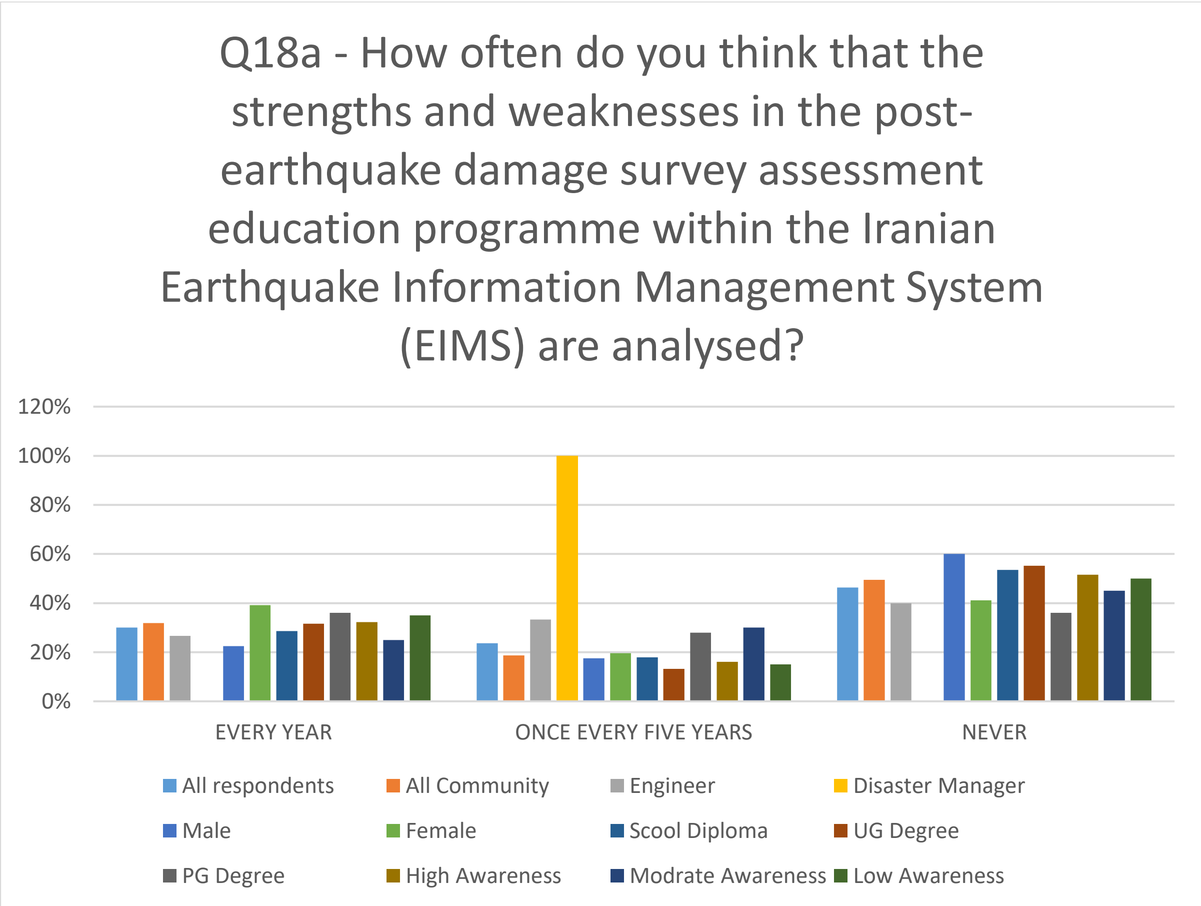


Figure 7.11 How often strengths and weaknesses in the post-earthquake damage survey assessment education programme are analysed.

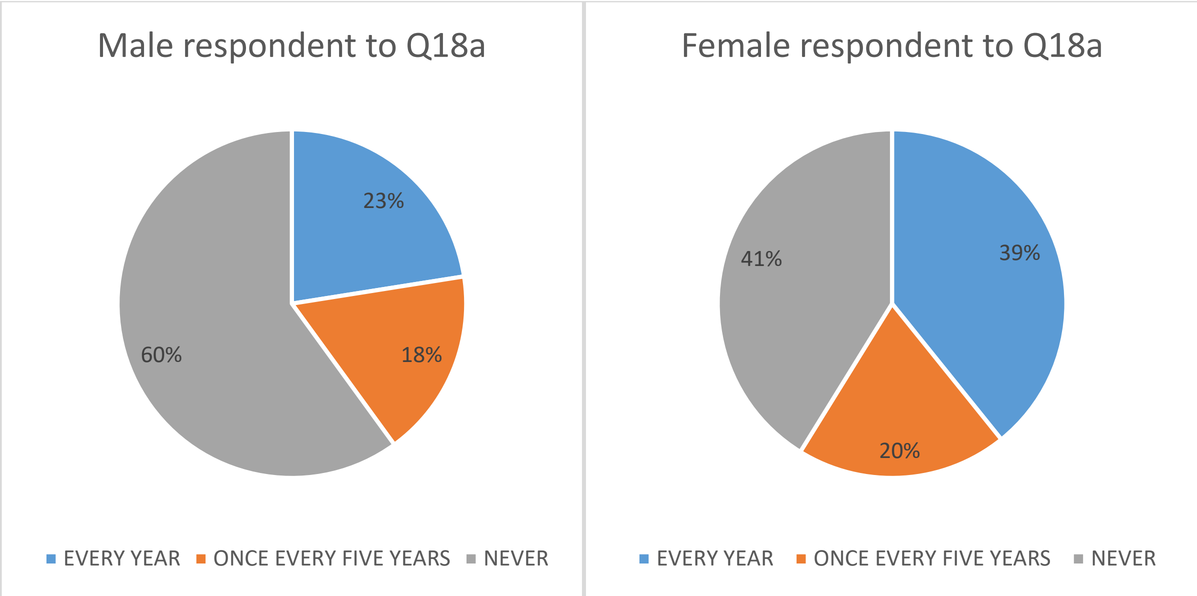


Figure 7.12 Gender of respondents to Q18a.

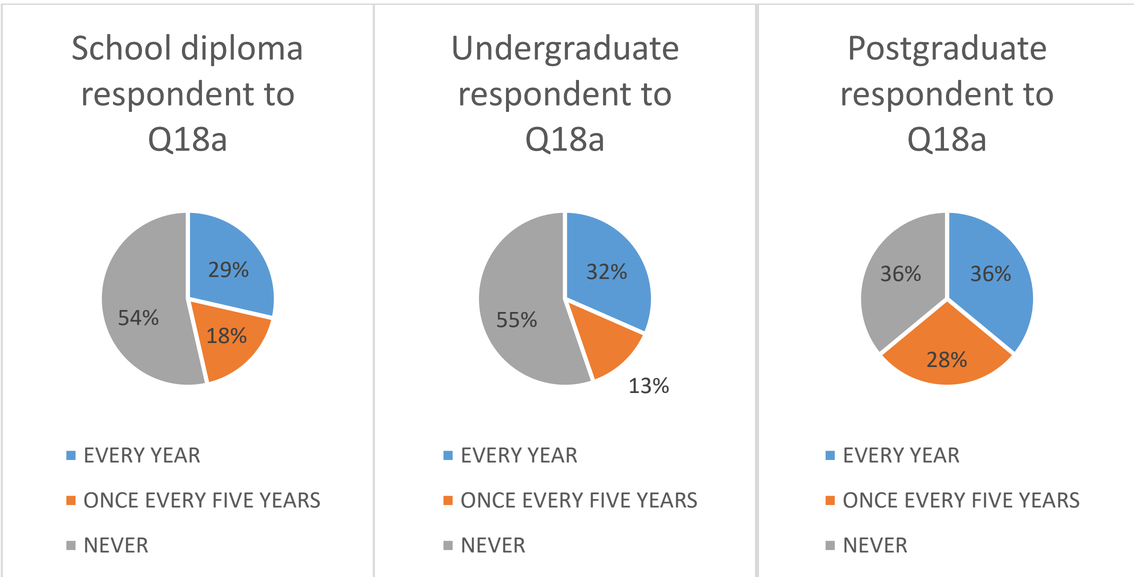


Figure 7.13 Academic qualifications of respondents to Q18a.

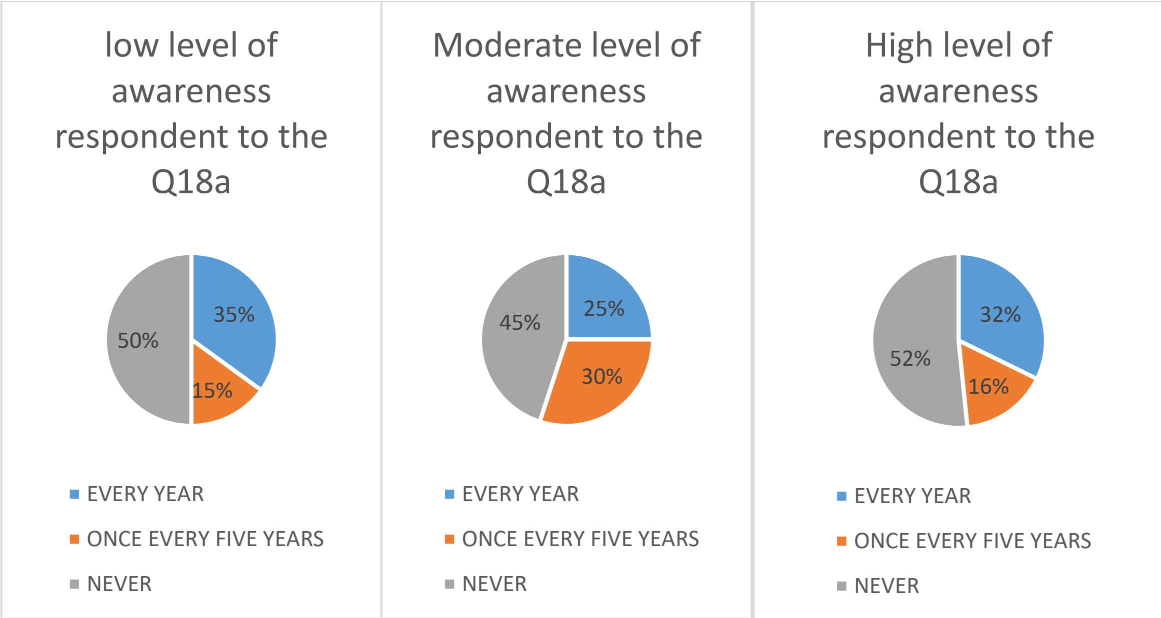


Figure 7.14 Level of awareness of respondents to Q18a.

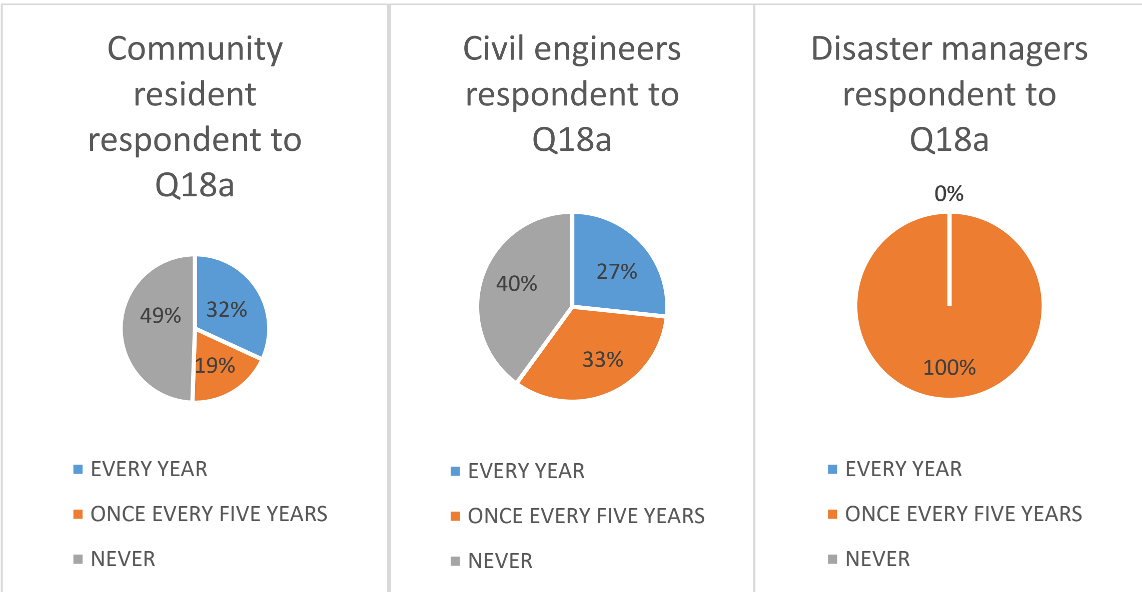


Figure 7.15 Profile of respondents to Q18a.

It is conceivable that the disaster managers in this instance are correct, and the others are wrong. That would be the case if all other sub-groups were not fully engaged in the process, which is possibly true.

Finally, respondent was asked how we often they think that the strengths and weaknesses in the post-earthquake damage survey assessment education programme within the Iranian Earthquake Information Management Systems (EIMS) should be analysed.

No disaster managers commented.

Only three engineers commented, and all were male with high or moderate levels of awareness of the earthquake management system. On balance their views were quite sceptical, suggesting that the review should take place after every major international earthquake, but suggesting that that does not happen and when it does it is not accurate or complete.

"Maybe, after every earthquake anywhere in the world." (Respondent 154, 2111)

"Training and assessment do not exist." (Respondent 165, 2112)

"Unfortunately, it is not done accurately and when it is done after a massive earthquake it is not accurate and not complete either of them." (Respondent 167, 2122)

Twelve male residents commented. The male residents with high levels of awareness were quite varied in their opinions, from not much being done to something done every year, but no accurate information on that is available.

"There is no accurate information available." (Respondent 21, 1111)

"So far no clear raising awareness has been done." (Respondent 148, 1121)

"They always do things post-earthquake." (Respondent 136, 1131)

"It must be done once a year." (Respondent 17, 1131)

Male residents with lower levels of awareness were clearer in their suggestions that strengths and weaknesses in the post-earthquake structural assessment education programme should be analysed after every major earthquake.

"I do not have any information." (Respondent 1, 1112)

"Whenever the earthquake happens." (Respondent 2, 1122)

"After any major earthquakes." (Respondent 137, 1123)

"If this had been done post-earthquake the bitter experiences of disaster would not have taken place." (Respondent 15, 1132)

"When an earthquake takes place." (Respondent 138, 1132)

"University student never get any training. I only heard hearsay." (Respondent 70, 1133)

"As when it happens, that is only when the disaster managers realise that the disaster has happened." (Respondent 112, 1133)

"When earthquake happens, which causes major losses." (Respondent 133, 1133)

Seven female residents answered this question and generally their responses were quite negative, suggesting that Iran has no strength in this area and not a lot is done.

"Only after when a major disaster takes place and even this seems to be fading too." (Respondent 113, 1212)

"There is no strength in this field." (Respondent 130, 1223)

"We do not have such programme in Iran." (Respondent 145, 1223)

"As I do not know such a thing exist, I do not know how often it is analysed, it needs to be said everything that is a necessity requires on going analysis." (Respondent 59, 1232)

"It must be done approximately once year, as this is sensitive task." (Respondent 18, 1233)

"Disaster management only look for solution when the actual disaster takes place." (Respondent 122, 1233)

"There is not a lot done in this matter and post-earthquake there is no accurate assessment done regarding the cost and etc." (Respondent 9,12xx)

In summary this section has revealed a very widespread level of support for the suggestion that a broad ranging education and training programme to raise awareness of the Iranian post-earthquake damage survey assessment system is needed. Disaster managers suggested that such a programme already exists but admitted that more could be done to include engineers in the programme, especially in advance of an earthquake event. It is possible that the current scheme is simply too small and narrowly focussed to be effective. The engineering community agreed that they need to be more engaged with the process, but also advocated that the training programme be widened to include member of the public and other relevant organisations. They also suggested that a range of different levels of education and training be implemented, for the public and for engineers. Most of the resident respondents advocated that the programme be supported by good international level research and be led by experts in the field. There was also a widespread belief that a special budget should be set aside for this activity, it should fund the purchase of special equipment and the use of a wide range of mass media technology to deliver education and training. There was also a suggestion that the current system is not reviewed often enough, possibly only once every five years. Engineers and residents both considered that the system should be reviewed much more frequently, even as often as after every major global earthquake event.

Reflecting on the scenario presented at the start of this chapter helps me to understand from the experience outlined in this section that the educations programmes should be design in ways to raise awareness about the post-earthquake damage survey assessment and its importance within an EIMS. Different methods of post-earthquake education system need to be tried, to see which one is more effective for each community.

7.5 Summary and main findings

This chapter set out to provide new insights about education system within the post-earthquake disaster management, using the system in Iran as a case study. Data from an observational visit, a variety of engagement activities undertaken and from a survey conducted in Tehran were analysed in order to reveal insights. Many of the insights relate directly to the Iran context, but some can be generalised to apply in a broader context.

The author revealed that post-earthquake disaster management education programmes in Iran are very weak, as not all the layers of community are included in the programme. The architects, civil and structural engineers are not included in the post-earthquake damage survey assessment, so there no education programme for them, which is very worrying. By including the structural engineers within the Iranian EIMS training and education programme, it would make the whole process of improving the post-earthquake damage survey assessment system easier and faster. But structural engineers need to be active themselves and seek out proper training, to make sure they ready to visit affected area, with proper equipment and they engage with the local community. To make sure that the post-earthquake damage survey assessment system works in Iran, the Iranian disaster management organization needs to make sure that architects, civil and structural engineers are involved in the planning of education and training from beginning to the end. The authorities must consider the opinion and ideas of structural engineers to improve the system. I also believe that collaboration with advanced countries in this field would be very beneficial to improve the post-earthquake damage survey assessment in Iran.

The author observational visit to Kermanshah helped to show that the community in that city did not know how to engage in the post-earthquake damage survey assessment system. They needed to learn what to do, who was responsible for what, which organization manages post-earthquake assessment and how the process would help in addressing their needs. This research also revealed that the education of all communities, not just in Kermanshah was so weak. From the disaster management point of view, the recent earthquakes in Iran highlight an urgent need in Iran for better education and training. In this research, the author has proposed new methods of educating the public and engineers about the post-earthquake damage survey assessment, to help improve the system in Iran. Iran cannot do this alone, it needs to engage more with other countries, with more advanced practices in this field, and learn from them to alter their own education and training system.

The author has found the weak links in Iranian system are as follows:

- Sometimes in Iran the priority of earthquake risk reduction issues is ignored or postponed due to the other issues that a country is facing.
- Iran needs to put the earthquake risk reduction activities more systematically integrated within the community and universities in order to get maximum results from their earthquake education system.
- Teachers in school need to get more education and training on earthquake risk reduction to be more effective in their schools and communities.

- Post-earthquake education activities in Tehran need to be sensitized in the communities.
- This research also finds that disaster managers should consult with communities for planning education programmes that are of interest to them and stimulate their interest in disaster risk reduction activities.
- Disaster management programme in Iran needs to get the civil engineer and architects' students more involved in post-earthquake damage survey assessment to make the assessment faster, make the community back to normal as soon as possible and make the economy back to normal.
- Make the opinion of the Senior and experienced civil engineers and architects' matter as they might suggest ideas to improve the post-earthquake damage survey assessment and learning material in universities more attractive to universities' students and communities.
- Informal post-earthquake education such as performing drills will be very effective in increasing the awareness of communities.
- The lack of community management in case of earthquakes is another challenge that Iran is facing, and it needs to be addressed soon.
- Iran needs to implement more formal and informal community-based earthquake education and training material, so they can raise awareness and develop the "culture of safety" and make the community more resilient to the impact of earthquakes in the future in Tehran.
- The role of mass media in introducing programs for community residents with themes of earthquake preparedness will be important in order to sensitize the communities in Tehran.

Chapter 8 - Conclusion and recommendations for further research

In this thesis, the importance of community-based activities in reducing building damages and human casualties of earthquake through education and engagement has been highlighted. Moreover, this research study has presented to evaluate the possibility of involving civil and structural engineer and community members in post-earthquake damage survey assessment.

In particular most community members in Tehran think that post-earthquake damage survey assessment cannot be done with current plan. There was a belief that if the government is unable to change the current plan the communities would be powerless.

However, some member of the community indicates that by providing with relevant training, facilities and improving the capabilities of disaster managers and engineers they can response better to the next earthquake.

Almost all participant believes that the disaster management system in Iran needs to be change for better. They need more experienced and capable disaster mangers. As mentioned previously, the schoolteachers can play a major role in post-earthquake education and engagement as they have close relationship with community member and local authority. If the disaster management system in Iran can train the teachers, they can supply the necessary information for the local community and can manage the post-earthquake activities for disaster management system in Iran. However, implementation of disaster risk reduction measures needs financial resources. If the economic condition of the community is not stable, the activities cannot be accomplished well. Meanwhile, it is very difficult for some communities to participate in post-earthquake management activities by themselves and therefore, the government financial support is very essential.

Moreover, another finding from this study include the children having no Experience in earthquake. Therefore, the story telling and images of a past earthquake will make them more prepared for future earthquake in Tehran. With right training, they might be able to assist in immediate response.

Lastly, another outcome of this research is the shortage of technical community-based organizations in Tehran in post-earthquake disaster management. Most of the NGOs in

Tehran are working in the charitable bases, and they do not have any information or skills in post-earthquake disaster management.

8.1 Findings and contribution to knowledge about the EIMS in Iran

Mass media is vital in communicating news and information to the public. Responsible journalism can also help clear inaccurate rumours and influence the public attitude toward disaster preparation. However, this thesis has revealed that the mass media has failed to inform regarding earthquake information management and preparedness guidance. It seems that the mass media in Iran is more interested in giving disastrous news than informing the public.

The first efforts to systematically collect and analyse earthquake data in Iran must be undertaken by national disaster managers. Based on this thesis Iran needs to have EIMS because of the following reason:

- It helps the relevant earthquake information gathered in one data bank.
- It helps the improvements of earthquake data continuously.
- The EIMS helps to analyse earthquake information more productively.
- The EIMS helps to coordinate activities between government organizations and non-government organizations more efficiently.
- The EIMS helps to prevent similar issues in future earthquakes.

The quantitative analysis of survey data helped to identify specific strengths and weaknesses in the EIMS of Iran. Q9a of the study reveals hopeful signs that Iranian disaster management authorities have created the basis for a good and strong EIMS. However, the direct observation demonstrated that trust in the new EIMS is low. Analysis of results from Q11 of survey suggested that all elements of the effective EIMS operated in Iran. However, there are clear areas that survey respondents advocated action to improve current practice. Q11 revealed strengths in the following areas:

- Record the location of damaged buildings.
- Identify safe zones around damaged buildings.
- Assess wider regional damage.

- Identify additional hazards around buildings.
- Calculate economic losses.
- Assess emergency management needs.

The weaker part of the system included:

- Disseminate data to public and other bodies.
- Collect data from the public and other bodies.
- Assess the long-term usability of buildings.
- Undertake short-term usability assessment.
- Add information to a central database.
- Calculate funding needed for reconstruction.

Almost all groups agreed that the weakest part of the system was:

- Estimate the social impact of the earthquake.

The final part of this research into the EIMS in Iran, analysed qualitative feedback from the survey. What this section revealed was the depth of feeling in relation to some of the weaknesses in the system, which were very powerfully felt by residents and a good proportion of engineers. The negative and pessimistic views expressed seemed to stem from a belief that if the EIMS does exist in Iran, then it does not function well. That led some survey respondents to speculate that disaster managers lack competence in the implementation of the system. Even more widespread and possibly reaching into the disaster management community, this research revealed a belief that there is no effective plan to improve the EIMS in Iran.

8.2 Findings and contribution to knowledge about the strength and weakness in the post-earthquake damage survey assessment system in Iran

The main aim of this thesis in comparing the post-earthquake damage survey assessment worksheets between Iran, Greece, Turkey USA, and Japan is highlighted that the lack of data collection in the practice in Iran. The damage survey assessment sheet in Iran is not sufficient to clarify the damage and its level. By looking at post-earthquake damage assessment sheet in Iran, it can be said that these worksheets are only for collecting superficial information about buildings in the affected area. For a country like Iran, which is highly prone to earthquakes, these post-earthquake damage assessment sheets should be re-organised, and the aim of these assessments should not only be focused on the current condition of the building but also on the quality of the materials, and the building's code of practice and rule of law.

From this research the point blow shows the weakness of Iranian damage survey assessment:

- In Iran the post-earthquake damage survey assessment system is not common.
- Civil engineers, architects and building survives are not familiar with post-earthquake damage survey assessment.
- The new building in Iran constructed without considering using structural health monitoring system.
- Poor construction management in Tehran.
- There is no training for construction workforce.

Strengths and weaknesses in the Iranian post-earthquake damage survey assessment system were assessed using quantitative data from the main survey instrument. The main finding from this analysis was that 76% of participants did not think that the Iranian EIMS included an effective post-earthquake damage survey assessment system. However, detailed questioning in Q11b did reveal that all elements of an effective system did exist in the country. This research was also able to identify strengths and weaknesses in the system. Specifically, this thesis has revealed that the weakest parts of the post-earthquake damage survey assessment system in Iran related to "assessing materials used in building construction" and "Record methods used for building construction". A major concern amongst survey respondents was that communities believe the strength and weakness of the system were rarely analysed. The results from the survey suggest that the system does not always function properly.

When analysing qualitative data about the beliefs, attitudes and behaviours towards the Iranian post-earthquake damage survey assessment system, it was found that further evidence is needed in Iran to record the method of construction. However, the government agencies currently have no systems to collect records about buildings. Another point that the engineers responding to the survey confirmed, was that Iran has no system for recording damage to structures from the past earthquake, which would act as a helpful database when assessing building that have been subject to further earthquake shocks. Some engineers in

Iran thought that there was no single organization responsible for post-earthquake damage survey assessment in the country. That was a problem, because every organization involved has their own system of recording damage and method for undertaking post-earthquake damage survey assessment. That makes it hard to compile all the data in one comprehensive EIMS. Overall, the engineers provided many suggestions on how to improve the system:

- Collect better and more accurate information about building design and construction.
- Invest in better and more advanced equipment for post-earthquake damage survey assessment.
- Educate and engage the public in initial post-earthquake inspections.
- Improve the EIMS system to collect and retrieve post-earthquake damage survey assessment data.
- Involve Universities in Iran about the education and training programmes relating post-earthquake damage survey assessment and the Iranian EIMS.
- Involve more civil and structural engineers in the post-earthquake damage survey assessment planning system.
- Improve training of disaster mangers in how to integrate a post-earthquake damage survey assessment system into and EIMS.
- Create more collaboration and more workshops with other countries in this post-earth-quake damage survey assessment and EIMS.

From the male and female resident point of view, the main point raised was about the competence of disaster mangers. There was widespread feeling that better monitoring of the design and construction of buildings before an earthquake was needed. The community response also suggested that more cooperation, rather than competition, between organisations involved in a disaster response was needed in Iran. The survey found a difference between male and female views on the Iranian post-earthquake damage survey assessment system. Woman were more positive in their belief that a better post-earthquake damage survey assessment system could be developed in Iran. The women were also willing to suggest ways of improving the system, by addressing the following issues:

- Creating a better disaster management system generally in Iran.

- Assessing weakness in the post-earthquake damage survey assessment within the EIMS.
- Sorting out deficiencies in construction methods used in Iran.
- Having better management plans for before, during and after an earthquake.
- Having a more effective system to punish contractors who breaking construction law.
- Enhance control and monitoring of new building construction.
- Stop bribery and corruption in the building regulation process.

8.3 Findings and contribution to knowledge about engagement with the post-earthquake damage survey assessment system in Iran

The analysis of quantitative survey data revealed that Disaster Management, National Governmental agencies, and emergency services were evident in their engagement in the post-earthquake damage survey assessment process. However, this study revealed that no international disaster relief agencies were evidently involved. There was evidence of the engagement of religious groups, but the expense of engagement by more organised and better qualified communities of engineers and building inspectors. The survey also suggested that Neighbourhood communities, volunteer groups, and non-governmental organisations are less engaged in Iran. However, the scenario suggested that in the wider community, this is possibly not the case, rather it is that the efforts of those communities are not well organised. One final finding that did correlate well between observation and survey data, was that transport authorities were not effectively engaged and that their lack of engagement did hamper post-earthquake relief efforts.

Qualitative data from the survey undertaken as part of this thesis, revealed that Disaster Management authorities would not be encouraging engagement in the post-earthquake response, or at least the message was not clear if engagement is wanted or not. It was judged that the lack of a clear message promoted a sense of distrust in the effectiveness of the disaster management authorities. The engineering community did not help the situation, it was split in their belief about whether engagement would be effective or not. Additionally, the data revealed that non-governmental expert communities did not show leadership in the response, failing to help train and engage the resident community. The reason for this could be that the male leaders of the professions were somewhat pessimistic about the outcome. In contrast, the female community residents were very eager for some kind of engagement opportunity but needing expert guidance from the professional bodies.

This research is about how to improve the current system. To that end, the identified weak points in the Iranian system, were identified as:

- Iran is lacking cooperation with international disaster relief organizations.
- Iran needs to broaden the existing engagement programme to include the structural engineers and community resident.
- An engagement programme is needed, that focusses on developing knowledge and understanding of the public, engineers, and managers.
- The education programme should be led by experts in the field and be informed through engagement with international studies from other earthquake prone countries such as USA and Japan.
- Some form of legal framework would be helpful to support its implementation across all levels of education, to make clear how roles and responsibilities are allocated and to explain the frequency with which the education is repeated.

This research also finds that the post-earthquake financial help will encourage the communities to be more engage in post-earthquake engagement activates such as building damage survey assessment and the build back better for future.

This research also finds that the disaster management system in Iran needs to encourage the local civil engineering companies and universities to be engage more in post-earthquake damage survey assessment. The disaster management programme in Iran can engage the communities in Iran with help of local civil engineering companies to be involved in not using of improper construction material and methods of construction.

This research finds the weaknesses on post-earthquake disaster management engagement programme in Iran:

- The post-earthquake disaster management engagement programme in Iran needs to focus on capacity building and empowerment in the long term.

- The post-earthquake damage survey assessment engagement programme in Iran needs to be well understood by the engineering community in Tehran to have better feedback from civil and structural engineers in the future.
- There was the belief within the civil engineers and member of communities that they cannot change the current conditions of the disaster management system engagement programme in Iran unless the government change the structure of disaster management system.
- The school teachers can play an important role in post-earthquake disaster management engagement programmes as they have a close relationship with their own community members and students, and the local authorities.

8.4 Findings and contribution to knowledge about education to enhance the post-earthquake damage survey assessment system in Iran

The survey data analysis revealed the Iranian education system was judged to have a good coverage of the important topic areas. However, what is highly significant for this research is that the topics of “Assessing building damage”, “Recording building damage” and “The role of structural engineers” which were the three lowest ranked education topics. In relation to “Actions to take before an earthquake”, “Actions to take after an earthquake” and the “Availability of education material”, engineers were less optimistic that the topics were always covered in detail. Disappointingly, and again an important finding from this thesis, engineers themselves considered that education about “The role of structural engineers” in post-earthquake damage survey assessment system was the weakest part of the education system in Iran. Moreover, the topic with the fewest responses amongst community residents was “Calculating the human and economic loss”. That said, the resident scores mainly differed from the engineers in the topics of “Actions to take before an earthquake”, “Actions to take after an earthquake” and the “Availability of education material”. In all of these topics, the residents considered that they were covered in more detail than suggested by the final survey ranking. To some extent the resident responses indicated that “The local disaster management system” and the topic of “Seismic faults in the local area” were not covered in as much detail as suggested by the overall ranking. Finally, as an important finding from this research study, residents considered that the weakest part of the post-earthquake damage survey assessment education system to be “Recording building damage”.

In summary, this thesis revealed a very widespread level of support, suggesting that a broad ranging education and training programme is essential to raise awareness of the Iranian post-earthquake damage survey assessment system. Disaster managers suggested that such a programme already exists; however, it was admitted that more could be done to include civil and structural engineers in the programme, especially in advance of an earthquake event. It is possible that the current scheme is simply too small and narrowly focussed to be effective. Thus, the civil and structural engineering community agreed that they need to be more engaged with the process, and they have advocated that the training programme to be widened, to include member of the public and other relevant organisations. They also suggested that a range of different levels of education and training will be implemented, for the public and for engineers. Furthermore, most of the resident respondents advocated the programme to be supported by good international level research and be led by experts in the field. There was also a widespread belief that a special budget should be set aside for this activity, which should fund the purchase of special equipment and the use of a wide range of mass media technology to deliver education and training. Lastly, another suggestion include that the current system is not reviewed often enough, possibly only once every five years. Engineers and residents both considered that the system should be reviewed much more frequently, even as often as after every major global earthquake event.

8.5 Recommendations for further research

According to the result of this thesis, the following recommendations can be proposed for future work to improve the disaster management and structural assessment in Iran.

- Improve the public awareness: this recommendation can be implemented by post-earthquake disaster management and structural assessment education in school, universities, and public and private organizations. Disaster management programme must broadcast earthquake information through mass media. The quality of education martials must improve according to new research.

- Promoting public participation and cooperation: for this purpose, the members of the community, engineering community and disaster management community should have clear and identified tasks. Furthermore, the committees of community member and structural engineer should be established in municipalities for promoting community involvement in post-earthquake disaster management and structural assessment and the guideline should be prepared for district, sub district and neighbourhood level.

- Developing community-based post-earthquake disaster preparedness and structural assessment: this aim will be achieved by using the capacity of the community of neighbourhood. The existing NGOs and civil and structural engineers need to be upgraded in post-earthquake structural assessment, disaster mitigation and management affair. The structural engineers and NGOs should be listed and screened for the appropriate task at the right time. Essential tools and equipment must be supplied for them by local governments.

- Establishing collaborative network between the community members, structural engineers, and disaster managers: for this purpose, joint workshop and meetings should be organized involving community members, structural engineers, and disaster mangers.

In conclusion, proper planning, technical and financial support, as well as regular monitoring and supervision by the expert government in disaster management and structural assessment, should be considered in order to assure success and sustainability in the future.

From this thesis the author finds that there are future opportunities that exist to explore more by undertaking further observational studies, more interviews with structural engineers in Iran and more interviews with disaster mangers. This is to see what the best possible solution is to get civil and structural engineers involve more in post-earthquake damage survey assessment and to see what structural engineer will recommend improving the post-earthquake damage survey assessment in Iran. Furthermore, in future research more civil and structural engineers' need to be interviewed to see where the strength and weakness of the Iranian post-earthquake damage survey assessment are.

From this research study, the author finds the future opportunities exist on how the post-earthquake damage survey assessment form in Iran can be improved. There are three issues with Iranian post-earthquake damage survey assessment including: utilising the same type of construction materials (concrete, masonry, steel and timber); the damage ranking assessment depends on the inspector experience and knowledge; and depending on the level of experience and knowledge of the inspectors where the result of a building assessment might be different.

Moreover, it was found that the post-earthquake damage survey assessment should be a single page, which can be easily and quickly filled under the post-earthquake condition. It should contain the information about the occupant so the government organization can benefit from it for government financial support. The post-earthquake damage survey assessment should be based on simple calculation.

Furthermore, the author finds that future opportunities exist on what post-earthquake education programme are needed. In addition, and how the locals can be sensitized to the post-earthquake education programme to arise awareness and develop the culture of safety and make the community more resilient to the impact of earthquakes in the future in Tehran (Iran).

Finally, this thesis also identifies the four points for the future research on post –earthquake damage survey assessment:

- For post-earthquake damage survey assessment in Iran, the external participators should be trained well and certified. These trainings can be carried out by responsible government authorities during the year.
- The post-earthquake damage survey assessment sheet should be extended and should cover more detailed information.
- The data base needs to be created for rural structures in Iran.
- For better understanding of post-earthquake damage survey assessment sheet in Iran, the criteria for damage level should be well defined by percentages.

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Appendices

List of items included in the appendices

1. Questionnaire survey questions
2. Questionnaire survey questions in Farsi
3. Questionnaire survey coding system
4. Survey respondent tree
5. Post-earthquake disaster management and structural assessment (IDRC DAVOS 2016, 28 Augest-01 September, 2016, Davos, Switzerland
6. Ethical Approval letter

Appendix 1

PLYMOUTH UNIVERSITY

FACULTY OF SCIENCE AND ENGINEERING

CONSENT TO PARICIPATE IN RESEARCH PROJECT

Name of Principal Investigator: **Nirvan Razaghi-Kashani**

Title of Research

An analysis of the Iranian post-earthquake management and structural assessment system

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Brief statement of purpose of work

Aim

Analyse the post-earthquake management and structural assessment system used in Iran in relation to state-of-the-art practices implemented in other seismically active regions of the world with a view to identifying strengths and weaknesses in the Iranian system and to propose actions that Iranian organisations can take to enhance the current system.

Objectives

- Review the state-of-the-art practices in post-earthquake management and structural assessment from seismically active regions of the world
- Review the existing practices in post-earthquake management and structural assessment from seismically active regions of Iran
- Analyse the overall system for post-earthquake management and structural assessment system used in Iran in relation to state-of-the-art practices implemented in other seismically active regions of the world
- Identify strengths and weaknesses in the Iranian system in relation to state-of-the-art practices implemented in other seismically active regions of the world

- Propose actions that Iranian organisations can take to enhance the current system of post-earthquake management and structural assessment in seismically active regions of Iran

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Ethical issues:

- The objectives of this research have been explained to me.
- I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.
- I understand that my anonymity is guaranteed, unless I expressly state otherwise.
- I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks.
- Under these circumstances, I agree to participate in the research.

Name: ……………………………………….

Signature: ....……………. Date: ....………….

Section 1 – Background information

1. Gender **Male/Female**

2. Age _____ **years old**

3. Highest educational qualification ___________________________

4. Official job title ___________________________

5. Official role in the management of earthquake risk in Tehran **Yes / No**

6. Score for level of awareness of the earthquake risk in Tehran. (1=very low and 5=very high), ______ **score**

7. Years working in Tehran ____ **years**

8. Years working as a disaster manager in Tehran ____ **number**

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9. Do you know if there is an Earthquake Information Management System (EIMS) in Tehran or anywhere else in Iran? **Yes / No / Do not know**

Brief explanation of answer:

10. Do you know if there is a plan to develop an Earthquake Information Management System (EIMS) for Tehran or more generally in Iran? **Yes / No / Do not know**

Brief explanation of answer:

Section 2 – Questions about your awareness of the Iranian system for managing earthquakes

11. Do you know if the Iranian earthquake management system includes a process to manage post-earthquake structural assessment? **YES/NO**

If NO proceed to Q12

If YES, the box below includes a number of activities that an earthquake management system may include. Please indicate how often you think that the Iranian earthquake management system undertakes each activity.

Activity	Your Response (please tick one box per row)		
	After every earthquake	Only after the largest earthquakes	Neve r
Assess materials used in building construction			
Record how the buildings are being used			
Record method used for building construction			
Assess wider regional damage			
Use of a standard system to record damage			
Undertake short-term usability assessment			
Calculate economic losses			
Calculate funding needed for reconstruction			
Estimate the social impact of the earthquake			

Assess emergency management needs			
Undertake a quick/rapid visual inspection			
Undertake a detailed damage assessment			
Assess the long-term usability of buildings			
Assess condition of structural elements			
Evaluate the overall building condition			
Classify the level of damage to each building			
Identify damage to non-structural elements			
Record the location of damaged buildings			
Measure the dimensions of damaged building			
Count the number of floors in buildings			
Record any foundation damage in buildings			
Identify additional hazards around buildings			
Identify a safe zone around damaged building			
Assess the need to improve the system			
Add information to a central database			
Collect data from the public and other bodies			
Disseminate data to public and other bodies			
Calculate the residual strength of buildings			

12. From your experience, do you believe that having an effective post-earthquake structural assessment system within the Iranian earthquake management systems is achievable? **YES/ NO/ Do not know**

Brief explanation of answer:

13. Assuming that the Iranian earthquake management systems does includes a post-earthquake structural assessment system within it, what do you believe needs to be done to raise awareness of the system?

Answer:

14. How often do you think that the strengths and weaknesses of a post-earthquake structural assessment system within the earthquake management systems are analysed?

Frequency of analysis	Tick one box below
Every year	
Once every five years	
Never	

Other (please give details)	

Section 3 – Questions about post-earthquake structural assessment education

15. Do you know if the Iranian earthquake management system includes a post-earthquake structural assessment ***education*** programme? **YES/NO**

If NO proceed to Q16

IF YES, the box below includes a number of topics that post-earthquake structural assessment education programme may include. Please indicate how well you think that the post-earthquake structural assessment education programme in Iran addresses each topic.

Education topic	Your Response (please tick one box per row)		
	Covered in detail	Mentioned but not covered in detail	Not included
The local disaster management system			
The role of local disaster managers			
The role of community residents			
The role of structural engineers			
Seismic faults in the local area			
The local seismic risk			
Calculating human and economic loss			
Recording building damage			
Assessing building damage			
Actions to take before an earthquake			

Actions to take during an earthquake			
Actions to take after an earthquake			
Incentives to act			
Availability of educational material			

16. From your experience, do you believe that an effective post-earthquake structural assessment ***education*** system is achievable in Iran? **YES / NO / Do not know**

Brief explanation of answer:

17. Assuming that the Iranian earthquake management system does includes a post-earthquake structural assessment ***education*** programme within it, what do you believe needs to be done to raise awareness of the system?

Answer:

18. How often do you think that the strengths and weaknesses in the post-earthquake structural assessment ***education*** programme within the earthquake management system are analysed?

Frequency of analysis	Tick one box below
Every year	
Once every five years	
Never	
Other (please give details)	

Section 4 – Questions about post-earthquake structural assessment engagement

19. Do you know if the Iranian earthquake management system includes a post-earthquake structural assessment ***engagement*** programme?? **YES/NO**

If NO proceed to Q20

If YES, the box below includes a number of entities that a post-earthquake structural assessment engagement programme may include. Please indicate how often you think that the post-earthquake structural assessment programme in Iran engages with each entity?

Engagement entity	Your Response (please tick one box per row)		
	Always	Sometimes	Never
The victim community			
Building inspectors			
Transport authorities			
Emergency services			
Disaster managers			
Engineers			
Neighbouring communities			
Non-Governmental Organisations			
Community-based Organisations			
Religious groups			
Health professionals			
National Government ministries			

International disaster relief agencies			
Local Government organisations			
Volunteer groups			
School children			
Disabled and vulnerable groups			
Private sector companies			

20. From your experience, do you believe that an effective post-earthquake structural assessment ***engagement*** system is achievable in Iran? **YES / NO / Do not know**

Brief explanation of answer:

21. Assuming that the Iranian earthquake management system does includes a post-earthquake structural assessment ***engagement*** programme within it, what do you believe needs to be done to raise awareness of the system?

Answer:

22. How often do you think that the strengths and weaknesses in the post-earthquake structural assessment ***engagement*** programme within the Iranian earthquake management system are analysed?

Frequency of analysis	Tick one box below
Every year	
Once every five years	
Never	
Other (please give details)	

THE END

If you would like feedback on the results of the research please can you provide me with your contact details in the box below

Your contact details (Optional) Name: Email: Contact telephone or mobile number:

Appendix 2

پرسش های مربوط به دوره تحقیقاتی دکترا

دانشگاه پلیموت

دانشکده علوم و مهندسی

برگه اطلاعات

نام محقق اصلی: نیروان رزاقی کاشانی

عنوان تحقیق: تحلیل سیستم مدیریت پس از زمین لرزه و ارزیابی سازه ای ایران

خلاصه ای از هدف کار

هدف

تحلیل سیستم مدیریت پس از زمین لرزه و ارزیابی سازه ای مورد استفاده در ایران در رابطه با جدید ترین روش های اجرا شده در دیگر مناطق جهان که از نظر لرزه ای فعال هستند همراه با نگاهی به تعیین و شناسایی نقاط قوت و ضعف موجود در سیستم ایران و پیشنهاد اقداماتی که سازمان های ایران می توانند به منظور بهبود و تقویت سیستم فعلی به عمل آورند.

اهداف

- بررسی جدیدترین روش ها در مدیریت پس از زمین لرزه و ارزیابی سازه ای از مناطقی از جهان که از نظر لرزه ای فعال هستند
- بررسی روش های موجود در مدیریت پس از زمین لرزه و ارزیابی سازه ای از مناطقی از ایران که از نظر لرزه ای فعال هستند
- تجزیه و تحلیل سیستم کلی مدیریت پس از زمین لرزه و سیستم ارزیابی سازه ای مورد استفاده در ایران در رابطه با جدیدترین روش های اجرا شده در دیگر مناطق جهان که از نظر لرزه ای فعال هستند
- تعیین نقاط قوت و ضعف در سیستم ایران در رابطه با جدیدترین روش های اجرا شده در دیگر مناطقی از جهان که از نظر لرزه ای فعال هستند
- پیشنهاد اقداماتی که سازمان های ایران می توانند به منظور تقویت و ارتقاء سیستم فعلی مدیریت پس از زمین لرزه و ارزیابی سازه ای در مناطقی از ایران که از نظر لرزه ای فعال هستند به عمل آورند

مسایل و موضوعات اخلاقی

شرح فرایند

لطفا پرسشنامه نظرسنجی را به عنوان بخشی از پروژه تحقیقاتی دکترا تکمیل کنید.

شرح ریسک ها و خطرات

این پرسشنامه شامل پرسش هایی در مورد نظرات شما در رابطه با سیستم مدیریت پس از زمین لرزه و ارزیابی سازه ای مورد استفاده در ایران است. در نتیجه، پاسخ های شما ممکن است شامل اطلاعات حساس یا محرمانه باشد. به همین دلیل، سوابق هویتی شما نگهداری نخواهد شد.

مزایای تحقیق پیشنهادی

امید است که نتایج حاصل از این تحقیق در راستای ارتقاء سیستم فعلی مدیریت پس از زمین لرزه و ارزیابی سازه ای در مناطقی از ایران که از نظر لرزه ای فعال هستند مورد استفاده قرار گیرد

حق انصراف

می توانید در هر زمان از این نظرسنجی انصراف دهید.

چنانچه از نحوه انجام تحقیقات ناراضی هستید لطفا از طریق شماره تماس 07531213621 با محقق اصلی تماس حاصل فرمایید. در صورتی که احساس می کنید مشکل برطرف نشده است لطفا از طربق شماره تلفن 01752584503 با منشی دانشکده علوم و مهندسی کمیته اخلاق انسانی خانم پائولا سیمون تماس حاصل فرمایید.

بخش اول – اطلاعات قبلی در مورد شما

1- جنسیت: مرد/زن
2- سن: ...... سال
3- بالاترین مدرک تحصیلی
4- با در نظر گرفتن مقیاس 1 تا 5 (1 = بسیار کم و 5 = بسیار زیاد)، امتیازی که سطح آگاهی خود از خطر زمین لرزه در تهران می دهید چه امتیازی است؟ ..... امتیاز
5- چند سال در تهران زندگی کرده اید؟ ..... سال
6- تعداد افرادی که در تهران با شما زندگی می کنند؟ ..... نفر
7- آیا از میان افرادی که با شما زندگی می کنند کسی در مقایسه با شما دارای سطح آگاهی بهتری در خصوص خطر زمین لرزه در تهران می باشد؟ بلی/خیر/غیر قابل اجرا
8- با در نظر گرفتن مقیاس 1 تا 5 (1 = بسیار کم و 5 = بسیار زیاد)، امتیاز سطح متوسط آگاهی افرادی که با شما زندگی می کنند از خطر زمین لرزه در تهران چه امتیازی است؟ .... امتیاز
9- ساختمانی که در آن زندگی می کنید چند طبقه است؟ .... طبقه
10- آیا ساختمانی که در آن زندگی می کنید دارای قاب بتنی است (ستون های آرماتوربندی شده، تیرچه و دال های کف)؟ بلی/خیر/اطلاعی ندارم

بخش دوم – پرسش هایی در مورد آگاهی شما از سیستم مدیریت زمین لرزه در ایران

11- آیا می دانید سیستم مدیریت اطلاعات زمین لرزه ایران (EIMS) شامل فرایندی جهت مدیریت ارزیابی سازه ای پس از زمین لرزه است؟ بلی/خیر
در صورتی که پاسخ شما منفی است لطفا به پرسش 12 بروید.

در صورتی که پاسخ شما مثبت است، کادر زیر شامل تعدادی از فعالیت هایی است که سیستم مدیریت زمین لرزه باید دارا باشد. لطفا مشخص کنید که از نظر شما سیستم مدیریت زمین لرزه ایران هر یک از این فعالیت ها را هر از چند گاهی به انجام می رساند؟

فعالیت	پاسخ شما (لطفا یکی از کادرهای زیر را تیک بزنید)		
	پس از هر زمین لرزه	فقط پس از بزرگ ترین زمین لرزه ها	هیچوقت
ارزیابی مصالح بکار رفته در ساختمان ها			
ثبت نحوه استفاده از ساختمان ها			
ثبت روش مورد استفاده در ساخت ساختمان			
ارزیابی خسارات منطقه ای وسیع تر			
استفاده از سیستم استاندارد ثبت خسارت			
ارزیابی قابلیت استفاده کوتاه مدت			
محاسبه زیان های اقتصادی			
محاسبه بودجه مورد نیاز برای بازسازی			
تخمین و برآورد تاثیر اجتماعی زمین لرزه			
ارزیابی نیازهای مدیریت اضطرار			
انجام بازرسی عینی سریع			
انجام ارزیابی تفصیلی خسارت			
ارزیابی قابلیت استفاده طولانی مدت ساختمان			
ارزیابی وضعیت المان های سازه ای			
ارزیابی وضعیت کلی ساختمان			

			طبقه بندی میزان خسارت وارده به هر ساختمان
			تعیین خسارت وارده به المان های غیر سازه ای
			ثبت محل ساخمان آسیب دیده
			ارزیابی ابعاد ساختمان آسیب دیده
			شمارش تعداد طبقات موجود در ساختمان ها
			ثبت هر گونه خسارت وارده به فونداسیون ساختمان ها
			تعیین دیگر خطرات موجود در اطراف ساختمان ها
			تعیین منطقه ای ایمن در اطراف ساختمان های آسیب دیده
			ارزیابی نیاز به بهبود سیستم
			افزودن اطلاعات به پایگاه داده های مرکزی
			جمع آوری اطلاعات از سازمان ها و نهادهای دولتی و دیگر سازمان ها
			انتشار اطلاعات به سازمان های دولتی و دیگر سازمان ها
			محاسبه مقاومت باقیمانده ساختمان ها

12- با توجه به تجربه ای که دارید به نظر شما آیا داشتن یک سیستم موثر ارزیابی سازه ای پس از زمین لرزه در سیستم های مدیریت اطلاعات زمین لرزه ایران (EIMS) قابل حصول است؟ بلی/خیر/اطلاعی ندارم

لطفا توضیح خلاصه ای از پاسخ خود را در این قسمت ذکر کنید:

13- با فرض اینکه سیستم های مدیریت اطلاعات زمین لرزه ایران (EIMS) فاقد سیستم ارزیابی سازه ای پس از زمین لرزه می باشند، به نظر شما چه اقدامی باید انجام شود تا سطح آگاهی این سیستم را افزایش دهد؟

لطفا توضیح مختصری را در این قسمت ذکر کنید:

14- به نظر شما نقاط قوت و ضعف سیستم ارزیابی سازه ای پس از زمین لرزه در سیستم های مدیریت اطلاعات زمین لرزه ایران هر از چند گاهی مورد تجزیه و تحلیل قرار می گیرند؟

درون یکی از کادرهای زیر را علامت بزنید	فراوانی تحلیل
	هر سال
	هر پنج سال یک بار
	هیچگاه
	سایر موارد (لطفا شرح دهید)

بخش سوم – پرسش هایی در خصوص آموزش ارزیابی سازه ای پس از زمین لرزه

15- آیا می دانید سیستم های مدیریت اطلاعات زمین لرزه ایران دارای برنامه آموزش ارزیابی سازه ای پس از زمین لرزه هستند یا خیر؟ بلی/خیر

در صورتی که پاسخ شما منفی است به پرسش 16 بروید

در صورتی که پاسخ شما مثبت است، کار زیر حاوی تعدادی از عناوینی است که برنامه آموزش ارزیابی سازه ای پس از زمین لرزه می تواند شامل آن باشد. لطفا مشخص کنید از نظر شما برنامه آموزش ارزیابی سازه ای پس از زمین لرزه در ایران تا چه حد هر یک از این عناوین را مد نظر قرار می دهد؟

عناوین آموزشی	پاسخ شما (لطفا یکی از کادرهای زیر را تیک بزنید)		
	پوشش مشروح	ذکر می گردد اما بطور کامل پوشش داده نمی شود	عدم شمول
سیستم مدیریت بحران محلی			
نقش مدیران بحران محلی			
نقش ساکنین جامعه			
نقش مهندسین سازه			
گسل های لرزه ای در منطقه محلی			
ریسک لرزه ای محلی			
محاسبه زیان های انسانی و اقتصادی			
ثبت خسارت ساختمان			
ارزیابی خسارت ساختمان			
اقداماتی که باید پیش از زمین لرزه به عمل آورد			

اقداماتی که باید طی زمین لرزه به عمل آورد			
اقداماتی که باید پس از زمین لرزه به عمل آورد			
انگیزه های اقدام			
موجود بودن مطالب آموزشی			

16- با توجه به تجربه خود، آیا به نظر شما دستیابی به سیستم آموزش ارزیابی سازه ای پس از زمین لرزه در ایران امکان پذیر است؟ بلی/خیر/اطلاعی ندارم

لطفا پاسخ خود را به طور مختصر در این قسمت بنویسید.

17- با فرض اینکه سیستم های مدیریت اطلاعات زمین لرزه ایران فاقد برنامه آموزش اریابی سازه ای پس از زمین لرزه می باشند، به نظر شما چه اقدامی باید صورت پذیرد تا منجر به افزایش سطح آگاهی سیستم گردد؟

لطفا پاسخ خود را بطور مختصر در این قسمت بنویسید.

18- به عقیده شما نقاط قوت و ضعف موجود در برنامه آموزش ارزیابی سازه ای پس از زمین لرزه در سیستم های مدیریت اطلاعات زمین لرزه ایران هر از چند گاهی مورد تجزیه و تحلیل قرار می گیرند؟

یکی از کادرهای زیر را علامت گذاری کنید	فرکانس تحیلی
	هر سال
	هر پنج سال یک بار
	هیچگاه
	سایر موراد (لطفا شرح دهید)

بخش چهارم – پرسش هایی در مورد مشارکت در ارزیابی سازه ای پس از زمین لرزه

19- آیا می دانید سیستم مدیریت اطلاعات زمین لرزه ایران دارای برنامه مشارکت در ارزیابی سازه ای پس از زمین لرزه است یا خیر؟

اگر پاشخ شما منفی است به پرسش بعد بروید.

اما چنانچه پاسخ شما مثبت است، کادر زیر حاوی تعدادی از هویت هایی است که ممکن است در برنامه مشارکت در ارزیابی سازه ای پس از زمین لرزه باشند. لطفا مشخص کنید به نظر شما برنامه ارزیابی سازه ای پس از زمین لرزه در ایران هر چند وقت یک بار نهادها و هویت های زیر را به کار می گیرد؟

نهاد مشارکت و تعامل	پاسخ شما (لطفا در هر ردیف فقط یک کادر را علامت بزنید)		
	همیشه	گاهی اوقات	هیچگاه
جامعه قربانیان			
بازرسان ساختمان			
سازمان های حمل و نقل			
خدمات اورژانس			
مدیران بحران			
مهندسین			
جوامع همجوار			
سازمان های غیر دولتی			
سازمان های مبتنی بر جامعه			
گروه های مذهبی			
متخصصین بهداشت و سلامت			
وزارت خانه های ملی دولتی			
آژانس های بین المللی نجات			
سازمان های دولت محلی			
گروه های داوطلب			
کودکان مدارس			

گروه های معلول و آسیب پیر			
شرکت های بخش خصوصی			

20- با توجه به تجربه خود، به نظر شما سیستم موثر مشارکت در ارزیابی سازه ای پس از زمین لرزه در ایران قابل حصول است؟ بلی/خیر/اطلاعی ندارم

لطفا توضیح مختصری ارائه دهید.

21- با فرض اینکه سیستم های مدیریت اطلاعات زمین لرزه ایران فاقد برنامه مشارکت در ارزیابی هستند، به نظ شما چه اقداماتی باید انجام شود تا سطح آگاهی سیستم افزایش یابد؟

لطفا توضیح مختصر خود را در این قسمت درج کنید

22- به نظر شما نقاط قوت و ضعف موجود در برنامه مشارکت در ارزیابی سازه ای پس از زمین لرزه در سیستم های مدیریت اطلاعات زمین لرزه ایران هر چند وقت یک بار مورد تجزیه و تحلیل قرار می گیرند؟

یکی از کادرهای زیر را علامت بزنید	فراوانی تجزیه و تحلیل
	هرسال
	هر پنج سال یک بار
	هیچوقت
	سایر موارد (لطفا شرح دهید)

پایان

در صورتی که تمایل دارید تا در مصاحبه پیگیری شرکت کنید یا مایلید تا به ارائه بازخورد در خصوص نتایج این تحقیق هستید، لطفا اطلاعات تماس خود را در کادر زیر وارد کنید.

اطلاعات تماس شما (اختیاری)
نام:
ایمیل:
شماره تلفن ثابت یا همراه:

با سپاس از شرکت شما در این تحقیق

نیروان رزاقی کاشانی

Appendix 3

		Answer Options	Answer Format	Answer coding
Cat	Survey category	Resident/Engineer/Disaster Manager	Number	Resident=1, Engineer=2, Disaster Manager=3
Section 1	**Background information about you**			
1	What is your gender?	Male/Female	Select Option	Male = 1, Female = 2
2	How old are you?	Answer in years	Number	Number value
3	What is your highest educational qualification?	Free choice	Text string	Lower School-Diploma=1, School-Diploma=2, BSc=3, MSc=4, PhD=5
4	What is your official job title	Free choice	Text string	Civil Engineer=1, Architect=2, Disaster Manger=3
5	How long have you lived/worked in Tehran?	Answer in years	Number	Number value
6	Do you have an official role in disaster management in Tehran?	Yes/No	Select Option	Yes = 1, No = 2
7	Do you have an official role in the management of earthquake risk in Tehran?	Yes/No	Select Option	Yes = 1, No = 2
8	On a scale of 1 to 5 (where 1=very low and 5=very high) how would you score the average level of awareness of the earthquake risk in Tehran?	Rank value 1 (low) to 5 (high)	Number	Number value
9a	Do you know if there is an Earthquake Information Management System (EIMS) in Iran?	Yes/No/Do not know	Select Option	Yes = 1, No = 2, Do not know = 3
9b	Please provide a brief explanation here:	Free choice	Text string	
10a	Do you know if there is a plan to develop an Earthquake Information Management System (EIMS) in Iran?	Yes/No/Do not know	Select Option	Yes = 1, No = 2, Do not know = 3
10b	Please provide a brief explanation here:	Free choice	Text string	

Section 2	**Questions about your awareness of the Iranian system for managing earthquakes**			
11a	Do you know if the Iranian Earthquake Information Management System (EIMS) includes a process to manage post-earthquake structural assessment?	Yes/No	Select Option	Yes = 1, No = 2
11b	Assess materials used in building construction	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11c	Record how the buildings are being used	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11d	Record method used for building construction	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11e	Assess wider regional damage	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11f	Use of a standard system to record damage	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11g	Undertake short-term usability assessment	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11h	Calculate economic losses	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11i	Calculate funding needed for reconstruction	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11j	Estimate the social impact of the earthquake	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11k	Assess emergency management needs	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11l	Undertake a quick/rapid visual inspection	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every

				occasion) to 3 (Never)
11m	Undertake a detailed damage assessment	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11n	Assess the long-term usability of buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11o	Assess condition of structural elements	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11p	Evaluate the overall building condition	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11q	Classify the level of damage to each building	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11r	Identify damage to non-structural elements	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11s	Record the location of damaged buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11t	Measure the dimensions of damaged building	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11u	Count the number of floors in buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11v	Record any foundation damage in buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11w	Identify additional hazards around buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11x	Identify a safe zone around damaged building	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)

11y	Assess the need to improve the system	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11z	Add information to a central database	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11aa	Collect data from the public and other bodies	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11ab	Disseminate data to public and other bodies	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
11ac	Calculate the residual strength of buildings	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every occasion) to 3 (Never)
12a	From your experience, do you believe that having an effective post-earthquake structural assessment system within the Iranian Earthquake Information Management Systems (EIMS) is achievable?	3 stage ranking from after every earthquake to never	Select Option	Yes = 1, No = 2, Do not know = 3
12b	Please provide a brief explanation here:	3 stage ranking from after every earthquake to never	Text string	
13	Assuming that the Iranian Earthquake Information Management Systems (EIMS) does includes a post-earthquake structural assessment system within it, what do you believe needs to be done to raise awareness of the system?	3 stage ranking from after every earthquake to never	Text string	
14a	How often do you think that the strengths and weaknesses of a post-earthquake structural assessment system within the Iranian Earthquake Information Management Systems (EIMS) are analysed?	3 stage ranking from after every earthquake to never	Select Option	Rank value 1 (every year) to 3 (Never), 4 = other
14b	Answer for "Other"	Free choice	Text string	
Section 3	**Questions about post-earthquake structural assessment education**			
15a	Do you know if the Iranian Earthquake Information	Yes/No	Select Option	Yes = 1, No = 2

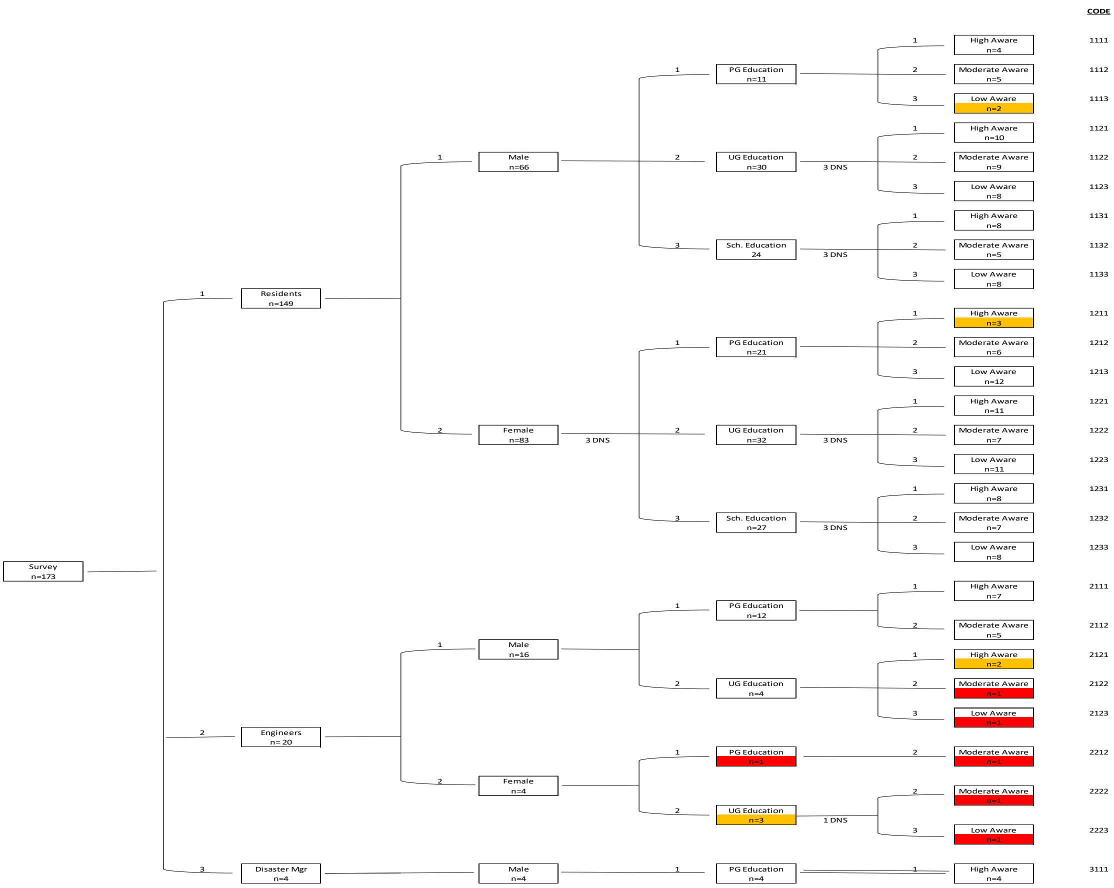
	Management System (EIMS) includes a post-earthquake structural assessment education programme?			
15b	The local disaster management system	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15c	The role of local disaster managers	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15d	The role of community residents	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15e	The role of structural engineers	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15f	Seismic faults in the local area	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15g	The local seismic risk	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15h	Calculating human and economic loss	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15i	Recording building damage	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15j	Assessing building damage	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15k	Actions to take before an earthquake	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15l	Actions to take during an earthquake	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15m	Actions to take after an earthquake	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in

				detail) to 3 (Not included)
15n	Incentives to take action	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
15o	Availability of educational material	3 stage ranking from covered in detail to not included	Select Option	Rank value 1 (covered in detail) to 3 (Not included)
16a	From your experience, do you believe that an effective post-earthquake structural assessment education system is achievable in Iran?	Yes/No/Do not know	Select Option	Yes = 1, No = 2, Do not know = 3
16b	Please provide a brief explanation here:	Free choice	Text string	
17	Assuming that the Iranian Earthquake Information Management Systems (EIMS) does includes a post-earthquake structural assessment education programme within it, what do you believe needs to be done to raise awareness of the system?	Free choice	Text string	
18a	How often do you think that the strengths and weaknesses in the post-earthquake structural assessment education programme within the Iranian Earthquake Information Management Systems (EIMS) are analysed?	3 stage ranking from every year to never, additional option for other	Select Option	Rank value 1 (every year) to 3 (Never), 4 = other
18b	Answer for "Other"	Free choice	Text string	
Section 4	**Questions about post-earthquake structural assessment engagement**			
19a	Do you know if the Iranian Earthquake Information Management System (EIMS) includes a post-earthquake structural assessment engagement programme?	Yes/No	Select Option	Yes = 1, No = 2
19b	The victim community	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19c	Building inspectors	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19d	Transport authorities	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)

19e	Emergency services	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19f	Disaster managers	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19g	Engineers	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19h	Neighbouring communities	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19i	Non-Governmental Organisations	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19j	Religious groups	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19k	Health professionals	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19l	National Government ministries	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19m	International disaster relief agencies	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19n	Local Government organisations	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19o	Volunteer groups	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19p	School children	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
19q	Disabled and vulnerable groups	3 stage ranking from always to never	Select Option	Rank value 1 (always) to 3 (never)
20a	From your experience, do you believe that an effective post-earthquake structural assessment engagement system is achievable in Iran?	Yes/No/Do not know	Select Option	Yes = 1, No = 2, Do not know = 3
20b	Please provide a brief explanation here:	Free choice	Text string	
21	Assuming that the Iranian Earthquake Information Management Systems (EIMS) does includes a post-earthquake structural assessment engagement	Free choice	Text string	

	programme within it, what do you believe needs to be done to raise awareness of the system?			
22a	How often do you think that the strengths and weaknesses in the post-earthquake structural assessment engagement programme within the Iranian Earthquake Information Management Systems (EIMS) are analysed?	3 stage ranking from every year to never, additional option for other	Select Option	Rank value 1 (every year) to 3 (Never), 4 = other
22b	Answer for "Other"	Free choice	Text string	
Section 5	**End of survey follow-up question**			
23	If you would be willing to engage with a follow-up interview, or if you would like feedback on the results of the research please can you provide me with your contact details in the box below	Free choice	Text string	

Appendix 4


CODE
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Residents n=149
Engineers n= 20
Disaster Mgr n=4
Male n=66
Female n=83
Male n=16
Female n=4
Male n=4
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PG Education n=11
UG Education n=30
Sch. Education 24
PG Education n=21
UG Education n=32
Sch. Education n=27
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UG Education n=4
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1 DNS
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Appendix 5

Post-earthquake disaster management and structural assessment

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ABSTRACT: This paper includes a comparative analysis of theory and practice in the area of post-earthquake disaster management and structural assessment. The analysis was conducted as part of a literature review for a PhD study programme, where it provided the basis for a critical assessment of systems in use by authorities in Iran. As well as providing an overview of the Iran system for post-earthquake disaster management and structural assessment, the paper includes an overview of systems used in Japan, Italy, Greece and Turkey, which serve as proxies to facilitate the assessment of strengths and weaknesses in the Iranian system. Specifically, the paper examines three sub-components of a wider disaster management system, namely: the requirements of an Earthquake Information Management Systems (EIMSs), seismic hazard education programmes and initiatives to engage communities in the disaster management process. Post-earthquake structural assessment provides the context for the analysis and readers will take away from this paper insights about how best to add value to an integrative risk management system and enhance urban resilience by effectively addressing post-earthquake structural assessment within the three sub-components of a broader post-earthquake disaster management system.

Keywords: Iran, post-earthquake disaster management, structural assessment

1. INTRODUCTION

This paper is mainly interested in providing readers with insights about how best to add value to an integrative risk management system with the aim of enhancing urban resilience. The main focus is to assess how post-earthquake structural assessment can be effectively incorporated within a broader post-earthquake disaster management system. It is important that every disaster management system record how past crises were managed, so that lessons can be learned to mitigate the impact of future events (Ajani, Fatahi and Moradi, 2006) and in earthquake prone areas such systems are often referred to as Earthquake Information Management Systems (EIMSs). The main aim of the EIMS is to help lawmakers make better decisions when planning for future earthquakes, but they also act as hubs around which actions to address earthquake risk are managed, monitored and implemented. In Japan, the EIMS is called the Preement Hyogos Emergency Management Network for Disaster Information Exchange (Phoenix) and it is used to collate all the information about an earthquake. The Japanese EIMS is managed by the Prime Minister's office and other National Government ministries, but data for the EIMS is gathered by independent experts, government departments and non-governmental organizations (Ajani et al. 2006). After collection, important seismic information is made publicly available (Hyogo Framework for Action 2005-2015). The Japanese EIMS provides a state-of-the-art example of a highly integrated earthquake risk management system, but some of the specifications for the system require a level of development that it significantly more advanced than systems available in Iran, where research for this paper is focussed. Iran's lack of an effective EIMS has been evident for several years, and some researchers (Ajani et al. 2006, Ajani, Fatahi and Moradi 2006) have called for the creation of a clearer model to illustrate how responsibility for earthquake disaster management is spread between Iranian disaster management organizations. Due to the perceived disparity between the level of development of the Iranian EIMS system and the system running in Japan, the authors reviewed other systems in countries with a more comparable culture, building tradition and level of development. Turkey was judged to offers more opportunities than Japan to learn lessons that can be quickly and easily applied in Iran. Turkey has a seismic risk, geography, level of development and system of building that is comparable to Iran. Turkey also has a well document history of efforts to establish an EIMS, which is overseen by a dedicated Government Ministry. The Turkish EIMS is called AFAYBIS and is based in the city of Istanbul, but every Government Ministry runs its own database that is tailored to their needs and goals (Eraslan et al. 2004). AFAYBIS compiles earthquake information for the whole of the country and provides essential services during and after a seismic event.

As with Iran, Turkey has a number of active earthquake zones and the country is growing at a fast pace, so Turkey's need for a clear and effective EIMS is similar to Iran (Eraslan et al. 2004, Ajani, Fatahi and Moradi 2006). For Iran, Ajani, Fatahi and Moradi (2006) judged that considerable challenges exist if it chose to follow the Turkish model, as in Iran there are many government agencies involved in earthquake management and the planning process is not clearly defined. According to IMPS (2005), there is evidence of an emerging IEMS system in Iran, but it is focused on data collection during and immediately after an earthquake and it is not designed to the address the needs of different regional and local areas within Iran. IMPS (2005) considered that the Iranian EIMS contained many weaknesses and lacked clarity on the roles played by different organizations involved in the management of earthquake information. The Iranian IEMS also lacked a proper data recording system covering before, during and after earthquake events. In addition, there was no proper classification of the information, from earthquake information management point of view. As a consequence of the analysis by IMPS (2005), Iran's IEMS was judged to be weak, or at best, insufficient. This research will seek to up-date the assessment of the Iranian EIMS, looking specifically at how it collects earthquakes information and how effective it is at publishing data at the right time and making it accessible to the wider public. An important part of the evaluation of the Iranian EIMS will involve assessing how the system utilises public news media. Dedeoglu (2008) highlighted valuable lessons from Turkey about the role that news media plays in disaster preparedness. In comparison to Turkey and Japan, Iran's use of news media in disaster preparedness is not well developed (Ajani et al. 2006). The Iranian news media has been used to relay information about recent earthquakes, mainly at the time of happening rather than in advance and as part of a system to educating the public. In Turkey, the news media were engaged more proactively, talking to officials involved in earthquake management in ways that are more directed to informing and educating the public (Dedeoglu, 2008). This paper is particularly interested in providing readers with new insight about how an EIMS can be used to educate and engage communities in post-earthquake structural assessment, as part of an integrative risk management system.

When assessing how best to include post-earthquake structural assessment within an EIMS, lessons were drawn from practice in Italy, Japan and Greece. In Italy, the post-earthquake structural assessment systems have traditionally been triggered by requests from property's owners, with inspection results sent to the local government administrative offices and subsequently a national body for classification (Goretti 2002). In Japan the post-earthquake structural assessment system was only used on multi-owner buildings and the results would form the basis for a suggested plan of action to the owners of the building (Ajani et al. 2006). In Greece the post-earthquake structural assessment system was done on all buildings in the area classified as the epicentre of the earthquake and only at the request of building owners/occupiers in areas outside the epicentre (Anagnostopoulos and Moretti 2006). Since 2001 the Italian department for National Civil Protection (NCP) and the National Seismic Survey (SSN) decided to use a unified standard classification procedure for usability and damage assessment in all the regions in Italy (Goretti 2002). The Italian procedure follows two steps. First buildings are classified based on the post-earthquake reconstruction aim: short term usability assessment, economic loss and the funding need for reconstruction, social impact assessment and emergency management. Second, buildings are classified by subject disciplines for after earthquake reconstruction: The methods that Italy and Greece employ are divided in to four categories. Pre-event assessments, based on quick visual inspections. First post-event assessments, normally conducted 2 to 3 days after the event. Second post-event, conducted 3 to 60 days after the event, focussing more on usability of buildings. Third post-event: assessment, conducted up to 1+ years after the event and focussing on long-term usability of the buildings (Building Research Institute 2002, Anagnostopoulos, Petrovski and Bouwkamp1989, Anagnostopoulos et al. 2004). In Greece the post-earthquake structural assessment system divides buildings into three states; safe for use, unsafe for use and dangerous for use and the damage assessment of the building would be done by two experience or well-trained structural engineers (Anagnostopoulos 1997, Anagnostopoulos and Moretti 2006). The main aim of rapid inspection would be to distinguish safe buildings from unsafe buildings as quick as possible. In rapid inspection the structural engineers would assess the outside of the building and if it is safe they would check the ground floor of the building, taking no more than 10-30 mins for each building assessment (Dandoulaki, Panoutsopoulou and Ioannides, 1998). What this brief review of post-earthquake structural assessments provides to the reader is that an EIMS that has post-earthquake structural assessment integrated within it will need to allow input from expert engineers, but also the community of building owner/occupiers. Allowing input from expert engineers and the wider community will only be effective in enhancing urban resilience if the EIMS also provides a facility to educate engineers and the community in both the methods for interacting with the EIMS and the methods for conducting post-earthquake structural assessments.

2. ADDED VALUE FOR INTEGRATIVE RISK MANAGEMENT AND URBAN RESILIENCE

What the narrative above has emphasised is that an effective EIMS lies at the heart of an integrated earthquake risk management system and that EIMS needs to be effectively managed if is to enhance urban resilience. In this section the authors will use the Iran case study to help illustrate where opportunities exist to enhance urban resilience to earthquakes via an EIMS that effectively addresses post-earthquake structural assessment in the areas of “Education” and “Engagement”.

2.1 Education

Iran has traditionally relied on the ‘International Institute of Earthquake Engineering and Seismology” (IIERRS) for increasing the attention paid to the effectiveness of earthquake management strategies (Fallhi and Parsizadeh 1997). Importantly for this research, the IIERRS also advised disaster management authorities on earthquake education and on raising public awareness about effective actions to take during and after earthquake events. The system overseen by the IIERRS comes under the heading of the Iranian Earthquake Risk Reduction Strategy, which has the aim of creating what it called a “Safety culture”, achieved by raising awareness and preparedness of the general public (Ghafory-Ashtiany and

Parsizadeh 2005). Heshmati and Parsizadeh (2007) looked in more detail at the educational component of Iran's Earthquake Risk Reduction Strategy, dividing it into three parts that focussed on educating disaster managers, the general public and school children. Iran suffers from a legacy of unsafe construction in schools, with most the schools in rural areas and small towns not built to adequate levels of seismic resistance, making them unsafe during an earthquake, so the Iranian Earthquake Risk Reduction Strategy states that protecting children's lives is an important part of this goal (Ghafory-Ashtiany and Parsizadeh, 2005). According to Parsizadeh, Seif and Heshmati (2007) the Iranian Earthquake Risk Reduction Strategy has addressed that legacy by introducing a "School earthquake safety drill" in 2003. The drill is designed to ensure all the theoretical knowledge and textbook information has is practically implemented. On the 29th of November, every year, all the high schools across the country perform the safety drill during.

The Iran earthquake education programme in schools is a good example of an effective education programme that should be incorporated within the EIMS, but post-earthquake structural assessment requires specialist skills and specific knowledge, which is not ordinarily included in the education programme. To enhance urban resilience in earthquake prone areas it is essential that the EIMS includes processes that extends the education programme in schools to educate both specialist engineers and also the general public in vulnerable communities. The idea here is that the EIMS can include processes to educate non-specialist members of the vulnerable community about the sort of data that engineers and earthquake managers need in order to analyse the impact of an earthquake on a building. The public education programme should also include elements to explain how the general public can engage with the EIMS, by uploading post-earthquake structural assessment data and by extracting information that is essential for both post-earthquake structural assessment data gathering and continued survival in the post-earthquake environment. For engineers the education element of the EIMS needs to ensure that a there is an up-to-date register of engineers who have received approved training in the structural analysis techniques appropriate for assessing building after an earthquake event. The engineering education system also needs to ensure that registered engineers are trained to effectively engage with the EIMS, to access post-earthquake structural assessment data gathered by communities in the earthquake affected areas, to engage with communities actively collecting data, to help coordinate further data gathering activity and to disseminate results from the analysis of damaged buildings.

2.2 Engagement

Iranian authorities realised the importance of the pubic engagement in disaster management after the bam earthquake in 2003. Prior to the 2003 earthquake, Bam residents had received little or no training in post-earthquake disaster management and they were unable to be engaged to maximum effect in the rescue operation (Mirhashemi, Ghanjal and Moharamzad 2007). Iran has a rich heritage of community-based organizations (CBOs), which help to engage local communities in a wide range of practical and administrative activities, but CBOs are rarely engaged in disaster preparedness activities. Movahedi (2009) stated that there was insufficient information and skills in disaster preparedness and management, insufficient attention towards vulnerability reduction using collaboration with CBOs and local government. However, the system has been improving and Hosseini and Hossaini (2009) found that some Iranian CBOs have started to engage local communities in disaster management activities, mirroring similar programmes that were established in Turkey and Nepal and providing training for local people to maximise their preparedness to earthquake events. In addition, Hosseini and Hossaini (2009) found that the Iranian disaster management authorities had made progress in engaging the public and CBOs through information dissemination campaigns, seminars, and workshop and by using mass media outlets. Further work by Izadkhah and Hossaini (2009) suggested that there were still gaps in the Iranian engagement efforts, with no regular training for rescue and relief, first aid, firefighting and evacuation in the case of an earthquake.

This paper suggests that Iranian engagement efforts must run in parallel with an education programme if it is to successfully enhance skills and knowledge about post-earthquake structural assessment. As part of the engagement process, the EIMS needs to monitor education activities to ensure that engineers and communities are engaged at all level and in all vulnerable areas of the country. It seems clear that education programmes in Iran have started to engage specialist engineers and vulnerable communities, but the engagement is not yet benefiting all vulnerable communities and is not effective at all levels of society. Earthquakes are notoriously unpredictable, so the engagement activity also needs to ensure that preparedness levels are maintained at all times and for prolonged periods between earthquake events. For specialist engineer's engagement activities may include visits to earthquake affected areas in other regions of the world, assisting or observing other engineers when undertaking the analysis earthquake damaged buildings. For vulnerable communities, the EIMS could be used to facilitate communication between other national or international communities that have suffered an earthquake event that communication would allow the communities to share experiences and to learn lessons about how members of the public can effectively take part in post-earthquake structural assessment activities. To ensure urban resilience is enhanced and maintained, the EIMS engagement process needs to include regular assessments of preparedness, by testing the effectiveness of education programmes and ensuring that skills and knowledge in post-earthquake structural assessment are maintained by both the specialist engineers and members of vulnerable communities.

3. CONCLUSIONS

This paper has reviewed literature on post-earthquake disaster management and structural assessment and contextualised the practical application of theory using evidence gathered about systems in operation in Iran. Iran was found to have extensive experience of earthquake events and a long history of managing the earthquake risk, but there was also extensive evidence of weakness at the heart of the EIMS system in Iran. Post-earthquake structural assessment was presented as an activity that needs engineers with specialist education, but not all post-earthquake structural assessment data needs specialist engineering input in its collection. The paper explained how members of the public, from communities vulnerable to earthquake events, could be educated and engaged in the post-earthquake structural assessment activities and also how the EIMS system could be used to facilitate the education and engagement activities for both engineers and members of the public, to make such an approach effective. The research presented in this paper is set to be further developed, with the next stage in the research programme focussing on gathering data from Iran to test theories and to assess the validity of proposals made in relation to how post-earthquake structural assessment can be effectively incorporated within a broader post-earthquake disaster management system. In so doing, the authors hope be able to present further evidence at future IDRC events to deepen understanding of how integrated approaches to earthquake risk management can be improved and how urban resilience to earthquakes can be enhanced by effectively incorporating post-earthquake structural assessment within a broader post-earthquake disaster management system.

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Appendix 6

23 June 2017

Dear Nirvan

Ethical Approval Application

Thank you for submitting the ethical approval form and details concerning your project: An Analysis of the Iranian post-earthquake management and structural assessment system I am pleased to inform you this has been approved subject to the following condition:

Regarding Right to withdraw for the questionnaire respondents: on the Participant Information Sheet, you need to give instructions as to how participants can withdraw from the study afterwards, should they choose to. This is because once you have collected their completed questionnaire, you would need a way of identifying which participant they are as names are not collected. If you cannot do this, you need to say that once the respondent gives you a completed questionnaire, they will be unable to withdraw retrospectively.

Kind regards

Paula Simson Secretary to Faculty Research Ethics Committee

Cc. Dr Andrew Fox Mr Dave Easterbrook

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