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CONCEPTUAL DESIGN OF E- GOVERNANCE IN DISASTER MANAGEMENT SYSTEM

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DOCTOR OF PHILOSOPHY THESIS
IN
THE DEPARTMENT OF MODELING AND DESIGN OF ENGINEERING SYSTEMS (MAIN FIELD OF STUDY: COMPUTER ENGINEERING)

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Approval of the Graduate School of Natural and Applied Sciences, Atilim University.

Prof. Dr. Ali KARA
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I certify that this thesis satisfies all the requirements as a thesis for the degree of **Doctor of Philosophy in Modeling and Design of Engineering System, Atilim University.**

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ABSTRACT

CONCEPTUAL DESIGN OF E- GOVERNANCE IN DISASTER MANAGEMENT SYSTEM

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Disasters pose a real threat to the lives and property of citizens; therefore, it is necessary to reduce their impact to the minimum possible. In order to achieve this goal, a framework for enhancing the current DMS was proposed, called Smart Disaster Management System (SDMS). The smart aspect of this system is due to the application of the principles of Information and Communication Technology (ICT), especially the Internet of Things (IoT).

All participants and activities of the proposed system were clarified by preparing a conceptual design by using The Unified Modeling Language (UML) diagrams (both, use-case and activity diagrams). This effort was made to overcome the lack of citizens' readiness towards the use of ICT as well as increase their readiness towards disasters.

Iraq was chosen as a case study for this research. The lack of readiness on part of Iraqi citizen was inferred by using two different methods, interviews with experts in the field of disasters and experts in the field of ICT. The other method was based on distributing a questionnaire form to the target sample.

Keywords: ICT, SDMS, E-government, IoT, Framework.

ÖZ

E-DEVLET İÇİN AFET YÖNETİM SİSTEMİNİ GELİŞTİREN ŞEYLER

Ibrahim, Thaer

Doktora, Mühendislik Sistemlerinin Modellenmesi ve Tasarımı

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Ocak 2020, 132 sayfa

Afetler vatandaşların yaşamları ve mülkleri için gerçek bir tehdit oluşturmaktadır. Bu nedenle, tehditlerini azaltmak gerekir. Bu hedefe ulaşmak için afet yönetim sisteminin geliştirilmesi için bir çerçeve önerilmiştir. Akıllı Afet Yönetim Sistemi (SDMS) adı verilen gelişmiş sistem; bit, özellikle Nesnelerin İnterneti (IoT) teknolojisine.

Önerilen sistemin tüm katılımcıları ve faaliyetleri, Birleşik Modelleme Dili (UML) diyagramları (kullanım-durum diyagramı ve aktivite diyagramı) kullanılarak sistem için kavramsal bir tasarım hazırlanarak açıklığa kavuşturuldu. Bu çaba vatandaşların BİT kullanımına karşı hazırlıklı olmama durumunun üstesinden gelmek ve afetlere karşı hazır olmalarını artırmak için yapılmıştır.

Irak bu araştırma için örnek olay olarak seçildi. Irak vatandaşlarının hazır bulunmaması, iki farklı yöntem kullanılarak, felaket alanındaki uzmanlarla ve BİT alanındaki uzmanlarla yapılan görüşmelerle çıkarıldı. Diğer yöntem Irak vatandaşlarına bir anket formu dağıtmaktır.

Anahtar Kelimeler: ICT, SDMS, E-devlet, IoT, Çerçeve.

To the soul of my father, may God have mercy on him.

To my dear family

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Praise be to God, Lord of the Worlds, who guided us to the path of righteousness, and facilitated for us to carry out this research. I extend my sincere thanks and appreciation to the supervisor of my thesis, Prof. Dr. Alok MISHRA, for his continuous efforts in supporting me to accomplish this research in addition to his guidance and high knowledge that accompanied me in my career in writing this thesis. My special thanks to my co-advisor Asst. Prof. Dr. Atila BOSTAN and all committee members for their monitoring of my study. In the end, I extend my sincere love and thanks to my family and all my friends for supporting me throughout my academic career.

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LIST OF SYMBOLS/ABBREVIATIONS

ICT	Information and Communication Technology
E-Government	Electronic Government
IoT	Internet of Things
DMS	Disaster Management System
SDMS	Smart Disaster Management System
SPSS	Statistical Package for the Social Sciences
G2G	Government-to- Government
G2B	Government-to- Baseness
G2E	Government-to- Employee
G2C	Government-to- Citizen
RFID	Radio-Frequency Identification
ALG	device-to-Application-Layer Gateway
IFRCS	International Federation of Red Cross and Red Crescent Societies
CS-IoT	Crowd Sourced-IoT
SCALE	Safe Community Awareness and Alerting Network
IIoT	Industrial IoT
FWI	Forest Weather Index
NDN	Named Data Networking
SSE	Service Systems Engineering
IDMS	Intelligent Disaster Management System
ER	Emergency Response
DR	Disaster Response
NOAA	National Oceanic and Atmospheric Administration
GFMC	Global Fire Monitoring Center
AI	Artificial Intelligence
ML	Machine Learning
GUI	Graphical User Interface
DB	Data Base

CHAPTER 1

INTRODUCTION

E-government has catapulted itself from just a pilot project into one of the most important requirements for a government to be successful in delivering its services in a quick and efficient way. Due to the continuous development of information and communication technology (ICT), E-government needs to be continuously improved and new features be added in accordance with the latest technology.

Therefore, the addition of Internet of Things (IoT) technology to E-government will increase its efficiency in all directions, because this technology carries great potential in the field of information and communication. Especially, when IoT is used in disaster management, it has a huge potential in saving people’s lives and property.

In order to make the reader familiar with the scope of this thesis, a general introduction to its main hypothesis and research questions will be provided in this chapter.

1.1. Problem statement

Natural disasters have a huge negative impact on people's lives and property. Therefore, these disasters must be addressed in a scientific and deliberate manner, and the necessary plans should be prepared in advance, before the disaster strikes. This procedure is called Disaster Management System (DMS) [1].

One of the most important responsibilities of any government is to protect its citizens and national resources from any threats, especially natural disasters. In addition, one of the main services provided by the government to its citizen is security, which is defined as preserving the life and property of citizens from damage, whether it is due to humans or the surrounding environment [2].

E-government is the best way to provide these services because it contains many advantages due to the use of the latest applications that are available in information and communication technologies such as the Internet of Things (IoT) [3].

1.2. Motivation

The suffering of my country from the impacts of natural disasters was the main motivation for this thesis. My country, Iraq, has two rivers, Tigris and the Euphrates, which meet the country's need for tap water. However, at the same time, these two rivers pose a threat to the lives and property of citizens because of frequent pollution and flooding. One reason for this suffering is the lack of a sophisticated DMS based on the latest technology in disaster management.

The second motivation is the unsuccessful implementation of the E-government project in my country due to the lack of technological readiness among citizens. Therefore, raising the level of electronic readiness among citizens will lead to increased confidence of the citizens in this project and thus lead to the success of the E-government project in Iraq.

1.3. Purpose and scope

This thesis aims to improve the use of DMS by implementing the principles of information and communication technology, specifically the use of E-government and the IoT. This will raise the readiness of citizens towards the use of E-government applications in addition to establishment of a knowledge-based society, capable of facing the risk of disasters, and as a result, reduce the proportion of losses inflicted by those disasters.

Therefore, the target sample of this thesis is mainly citizens and then disaster management teams. The scope of this thesis is summarized as follows:

1. The scope of disaster management. This research aims to automate the DMS and improve its infrastructure in order to get the most optimal results.

2. The scope of information and communication technology. It aims to use the latest technologies in the field of ICT and harness them in improving the performance of the DMS.
3. Scope of systems design. It aims to support the developers to design and develop the proposed system by clarifying all the activities of the system, data transmission methods, and the role of each person within the system.
4. The scope of human rights. This system aims to protect the lives and property of the citizens, minimize the losses and provide the basic necessities for people affected by disasters.
5. Scope of savings. This thesis aims to replace the often non-efficient and expensive traditional DMS with a cutting-edge one based on Information and Communication Technology (ICT), in this manner saving time, effort and money.

1.4. Research question

In this thesis, the aim is to answer the following four questions in order to fulfill the purpose of the research.

1. Can the enhanced DMS satisfy the end-user needs?
2. Can the enhanced DMS increase citizen's readiness toward disasters?
3. Can the enhanced DMS increase citizen's technological readiness?
4. What are the differences between the traditional DMS and the modern one?

1.5. Methodology

Depending on the question to be answered, the methodology of this research has been arranged into three parts:

A. Clarify the purpose, scope and the methodology of the thesis.

The purpose of the second Chapter of this thesis is to clarify its main purpose and scope. Therefore, the structure of the second Chapter is as follows:

1. The idea of the research came from the reality of the Iraqi citizens who are frequently exposed to different types of disasters. In addition, the DMS in Iraq is quite old and based on outdated traditional methods, so it needs to be updated.
2. Many research articles on the subject have been read, analyzed and summarized. They are all related to the latest approaches in the field of disaster management and the use of ICT in this area.

B. Make observations in order to define the system's objectives and requirements, to design an enhanced disaster management system.

According to research analysis and outcomes, the objectives of this thesis are defined in six steps that will be clarified in Chapter 3. These steps are as follows:

1. In order to define the thesis hypotheses, a survey of previous studies was first completed
2. A questionnaire was prepared to test hypotheses on a real sample, which was composed of Iraqi citizens affected by natural disasters.
3. Two methods were adopted to distribute the questionnaire, the traditional method using printed papers and the modern method using Google frames.
4. Test hypotheses by analyzing feedback data.
5. Reach conclusions based on the data analysis. The conclusions reached are listed below:

    - There is a lack of disaster awareness among citizens.
    - There is a lack of disaster management experiences.
    - There is a lack of the use of E-government applications.
    - There is a lack of trust in E-government applications.

C. Prepare a conceptual design to enhance Disaster Management System.

According to experts' recommendations, disaster scenarios must be visualized in order to enhance the DMS by:

1. Defining the system requirements.
2. Using Use Case diagram approach to visualize the role of participants.
3. Using Class diagram approach to visualize the system activities.

1.6. Software tools

1. Google forms were used to design, distribute and collect the feedback of the questionnaire.
2. Microsoft © Excel 2016 was used to code feedbacks of the questionnaire.
3. IBM © (SPSS), The Statistical Package for the Social Sciences software version 18.0 was used to statistically analyze feedbacks of the questionnaire.
4. Microsoft © Visio 2016 was used to prepare all diagrams for the thesis.

1.7. Obtaining data

1. Several interviews were conducted with experts in the field of disaster management in Iraq to find out the status of the DMS in the country.
2. Five experts in the field of disaster management systems from different nationalities have been contacted to be acquainted with the latest findings in this field.
3. As mentioned in Section 1.5, using the questionnaire form feedback from 514 people representing all spectrums of Iraqi society and of different areas of residence were collected for analysis.

CHAPTER 2

LITERATURE REVIEW

In order to define the scope, purpose and methodology of the thesis, a survey was performed on literature and related works. In this chapter, a brief background on definitions of the terminology will be presented, to be then followed by a more detailed literature review. Finally, the Chapter will be closed by a brief conclusion.

2.1. Background

2.1.1. Electronic-Government (E-government)

E-government can be defined as the change in the administrative structure of government institutions in conjunction with the use of information and communication technologies to improve the way of providing services to its institutions, citizens, and businesses (Committee for the implementation of e-governance project in Iraq) [4, 5]. On the other hand, it can also be defined as an environment where services are provided to the citizens in an easy way by a single government agency, or by many government agencies using ICT [6].

There are four main channels for the E-government services, depending on the end-user [7, 8]:

1. Government-to-Government (G2G): this channel stands for services provided by a government agency to another government agency. In another way, it refers to the cooperation between government agencies to provide better services to citizens [9].
2. Government-to-Business (G2B): refers to the services provided by the government agency to businesses, such as accounting services or commerce services [9].

3. Government-to-Employee (G2E): it is the services provided by the government agency to the employees, like training and exchanging knowledge [10].
4. Government-to-Citizen (G2C): Includes all transactions between the government agency and the citizen with the aim of facilitating the process of citizens' access to services and information at any time and from anywhere [9].

There are four additional service channels for E-government, which are Government-to-Nonprofit (G2N), Nonprofit-to-Government (N2G), Business-to-Government (B2G), and Citizen-to- Government (C2G).

In the first generation of E-Government project, in addition to the necessity of asking for the service type they needed, costumers also had to visit each E-Government agency website to get the desired service. After that, the government agency would provide the service to the consumer [3].

Afterwards, the service provision style modified to the new version, which is called "E-Government One-Stop-Shop", where the consumer can finish all the necessary operations by using one government portal with a unique user name and password [11]. This type of service provision is called Reactive Services, and the consumer has to ask for the service to have it. The next service provision style known as "E-Government Zero-Stop-Shop". According to this new approach, the government agency would provide the service to the consumers without their request, but by analyzing the consumer profile information as well as their social media information, the agency was able to predict the type of service needed and deliver it at the right time [12].

The modern version of E-government is called "Smart-Government". This latest approach relies heavily on smart technology for service delivery [13]. The smart government has four essential features [14]:

1. Elasticity

It must accommodate the growing demand for computing power and data storage in a dynamic manner, therefore, smart-government infrastructure must be expandable according to the needs.

2. Mobility

The smart government should benefit from the modern features of mobile devices as it deploys its services on these devices in an efficient and secure manner (the E-government services become much closer to the citizen).

3. Social Government

The smart government must interact with its audience transparently by knowing the wishes and needs of citizens, and involving them in the decisions taken by the government.

4. Sensitivity

The smart government should have the ability to capture data scattered in different governmental institutions via smart sensors.

The use of ICT makes E-government project one of the tools used by the government to protect citizen and national resources. However, due to the low readiness of citizens to use E-government applications, as well as the misuse of ICT technology has led to failure to achieve the goals.

2.1.2. Internet of Things (IoT)

A network connects physical things with actuators, sensors, software, RFID devices in order to enable them to interact among themselves and humans to facilitate the lifestyle of people [15]. Another definition for "IoT or smart object networking" is physical things connected to the internet, which has the ability to identify to other devices and communicate with them [16].

Internet of Thing has four types of communication models, which are [17]:

1. Device-to-Device communication : In this model, there are two or more devices directly connected and communicating with each other.
2. Device-to-Cloud Communications: In this model, IoT devices are connected directly to an Internet cloud service to exchange data and control message traffic like an application service provider.
3. Device-to-Gateway Model: In this model, IoT devices are connected through device-to-Application-Layer Gateway (ALG) service to use it as a channel to reach the cloud service. Local gateway devices, such as smartphones running an application, communicate with the IoT device and relay data to a cloud service.
4. Back-End Data-Sharing Model: This model refers to the architecture of communication that enables users to export and analyze smart object data from a cloud service and combine them with data from other sources in order to facilitate the needs of portability of data.

2.1.3. Disasters

A disaster is an event that disrupts the natural state of life and causes so much suffering to the community that it cannot cope with the event [18]. Disasters can be classified into two types, namely Natural disasters and Human-made disasters. Disaster types will be discussed in more detail in Chapter 3.

2.1.4. Disaster Management System (DMS)

This means to harness the full potential of governmental and non-governmental institutions in the event of a disaster in order to minimize the damage caused by the later [19]. In other words, DMS is the system that is used to manage disaster-related data by using information technology, which combines geographical information with administration information to facilitate access to, and use of these data in all disasters stages [20].

Disaster management can be divided into three stages [21]:

a. Before Disaster

In this stage, the disaster management team has the following duties:

- Take all the necessary preventive measures, both administrative and executive, to save the life and property of citizens, and minimize losses to the lowest possible rate.
- Review all studies on disaster risk reduction and take into account all proposals referred to in these studies.
- Stay alert in the event of a disaster to ensure prompt and effective action.
- Raise awareness among the citizens and create a well-informed society in order to obtain their assistance in event of disasters, thus reducing the damage to a minimum.

b. During Disaster

This is the most critical stage for the disaster management team because of the chaos caused by the disaster; therefore, the team has deferent responsibilities, such as [22]:

- Provide decision-makers with real-time data about the disaster, people affected and the physical damage.
- Saving as many afflicted citizens as possible.
- Coordinate with government institutions, civil society organizations, and citizens trained in first aid to maximize their efforts in rescuing citizens.
- Act directly to rescue people injured or trapped under rubble.

c. After Disaster

At this stage, the disaster management team has the following duties:

- Provide suitable shelters for citizens who have lost their homes.
- Provide affected people with the necessary needs for daily life, such as food and medicine.
- Provide material and moral compensation to citizens who suffered losses during the disaster.

2.1.5. Smart Disaster Management System (SDMS)

The DMS was modified by the addition of ICT (ICT) [23]. This system takes advantage of the facilities provided by information and communication technologies to accelerate the delivery of information and reduce the rate of error in decision-making in the event of a disaster. The intelligence of this system comes from its ability to both, collect information related to the disaster, and make decisions in real-time [24].

2.2. Literature Review

Disasters cannot be prevented, but their losses can be minimized by predicting their occurrence through the utilization of modern scientific methods and new technologies. Disasters cause heavy losses in life and property of the inhabitants of this planet. Data from the World Disaster Report show that two billion people have been affected by disasters in the last 10 years in addition to a cost of 1,658 billion US dollars for the same period of time (Figure 2.1) [25].

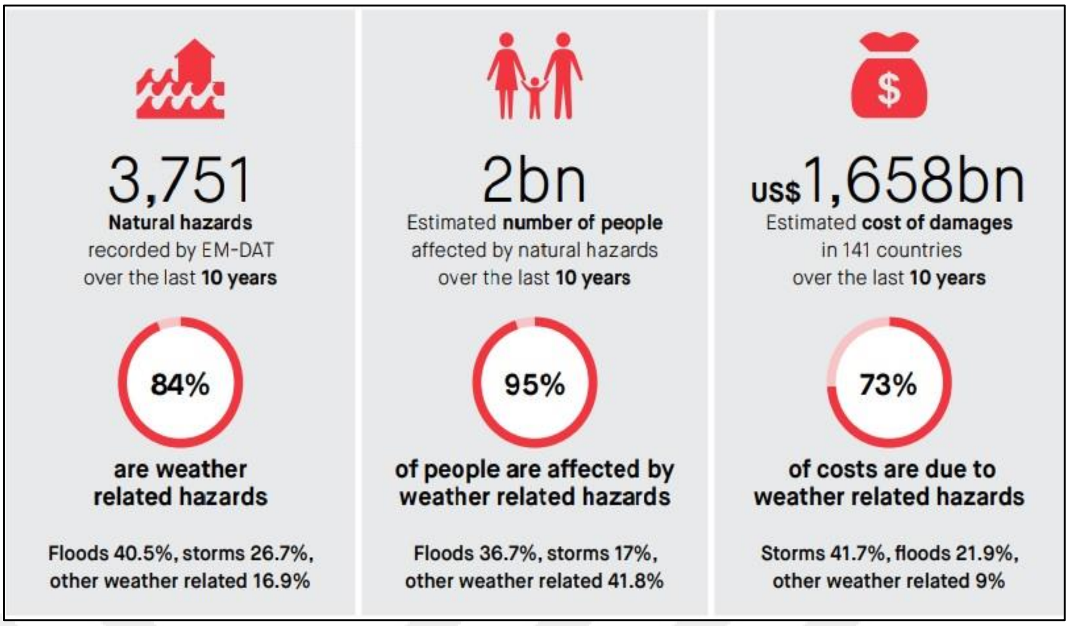

Figure 2.1. Overview of natural hazards 2008-2017 [25].

The International Federation of Red Cross and Red Crescent Societies (IFRCS) estimated that between 2008 and 2017 about 18.8 million people were displaced because of disasters, 18 million of whom due to weather-related phenomena [25]. The afflicted people were distributed as follows:

- 8.6 million people because of the floods.
- 7.5 million people because of the storms (6.9 million people because of the typhoons, and 619000 people for other storms types).
- 1.3 million people because of the droughts.
- 38 thousand people because of landslides.
- 4.5 thousand people because of the extreme temperature.

The rest 758 thousand people were displaced because of geophysical reasons (589 thousand because of the earthquakes, and 169 thousand people because of volcanic eruptions).

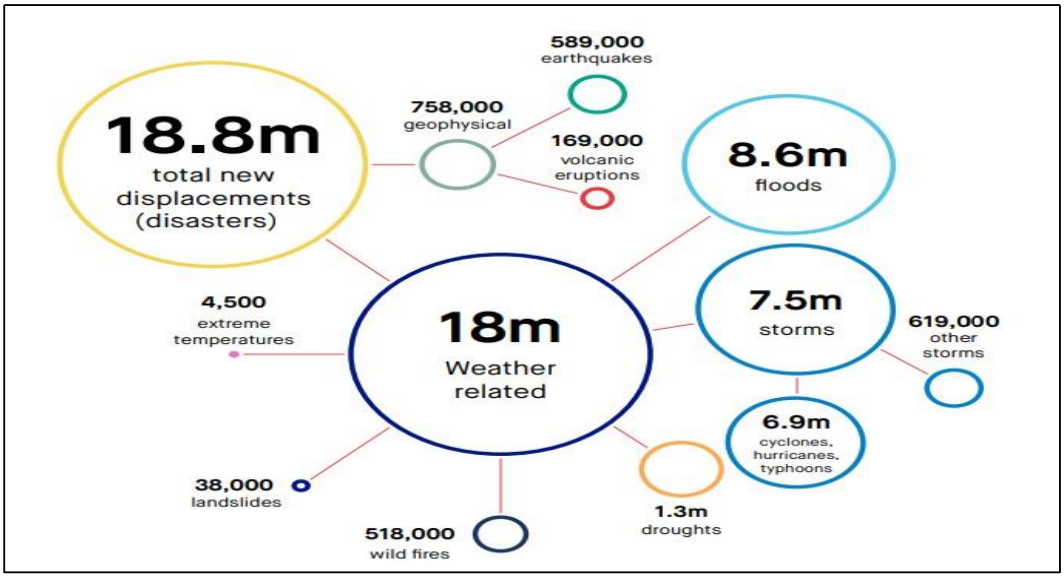

Figure 2.2. Breakdown of displacement by disaster, 2017 [25].

Disaster damage can be reduced using a Disaster Management System (DMS). Even though this system does not avoid or completely eliminate disaster damage, it greatly helps in taking precautions to mitigate the severity of these disasters [1]. The DMS sets up a plan for tasks to be accomplished before, during and after a disaster happens. The prediction of a catastrophe beforehand leads to preparedness, and as a result reduction of the losses caused by it [26].

While reviewing the published research regarding disaster management systems, except for some brief discussions, Wellington J, et al. (2017) observed a lack of focus on the technical aspects of IoT technology [27]. As a result, they tried to change the administrative structure of the DMS by proposing the use of the communications side of (IoT) to connect all parts of the system with each other and make them work as one integrated unit. Then, they went on suggesting the establishment of a central control unit that will communicate with all the other units of DMS using IoT, putting them under one command. In addition, the aforementioned group focused on the speed of dealing with the following aspects during the disaster:

(i) Providing organized traffic.
(ii) Providing ambulances and medical services.
(iii) Facilitate the arrival of rescue vehicles, fire trucks, and police cars.

(iv) Continue to warn citizens and update them on the latest developments of the disaster.

(v) Fulfill urgent needs of citizens such as water, food, medicine, and electricity.

(vi) Rehabilitation of damaged infrastructure and buildings as soon as possible.

In a research article published by Pratim Ray, et al. (2017), disasters were classified from the point of view of communications during the disaster into four categories as:

(i) Service-oriented

(ii) Natural

(iii) Man-made

(iv) Post-disaster management systems (Figure 2.3) [28].

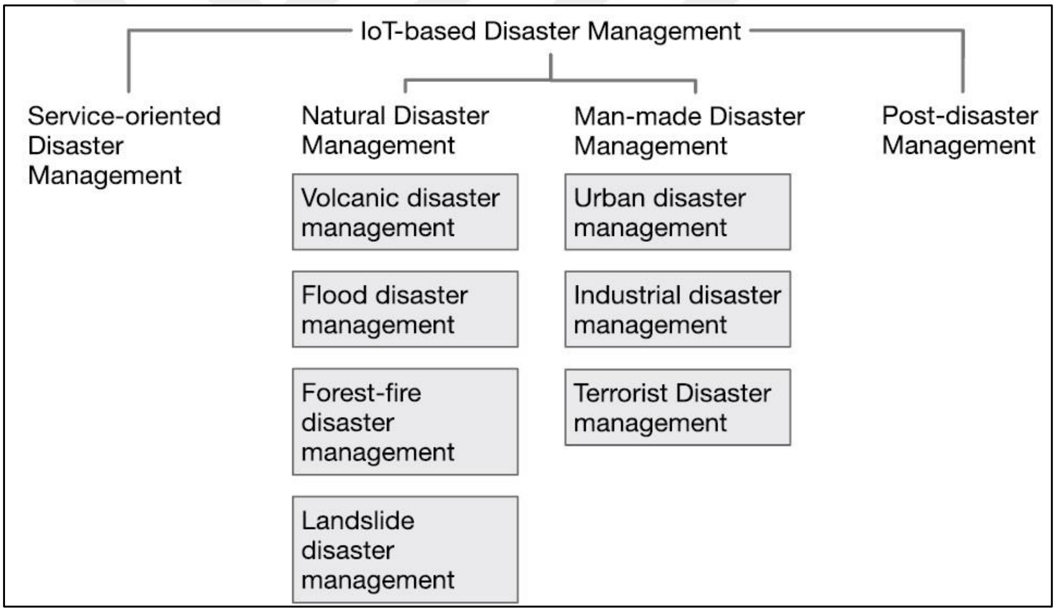

Figure 2.3. Classification of IoT-based disaster management systems [28].

In addition, they summarized most of the techniques available for disaster management using IoT and discussed the possibility of applying these techniques in the event of a disaster. Moreover, they discussed some challenges of implementing the DMS [28]. As well as, the research presented a study on the available applications used in disaster management systems. In another study, Dubey, et al. (2015), discussed the possibility of using Crowd Sourced-IoT (CS-IoT) technology in disaster management by preparing a questionnaire consisting of the following questions:

(i) What is the usability of using Crowd Sourced-IoT (CS-IoT) to enhance the disaster response?
(ii) What is the usability of using IoT technology in disaster?
(iii) How can Crowd Sourcing and IoT be combined to reduce disaster effects? [29].

The IoT-based Safe Community Awareness and Alerting Network (SCALE) platform is the same as the original SCALE platform with some important changes. The new version contains a cost effective sensor, microcontroller, and actuator, with the goal of providing an early warning when it senses anything abnormal in the areas under monitoring [30]. In the field of using the Internet of Things in volcanic activities, Bolton (2016) proposed an early warning system based on Industrial IoT (IIoT) technology by using 80 industrial sensors to detect volcanic activity [31]. The sensors are placed inside the crater and send their data to the control center via cloud services. The proposed system provides continuous monitoring of volcanic activity and has an ability to predict the timing of the volcano eruption by using artificial intelligence and machine learning algorithms. In the field of flooding and aquatic monitoring, Shalini, et al. (2016) designed a system to measure the level of water in the river. This system uses special sensors to measure water levels as the distance from the bottom of the river and send the data to the monitoring center using Wi-Fi technology, which then sends the information via smartphones using GSM technology to the decision-makers. The system provides flood forecasting using the Internet of Things, GSM and SMS [32].

Based on the Forest Weather Index (FWI), Alkhatib (2013) designed an early warning system for forest fires based on a new algorithm receiving data from sensors [33]. The function of these sensors is to monitor forest fires by collecting data on temperature, gas emissions, shade, etc. When signals amounting to danger are collected, the sensors send an alert message to the control center, which in turn sends warning messages to decision-makers. Many phenomena such as earthquakes, deforestation and heavy rains cause landslides. Morello, et al. (2013) have proposed an early detection system for landslides by relying on topographic information from the WSN [34]. The sensors send data on humidity, pressure, and other geophysical parameters to the data center in real-time using ZigBee technology. The data center then sends warning messages using GSM to people near the landslide site based on GPS technology. Alphonsa & Ravi (2016) developed a similar approach utilizing ZigBee technology in earthquake prediction [35]. Earthquakes are disasters that occur almost on a daily basis on the surface of our planet. These researchers noted that earthquake prediction, in addition to real-time data, needs historical data as well. Therefore, they believe that the success of an earthquake prediction system depends largely on sharing previous information on the phenomenon. They proposed an early warning system for earthquakes using IoT, specifically ZigBee technology, in which accelerometers collect data on the vibration from different areas of Earth's surface, send them to the PIC microcontroller, which performs calculations and compares the results with historical data. If the results are negative and the vibration amplitude is above the threshold level, the system collects data on people in the danger zone using GPS technology. It then sends out warning messages to the potential victims and disaster response teams to arrive promptly at the site.

Abdul Hannan, et al. (2018) proposed a Named Data Networking (NDN) system based on IoT- DMS (NDN-DISCA) to overcome the disaster of fire [36]. This system generates and sends an alarm message to people who are near to the fire area. Similar to the procedure of alarm systems in smart campus, the interested people can send a request message to the system to be marked “interested”, after which the system will keep them updated with the latest information on the disaster. When the NDN-DISCA was simulated in NDN-SIM , it was found that the enhanced system had a shorter delay when compared to the NDN system.

Saputra (2014) [37] has proposed a new style of DMS based on a combination of Service Systems Engineering (SSE) and Disaster Management System (DMS), creating an Intelligent Disaster Management System (IDMS) [36]. It is hoped that this system will be an effective instrument in reducing the effects of disasters in Indonesia. It is based on four important assumptions:

(i) The government has to deal with disasters as fast as possible.
(ii) The society should have enough education on disasters.
(iii) Disaster management teams should be distributed in all regions of the country.
(iv) Coordination should be strong between governmental and non-governmental agents, as well as citizens to reduce the effect of disaster.

Yang, et al (2013) divided the Emergency Response (ER) and Disaster Response (DR) processes into three rhythms: that of preparations, of initial assessment, and the rhythm of treatment [38]. They also tried to link the emergency response system to the IoT by setting up two hypotheses: the first hypothesis (H1) was that the IoT would provide information for emergency response, and the second hypothesis (H2) that the IoT would improve the system of emergency response. They went on to test the hypothesis and proved them correct.

On the aspect of citizens' readiness towards the use of ICTs, Albion, et al. (2011) prepared a questionnaire on the impact of age on the usage of ICT and distributed it to a group of students and teachers in Australia [39]. They found that the percentage of people who use this technology increases with age since children under the age of five have little use of smart devices, whereas ages between 5 to 12 years are using them but have limitations on internet connection. Participants between the ages of 12 and 45 have a relatively high usage of smart devices and a high percentage of internet usage, but the interest begins to decrease gradually after 45 years of age.

Thus, they showed that users' knowledge and interest in ICT are directly proportional to their age except the children under five and adults over 45 years of age. The same thing can be applied to E-government readiness and awareness since ICT applications can be the same as E-government applications.

In a study conducted by Alazzam, et al., (2012), a questionnaire in which 329 Malaysian teachers participated was prepared with the aim of determining the level of readiness of Malaysian citizens to use ICTs and discovering the impact of academic level and gender on that readiness [40]. The questionnaire consists of questions about the extent of citizens' knowledge of ICTs, their skills and willingness to use it. The study indicated that teachers' knowledge was above average, their skills were average, and their desire to use ICT was relatively high. While the study also pointed out that the gender factor had a significant impact on these variables, the opposite case was for educational level.

In another important study, Cvetković & Stanišić (2015) [41] conducted personal interviews with 3063 high school students in Belgrade, Serbia. They asked a similar set of questions to all students, and after performing statistical analysis of the answers, the results were as follows:

- The gender of students affects their knowledge of disasters, with female students being more aware than their male counterparts.
- The gender of students does not have an impact on the subject of disasters, as boys and girls show equal level of attention to disasters.
- There is no relationship between the age of the students and the degree of knowledge of disasters. In other words, attention must be paid in raising the level of knowledge for students of all age groups.
- The level of education directly affects the level of interest and knowledge on the subject of disasters. Therefore, the higher the level of education, the greater the attention and knowledge of the student.

CHAPTER 3

ANALYSIS

According to the methodology of this thesis, the first step is the investigation, which is then followed by analysis. The aim of these two steps is to understand the way the system is functioning and understand its elements. In addition, it also aims to understand the role of ICT and E-government applications in reducing the damages resulting from natural disasters. Where these elements will define factors that will affect system performance. Thus, the investigation step will be explained in detail in the current Chapter (Chapter 3), and the analysis step will be elaborated further in Chapter 4.

As mentioned above, this Chapter is dedicated to explain in detail the investigation process and it will contribute to the following points [42]:

1. To clarify problems faced by citizens in the field of Disasters and ICT.
2. Define the contribution of ICT and E-government applications in enhancing the Disaster Management System.
3. Define the needs of the end-users.
4. Define the structure of the enhanced Disaster Management System.

This part of the study was conducted according to the principles of the scientific method with all its six steps [43]:

1. Investigation
2. The Construction of hypotheses
3. Making experiments
4. Experimental analysis
5. Discussion

6. Conclusion

The proposed methodology for the investigation and the analysis of the enhanced DMS is diagrammatically shown in Figure 3.1 and the steps are explained in further details in the following subsections.

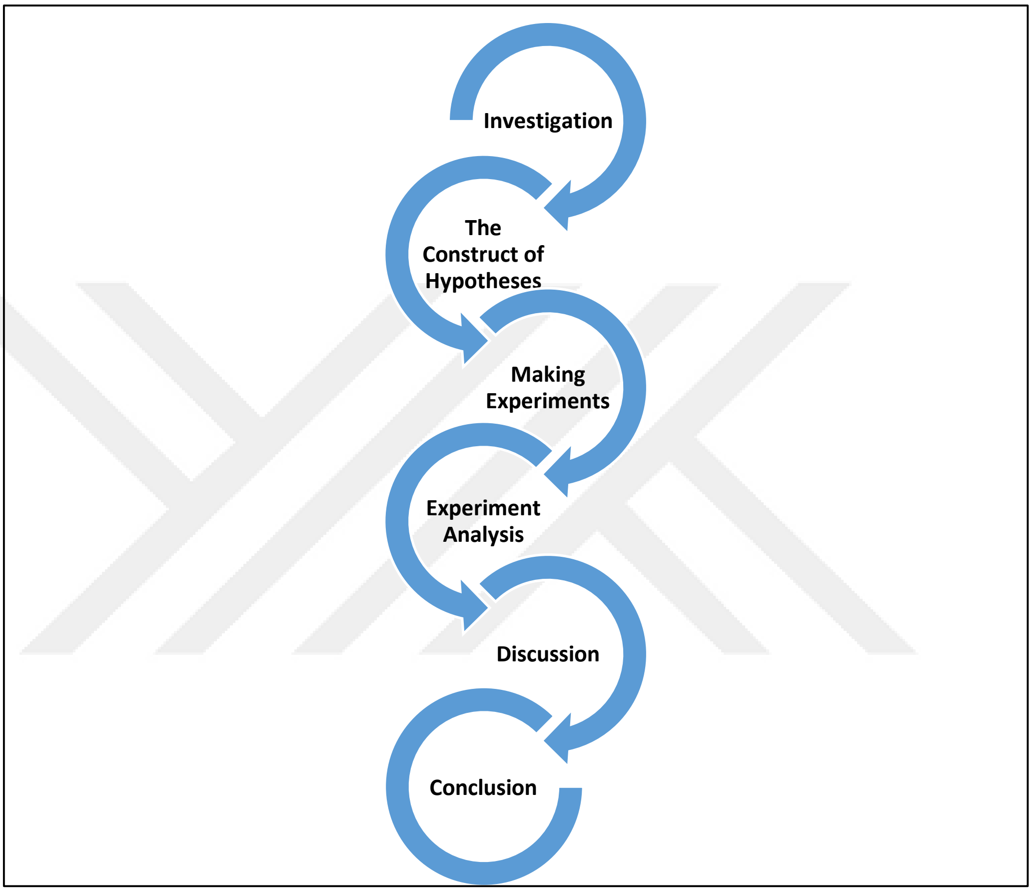

Figure 3.1. The Investigation and Analysis approach for the EDMS.

3.1. Investigation

In order to have a successful investigation, it was essential to conduct a survey on a representative sample of Iraqi citizens that face natural disasters as well as the ICT side.

3.1.1. Disasters

As discussed in Section 2.1.3, disaster is defined as an event that disrupts the natural state of life and causes so much suffering to the community that the society cannot cope with the event [44]. Disasters can be classified into two types, Natural disasters and Human-made disasters, both of them are briefly discussed below.

A. Natural Disasters

Natural disasters can be defined as a group of violent natural activities that occur suddenly in populated areas, causing heavy casualties and not preventing people from taking precautions to mitigate their destructive effects [45]. Natural disasters are further classified into many subtypes.

1. The Avalanches

Landslides occur when large slabs of snow crumble from the slopes of the mountains and are scattered as shattered glass on their way down the mountain faces and passes. The movement of these landslides may reach 130 km/h within 5 seconds. Winter avalanches become dangerous when the slope of the mountain exceeds 22 degrees and the depth of recent snow is greater than 75 cm. Moreover, 90% of avalanches occur during snowstorms.

Figure 3.2. The Avalanches [46].

The demolition of buildings and internal vortices within these landslides are measured at 300 km/h, and wet landslides carry with them uprooted trees and rocks, estimated at 2.5 million tons, which would generate 300 million horsepower, and threatening massive destruction when bumped against anything in front of them.

Any rapid change in weather, snow or land formation can cause collapses and create conditions for low, medium, large, or high-risk landslides. Climate change is one of the major risk factors for the future as any temperature change carries with it the potential for collapses [47].

2. Droughts

Droughts are natural climate-related hazards that can affect large areas for long time. They can have noteworthy impact on the financial performance of a country or region, particularly with regard to food production. Since 1980, more than 558 thousand individuals have died and more than 1.6 billion have been influenced by dry spells. Dry season harm is anticipated to extend, primarily due to the increase in population and depletion of underground water due to populace development, natural debasement, and improvement weights.

Dry spell, as a rule, alludes to an extended period in which precipitation is lower than typical. In spite of the fact that there is a lot of variation within the normal rates from one locale to another, the dry season could be a repetitive highlight in nearly all regions of the world. The impact of dry season may shift broadly depending on agrarian, urban, and water needs [48]. There are four ways in which dry season can be distinguished and characterized:

- The atmospheric method, which measures the deviation of rainfall from normal rates
- The agricultural method, which alludes to circumstances where the extent of water within the soil cannot meet the needs of the vegetation
- Hydrological Method, according to which dry season happens when the surface and groundwater supply is less than regular.
- The socioeconomic approach, which refers to a situation in which water shortages have an impact on people.

Climate dangers are not caused only by sporadic precipitation, but also by destruction of rustic ranges, destitute water and soil administration, and climate alterations, with the later, further contributing to diminished precipitation, and hence desertification. According to the Interval Board on Climate Alter (IPCC) 2007 "Climate Alter Impacts, Adjustment, and Powerlessness" report, it was emphasized that the climate is warming, a slant that has an effect on the frequency and seriousness of certain characteristic risks such as dry season. As a real case in hand, hotter and drier conditions within the Sahel locale have contracted the developing season, among a number of other negative impacts on crops. In Southern Africa, long dry seasons and more vulnerability to very scant precipitation have energized adjustment measures [49].

3. Earthquakes

Seismic tremors are normal risks that cause most passing compared to other occasions. According to a study by the Center for Catastrophe The study of disease, transmission Inquire about gauges that, between 1988 and 2000, more than 495,000 individuals died from seismic tremors, and around 3 million more live in earthquake-prone zones. Geophysicists can locate places where seismic tremors are certain, but no one can foresee when such tremor will happen.

The Earth's crust is made up of structural plates, all of which can move, causing seismic tremor. About 90% of the most devastating earthquakes are of tectonic origin, 3% are of volcanic origin, and 1% due to underground landslides. Seismologists report more than 30,000 earthquakes each year, most of them weak in magnitude [50].

There are several factors, which aggravate earthquake consequences, such as [51]:

- Population density, since huge numbers of individuals live in earthquake-prone zones, more people are at greater risk. Seismic tremors, of which are affect eight out of 10 densely populated cities in the world. Most of the world's seismic tremors are in the Pacific Edge followed by Asia where two-thirds of the world's populace lives.
- Poorly developed and ineffective building construction; buildings that cannot withstand the constrain of seismic tremors are more inclined to collapse. Poverty forces numerous individuals to live in stuffed, substandard and hazardous places and lodgings. The destitute are affected more by seismic tremors than the wealthy individuals did.

4. Flood

Floods affect people more than any other natural disaster. Over the last decade of the twentieth century, floods have influenced some 1.5 billion individuals. Around 200 million people worldwide live in coastal areas prone to flooding.

Figure 3.3. Floods [52].

Floods, more often than not are the result of extreme and consistent precipitation that surpasses the absorptive capacity of the soil and the draining capacity of streams and rivers, especially in coastal regions. Thunderstorms, tornadoes, tropical cyclones, monsoons, melting ice and dams could cause flooding as well. The foremost types of floods are sudden flooding, snow-melting surges, coastal flooding, and waterway flooding. Sudden flash surges are the most perilous since they happen unexpectedly, particularly at night (Chan, and N. W.) [53].

Increased population density, fast and poorly planned urbanization, such as destruction of timberlands and natural confinement zones that prevent destructive floods, and climate alteration are all major factors of floods. As these processes are increasing, more individuals will be exposed to future floods. Dissolving ice sheets and rising ocean levels will cause flooding in areas that had not been exposed to surge hazards. Developing countries are at the greatest risk, and in spite of the fact that Asia remains the worst continent hit by surges, Africa and Latin America are have been affected more frequently in recent years. It should be emphasized that wealthy nations are not safe from the threats of flooding. Surges in Europe in 2002 claimed the lives of more than 100 individuals, and heavy streak surges caused Great Britain 2 billion dollars in damages [54].

5. Tornadoes

Millions of people are affected every year by hurricanes which are likely to intensify in the future due to climate change. Typically, hurricanes are more devastating than floods, causing catastrophic damage along the coastlines and deep into the land (up to hundreds of miles). Hurricanes Katrina and Mitch are among the worst in Atlantic history; the later killed 11,000 people in 1998, causing more than $5 billion in damages, while in 2005, Hurricane Katrina killed 1,800 people and caused $130 billion damages in New Orleans.

Hurricanes, despite being of different kinds and names, describe the same type of disaster. They are known as typhoons in the Western Atlantic and Eastern Pacific, and hurricanes in the South and Western Pacific. In the Caribbean, August and September are the peak of the hurricane season, which runs from the beginning of June to the end of November. In the eastern Pacific, the season begins in mid-May and ends in November [55].

Climate change, environmental destruction and urban growth in rural areas are likely to expose more people to hurricanes in the future, but coastal areas remain the most vulnerable. Typically, hurricanes follow heavy rains and floods in flat coastal areas.

The countries most affected by this type of disaster are China, India and the Caribbean. People living near coastal areas, sub-standard buildings and fragile structures are also more vulnerable because high winds cause significant damage to infrastructure and housing. In addition, people living in mobile homes in hurricane areas are extremely vulnerable [56].

6. Landslides

While Asia is hardest, hit continent by landslides, the Americas suffer from increased mortality and Europe bears the hardest economic losses, with an average of $ 23 billion a year. The speed of landslides can exceed 50 km/h and affect people or buildings that are found on their way. Landslides are unpredictable, but warnings to those living in areas prone can be given in advance if there is an alarm system that measures rainfall [57].

There are 5 main types of major landslide traffic: The most common species are soil slides, stones, mudflows and ruins, and these are among the most destructive. Collapses on the seafloor, large slides, or falling stones that hit the seas can even cause tsunamis.

Landslides can occur for geological or physical reasons such as melting glaciers or snow, heavy rains, increased water pressure, earthquakes, volcanic eruptions, and severe slopes. Humans can also cause landslides, and a common example is the construction on slopes.

Worldwide population growth, rapid urbanization, environmental degradation, deforestation, inappropriate land use, and construction on slopes all increase the risk of landslides and put more people at risk [58].

Urban areas pose the greatest risk to the population, in particular, those located on slopes or slant surfaces. Areas previously affected by landslides and those siting on unstable top-down slopes are at greater risk of landslides. Poor people remain among the hardest hit as they are often forced to live in high-risk areas such as slopes, flood plains, and foothills. Moreover, due to economic reasons, they have very limited abilities to cope with and respond to disasters [59].

7. Tornado whirlwinds

The average number of people killed by tornadoes is less than 100 a year, but these storms are devastating and cause enormous economic losses. The United States is one of the biggest hotspots, with up to 1,000 tornadoes a year which kill about 80 people and injured more than 1,500 annually. Globally, US accounts for 75% of the storms, followed by Canada and Bangladesh, where on April 26, 1989, a storm killed 1,300 people in northern Dhaka. New Zealand, South Africa, India, Argentina, and the Russian Federation are also under severe storms [60].

Tornadoes are vertical cones of fast circular air currents with wind reaching up to 400 km/h and an ability to penetrate a path more than 1 km wide and 80 km long. Most of these storms are 100 meters wide; larger storms can reach 1 km in width and can travel 50 km or more. The size of a storm does not necessarily show its destructive power as small whirlwinds can also be devastating. Many tornadoes can be seen in the daytime when visibility is not blocked by rain or low clouds. Tornados take distinctive shapes, sizes, and grades [61].

The lack of early warning systems and preparedness programs increases the risk of the entire population. However, in the case when early warning systems are functioning, mortality rates are higher among the elderly and children because of their poor response capacity. People living in mobile homes are at increased risk of tornadoes with an incidence rate of 85.1 per 1,000, compared with 3 per 1,000 for those living in habitual homes [62].

The most vulnerable areas to Tornados are North America, especially the Great Plains of the United States and South-Central Canada. The "Tempus Corridor" is an area that includes southeast Dakota, Nebraska, Kansas, Oklahoma, North Texas, and eastern Colorado, home to some of the most powerful and devastating storms.

Large numbers of storms are reported in the plains of Europe, South Asia and Asia, Australia, and South America as well. Communities living in fragile buildings such as mobile homes and raised buildings that can collapse are the most vulnerable. In addition, communities living in poorly constructed houses near objects likely to fly are at a particular high risk, while those living in the open are at greater risk of death when the storms occur [63].

8. Tsunami waves

The US National Oceanic and Atmospheric Administration (NOAA) estimates that the Pacific region is one of the most active tsunamis zones, but was born in the Caribbean, Mediterranean and Indian and Atlantic oceans.

Figure 3.4. Tsunami waves [64].

The word tsunami comes from a Japanese word meaning, "harbor wave." It is a series of giant and long ocean waves, 10 or more in number, caused by underwater disturbances such as earthquakes, landslides, volcanic eruptions or the impact of a meteorite. The danger from the tsunami could last for several hours after the first wave arrives [65].

The most devastating tsunamis are caused by large, shallow earthquakes with epicenters or fault lines near the ocean floor. Typically, an earthquake measuring 7.5 on the Richter scale can cause a devastating tsunami. One of the most visible signs of a tsunami is water blockage, and experts believe this phenomenon can provide people with an early warning of about 5 minutes to evacuate the area [66].

Sometimes, a tsunami causes water to be trapped near the shore, showing the ocean floor. Tsunami waves can be very long (up to 100 km) and up to one hour away from each other. They have the capability to cross the entire ocean without significant loss of energy. The Indian Ocean tsunami moved about 5,000 km to Africa, and reached its shores with enough force to kill people and destroy property. Tsunamis can move into rivers and streams that flow into the oceans and expose thousands of people inland to danger. Although violent volcanic eruptions are not relatively frequent, they also represent spontaneous disturbances that can displace vast amounts of water and generate highly destructive tsunamis in the nearby source areas.

Many people living near the sea, in areas prone to earthquakes and buildings of poor quality are under high risk to tsunami damages. In addition, destruction of the environment and natural barriers, and lack of coastal land-use planning further increase the risk and impacts of tsunamis. The development and growth of densely populated settlements in tsunami-prone areas without any assessment of these risks further increases their [67].

9. Volcanoes

A volcano is an opening or cracking on the Earth's crust that allows molten rocks, heat, ash and gases to escape from the depths of the mantel to the surface. Volcanic eruptions can be categorized across a spectrum ranging from calm to violent ones, and non-explosive and slow-moving lava flows to explosive lava flows that blast substances into the atmosphere (magazines and gases). Volumes and volatility, gas agitation and the speed of magma itself mainly determine explosion the violence [68].

The number of potential volcanoes around the world is estimated to be more than 1,500, 50-60 of them erupting each year. However, more than one million are estimated to be under the ocean and sea surfaces. Volcanoes produce a variety of hazards that can kill people and cause huge economic losses. The landslides generated by large cone conglomerates can slip into the sea and trigger tsunamis. Compared to other disasters, such as earthquakes, volcanic eruptions have resulted in lower death rates because they are often predictable, and as a result, people can be evacuated from the affected area in time [69].

Although recent decades have seen remarkable progress in monitoring active volcanoes, it should be noted that the risk of volcanoes is increasing due to the rapid urbanization and the high density of populations living on the slopes and valleys of volcanic areas. Around 500 million people worldwide are at risk of being affected by volcanoes each year, and more than 60 major cities are located near active sites. High-risk volcanoes are located in developing countries around the Pacific Belt, which includes part of Asia, Latin America, the Caribbean and the Southwest Pacific.

People living near volcanoes without monitoring and early warning systems are the most vulnerable to volcanic eruptions. As in the case of other disasters, poor people are among the most vulnerable because they are economically obliged to live in high-risk areas such as active volcanic slopes or near volcanic valleys, and are less prepared to deal with disasters. Those living near volcanoes will be the most vulnerable and will sometimes have to give up their lands and homes forever. People living away from the explosions could also be affected because mudslides, volcanic water, ash, floods, and increased temperatures have greatly affect their cities, towns, crops, factories, transport systems, and their electricity distribution grids [70].

10. Forest fires

Forest fires are not a major cause of death but can have devastating economic consequences. Human activity is the cause of many forest fires, either by accident or intentionally. These fires often get out of control and easily spread over large areas.

Figure 3.5. Forest Fires [71].

Greece's forest fires in 2007 killed 77 people, while fires in California in October 2007 destroyed at least 150 homes and more than 200,000 hectares of land from Santa Barbara County on the US border with Mexico. Forest fires in the Russian Federation in 2010 killed at least 50 people and destroyed 40,000 hectares of the protected forest [72].

The term “forest fires” is used to describe uncontrolled fires in forests and other types of vegetation, including animal species. For forest fires to occur, two conditions are required. The first condition is fuel, which is any flammable material around the fire, including trees, gases, shrubs, and even houses. The second condition is the source of fire itself, which could be anything from lightning, heating fire, cigarettes, warm winds, and even sunlight.

The Global Fire Monitoring Center (GFMC) predicts an increased risk of future fires due to increased demand for agricultural land for food and cereal production, the need to use fire to change land usage pattern, the expansion of residential areas and urban infrastructure near vegetation vulnerable to fire, as well as extended droughts. Forest fires lead to further land degradation such as soil erosion and loss of land productivity, resulting in more floods and landslides [73].

Agricultural and grazing lands that are used to control weeds are most at risk from forest fires. Besides human-caused fires, forests are also exposed to natural fires; shrubs and ecosystems in grasslands in subtropical areas of Africa and Australia, the northern regions such as North America and Russia, and agricultural areas and crop forests with eucalyptus and pineapple cultivation have cycles of natural fires that are essential for a healthy ecosystem. Residential areas or scattered houses or other infrastructure that are closest to exposed vegetation, or residential areas or individual buildings made of highly flammable materials such as wood, straw, wood-based panels, and other combustible roofing materials are at great risk. Abandoned rural villages or human settlements without good management to prevent or deals with fires are also in the high-risk category [74].

B. Human-made Disasters

The disaster caused by human activity such as road accidents, terrorism and the fall of airplanes, are called human-made disaster because their common cause is human activity. Many disasters have occurred due to human activity, including the disaster of Bhopal (Indian city), Chernobyl, Toulouse, and Fukushima [75]. However, since this research is focused on natural disasters due to their diversity, higher frequency, difficulty of predicting their occurrence, no we will not concentrate on human-made disasters any further.

3.1.2. Information and Communication Technology (ICT)

ICT can be defined as the combination of methods and steps to achieve the process of communication, and dissemination of information by using electronic devices, which operate according calculations and scientific laws developed, intended for this purpose, such as computers, communication and smart devices [76]. Figure 3.6 shows Information System and its components.

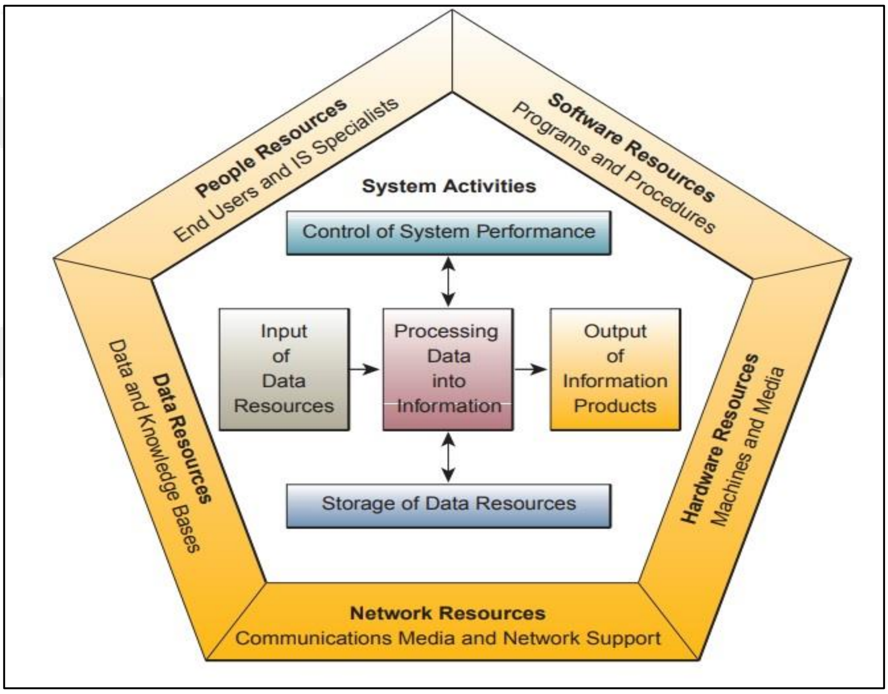

Figure 3.6. Information System components [76].

ICT is divided into five main sections and detailed explanations for each of them are provided in the following subsections.

A. Physical devices (Hardware Resources)

This group includes all devices used for input, output, and processing of data, and they can be further classified into six categories.

1. Power supply

It is the component responsible for supplying and powering the computer itself. The function of the power supply is not only to provide electricity, but also to perform an important organizational process for the device [77].

2. Computers

A computer is an electronic device that stores and processes data and information. It contains input units such as a keyboard, barcode reader and mouse, processing units such as CPU, and output units such as monitor, speakers, and printer [78].

3. Storage Media

These are devices that have the ability to store and retrieve data, and can be either internal or external units. Storage capacity is measure in bytes. The volume of data stored and their speed of retrieving this data [79] measure the efficiency of storage units.

4. Sensors

An electronic device that converts physical signals, such as heat, pressure, lighting, etc. into electrical signals such as current, voltage, and resistance. Sensors are sensory organs of the control system, without which, the control system will be powerless because it is isolated from the external medium and changes occurring in the controlled system. Without sensors, it cannot identify problems that occur in other parts of the system [80].

5. Smart Devices

They include the new generation of mobile phones, also called smartphones and tablets. These devices not only have the ability to make phone calls, but they can also act as control devices through the connection to the Internet, but by using control applications, they can also serve as sensors if harnessed for that particular purpose [81].

6. Network and communication devices

They are wired and wireless connection devices like antennas, receivers, and signal senders used to connect all other devices in the system in order to complete the transfer of information from one side to another within the network [82].

B. Software Resources

This Section is devoted to explaining all software and technologies that facilitate the implementation of the system in the appropriate and efficient manner to reach the desired targets [83]. It is composed of four subsections.

1. Programming languages

A set of commands, written in accordance with the rules set by the programming language; pass through several stages until they are executed on the computer [84]. Programming languages can be divided into three types, depending on their level [85]:

The first type of programming language is machine language, which is the language that the computer understands directly represented by binary numbers 1 and 0.

The second type of programming languages in this category are low-level languages, which are the closest lowest-level machine language and under the assembly language. These languages are characterized by the fact that they contain only commands that are understood by the computer, and therefore are far away from the language understood by humans, but at the same time, they allow the programmer to have full control over the program.

High-level languages are the third-level machine languages and are closer to human understanding, but they do not offer as much control as the low-level languages to the programmer in terms of the ways the computer memory and data are organized.

However, some important features of high-level programming languages are the programmer's ability to use variables, objects, and procedures. Therefore, the programmer executes a large number of commands by typing a single line of code. Examples of this type of programming language are Python and Ruby [86].

2. Software Engineering

Software engineering is a branch of engineering based on a set of principles and rules that aim to design and develop programs in abundance and high quality to meet the needs of users. This branch of engineering is characterized by the fact that it does not require a large budget and therefore the need for investment is lower in contrast to other branches of engineering. A software engineering project needs to have an integrated team of good software engineers where the presence of one person is not enough to complete the work [87].

3. Artificial Intelligence (AI)

Artificial intelligence is the public sphere that covers everything related to granting machines "intelligence" in order to simulate the unique logical thinking abilities of humans. It specializes in giving machines the ability to "learn". This is achieved with algorithms that can detect patterns and generate ideas from data presented to them to be applied to decision-making processes and future forecasts. On the other hand, deep learning is a subset of machine learning and it is the most sophisticated branch of artificial intelligence, which brings AI closer than ever to the goal of enabling machines to learn and think as much like humans as possible [88]. There are five basic facts about Artificial Intelligence [89]:

a) Artificial intelligence is a set of software, and not an electrical device. Artificial intelligence aims to design machines capable of achieving a particular goal in a manner similar to, or even beyond the capacity of humans. Often times they are algorithms (software) that run on a computer or groups of computers.
b) Artificial intelligence consists of a set of different goals and capabilities. It includes Machine Learning, Knowledge Organization, Knowledge Analysis, Language

Analysis (NLP), Speech Recognition, Image and Video Understanding, Computer Vision, Creativity, emotional and societal coping, and moving robots.

c) Research in artificial intelligence is old and diverse. The dilemma of artificial intelligence is old and complex and has many details beyond the scope of this thesis, as there is a difference between the approach on the types of applications that fall within artificial intelligence, and the procedures to be followed in reaching certain goals. Seventy years ago, there was great optimism that within 20 years time, the dilemma of artificial intelligence would be solved, but to date, we are far from solving that dilemma altogether.

d) Artificial intelligence has enormous potential applications, but little has been discovered yet. Research in artificial intelligence has contributed significantly to the development of useful tools such as machine learning (ML), which in turn have contributed to applications in medicine and economics (applications to tools and not to AI itself). The applications of artificial intelligence are huge, and they will dramatically change human lives. However, we have found very little in our daily dealings.

e) Artificial intelligence marks a turning point in the field of data and computing power. Although AI-related science has not radically evolved over the last decade, the field is making a strong returned. This is due to the abundance of data and the significant developments in computing power and licensing, in particular, parallel computing found in the graphics cards of gaming devices (GPUs). All of this has contributed to the ability of the old algorithms from the eighties and nineties to work with excellent efficiency now and bypass the known programming methods in many human tasks. It is now easy to train these models to perform tasks that were once considered difficult or almost impossible in the past, such as identifying cancer cells or self-driving cars.

4. Graphical User Interface (GUI)

Graphical user interfaces are a graphical display in one or more windows with tools and components that allow the user to efficiently and easily engage and accomplish otherwise difficult computer-related tasks. These components include menus, toolbar, Pushbuttons, select buttons, Drop-down menus among many. Through the interfaces, we can write and read data, create connections between more than one interfaces, and share data between them. In addition, they allow us to display the data in the form of graphs and tables [90].

C. Human Resources

Human resources is an umbrella term for a set of processes such as planning, organizing, directing and monitoring all aspects of individuals in order to maintain, develop, raise awareness and compensate them without the need for any separate specialized department [91].

The Section of human resources in the information and communication system is the most important pillar on which the whole system relays. That is because the lack of human resources, either means that the system does not exist at all, or that it will be useless as it lacks users. Human resources consist of two groups:

The first group is the people who plan, program, operate, maintain and update the system. These people are the ones responsible for building and maintaining the system [92].

The second group is the end-users of the system, and they are the people who may be specialists in the field of information technology and communications or be not related to the field at all, but their role is to use the system [93].

D. Data Bases (Data Resources)

Data is the raw material on which the system depends for it to function. The sources of data in information systems are of two types [94]:

1. Historical data, which are stored in databases and holds information collected earlier on a particular subject. These data are retrieved and analyzed in order to be used in future decisions, such as climate forecasts or natural disasters.

2. Real-time data, which are collected using various sources such as sensors and cameras, and can even benefit from user feedback, such as from social media. Real-time data are used to make real-time decisions to address a particular problem or act towards an upcoming risk.

The data pass through several stages to be ready for use by the information system:

- Data collection
- Data classification
- Data analysis
- Data storage

3.2. Set Hypotheses

The motivation behind the design of a Smart Disaster Management System (SDMS) is to increase the readiness of Iraqi citizens to use Information and Communication Technology (ICT) in a correct and efficient manner. In addition, it aims to increase the citizens' reliability on E-government applications by enhancing the utility of these applications.

Another important aim is increasing the citizens' readiness for disaster management through facilitating the ways of communication between citizens and the Smart Disaster Management System. The demographic factors that effects the readiness of Iraqi citizens are three, namely gender, age, and education level. These factors are considered as independent variables as shown in Figure 3.7.

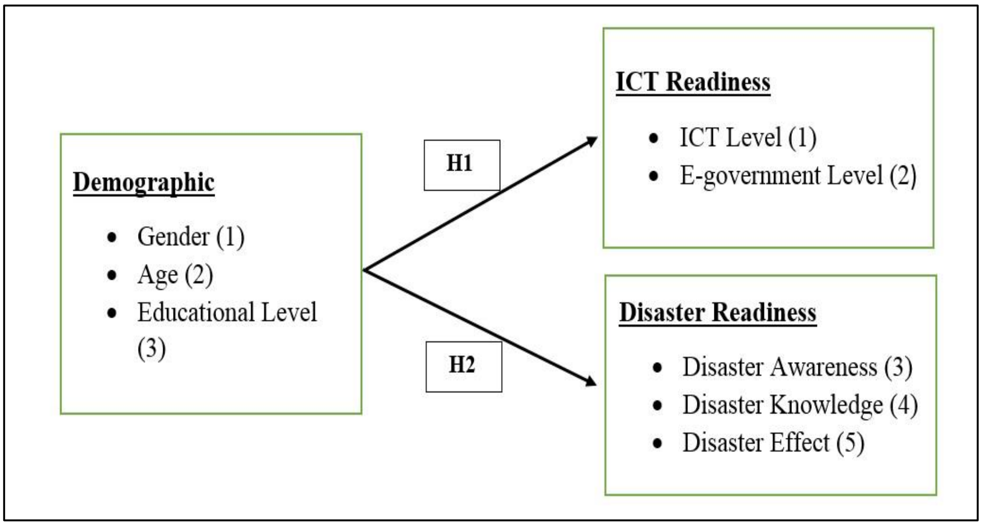

Figure 3.7. Research Model of Hypotheses of Readiness.

On the other hand, dependent factors are two:

A. Information and Communication Technology Readiness
It is defined as hypotheses H1J, where J= 1,2.

B. Disaster readiness
It is defined as hypotheses H2K, where K= 3,4,5.

Then, the hypothesis for each one of these variables are configured as follows:

3.2.1. Hypotheses of ICT Readiness

The hypotheses related to Information and Communication Technology (ICT) are included in the following table.

Table 3.1. The Definition of Hypotheses of ICT readiness.

Hypothesis	Definition
H_{111}	Citizens' age has a positive impact on ICT level
H_{121}	Citizens' gender has a positive impact on ICT level
H_{131}	Citizens' education level has a positive impact on ICT level
H_{112}	Citizens' age has a positive impact on E-government level
H_{122}	Citizens' gender has a positive impact on E-government level
H_{132}	Citizens' education level has a positive impact on E-government level

Information and Communication Technology (ICT) Readiness

Literature shows that the demographic factors act as independent variables that effect the Information and Communication Technology (ICT) readiness for citizens. On the other hand, ICT factors acting as dependent variables are ICT level, and E-government level.

ICT level means the frequency and the way the citizens use Information and Communication Technology. E-government level refers to the ability of citizens to use the E-government applications, as well as the percentage of citizens' confidence in them.

Therefore, the hypotheses related to these dependent factors are followed:

H_{111}: Citizens' age has a positive impact on ICT levels.
H_{121}: Citizens' gender has a positive impact on ICT levels.
H_{131}: Citizens' education level has a positive impact on ICT levels.
H_{112}: Citizens' age has a positive impact on the E-government level.
H_{122}: Citizens' gender has a positive impact on the E-government level.
H_{132}: Citizens' education level has a positive impact on the E-government level.

3.2.2. Hypotheses of Disaster Readiness

The following table contains the hypotheses related to Disaster readiness.

Table 3.2. The Definition of Hypotheses of Disaster readiness.

Hypothesis	Definition
H_{213}	Citizens' age has a positive impact on Disaster Awareness
H_{223}	Citizens' gender has a positive impact on Disaster Awareness
H_{233}	Citizens' education level has a positive impact on Disaster Awareness
H_{214}	Citizens' age has a positive impact on Disaster knowledge
H_{224}	Citizens' gender has a positive impact on Disaster knowledge
H_{234}	Citizens' education level has a positive impact on Disaster knowledge
H_{215}	Citizens' age has a positive impact on Disaster Effect
H_{225}	Citizens' gender has a positive impact on Disaster Effect
H_{235}	Citizens' education level has a positive impact on Disaster Effect

Disaster Readiness

Disaster readiness means the way citizens think about disasters, whether they are aware, have the necessary knowledge, know about the consequences, and are able to act to reduce the damages to the possible minimum.

Therefore, the dependent factors related to disaster readiness are:

- Disaster Awareness
- Disaster Knowledge
- Disaster Effect

As a result, the hypotheses that related to these dependent factors are as follows:

H_{213}: Citizens' age has a positive impact on Disaster Awareness.
H_{223}: Citizens' gender has a positive impact on Disaster Awareness.
H_{233}: Citizens' education level has a positive impact on Disaster Awareness.
H_{214}: Citizens' age has a positive impact on Disaster knowledge.
H_{224}: Citizens' gender has a positive impact on Disaster knowledge.
H_{234}: Citizens' education level has a positive impact on Disaster knowledge.
H_{215}: Citizens' age has a positive impact on Disaster Effect.
H_{225}: Citizens' gender has a positive impact on Disaster Effect.
H_{235}: Citizens' education level has a positive impact on Disaster Effect.

CHAPTER 4

CONDUCTING EXPERIMENTS

4.1. Conducting Experiments

Carrying out the procedure of the study according to the scientific way, after hypotheses come experiments, to either prove or reject these hypotheses. This was achieved by using two powerful polling techniques; interviews and questionnaires. The implementation of these methods was as follows:

4.1.1. Preparation and Distribution of Questionnaire Form

As mentioned before, the four objectives of this study were:

1. Test hypotheses as defined in Section 3.1.
2. Evaluate the awareness of Iraqi citizens towards disasters.
3. Evaluate the readiness of Iraqi citizens in utilizing ICT in cases of disasters.
4. Determine types of disasters that affect Iraqi citizens.

In order to reach these objectives, the following steps were followed:

A. Questionnaire Form Preparation

In order to check citizen's awareness about disasters and know their ability to use E-government applications to reduce their impact hypotheses developed in Section 3.2 was tested through a questionnaire.

The questionnaire contains three main sections, which are:

1. Personal Information; this Section contains three questions related to demographic information about the participants. The questions included in this Section are as follows:
   Q1. What is your Age?
   Q2. What is your Gender?
   Q3. What is your Settlement Area?
   Q4. What is your Educational level?

2. Questions related to information and communication technologies, which are crucial for us to understand the readiness level of citizens toward ICT. This Section contains two questions:

Q5. What is your Information and Communication (ICT) level?

This multiple-choice question will be used to test H_{11}, which is related to the citizen's ICT know-how level.

Q6. What is the level of your knowledge about E-government applications?

This multiple-choice question will be used to test H_{12}, which concerns the citizen's knowledge of E-government applications.

3. Questions related to disasters; this Section will help us understand the readiness level of citizens against disasters and it contains five questions:

Q7. What is your level of disaster knowledge?

This multiple-choice question concerns H_{23}, which will test whether the level of citizen's knowledge about disasters is adequate.

Q8. What is your disaster awareness level?

This multiple-choice question concerns H_{24}, which will test the citizen's level of awareness on disasters.

Q9. What is your knowledge level on Disaster Management?

This multiple-choice question concerns H_{25}, which will test the citizen's knowledge level about disaster management.

Q10. Have you ever been affected by any disaster?

This multiple-choice question will be used for statistical purposes in future studies to check if the citizens have been affected by disasters.

Q11. By which kind of disaster have you been affected?

This multiple-choice question will be used for statistical purposes in future studies in defining the types of disasters that have affected Iraqi citizens.

B. Questionnaire Form Coding

Questionnaire coding is the next step on the questionnaire implementation procedure. As mentioned before (Section 1.5), the questionnaire was distributed by using both, traditional and modern methods. Therefore, the feedbacks were also divided into two parts as follows:

1. The first part was collecting feedbacks via the modern method, that of a Google distributed to the attended sample, so feedbacks were coded automatically by Google and transferred to an Excel sheet, making it easier to analyze on a statistical software. The coded feedbacks are shown in Figure 4.1.

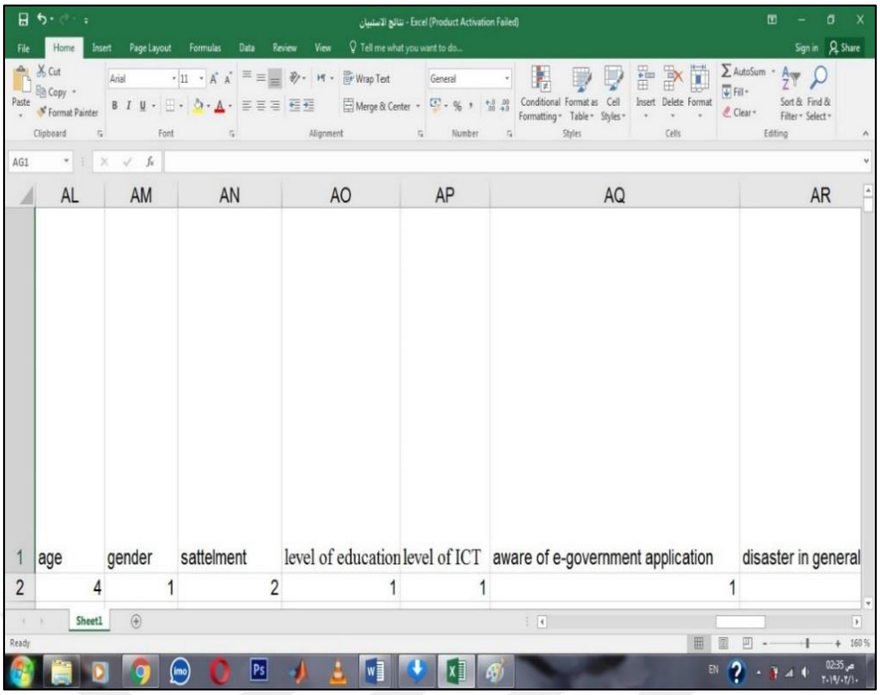

Figure 4.1. Questionnaire coded feedbacks.

2. The second part was collecting feedbacks using the traditional method by collecting the paper-based questionnaire, which was distributed to the participants. In contrast to the google form, they had to be coded in order to be used in the statistical software. The coding was done as follows:

Question 1 is multiple-choice questions, and it coded as shown in Table 4.1

Table 4.1. Coding of Multiple-Choice-1 Question.

Q Number	Value	Code	Notes
Q1	Less than 20 years	1	
	20-30 years	2	
	30-40 years	3	
	40-50 years	4	
	More than 50 years	5	

Question 2 is a close question, and it coded as shown in Table 4.2

Table 4.2. Coding of Close-1 Questions.

Q Number	Value	Code
Q2	Male	1

	Female	2

Question 3 is a close question, and it coded as shown in Table 4.3

Table 4.3. Coding of Close-2 Questions.

Q Number	Value	Code
Q2	Town	1
	Village	2

Questions 4 is a multiple-choice, and it coded as shown in Table 4.4.

Table 4.4. Coding of Multiple-Choice-2 Question.

Q Number	Value	Code	Notes
Q4	Primary school or less	1	
	Secondary school	2	
	Bachelor's degree	3	
	Master's degree	4	
	Ph.D. degree	5	

Questions 5, 6, and 9 are multiple-choice, and it coded as shown in Table 4.5.

Table 4.5. Coding of Multiple-Choice-3 Question.

Q Number	Value	Code	Notes
Q5,6,9	Very Good	1	
	Good	2	
	Average	3	
	Few	4	
	Very Few	5	

Questions 7 is a multiple-choice, and it coded as shown in Table 4.6.

Table 4.6. Coding of Multiple-Choice-4 Question.

Q Number	Value	Code	Notes
Q7	Very Good	1	
	Good	2	
	Average	3	
	Few	4	
	Very Few	5	
	I have no idea	6	

Questions 8 is a multiple-choice, and it coded as shown in Table 4.7

Table 4.7. Coding of Multiple-Choice-5 Question.

Q Number	Value	Code	Notes
Q8	Very Interested	1	
	Interested	2	
	Average	3	
	Limit Interested	4	
	Not Interested	5	

Questions 10 is a multiple-choice, and it coded as shown in Table 4.8.

Table 4.8. Coding of Multiple Choice-4 Question.

Q Number	Value	Code	Notes
Q10	Always	1	
	Many Times	2	
	Sometimes	3	
	Once only	4	
	Never	5	
	I have no idea	6	

Questions 11 is a multiple-choice, and it coded as shown in Table 4.9.

Table 4.9. Coding of Multiple-Choice-5 Question.

Q Number	Value	Code	Notes
Q11	Flood	1	
	Drought	2	
	Earthquakes	3	
	Forest Fires	4	
	Tornados	5	

C. Reliability Testing

An important step to be taken before distribution of the questionnaire is testing its reliability. For that, a training random sample containing 30 participants was chosen and tested on Statistical Package for Social Sciences (SPSS) from IBM© V.18.0.

Using the Cronbach's Alpha function for testing the reliability, it was found that the reliability for this sample was 0.732, meaning its reliability is 73%, higher than the necessary threshold of 70% (Figure 4.2). Therefore, we concluded that the questionnaire is reliable enough to be applied on a real sample.

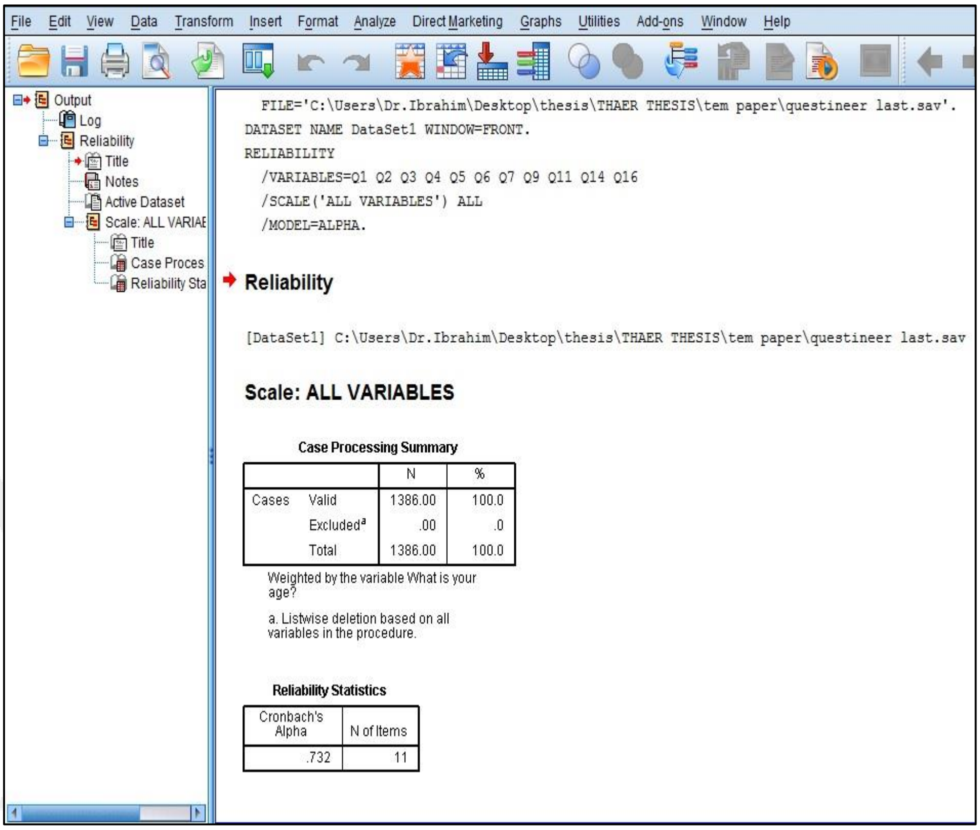

Figure 4.2. Reliability of Questionnaire Form.

D. Questionnaire Dissemination

After checking the reliability of the questionnaire, it was distributed among the real sample, the Iraqi citizens who might have been affected by disasters in order to test their readiness in utilizing ICT and protect themselves from disasters. As the audience were Iraqi citizens, the questionnaire was originally prepared in Arabic Language, which is the mother tongue of Iraqis. In the traditional method, paper sheets were printed and given to the people to be filled up and handed back again. The second method of dissemination was by using Google Forms and send them to the citizen and receive their feedbacks. Collection of the feedbacks was stopped on April 25.2019 after 513 responses were gathered. Results of the questionnaire are shown in Figures 4.3 - 4.13.

Q1/ What is your Age?				
# of Participants		513	# of Feedbacks	513
Answers	Less than 20 years	142	27.7%	
	20-30 years	83	16.2%	
	30-40 years	133	25.9%	
	40-50 years	99	19.3%	
	More than 50 years	56	10.9%	

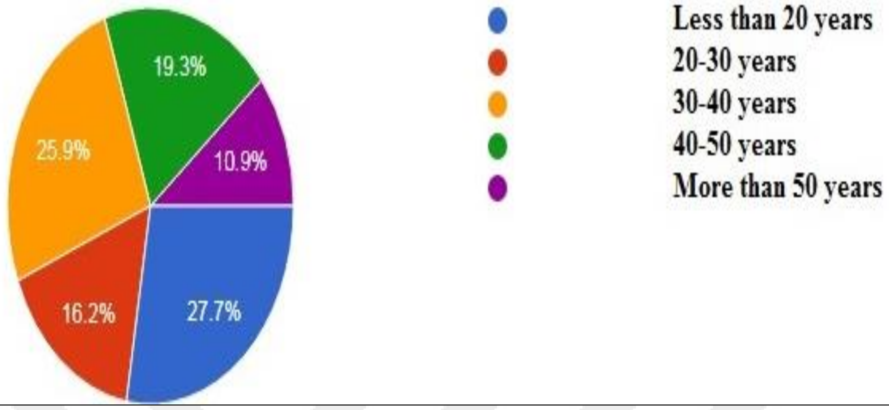

Figure 4.3. Results of Question 1 of Questionnaire Form.

Q2/ What is your Gender?				
# of Participants		513	# of Feedbacks	513
Answers	Male	323	63.5%	
	Female	186	36.5%	

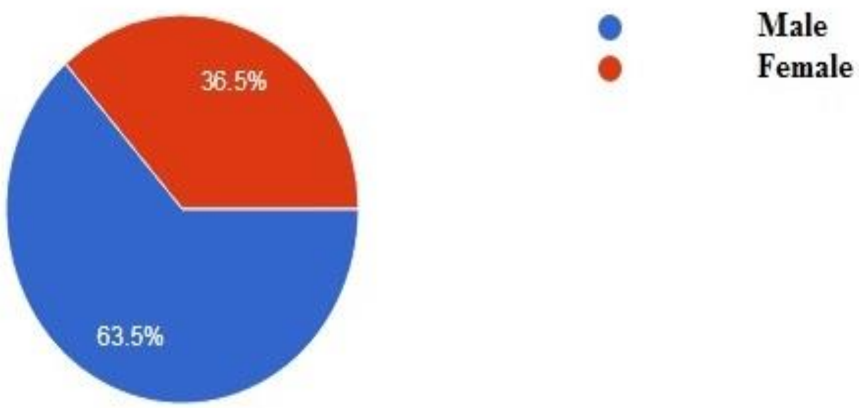

Figure 4.4. Results of Question 2 of Questionnaire Form.

Q3/ What is your Settlement Area?				
# of Participants		513	# of Feedbacks	513
Answers	Town	339	66.1%	
	Village	174	33.9%	

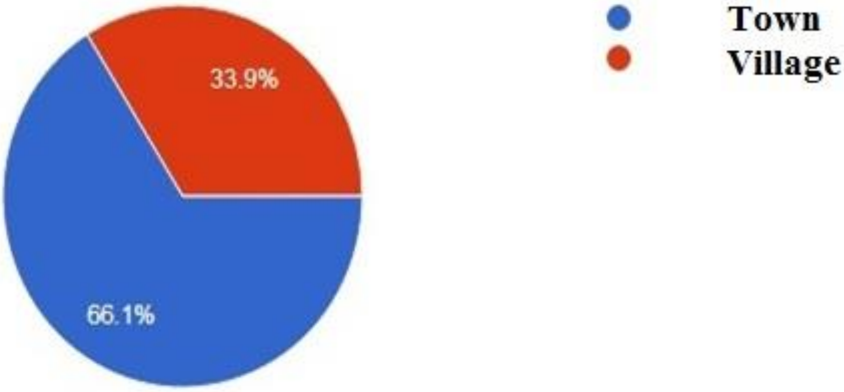

Figure 4.5. Results of Question 3 of Questionnaire Form.

Q4/ What is your Education level?				
# of Participants		513	# of Feedbacks	513
Answers	Primary school or less	36	7%	
	Secondary school	178	34.7%	
	Bachelor's degree	187	36.5%	
	Master's degree	78	15.2%	
	Ph.D. degree	34	6.6%	

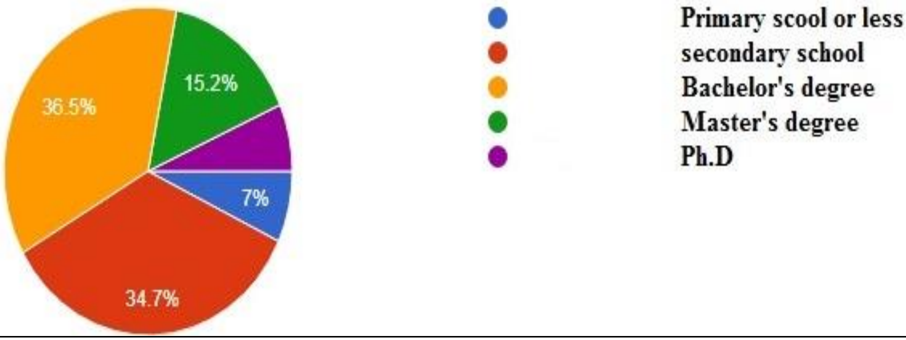

Figure 4.6. Results of Question 4 of Questionnaire Form.

Q5/ What is your Information and Communication (ICT) level?				
# of Participants		513	# of Feedbacks	513
Answers	Very Good	159	31%	
	Good	180	35.1%	
	Average	142	24.2%	
	Few	29	5.7%	
	Very Few	21	4.1%	

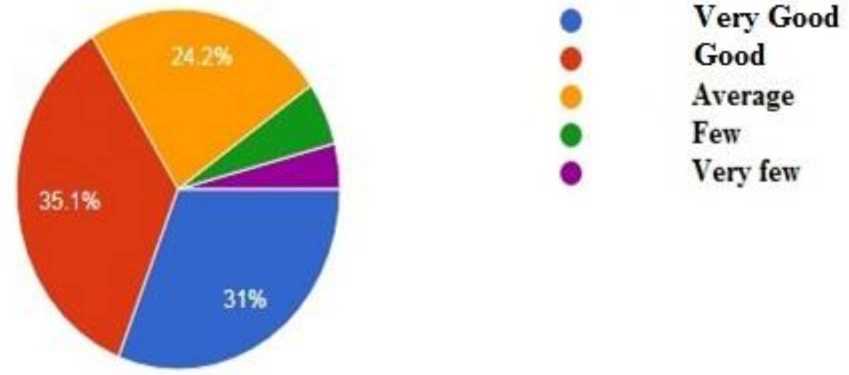

Figure 4.7. Results of Question 5 of Questionnaire Form.

Q6/ What is your knowledge level towards E-government applications?				
# of Participants		513	# of Feedbacks	513
Answers	Very Good	77	15%	
	Good	104	20.3%	
	Average	133	25.9%	
	Few	108	21.1%	
	Very Few	91	17.7%	

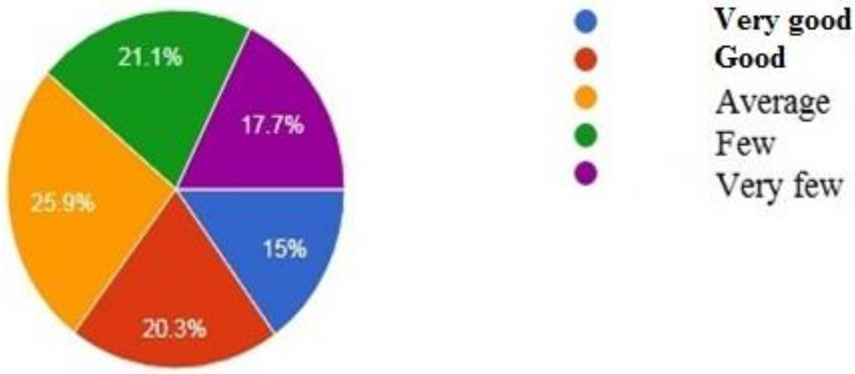

Figure 4.8. Results of Question 6 of Questionnaire Form.

Q7/ What is your level of disaster knowledge?				
# of Participants		513	# of Feedbacks	513
Answers	Very Good	72	14%	
	Good	147	28.7%	
	Average	140	27.3%	
	Few	65	12.7%	
	Very Few	39	7.6%	
	I have no idea	50	9.7%	

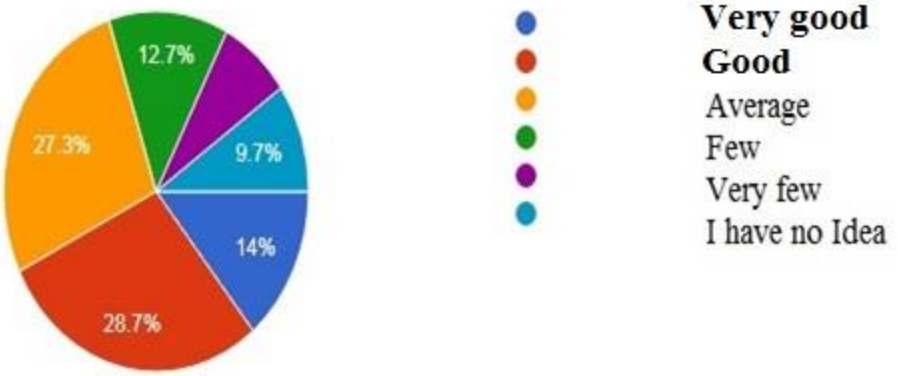

Figure 4.9. Results of Question 7 of Questionnaire Form.

Q8/ What is your disaster awareness level?				
# of Participants		513	# of Feedbacks	513
Answers	Very Interested	162	40.5%	
	Interested	198	33.9%	
	Average	70	13.6%	
	Limit Interested	62	8.4%	
	Not Interested	21	4.1%	

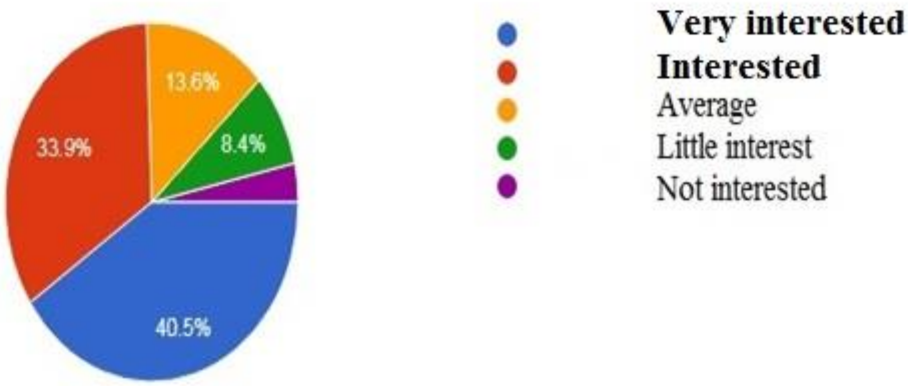

Figure 4.10. Results of Question 8 of Questionnaire Form.

Q9/ What is your knowledge level on Disaster Management?				
# of Participants		513	# of Feedbacks	513
Answers	Very Good	63	12.3%	
	Good	78	15.2%	
	Average	128	25%	
	Few	136	26.5%	
	Very Few	108	21.1%	

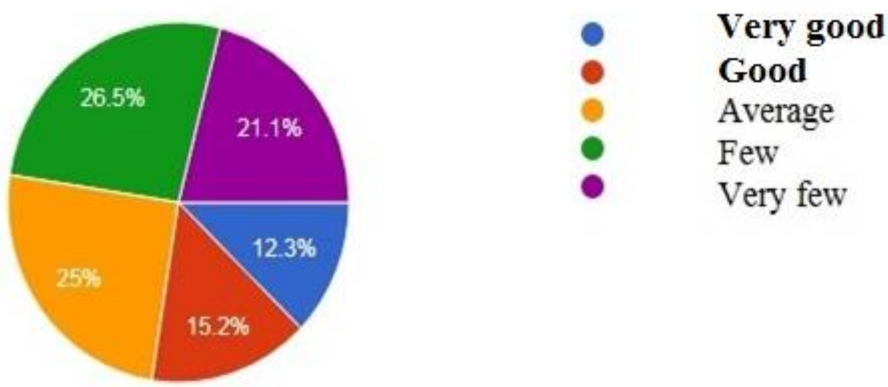

Figure 4.11. Results of Question 9 of Questionnaire Form.

Q10/ Have you ever been affected by any disaster?				
# of Participants		513	# of Feedbacks	513
Answers	Always	29	5.7%	
	Many Times	99	19.3%	
	Sometimes	150	29.2%	
	Once only	65	12.7%	
	Never	138	26.9%	
	I have no idea	32	6.2%	

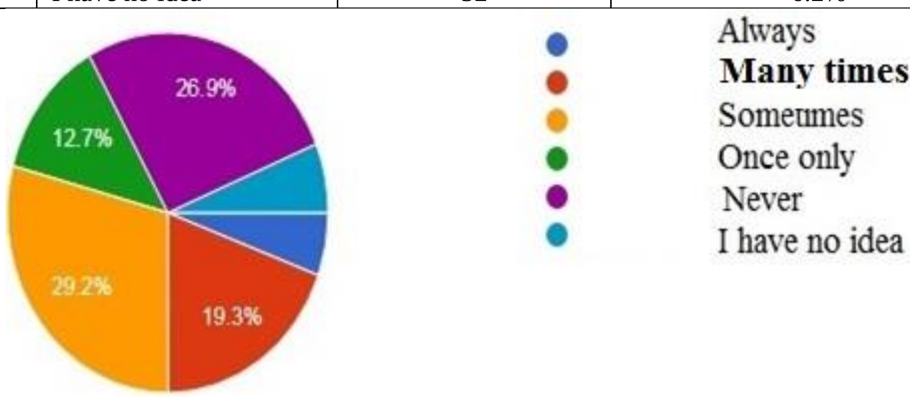

Figure 4.12. Results of Question 10 of Questionnaire Form.

Q11/ Which kind of disaster have you been affected?				
# of Participants		513	# of Feedbacks	513
Answers	Flood	305	59.5%	
	Drought	177	34.5%	
	Earthquakes	25	4.9%	
	Forest Fires	4	0.8%	
	Tornados	2	0.4%	

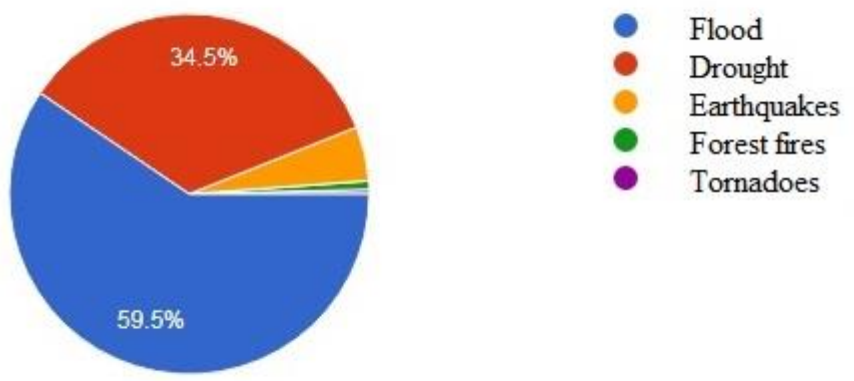

Figure 4.13. Results of Question 11 of Questionnaire Form.

In addition, the results about the demographic questions are as shown in Table 4.10.

Table 4.10. Demographic Information about Participants.

Variable		Number	Percentage
Participants		513	
Gender			
	Male	323	63.5%
	Female	186	36.5%
Age			
	< 20	142	27.7%
	20-30	83	16.2%
	30-40	133	25.9%
	40-50	99	19.3%
	> 50	56	10.9%
Settlement Area			
	Town	339	66.1%
	Village	174	33.9%
Educational Level			
	Primary school or less	36	7%
	Secondary school	178	34.7%
	Bachelor's degree	187	36.5%
	Master's degree	78	15.2%
	Ph.D. degree	34	6.6%

4.1.2. Interviews with Academic Experts

In order to detect the problems faced by Iraqi citizens in their preparedness to deal with natural disasters, as well as to clarify the issues about their readiness to utilize Information and Communication Technology (ICT) and E-government applications to that end, two groups of experts were interviewed.

A. Disaster Group

The first group was the disaster experts. For this purpose, the researcher visited the Iraqi Ministry of Environment which is responsible for disaster and disaster management in the Iraqi government in the capital city of Baghdad and conducted personal meetings with experts in the field of disaster management.

The first meeting was with the Director of Disaster Management, with whom the types of disasters suffered by Iraqi citizens were discussed. In addition to the methods used in the management of disasters, the measures taken during the period of the disaster to minimize the damage were also discussed. The Director of Disaster Management pointed to the lack of citizens' readiness and knowledge insufficiency in dealing with disasters.

A second one with the Director of Projects Development at the Ministry of Environment followed this meeting. His defined methods and techniques used in disaster management, as well as the possibility of using modern scientific methods and harnessing information and communication technologies in the field of disaster management.

B. Information and Communication Technology Group

The second group was ICT and the E-government group. For this, the researcher visited the Iraqi ministries of Communication and Science and Technology in Baghdad because they are responsible for ICT technology E-government projects in Iraq. These meetings were important for defining the Iraqi citizen's problems with ICT and E-government, as well as discussing their readiness toward these technologies.

A meeting was held with the Director of Information Technology at the Ministry of Communications to discuss the reality of information technology, communications infrastructure and Internet service in Iraq.

The Director pointed out that there were deficiencies in the infrastructure of the telecommunications network and there were no landline services in most governorates because of wars, which were affecting the provision of wired Internet services to citizens, especially in rural areas, therefore forcing them to rely on wireless services for access to the Internet. These deficiencies have significantly affected citizens' readiness towards ICTs.

Another meeting was held with one of people responsible for the implementation of the E-government project in Iraq. He said that the failure to implement the E-government project at the required level was due to the focus of those responsible for the project on the technological side and their neglect of administrative changes in government institutions.

In addition, there was resistance to changes by the managers of government institutions because of bribery and corruption. To compound the matters even more, the electronic payment services are not yet available in Iraq and it is not activated in government institutions. Therefore, citizens cannot complete any transaction involving electronic payments through the E-government portal. Another important issue is that, although smartphones and computers are widespread in Iraq, these devices have not been used properly to eradicate electronic illiteracy among citizens.

All these reasons have led to low reliability of the E-government project and the low reediness of Iraqi citizen to utilize its services.

4.2. Experimental Analysis

In order to accept or reject the hypotheses mentioned in Section 3.2, statistical analysis were carried out using the Statistical Package for The Social Sciences (SPSS) from IBM © V.18.0. The statistical procedure involved the following steps:

A. Preparing data of feedbacks

The preparation of feedback data is be the first step towards feedback analysis. In order to obtain meaningful results, the parameters were as follows:

1. Demographic parameters: these are the independent parameters, which are related to the questionnaire's participants. These questions were utilized to clarify each participant's personal information, and the parameters were:

a) Parameters of Q1: this multiple-choice question is used to define the age of the participants, with the range of this 1 for less than 20, to 5, for more than 50 years old.
b) Parameters of Q2: this multiple-choice question was used to define the Gender of the participants, and it had a range of 1 for Males, and 2 for Females.
c) Parameters of Q3: this multiple-choice question was used to define the Settlement Area of the participant, and it had a range of 1 for Town, and 2 for Village settlers.
d) Parameters of Q4: this multiple-choice question was used to define Education Level of the participants, with ranges 1 for Primary school or less, to 5 for holders of PhD degrees.

The Demographic Multiple-Choice questions are shown in Figure 4.14.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	var
1	4.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	3.00	2.00	1.00	
2	4.00	1.00	2.00	3.00	2.00	2.00	2.00	3.00	5.00	3.00	2.00	
3	4.00	1.00	2.00	1.00	1.00	1.00	3.00	4.00	4.00	3.00	1.00	
4	4.00	2.00	2.00	3.00	2.00	2.00	5.00	4.00	4.00	5.00	1.00	
5	5.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	
6	3.00	1.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	1.00	
7	4.00	1.00	2.00	2.00	1.00	4.00	2.00	2.00	3.00	2.00	2.00	
8	3.00	1.00	2.00	3.00	2.00	2.00	2.00	1.00	3.00	3.00	1.00	
9	3.00	1.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	
10	4.00	1.00	2.00	3.00	1.00	2.00	2.00	2.00	2.00	3.00	4.00	
11	3.00	1.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	1.00	
12	4.00	1.00	1.00	3.00	2.00	2.00	3.00	2.00	4.00	3.00	2.00	
13	4.00	1.00	2.00	3.00	1.00	1.00	3.00	2.00	5.00	4.00	1.00	
14	3.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	1.00	
15	4.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	4.00	4.00	1.00	
16	3.00	1.00	2.00	3.00	1.00	2.00	2.00	1.00	3.00	2.00	1.00	
17	3.00	1.00	2.00	3.00	1.00	4.00	3.00	3.00	6.00	5.00	2.00	
18	4.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	3.00	4.00	1.00	
19	5.00	1.00	2.00	2.00	2.00	3.00	2.00	1.00	6.00	3.00	1.00	
20	4.00	1.00	2.00	3.00	1.00	3.00	3.00	2.00	6.00	4.00	1.00	
21	3.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	5.00	2.00	2.00	
22	4.00	1.00	2.00	3.00	1.00	1.00	2.00	1.00	3.00	3.00	2.00	
23	5.00	1.00	2.00	3.00	1.00	2.00	4.00	3.00	4.00	3.00	2.00	

Figure 4. 14. Parameters of Multiple-Choice Demographic Questions.

2. ICT Readiness: these are dependent parameters related to citizens' readiness toward ICT. These were generated from feedback data section on citizens' readiness towards ICT and were used for acceptance or rejection of ICT related hypotheses. These hypotheses were coded as $H1_J$ Where J = 1,2. ICT readiness questions parameters are as follows:

a) Parameters of Q5: this multiple-choice question is used to define the level knowledge of the participant about Information and Communication Technology (ICT), and its range starts from 1, which stands for Very Good, to 5, which stands for Very Little.
b) Parameters of Q6: this multiple-choice question is used to define the level of knowledge of the participant on E-government applications, with range starting from 1 for Very Good, to 5 = Very Little.

ICT readiness Multiple-Choice questions are shown in Figure 4.15.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	var
1	4.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	3.00	2.00	1.00	
2	4.00	1.00	2.00	3.00	2.00	2.00	2.00	3.00	5.00	3.00	2.00	
3	4.00	1.00	2.00	1.00	1.00	1.00	3.00	4.00	4.00	3.00	1.00	
4	4.00	2.00	2.00	3.00	2.00	2.00	5.00	4.00	4.00	5.00	1.00	
5	5.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	
6	3.00	1.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	1.00	
7	4.00	1.00	2.00	2.00	1.00	4.00	2.00	2.00	3.00	2.00	2.00	
8	3.00	1.00	2.00	3.00	2.00	2.00	2.00	1.00	3.00	3.00	1.00	
9	3.00	1.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	
10	4.00	1.00	2.00	3.00	1.00	2.00	2.00	2.00	2.00	3.00	4.00	
11	3.00	1.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	1.00	
12	4.00	1.00	1.00	3.00	2.00	2.00	3.00	2.00	4.00	3.00	2.00	
13	4.00	1.00	2.00	3.00	1.00	1.00	3.00	2.00	5.00	4.00	1.00	
14	3.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	1.00	
15	4.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	4.00	4.00	1.00	
16	3.00	1.00	2.00	3.00	1.00	2.00	2.00	1.00	3.00	2.00	1.00	
17	3.00	1.00	2.00	3.00	1.00	4.00	3.00	3.00	6.00	5.00	2.00	
18	4.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	3.00	4.00	1.00	
19	5.00	1.00	2.00	2.00	2.00	3.00	2.00	1.00	6.00	3.00	1.00	
20	4.00	1.00	2.00	3.00	1.00	3.00	3.00	2.00	6.00	4.00	1.00	
21	3.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	5.00	2.00	2.00	
22	4.00	1.00	2.00	3.00	1.00	1.00	2.00	1.00	3.00	3.00	2.00	
23	5.00	1.00	2.00	3.00	1.00	2.00	4.00	3.00	4.00	3.00	2.00	

Figure 4.15. Parameters of Multiple-Choice ICT Questions.

3. Disaster Readiness: This also depends on parameters related to citizen readiness toward disasters. These parameters were generated from feedback data on citizens' readiness towards disasters, and are used for acceptance or rejection of disaster-related hypotheses. These hypotheses are coded as $H2_K$, Where K= 3,4,5. E-government readiness questions parameters are as follows:

a) Parameters of Q7: this multiple-choice question is used to define the level of knowledge of the participant about disasters, with range starting from 1 for Very good, to 6 for having no idea.
b) Parameters of Q8: this multiple-choice question is used to define the level of the participant's awareness towards disasters, with range starting from 1 for Very interested, to 5, for Not interested.
c) Parameters of Q9: this multiple-choice question is used to define the level of knowledge of participants about disaster management, with range starting from 1 for Very good, to 5 for Very little.
d) Parameters of Q10: this multiple-choice question is used to check if the citizen has been affected by any disaster before, with range starting from 1 for "Always", to 6 for "I have never been affected".
e) Parameters of Q11: this multiple-choice question is used to define the types of disasters that have affected the Iraqi citizens, with range from 1 for Floods, to 5 for Tornadoes.

Disaster readiness Multiple-Choice questions are shown in Figure 4.16.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	var
1	4.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00	3.00	2.00	1.00	
2	4.00	1.00	2.00	3.00	2.00	2.00	2.00	3.00	5.00	3.00	2.00	
3	4.00	1.00	2.00	1.00	1.00	1.00	3.00	4.00	4.00	3.00	1.00	
4	4.00	2.00	2.00	3.00	2.00	2.00	5.00	4.00	4.00	5.00	1.00	
5	5.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	
6	3.00	1.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	1.00	
7	4.00	1.00	2.00	2.00	1.00	4.00	2.00	2.00	3.00	2.00	2.00	
8	3.00	1.00	2.00	3.00	2.00	2.00	2.00	1.00	3.00	3.00	1.00	
9	3.00	1.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	
10	4.00	1.00	2.00	3.00	1.00	2.00	2.00	2.00	2.00	3.00	4.00	
11	3.00	1.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	1.00	
12	4.00	1.00	1.00	3.00	2.00	2.00	3.00	2.00	4.00	3.00	2.00	
13	4.00	1.00	2.00	3.00	1.00	1.00	3.00	2.00	5.00	4.00	1.00	
14	3.00	1.00	2.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	1.00	
15	4.00	1.00	2.00	2.00	3.00	3.00	3.00	2.00	4.00	4.00	1.00	
16	3.00	1.00	2.00	3.00	1.00	2.00	2.00	1.00	3.00	2.00	1.00	
17	3.00	1.00	2.00	3.00	1.00	4.00	3.00	3.00	6.00	5.00	2.00	
18	4.00	2.00	2.00	3.00	1.00	1.00	3.00	1.00	3.00	4.00	1.00	
19	5.00	1.00	2.00	2.00	2.00	3.00	2.00	1.00	6.00	3.00	1.00	
20	4.00	1.00	2.00	3.00	1.00	3.00	3.00	2.00	6.00	4.00	1.00	
21	3.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	5.00	2.00	2.00	
22	4.00	1.00	2.00	3.00	1.00	1.00	2.00	1.00	3.00	3.00	2.00	
23	5.00	1.00	2.00	3.00	1.00	2.00	4.00	3.00	4.00	3.00	2.00	

Figure 4.16. Parameters of Multiple-Choice Disaster Questions.

B. Results of statistical analysis

After coding the results obtained from the Questionnaire according to the parameter mentioned above, SPSS statistical software was used to analyze these data. A Linear Regression function was used to test the correlations between questions in the questionnaire form. The steps followed were as shown on Figures 4.17-4.18.

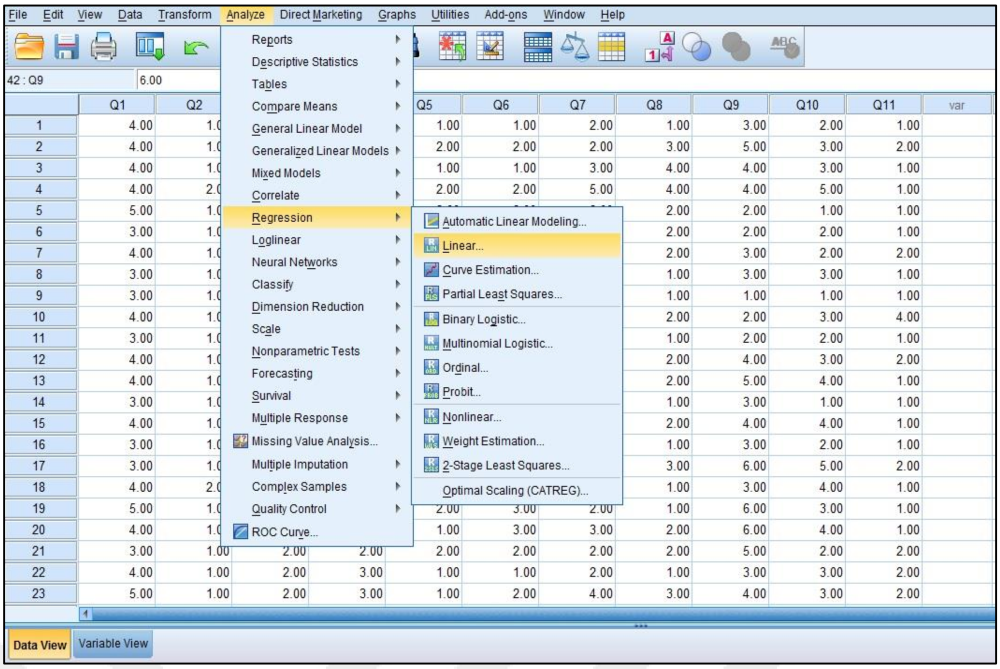

Figure 4.17. Applying Linear Regression Function.

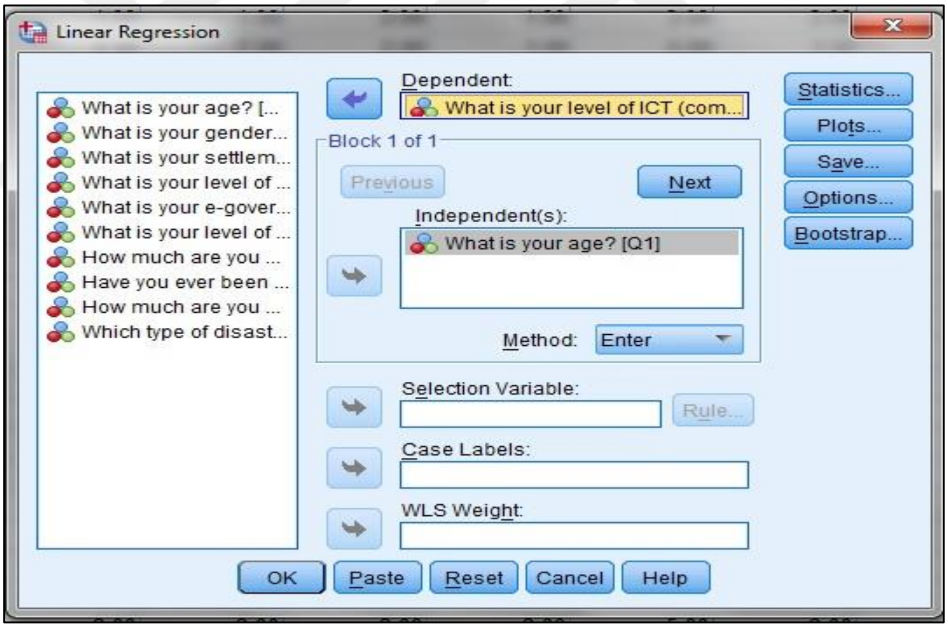

Figure 4.18. Execution of Linear Regression Function.

The results of the Linear Regression function between age as an independent parameter and ICT level as a dependent parameter shows that there is a positive correlation between these parameters and the age affects ICT level with 14.5%, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.11 below.

Table 4.11. Correlation between Q1 and Q5.

		What is your level of ICT experience?	What is your age?
Pearson Correlation	What is your level of ICT experience?	1.000	.145
	What is your age?	.145	1.000
Sig. (1-tailed)	What is your level of ICT experience?	.	.000
	What is your age?	.000	.
N	What is your level of ICT experience?	513	513
	What is your age?	513	513

Figure 4.19 below shows the Normal P Plot of regression between Q1 and Q5. The Figure shows that the dependent parameter has normal distribution.

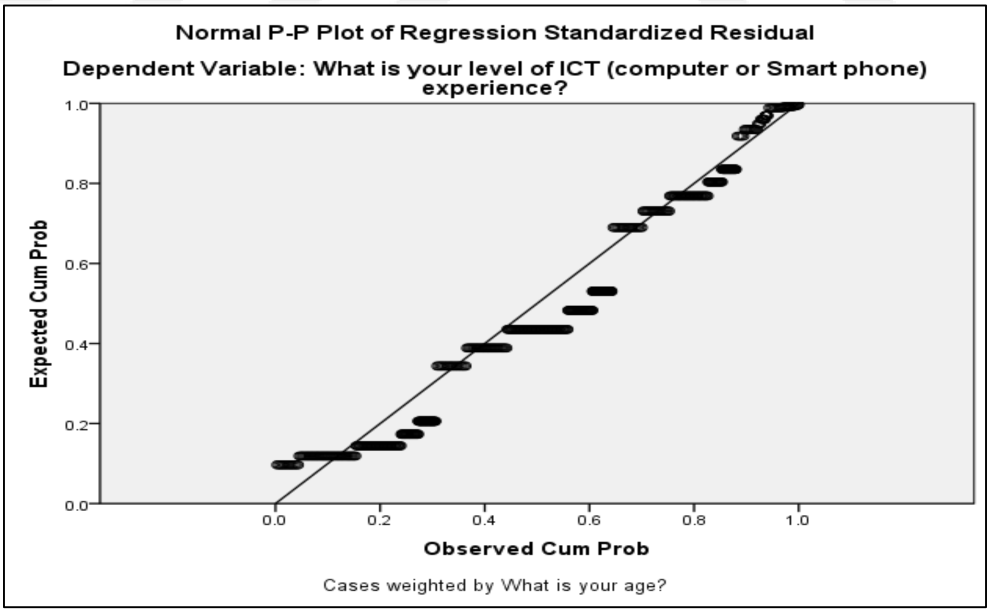

Figure 4.19. Normal P Plot of regression between Q1 and Q5.

The results of the Linear Regression function between gender as an independent parameter and ICT level as a dependent parameter shows that there is a positive correlation between these parameters, and the gender affects ICT level with 8.8 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.12.

Table 4.12. Correlation between Q2 and Q5.

		What is your level of ICT experience?	What is your Gender?
Pearson Correlation	What is your level of ICT experience?	1.000	.088
	What is your Gender?	.088	1.000
Sig. (1-tailed)	What is your level of ICT experience?	.	.010
	What is your Gender?	.010	.
N	What is your level of ICT experience?	513	513
	What is your Gender?	513	513

Figure 4.20 shows the Normal P Plot of regression between Q2 and Q5. The Figure shows that the dependent parameter has normal distribution.

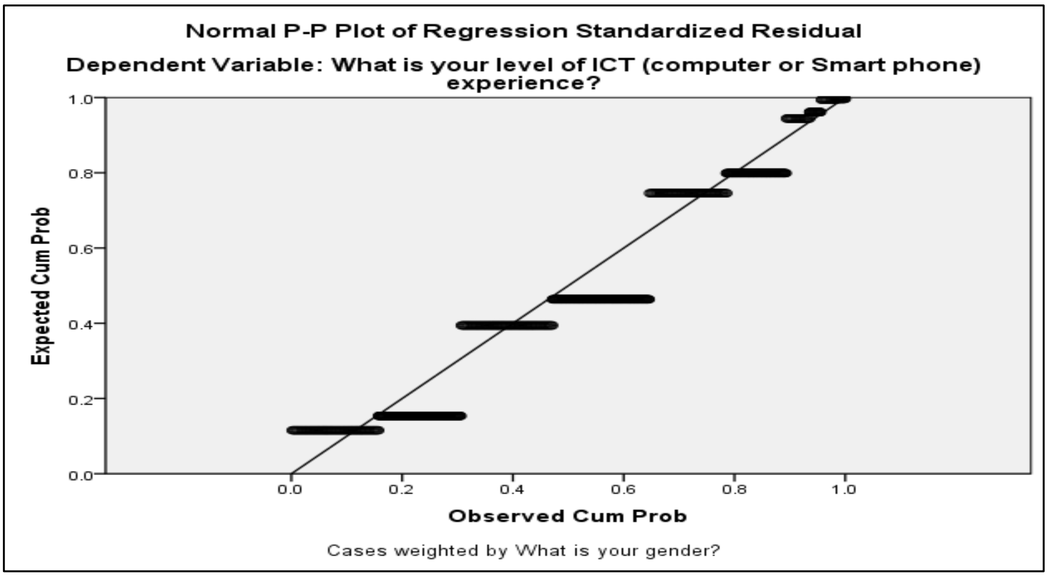

Figure 4.20. Normal P Plot of regression between Q2 and Q5.

The results of the Linear Regression function between education level as an independent parameter and ICT level as a dependent parameter shows that there is a positive correlation between these parameters, and the educational level affects ICT level with 40.4 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.13.

Table 4.13. Correlation between Q4 and Q5.

		What is your level of ICT experience?	What is your Educational Level?
Pearson Correlation	What is your level of ICT experience?	1.000	.404
	What is your Educational Level?	.404	1.000
Sig. (1-tailed)	What is your level of ICT experience?	.	.000
	What is your Educational Level?	.000	.
N	What is your level of ICT experience?	513	513
	What is your Educational Level?	513	513

Figure 4.21 shows the Normal P Plot of regression between Q4 and Q5. The Figure shows that the dependent parameter has normal distribution.

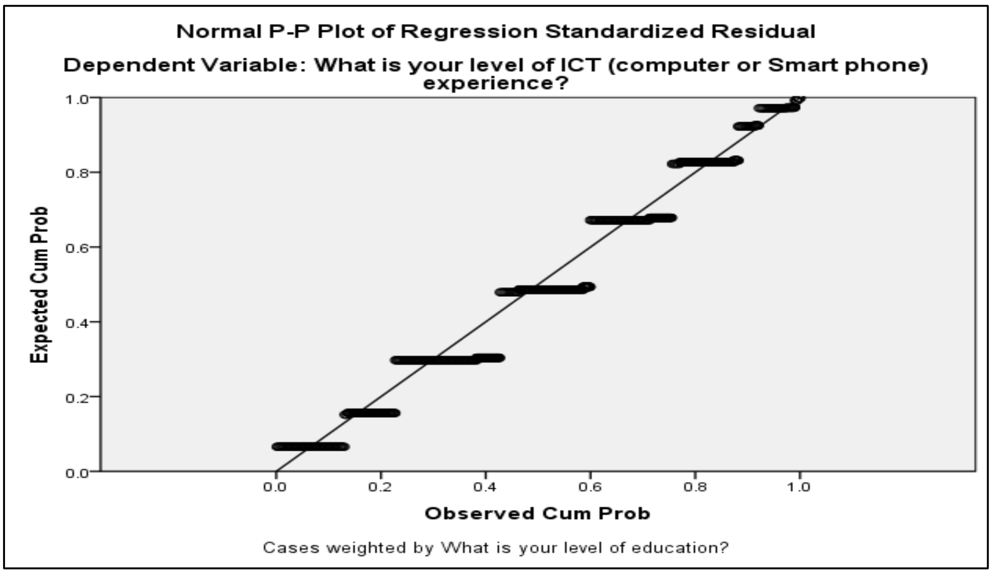

Figure 4.21. Normal P Plot of regression between Q4 and Q5.

The results of the Linear Regression function between age as an independent parameter and E-government experience as a dependent parameter shows that there is a negative correlation between these parameters, and the age affects E-government experience with 7.4 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.14.

Table 4.14. Correlation between Q1 and Q6.

		What is your level of E-government experience?	What is your Age?
Pearson Correlation	What is your level of E-government experience?	1.000	-.074
	What is your Age?	-.074	1.000
Sig. (1-tailed)	What is your level of E-government experience?	.	.003
	What is your Age?	.003	.
N	What is your level of E-government experience?	513	513
	What is your Age?	513	513

Figure 4.22 shows the Normal P Plot of regression between Q1 and Q6. The Figure shows that the dependent parameter has normal distribution.

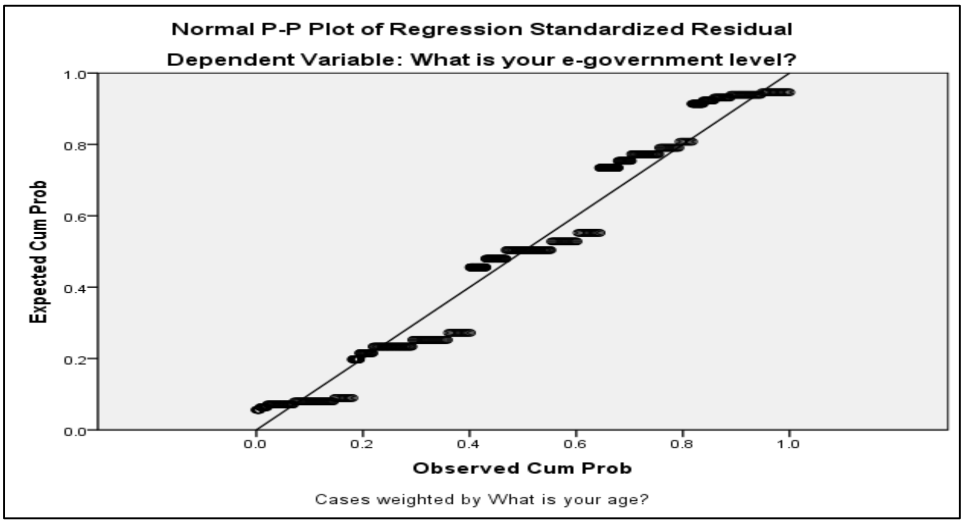

Figure 4.22. Normal P Plot of regression between Q1 and Q6.

The results of the Linear Regression function between the gender as an independent parameter and E-government experience as a dependent parameter shows that there is a positive correlation between these parameters, and the gender affects E-government experience with 12.3 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.15.

Table 4.15. Correlation between Q2 and Q6.

		What is your level of E-government experience?	What is your Gender?
Pearson Correlation	What is your level of E-government experience?	1.000	.123
	What is your Gender?	.123	1.000
Sig. (1-tailed)	What is your level of E-government experience?	.	.001
	What is your Gender?	.001	.
N	What is your level of E-government experience?	513	513
	What is your Gender?	513	513

Figure 4.23 shows the Normal P Plot of regression between Q2 and Q6. The Figure shows that the dependent parameter has normal distribution.

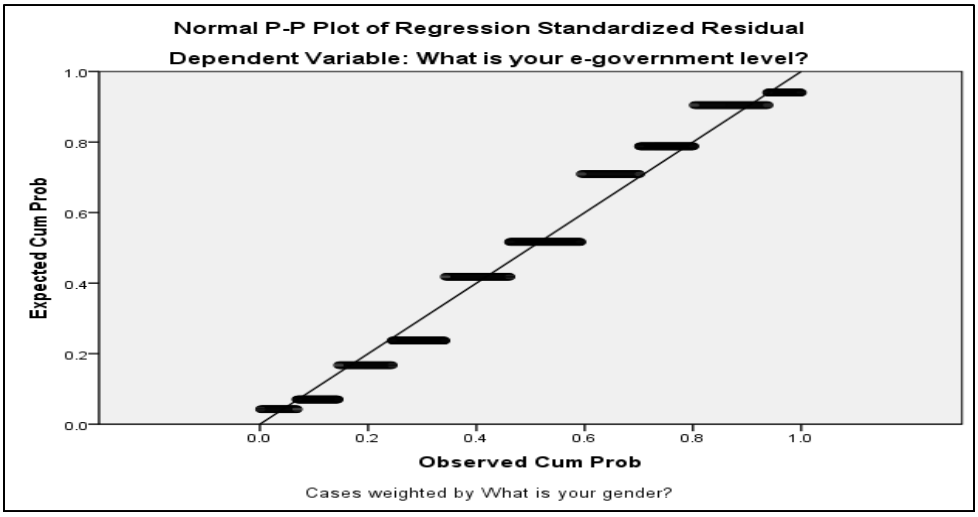

Figure 4.23. Normal P Plot of regression between Q2 and Q6.

The results of the Linear Regression function between educational level as an independent parameter and E-government experience as a dependent parameter shows that there is a positive correlation between these parameters, and the educational level affects E-government experience with 50.1 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.16.

Table 4.16. Correlation between Q4 and Q6.

		What is your level of E-government experience?	What is your Educational Level?
Pearson Correlation	What is your level of E-government experience?	1.000	.501
	What is your Educational Level?	.501	1.000
Sig. (1-tailed)	What is your level of E-government experience?	.	.000
	What is your Educational Level?	.000	.
N	What is your level of E-government experience?	513	513
	What is your Educational Level?	513	513

Figure 4.24 shows the Normal P Plot of regression between Q4 and Q6. The Figure shows that the dependent parameter has normal distribution.

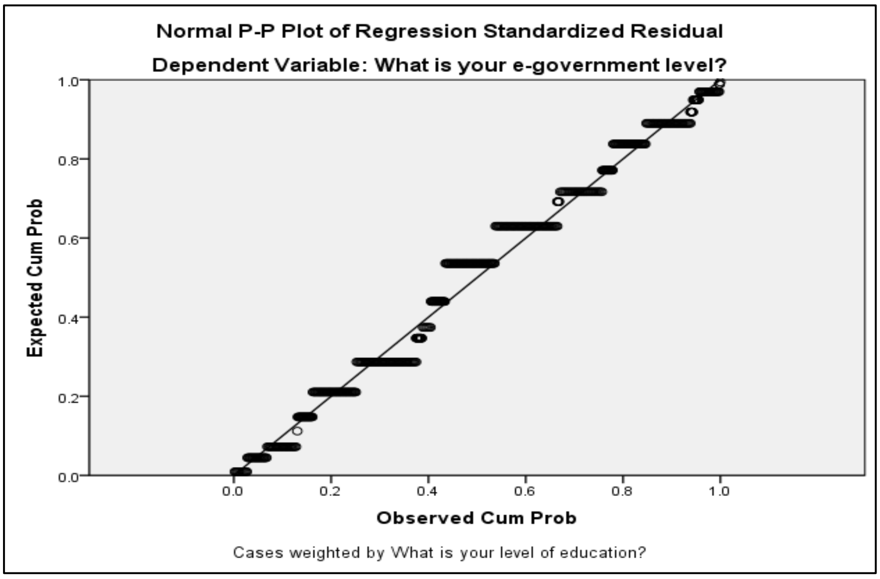

Figure 4.24. Normal P Plot of regression between Q4 and Q6.

The results of the Linear Regression function between age as an independent parameter and disaster knowledge as a dependent parameter shows that there is a negative correlation between these parameters, and the age affects disaster knowledge with 11.6 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.17.

Table 4.17. Correlation between Q1 and Q7.

		What is your level of disaster knowledge?	What is your Age?
Pearson Correlation	What is your level of disaster knowledge?	1.000	-.116
	What is your Age?	-.116	1.000
Sig. (1-tailed)	What is your level of disaster knowledge?	.	.000
	What is your Age?	.000	.
N	What is your level of disaster knowledge?	513	513
	What is your Age?	513	513

Figure 4.25 shows the Normal P Plot of regression between Q1 and Q7. The Figure shows that the dependent parameter has normal distribution.

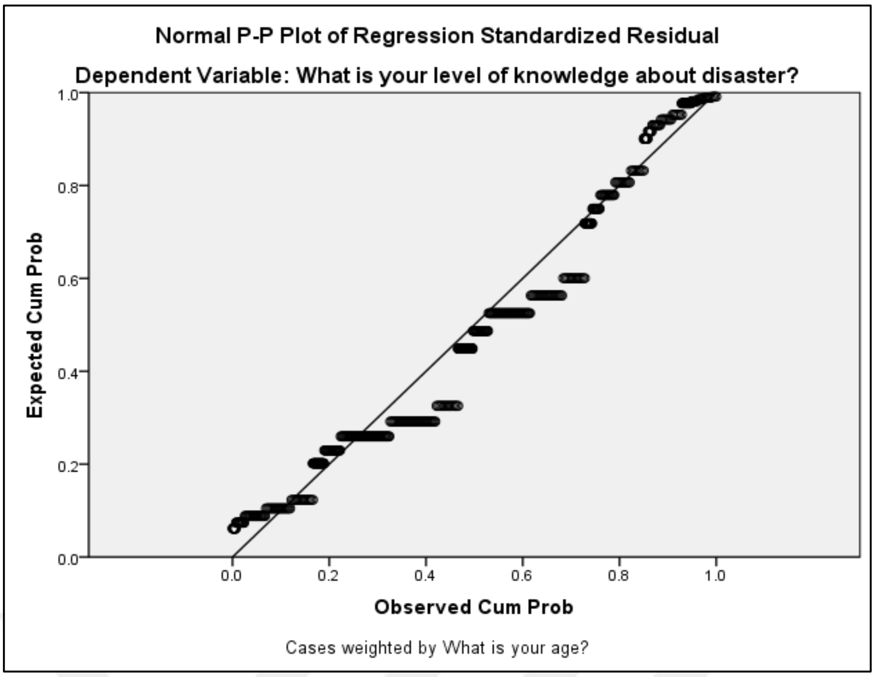

Figure 4.25. Normal P Plot of regression between Q1 and Q7.

The results of the Linear Regression function between gender as an independent parameter and disaster knowledge as a dependent parameter shows that there is a positive correlation between these parameters, and the gender affects disaster knowledge with 9.9 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.18.

Table 4.18. Correlation between Q2 and Q7.

		What is your level of disaster knowledge?	What is your Gender?
Pearson Correlation	What is your level of disaster knowledge?	1.000	.099
	What is your Gender?	.099	1.000
Sig. (1-tailed)	What is your level of disaster knowledge?	.	.004
	What is your Gender?	.004	.
N	What is your level of disaster knowledge?	513	513
	What is your Gender?	513	513

Figure 4.26 shows the Normal P Plot of regression between Q2 and Q7. The Figure shows that the dependent parameter has normal distribution.

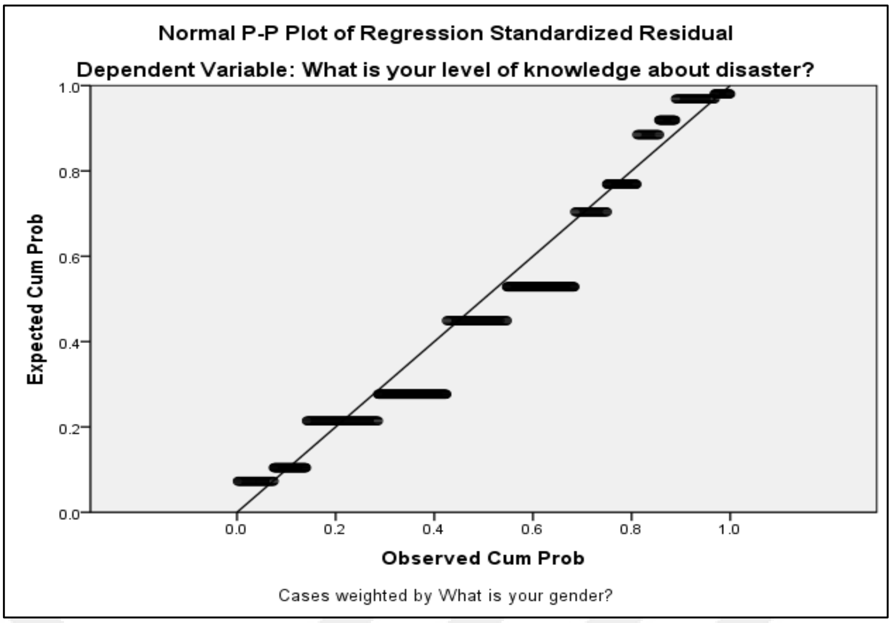

Figure 4.26. Normal P Plot of regression between Q2 and Q7.

The results of the Linear Regression function between educational level as an independent parameter and disaster knowledge as a dependent parameter shows that there is a positive correlation between these parameters, and the educational level affects disaster knowledge with 47.7 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.19.

Table 4.19. Correlation between Q4 and Q7.

		What is your level of disaster knowledge?	What is your Educational Level?
Pearson Correlation	What is your level of disaster knowledge?	1.000	.477
	What is your Educational Level?	.477	1.000
Sig. (1-tailed)	What is your level of disaster knowledge?	.	.000
	What is your Educational Level?	.000	.
N	What is your level of disaster knowledge?	513	513
	What is your Educational Level?	513	513

Figure 4.27 shows the Normal P Plot of regression between Q4 and Q7. The Figure shows that the dependent parameter has normal distribution.

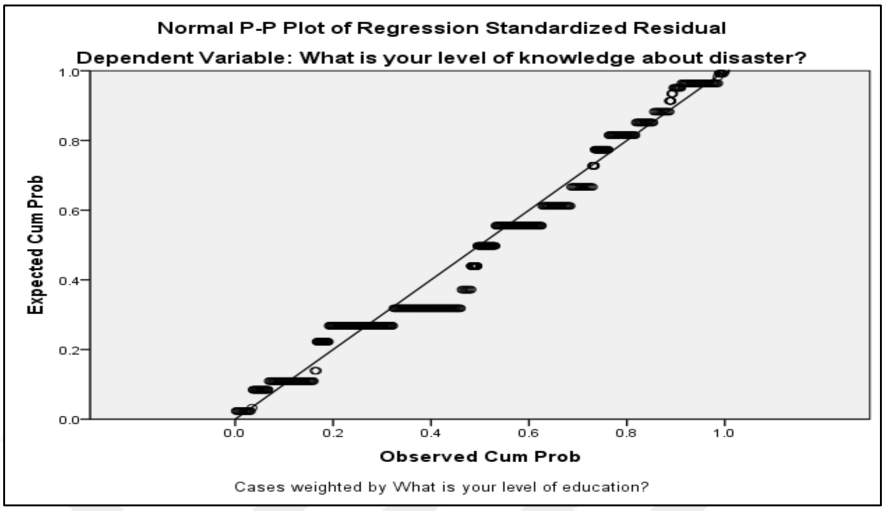

Figure 4.27. Normal P Plot of regression between Q4 and Q7.

The results of the Linear Regression function between age as an independent parameter and disaster awareness as a dependent parameter shows that there is a negative correlation between these parameters, and the age affects disaster awareness with 13 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.20.

Table 4.20. Correlation between Q1 and Q8.

		What is your level towards disaster awareness?	What is your Age?
Pearson Correlation	What is your level towards disaster awareness?	1.000	-.130
	What is your Age?	-.130	1.000
Sig. (1-tailed)	What is your level towards disaster awareness?	.	.000
	What is your Age?	.000	.
N	What is your level towards disaster awareness?	513	513
	What is your Age?	513	513

Figure 4.28 shows the Normal P Plot of regression between Q1 and Q8. The Figure shows that the dependent parameter has normal distribution.

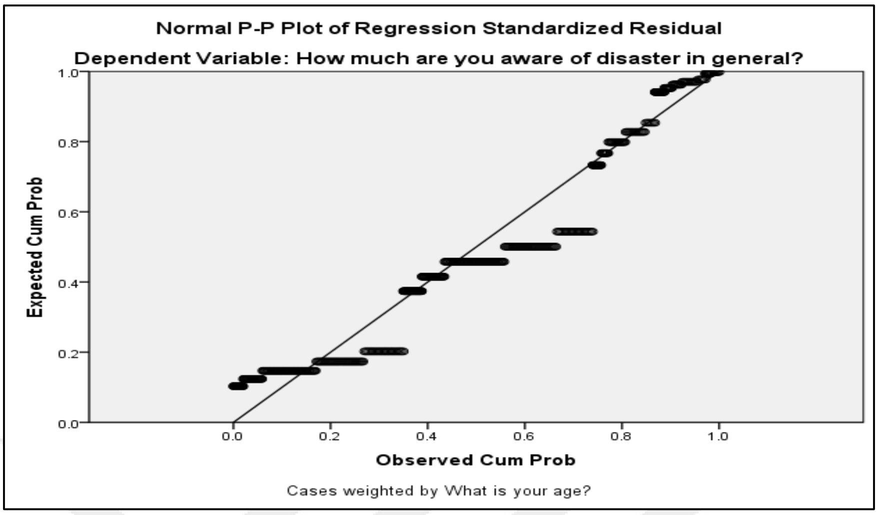

Figure 4.28. Normal P Plot of regression between Q1 and Q8.

The results of the Linear Regression function between gender as an independent parameter and disaster awareness as a dependent parameter shows that there is a positive correlation between these parameters, and the gender affects disaster awareness with 9.3 %. However, this percentage has no statistical meaning because its significant value is more than 0.05. The results are shown in Table 4.21.

Table 4.21. Correlation between Q2 and Q8.

		What is your level towards disaster awareness?	What is your Gender?
Pearson Correlation	What is your level towards disaster awareness?	1.000	.093
	What is your Gender?	.093	1.000
Sig. (1-tailed)	What is your level towards disaster awareness?	.	.007
	What is your Gender?	.007	.
N	What is your level towards disaster awareness?	513	513
	What is your Gender?	513	513

Figure 4.29 shows the Normal P Plot of regression between Q2 and Q8. The Figure shows that the dependent parameter has normal distribution.

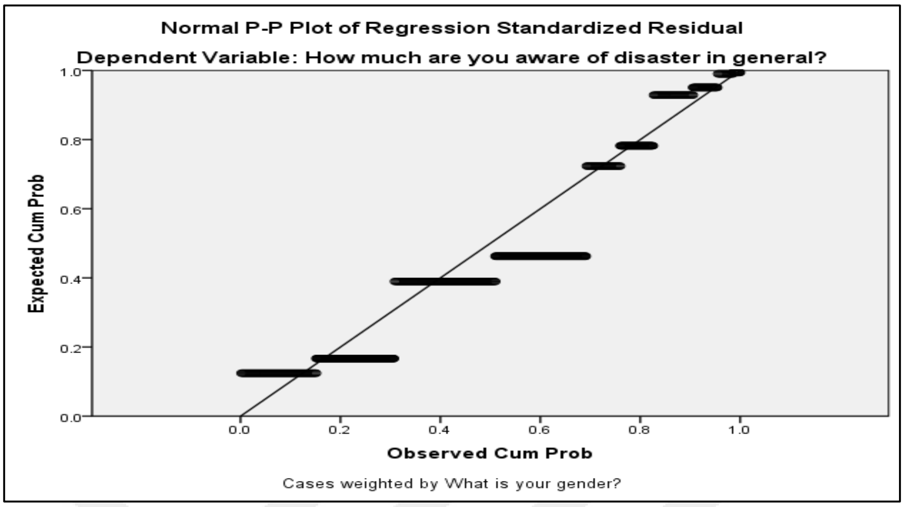

Figure 4.29. Normal P Plot of regression between Q2 and Q8.

The results of the Linear Regression function between educational level as an independent parameter and disaster awareness as a dependent parameter shows that there is a positive correlation between these parameters, and the educational level affects disaster awareness with 41.3 %, this percentage has a statistical meaning because its significant value is less than 0.05. The results are shown in Table 4.22.

Table 4.22. Correlation between Q4 and Q8.

		What is your level towards disaster awareness?	What is your Educational Level?
Pearson Correlation	What is your level towards disaster awareness?	1.000	.413
	What is your Educational Level?	.413	1.000
Sig. (1-tailed)	What is your level towards disaster awareness?	.	.000
	What is your Educational Level?	.000	.
N	What is your level towards disaster awareness?	513	513
	What is your Educational Level?	513	513

Figure 4.30 shows the Normal P Plot of regression between Q4 and Q8. The Figure shows that the dependent parameter has normal distribution.

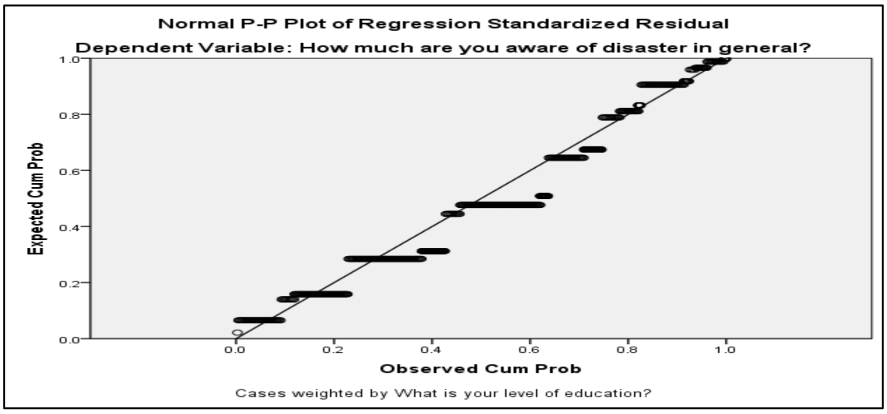

Figure 4.30. Normal P Plot of regression between Q4 and Q8.

The results of the Linear Regression function between age as an independent parameter and disaster effect as a dependent parameter shows that there is a positive correlation between these parameters, and the age affects disaster effect with 3.3 %. However, this percentage has no statistical meaning because its significant value is more than 0.05. The results are shown in Table 4.23.

Table 4.23. Correlation between Q1 and Q10.

		Have you affected by disaster before?	What is your Age?
Pearson Correlation	Have you affected by disaster before?	1.000	.033
	What is your Age?	.033	1.000
Sig. (1-tailed)	Have you affected by disaster before?	.	.109
	What is your Age?	.109	.
N	Have you affected by disaster before?	513	513
	What is your Age?	513	513

Figure 4.31 shows the Normal P Plot of regression between Q1 and Q10. The Figure shows that the dependent parameter has normal distribution.

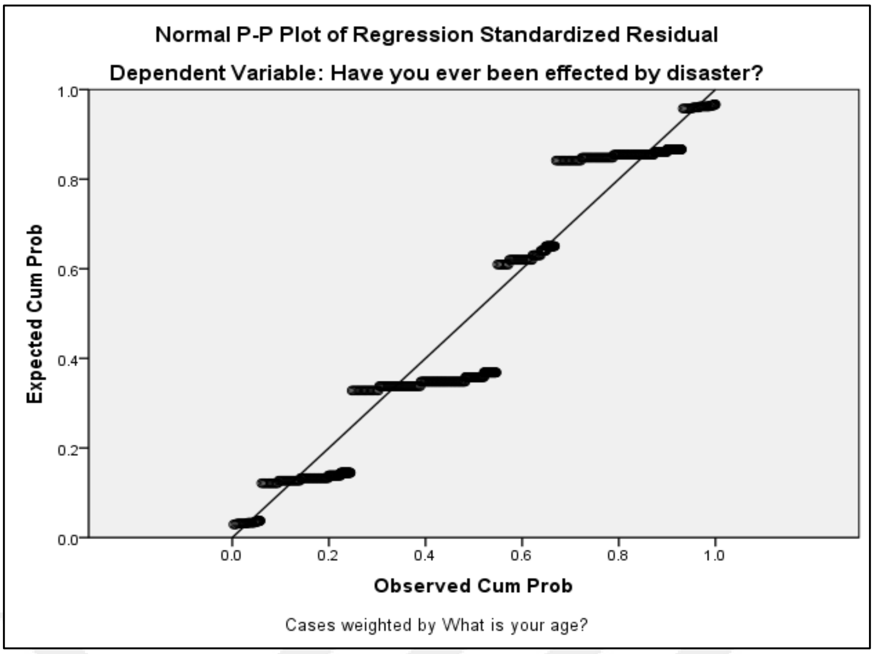

Figure 4.31. Normal P Plot of regression between Q1 and Q10.

The results of the Linear Regression function between gender as an independent parameter and disaster effect as a dependent parameter shows that there is a positive correlation between these parameters, and the gender affects disaster effect with 1.7 %. However, this percentage has no statistical meaning because its significant value is more than 0.05. The results are shown in Table 4.24.

Table 4.24. Correlation between Q2 and Q10.

		Have you affected by disaster before?	What is your Gender?
Pearson Correlation	Have you affected by disaster before?	1.000	.017
	What is your Gender?	.017	1.000
Sig. (1-tailed)	Have you affected by disaster before?	.	.323
	What is your Gender?	.323	.
N	Have you affected by disaster before?	513	513
	What is your Gender?	513	513

Figure 4.32 shows the Normal P Plot of regression between Q2 and Q10. The Figure shows that the dependent parameter has normal distribution.

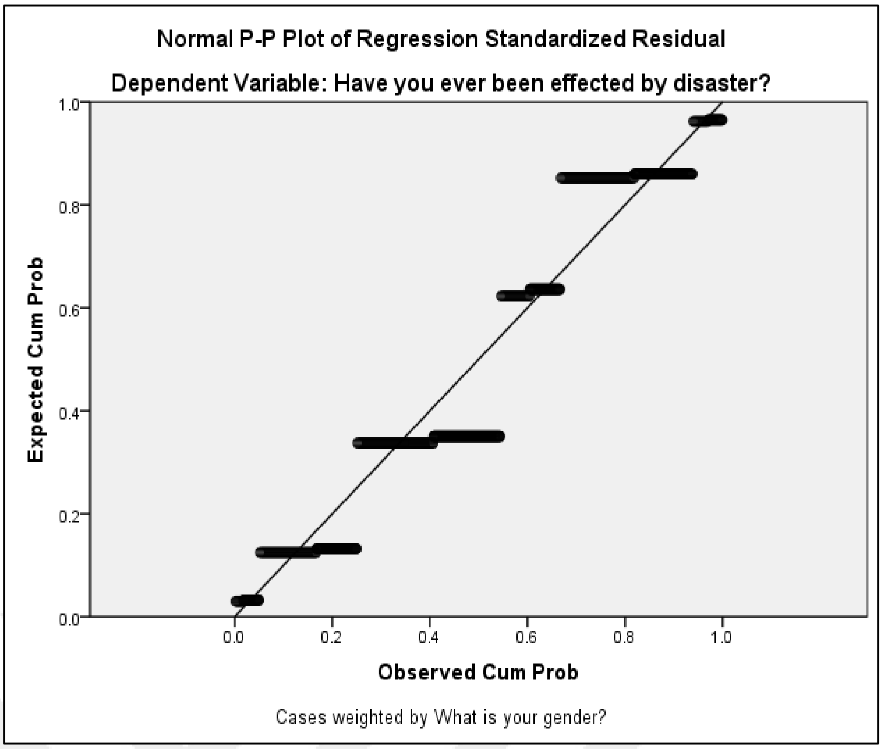

Figure 4.32. Normal P Plot of regression between Q2 and Q10.

The results of the Linear Regression function between educational level as an independent parameter and disaster effect as a dependent parameter shows that there is a negative correlation between these parameters, and the educational level affects disaster effect with 1.3 %. However, this percentage has no statistical meaning because its significant value is more than 0.05. The results are shown in Table 4.25.

Table 4.25. Correlation between Q4 and Q10.

		Have you affected by disaster before?	What is your Educational Level?
Pearson Correlation	Have you affected by disaster before?	1.000	-.013
	What is your Educational Level?	-.013	1.000
Sig. (1-tailed)	Have you affected by disaster before?	.	.302
	What is your Educational Level?	.302	.
N	Have you affected by disaster before?	513	513
	What is your Educational Level?	513	513

Figure 4.33 shows the Normal P Plot of regression between Q4 and Q10. The Figure shows that the dependent parameter has normal distribution.

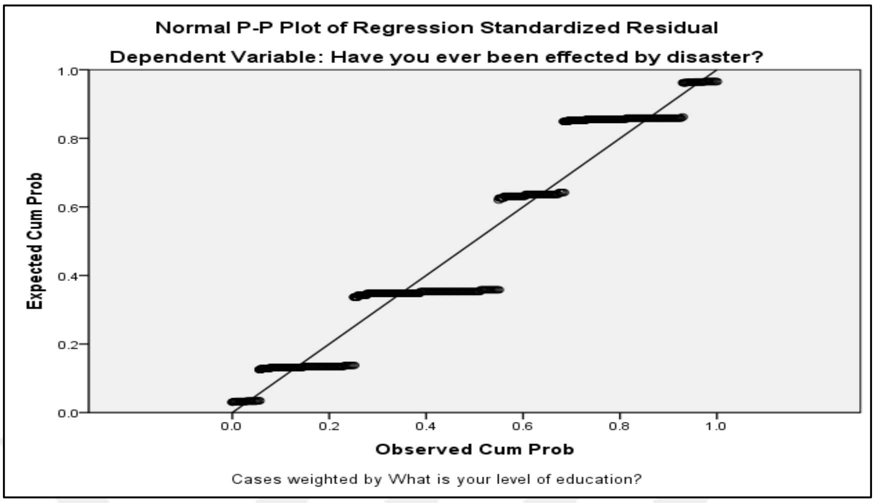

Figure 4.33. Normal P Plot of regression between Q4 and Q10.

4.3. Conclusion

Our statistical analysis show that that demographic factors can affect the readiness of citizens towards ICT and Disasters. Therefore, it can be concluded that the enhanced Smart Disaster Management System (SDMS) has good contribution by enhancing the readiness of citizens towards ICT and Disasters. As a result, the proposed system is compatible with the aims of this research.

In order to ensure the correct implementation of the proposed SDMS, a plan was prepared and a conceptual design will be put forth, with its components described in detail and visualized by using UML diagrams in Chapter 5.

The proposed system is aimed at enhancing the DMS by utilizing the cutting-edge ICT, especially components of the Internet of things (IoT), and provide a proactive service for citizens as one of E-government services.

From what has been presented in Chapters 3 and 4, it can be concluded that improving the DMS will significantly contribute to raising the readiness of citizens against cases of natural disasters. In addition, the use of the improved system will ensure the proper usage of ICT by the citizens, and increase their appetite for E-government applications, thus increasing their trust on the project. Using the proposed mechanism, we expect to solve two independent problems at once.

CHAPTER 5

CONCEPTUAL DESIGN OF SMART DISASTER MANAGEMENT SYSTEM (SDMS)

Based on the statistical results shown in Chapter 4, an enhanced DMS called Smart Disaster Management System (SDMS) is proposed to increase the readiness of citizens towards disasters as well as making them more familiar with ICT.

The aim of this Chapter is to describe and explain the conceptual design of the proposed system by visualizing all the system's components and activities, describing the positions of each person within it, the relationship among the disaster management team members and that between the later and the affected victims. This description will provide a clear roadmap to developers and facilitate the implementation of the SDMS, one of the main objectives of this thesis.

5.1. SDMS Stages

As mentioned in Section 2.1.4, the response of the DMS is on three stages, Before Disaster, During Disaster, and After Disaster. These stages are the same in all kinds of disasters; therefore, a scenario will be prepared for each stage to explain the activities and responsibilities of each person within the system. After that, a part of the scenario will be allocated to each type of disaster to clarify the roles of the disaster teams for each case. The smartness of this system is achieved by adding ICT to each stage in order to reduce the percentages of error during the process in addition to saving time, effort and money. The system stages explained as follows:

5.1.1. Before Disaster Stage

This stage is the pre-disaster stage and includes all the physical and psychological preparations needed in case a disaster strikes the scenario of this stage is as follows:

a. Objectives

1. Installing deferent types of Wireless Sensor Networks (WSN) in order to detect different types of disasters. These WSNs should be connected to a data center that has already been equipped with Artificial Intelligence (AI) software with decision-making ability. This system will be used as an early warning system when anything abnormal happens.
2. Training citizens on first aid, rescuing the injured and evacuation methods in order to benefit from those skills in case of disaster.
3. Equip and train the emergency response teams and keep them on standby for disaster risk.
4. Identify areas for evacuating the citizens and prepare plans for the process. Additionally, prepare emergency shelters and identify roads leading to them, stockpile food, medicines, and equipment that must be available for any emergent scenario.
5. Predict the number of casualties for each type of disaster based on historical data and provide the requirements for their treatment.
6. Prepare a database containing the medical history of each person to identify people with chronic diseases. In addition, identify people with special needs, the elderly and the disabled, and locate their places of residence to facilitate their rescue in the event of disasters.

b. Activity Diagram

The main activities to be done before the disaster stage is shown in Figure 5.1, which includes the requirements, participants and detailed activities of this stage.

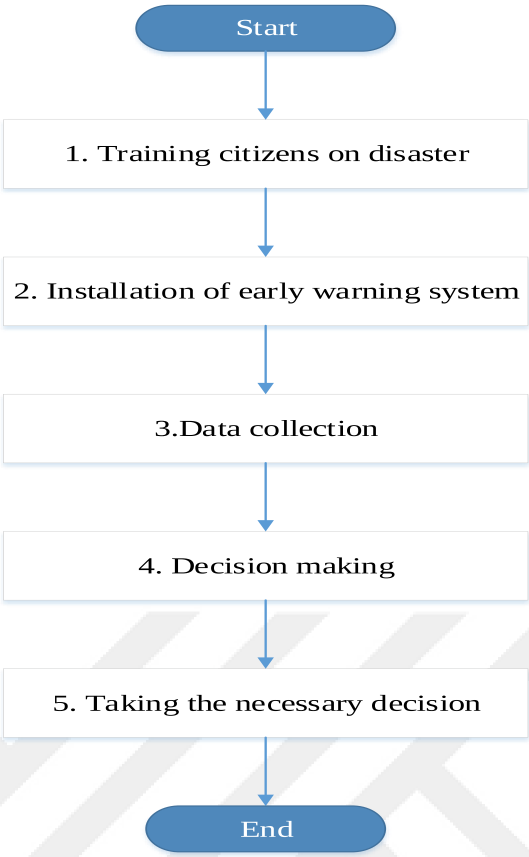

Figure 5.1. Main activities of before disaster stage.

c. Requirements

1. PCs, sensors, networks, data centers, DB, and Internet service.
2. Smart devices containing GPS software.
3. The alarming system connected to AI software.
4. The training center containing all training requirements to train citizens and disaster teams.
5. Food, medicines, and equipment to be used during and after the disaster.

d. People

1. Disaster Management Team

- Team Leader: This person is responsible for declaring a state of emergency in the event of a disaster and has the authority to issue instructions to the disaster management and support teams as well as volunteers. This person is also responsible for the management of disaster from the moment of its occurrence until the last stage. Therefore, this person must have administrative authority, such as being a governor or the city mayor.

- Team members: As members of the Disaster Management Team, they are experienced in dealing with all types of disasters and have sufficient skills to train volunteers and control any emergency during a disaster. Members of the team must always be on a state of readiness for disasters.

2. Supporting

They are non-permanent members of the disaster management team, but when a disaster occurs, they are on alert to help the disaster management team. In addition, they must be skilled in dealing with emergencies. These are:

- Police officers: Police officers have an important role in the event of disasters, as they have experience in first aid and various other ways to deal with emergencies. In addition, they can protect important facilities from tampering and theft.
- Firefighters: The main role of firefighters is to put out the fires caused by the disaster; they are also essential in rescuing people trapped in the rubble because of the collapse of buildings. They also have experience in first aid.
- Paramedics: The primary duty of paramedics is to provide first aid to injured people and transfer serious cases to the hospital in the event of disasters.
- Transporters: Transporters evacuate people affected by the disaster to safe areas in order to preserve their lives. In addition, they must also be able to provide first aid during the disaster.

3. Volunteers: Volunteers are civilians who have been trained by the disaster management teams on first aid, therefore, they are useful during disasters to save people and minimize casualties.

e. Detailed Activities

The activities of the stage before disaster are shown diagrammatically in Figure 5.3 and will be discussed in detail below.

1. Disaster Preparedness: This phase precedes the actual implementation of the disaster management scenario. It is an ongoing process and is not timed. At this stage, research is constantly being conducted on how to improve disaster management and reduce the resulting risk.

Citizens are also trained on first aid and evacuations. In addition, various disaster types and scenarios are simulated and training on how to manage them by the disaster management team, the supporters and volunteers are carried out accordingly. The evacuation areas are periodically checked to ensure that their readiness to receive people when the disaster strikes.

2. The first step of the before disaster stage scenario is the installation of Wireless Sensor Network (WSN), which contains Sensors, Database, Network, and PCs. Each sensor has a record in the DB, which contains sensor ID, location, type, and status. The sensors are installed in deferent places depending on the geographic location of the monitored area and the disaster types that are likely to threaten that locality.
3. WSN sends its data to the data center. Every incoming data point from sensors contains two variables as shown in Figure 5.2 below. The first variable represents the sensor ID that will be used to detect the sensor location in order to designate the affected area. The second part of the sensor data contains the sensor value which will be checked by the system to detect if it is normal or abnormal in order to decide whether there is a risk of disaster or not.

Sensor ID	Sensor Value

Figure 5.2. Alarm message structure.

Figure 5.3 shows the message transfer between different stages of SDMS to clarify the smartness of the system.

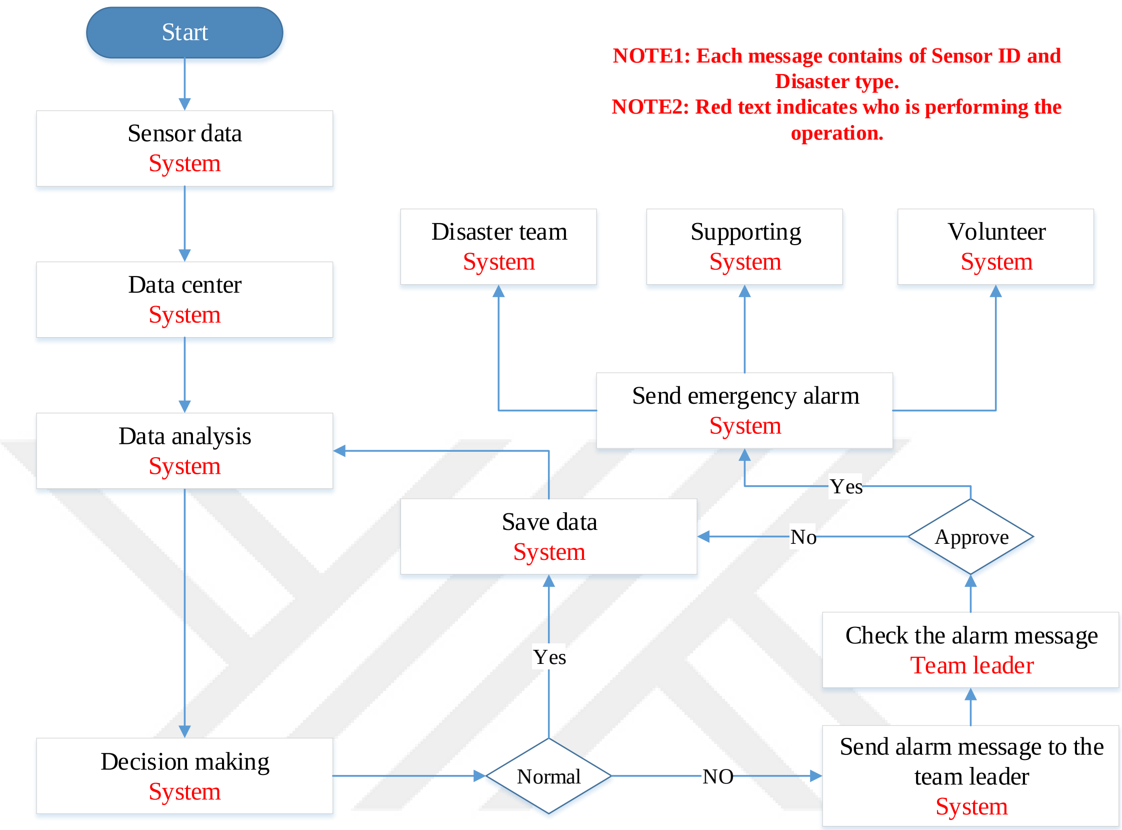

Figure 5.3. SDMS message transfer.

4. The data center also contains a database (DB), which stores historical data related to the previous disasters. Here, comparisons of the data sent by the sensors with historical data stored in the DB are conducted in a continuous manner. If the sent data contains information that does not fit the normal patters, an alarm message will be sent to the team leader. Else, the data center will save the data and continue receiving data from the WSN.
5. The team leader will check the received message to determine the severity, and if there is a high risk of a disaster, then he/she will send an emergency alarm to the disaster, supporting, and civilian volunteers teams to shift to the emergency mode. Else, the team leader will neglect the alarm message and go back to standby mode.

Figure 5.4 below shows the system detailed activities of after disaster stage.

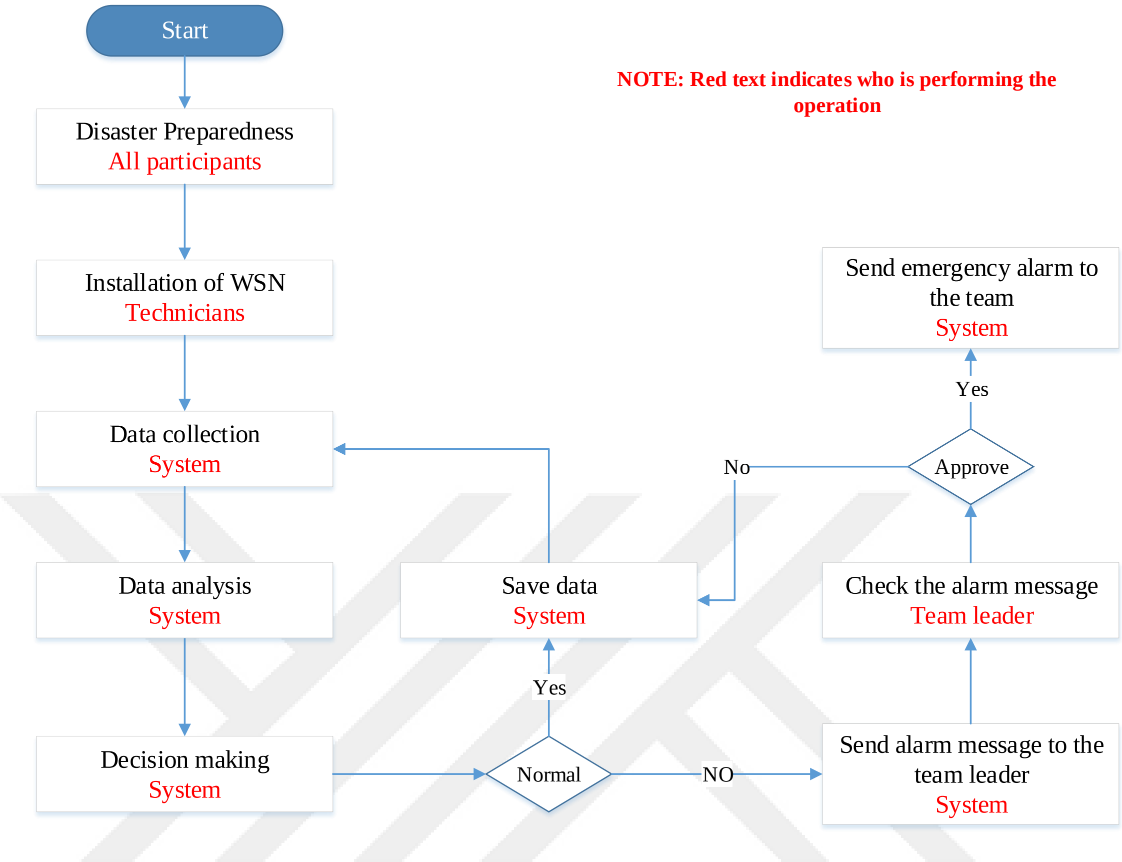

Figure 5.4. Flowchart of detailed activities of before disaster stage.

In accordance with the guidance of the Thesis Monitoring Committee, a forest fire scenario was developed in the first stage (before the disaster stage) as an example.

Let us suppose that the WSN installed in a forest sent information to the data center about smokes and high temperatures in a forest. The information will immediately be compared with the historical data stored in the DB, and the results will show that the information received is abnormal and matches to patterns forest fires. As a result, an alarm message will be sent to the team leader automatically.

When the team leader checks the information in the alarm message, he notices that only one area has abnormal data, therefore he decided that the case is a limited forest fire and not a disaster of great proportions. The team leader sends the information to the firefighters to deal with the fire as soon as possible.

f. Use Case Diagram for the Stage Before Disaster

Use Case diagrams for the stage before disaster were used based on the advice of the Thesis Monitoring Committee and the recommendations of the system developers. The purpose of using these diagrams is to illustrate the roles of people involved, processes, and data flow within the system. Figure 5.5 shows a diagram for the stage before disaster in the proposed SDMS.

1. The team leader is responsible for determining the training plan, its dates, the participants and the necessary materials.
2. All SDMS team, including the team leader, will participate in the training program in order to be ready to deal with the disaster.
3. Technicians are responsible for installing the system hardware, connecting and testing the network and conducting periodic checks on all parts to ensure it is working properly.
4. Sensors start sending their data to the data center to check the monitored area for any abnormal situation.
5. The data center will receive data and analyze it; if any abnormal pattern is detected, the system will compare the abnormal data with the historical data stored in the DB.
6. If the system decides that there is danger, an alarm message will be sent to the team leader.
7. The team leader will determine the risk ratio according to the data received from the data center.
8. If the situation is controllable, the team leader will send the specialists to control the situation and send his report to the DB to be saved as historical data.
9. If the level of risk is high, the team leader will declare an emergency and start the second phase of the system.

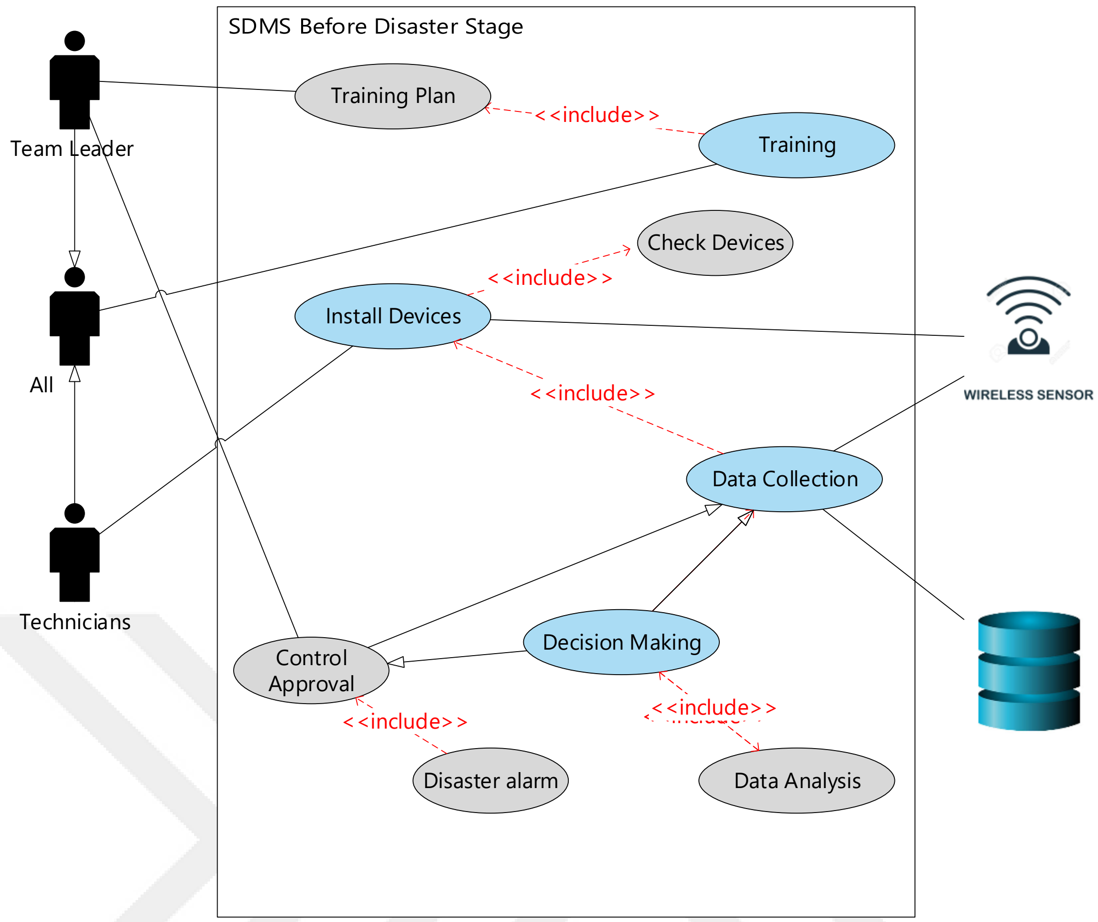

Figure 5.5. Use case diagram of before disaster stage.

5.1.2. During Disaster Stage

This is the most dangerous and important stage for the Smart Disaster Management System. During this stage, events are handled in real-time and the disaster management team must be adequately trained and equipped to deal with the situation. Successful management of this stage significantly reduces the loss of life and property.

The addition of ICTs to the DMS will significantly improve the performance of the system. GPS and IoT can be used to transmit information in real-time and controlling many devices remotely can be an important factor in the success of disaster management and control at this stage. The scenario of this stage is as follows:

a. Objectives

The objectives of this stage can generalize on all types of disasters, with the exception of few cases that require special status.

1. Warning people about the disaster by using different means of communication, such as SMSs, social media, emails, TV channels, and speakers.
2. Evacuation means carrying people to the safe zone or to places that have already been prepared for this purpose and are therefore equipped with essential life supplies such as food, clean water, and medicine.
3. Cut off electricity, gas and water sources by using a smart controller or cut it manually in order to avoid any problem that may come because of them.
4. Providing first aid, an action that can be done by paramedics or civilian volunteers. The aim is to give medical treatment to the affected people locally without the need to send them to hospitals and cause ward overloading.
5. Transporting people who are suffering from serious injuries so that first aid is insufficient to hospitals where more advanced treatments are possible in order to save their lives.
6. Rescue people trapped in the rubble, a duty to be carried out by firefighters with the help of civilian volunteers. They have to check and make sure that no people trapped under rubble are left behind.
7. Special cases

After fulfilling the general objectives, there are some special objectives for each one of the disasters elaborated on as follows:

i. Flood: Objectives related specifically to floods are as follows:

1. Rescue Boats to save people at risk of drowning and recover dead bodies.
2. Provide water suction pumps to reduce the water pressure from the affected areas.
3. The use of loaders and lorries to make earth mounds that prevent floodwaters.

ii. Forest fires: They also have its own special objectives, which are enumerated as follows:

1. Fire Fighting Aircraft to put out large fires that cannot be controlled using fire engines.
2. Provide paramedics with respirators to save people exposed to choking.
3. Distributing fire extinguishers to civilian volunteers to put out small fires.

iii. Earthquakes: the special objectives of earthquakes are as follows:

1. Rescue people trapped in the rubble as soon as possible.
2. Keeping people away from buildings because of the possibility of collapse due to the presence of aftershocks or rebounding earthquakes.

b. Activity Diagram

The main activities during the disaster stage are shown in Figure 5.6, which illustrates the requirements, participants and detailed activities of this stage.

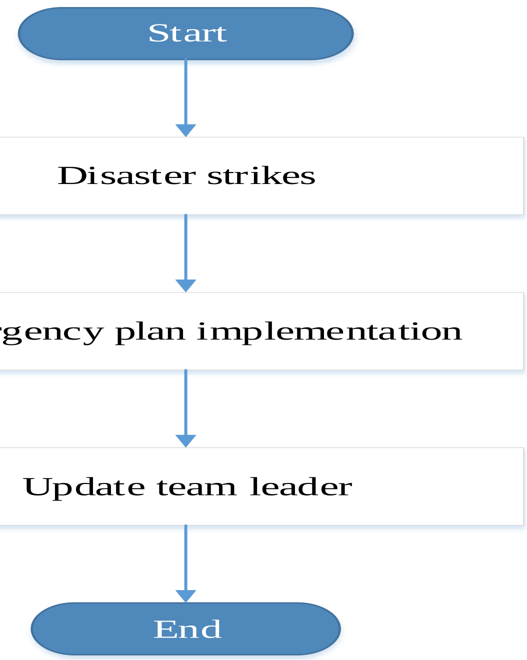

Figure 5.6. Main activities of during disaster stage.

c. Requirements

1. Cell phones, smart devices, PCs, satellite channels, and internet service.
2. Buses, Ambulances, Fire Vehicles, Police Cars, Fire Fighting Aircraft, Rescue Boats, Lifeboats, Loaders, and Lorries.
3. Sensors, RFIDs, Wireless communication devices.
4. Electric generators, water suction pumps, masks, respirators, and Fire extinguishers.

d. People

1. Disaster Management Team

- Team Leader
- Team members

2. Supporting

- Police officers
- Firefighters
- Pilots (to drive firefighting aircraft)
- Divers (to search for sunken people)
- Paramedics
- Transporters

3. Volunteers

e. Detailed Activities

In accordance with the guidelines provided by the thesis monitoring committee, the detailed activities during the disaster stage will be divided into three different scenarios depending on the three main disasters that affect Iraq. These scenarios will be discussed in detail separately, starting with flooding scenario (Figure 5.7).

1. Flooding scenario

i. The team leader sends an alarm message to the team members, supporting teams, and civilian volunteers, ordering them to start the flooding disaster plan.
ii. The first step in the flooding disaster plan is warning people of flood disaster by using all communication methods like SMSs, social media, TV channels, and Radios and encourage them to go to the safe zone.
iii. Use the RFID technology to detect the location of the elderly and the disabled in order to save them.
iv. Evacuate people and transport them to safe areas that have been prepared during the preparatory phase of the disaster.
v. Cut off electricity, gas, and water sources to avoid any additional damage caused by them.
vi. Use rescue boats to save people at risk of drowning and recover bodies.
vii. Use water suction pumps to reduce the water pressure from the affected areas.
viii. Use of loaders and Lorries to make earth mounds that keep floodwaters in control.
ix. Use of RFID to detect trapped people and save them.
x. Provide the first aid to the people affected with minor injuries.
xi. Transport the people seriously injured to the hospital.
xii. Keep the team leader informed about the latest updates of the disaster and the real situation on the ground.

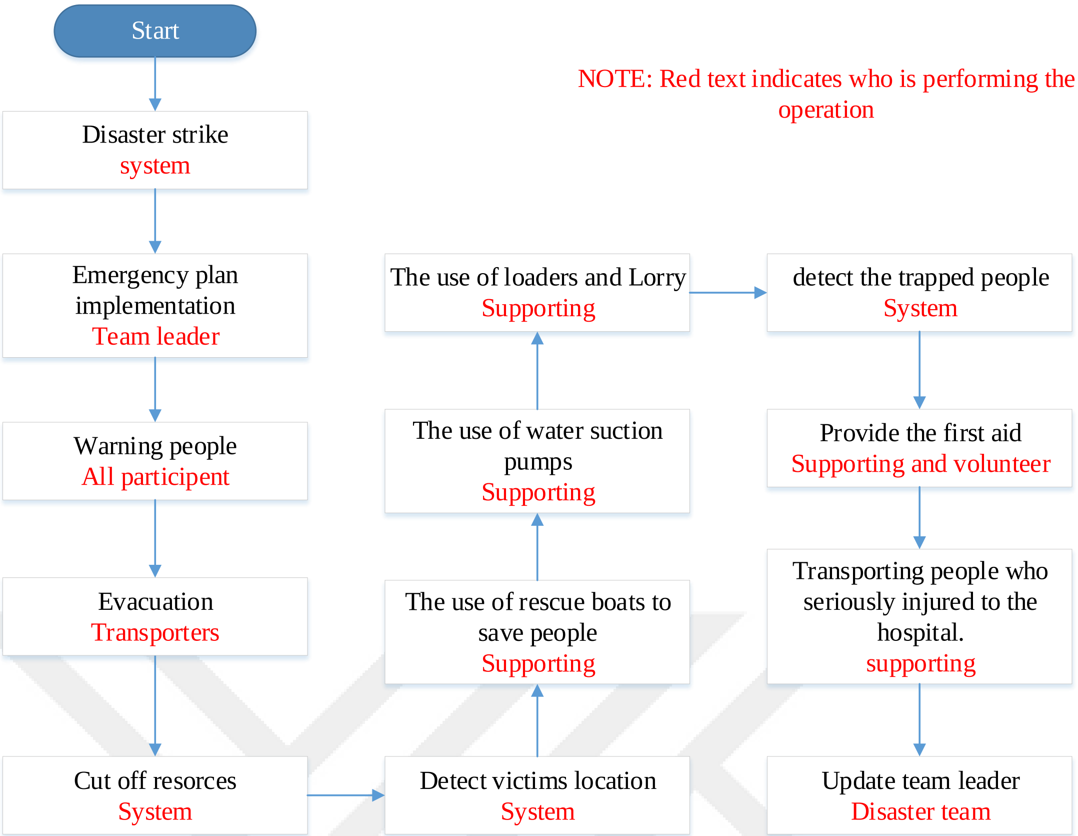

Figure 5.7. Flowchart of detailed activities of flooding in during disaster stage.

2. Forest fire scenario:

i. The team leader sends an alarm message to the team members, supporting teams, and civilian volunteers to order them to start the forest fire disaster plan.

ii. The first step in the forest fire disaster plan is warning people of forest fire disaster by using all communication methods like SMSs, social media, TV channels, and Radio, asking them to go to the safe zone.

iii. Use the RFID technology to detect the location of the elderly and the disabled in order to save them.

iv. Evacuate people and transport them to safe areas that have already been prepared in the preparation phase of disaster management.

v. Cut off electricity, gas, and water sources to avoid any additional damage caused by them.

vi. Use fire fighter aircrafts to put out large fires that cannot be controlled by using fire engines.

vii. Provide paramedics with respirators to save people exposed to choking.
viii. Distribute fire extinguishers to civilian volunteers to put out small fires.
ix. Use RFID to detect trapped people and save them.
x. Provide the first aid to the affected people with minor injuries.
xi. Transport people who have been seriously injured to the hospital.
xii. Keep the team leader informed about the latest updates on the disaster and the real situation on the ground.

Figure 5.8 shows the detailed activities of the forest fire scenarios:

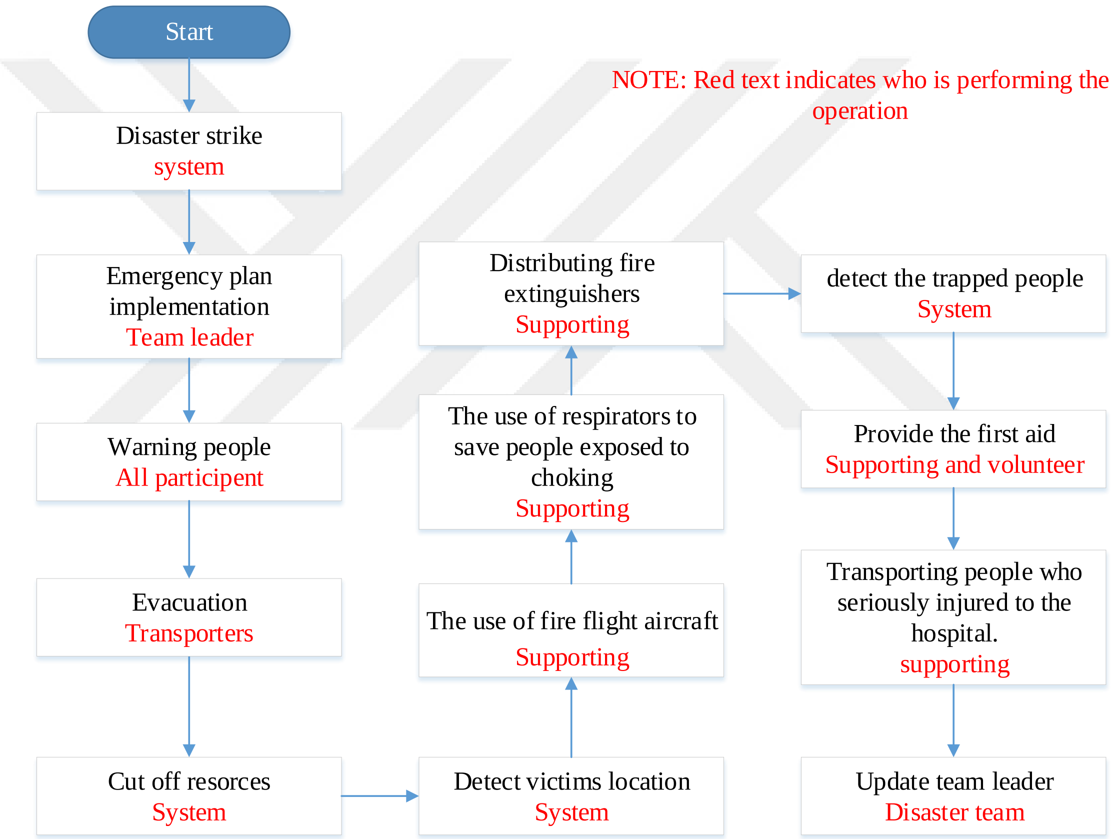

Figure 5.8. Flowchart of detailed activities of forest fire during disaster stage.

3. Earthquake scenario:

i. The team leader sends an alarm message to the team members, supporting teams, and civilian volunteers, ordering them to start the earthquake disaster plan.

ii. The first step in the earthquake disaster plan is warning people of earthquake, using all communication methods like SMSs, social media, TV channels, and Radio, and asking them to go to the safe zone.
iii. Use the RFID technology to detect the location of the elderly and the disabled in order to save them.
iv. Evacuate people and transport them to safe areas that have been prepared during the preparation phase of the disaster management.
v. Cut off electricity, gas, and water sources to avoid any additional damage caused by them.
vi. Use RFID to detect trapped people and save them.
vii. Keep people far from buildings because of the possibility of collapse due to the presence of rebound earthquakes.
viii. Provide the first aid to the affected people with minor injuries.
ix. Transport people seriously injured to the hospital.
x. Keep the team leader informed about the latest updates related to the disaster and the real situation on the ground.

Figure 5.9 shows the detailed activities of the earthquake scenarios:

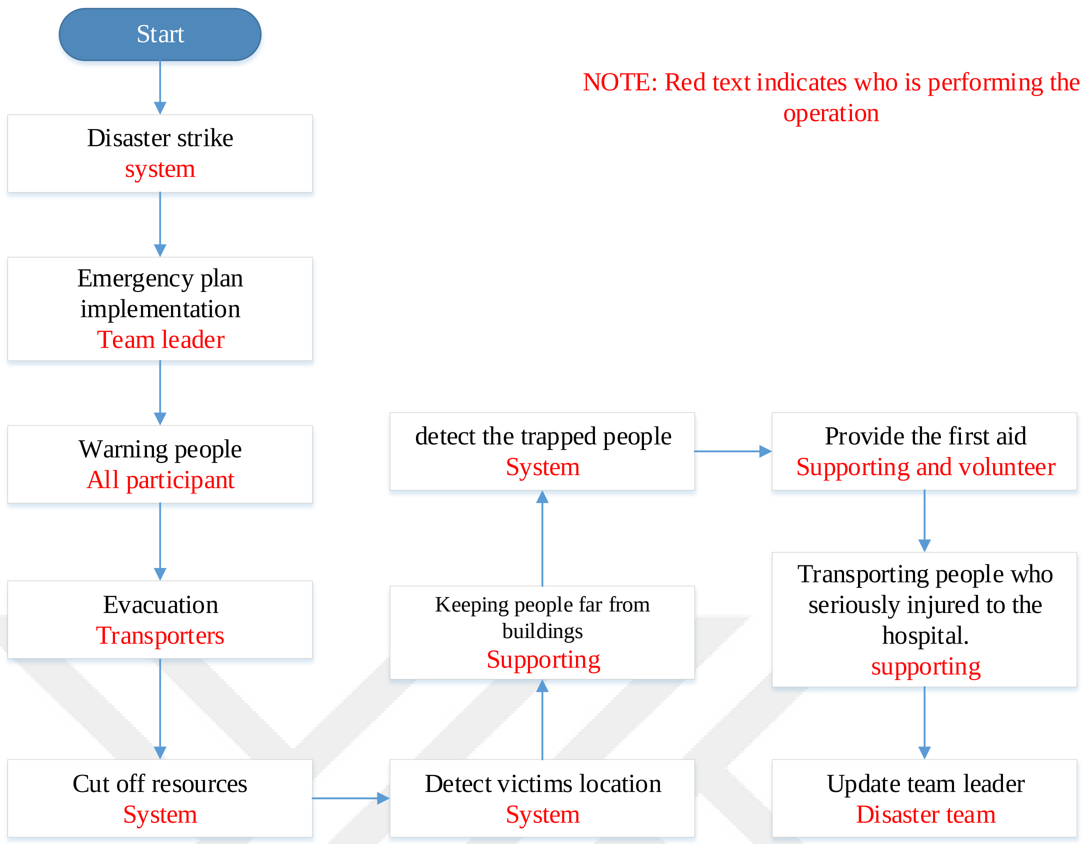

Figure 5.9. Flowchart of detailed activities of earthquake in during disaster stage.

As an example of a flooding scenario, let us suppose that the team leader sent an alarm message to his team that a flood would happen soon. Therefore, he orders his team to start the flooding disaster plan that they have been trained and prepared for.

The disaster and supporting teams, together with civilian volunteers will take their positions and will start by warning people about the risk of flooding using all communication methods. After that, transporters with the help of traffic police will start the evacuation of people to the safe zones or to areas already prepared to keep them safe in the case of flooding disaster.

The disaster team will cut off the electricity, gas and water resources by using the IoT controller to avoid any additional damage that may be caused by them.

The rescue team will use the RFIDs to detect the position of any people at risk of drowning and recovering bodies by using the rescue boats with the help of divers. On the other side, the police officers sometimes with the help of the army will use the water suction pumps to reduce water pressure from the affected areas. Furthermore, they will use loaders and Lorries to make earth mounds to prevent water from further getting into the affected area.

The rescue teams will use the RFID again to detect the trapped people's position and save them. Paramedics, with the help of civilian volunteers will provide the first aid to the people with minor injuries to reduce the load on the hospital while ambulances will take seriously injured people to hospital.

All disaster team members will keep direct contact with the team leader and provide him with the latest updates and take orders accordingly. After that, the team will start the last stage of the disaster plan, which is the after disaster stage.

5. Use Case Diagram of During disaster stage

The use case diagrams for the period during the disaster stage were designed according to the recommendations of the system developers. The purpose of using the use case diagram is to illustrate the roles of people, processes and data flow within the system. This stage contains four diagrams, one for the main activities of this stage, and three for the special cases. These diagrams explain the special activities for three types of disasters. Figure 5.10 below shows the use case diagram during the disaster stage of SDMS.

1. The team leader is responsible for announcing the disaster and approving the use of the emergency plan.
2. All SDMS teams will start warning people about the disaster.
3. The transporters who are part of supporting team will evacuate people to the safe zone.
4. The supporting team and the system will cut off the electricity, gas, and water to prevent additional damage.
6. The supporting team will deal with the special cases which will be explained in detail later.

7. The volunteer team will provide the first aid to injured people who are not in critical conditions.

8. Ambulances from the supporting team will transfer the critical cases to the hospital.

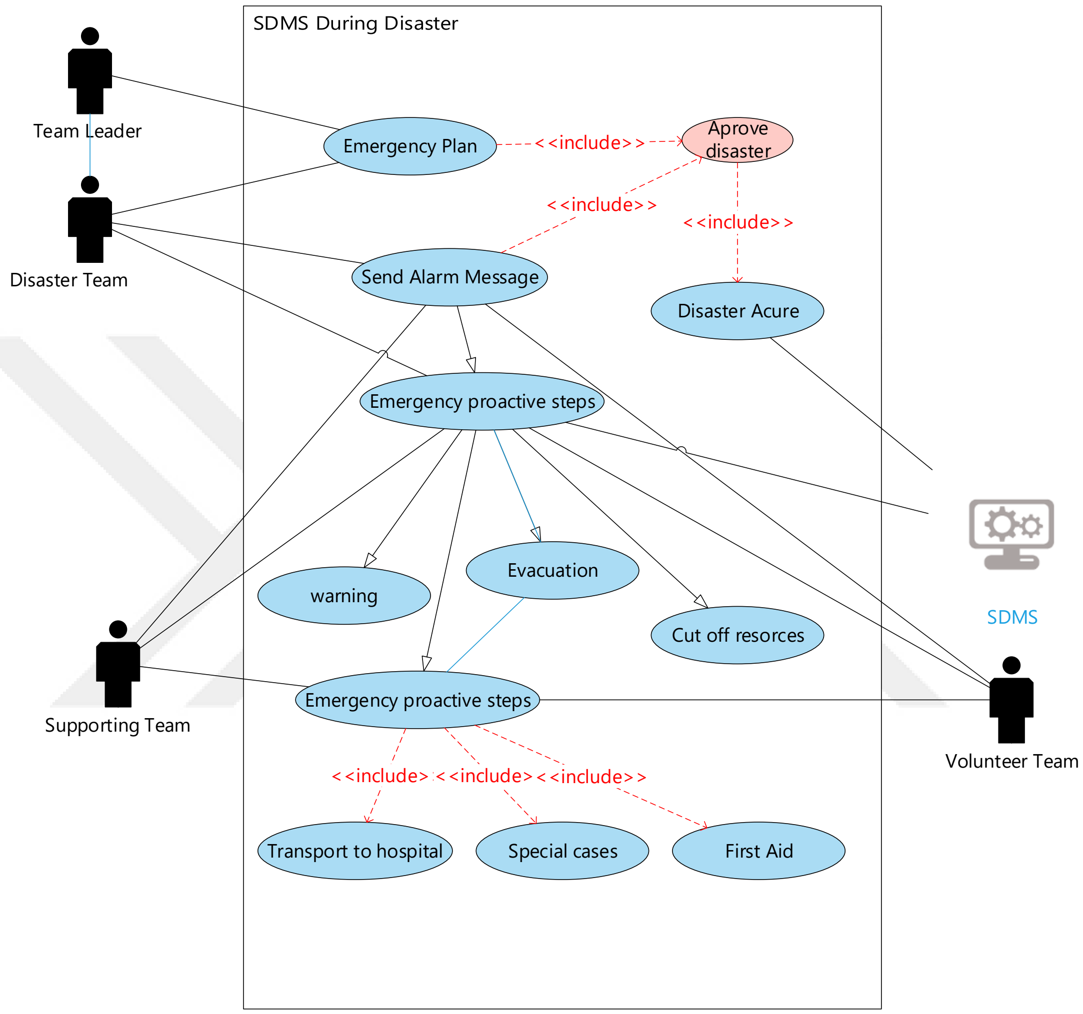

Figure 5.10. Use case diagram of during disaster stage.

The first special case is flooding, the activities, which are shown diagrammatically in, Figure 5.11.

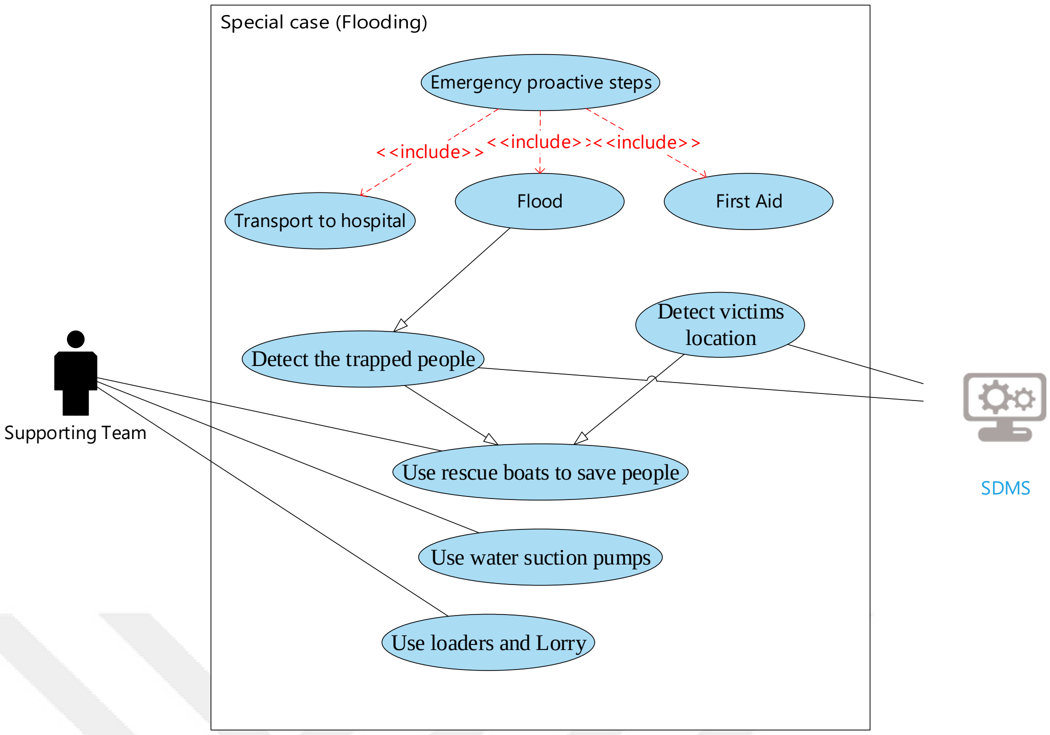

Figure 5.11. Use case diagram of flooding.

The second special case is the Forest fire, the activities of which are diagrammatically shown in Figure 5.12.

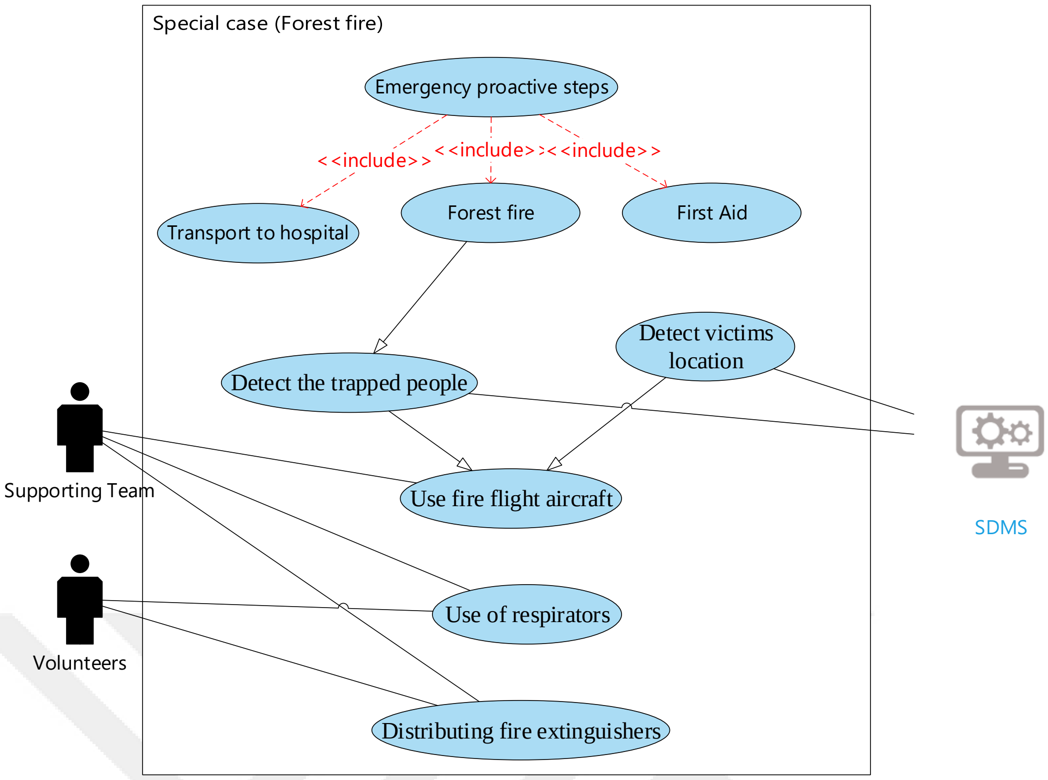

Figure 5.12. Use case diagram of forest fire.

The third special case is that of earthquake, the activities of which are illustrated by the diagram in Figure 5.13.

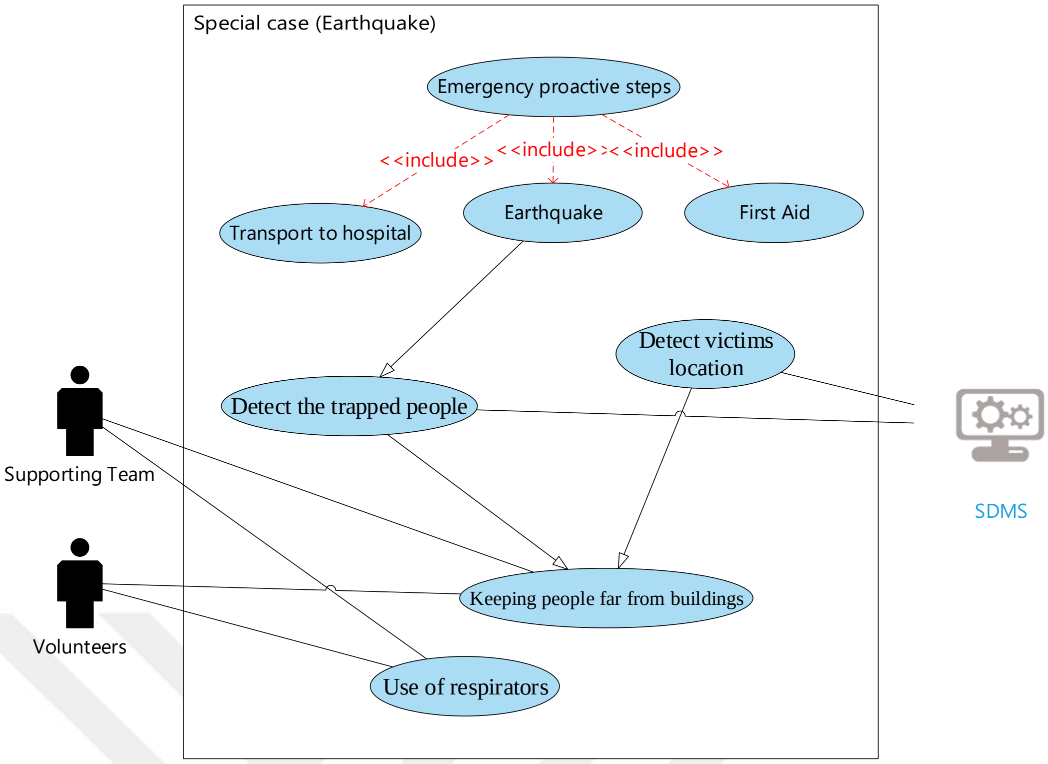

Figure 5.13. Use case diagram of earthquake.

5.1.3. After Disaster Stage

This is the last stage in the SDMS, at the end of which, the system will go back to the standby mode. During this stage, the disaster management team, supporting team and civilian volunteers have different duties in a different scenario, which is as follows:

a. Objectives

1. To remain on standby for 72 hours after the disaster, due to the possibility of new disasters resulting from the main one, such as epidemics and disease outbreaks after floods. The disaster management team, supporting, and civilian volunteers can take this action over.
2. Provide statistics on the number of people who survived, got injured and are still missing. In addition, report on the number of deaths and financial losses resulting from the disaster. Statistics experts can do this activity with the help of RFID.

3. Provision of essential necessities for life, such as tents, food, water, and medicine for the survivors of the disaster and those in the evacuation sites. Transporters and civilian volunteers can do this action.
4. Provide adequate housing as well as electricity and means of communications for the affected people. This action can be done during the preparation stage by the disaster team.
5. Provide protection for damaged buildings, archaeological areas, and government buildings to prevent theft. Police officers can do this action.
6. Eliminate the consequences of the disaster in order to rehabilitate the affected areas. The rehabilitation team can accomplish this action.
7. Rehabilitation of infrastructure, water, electricity, and gas, as well as rehabilitation of buildings in addition to the restoration of basic services such as Internet and communications. The rehabilitation team can accomplish this action.
8. Evaluate the performance of disaster management team, supporters, civilian volunteers and the percentage of success achieved during the disaster. The leader of the disaster management team does this action.

b. Activity Diagram

The main activities, requirements and participants of after disaster stage are shown diagrammatically in Figure 5.14.

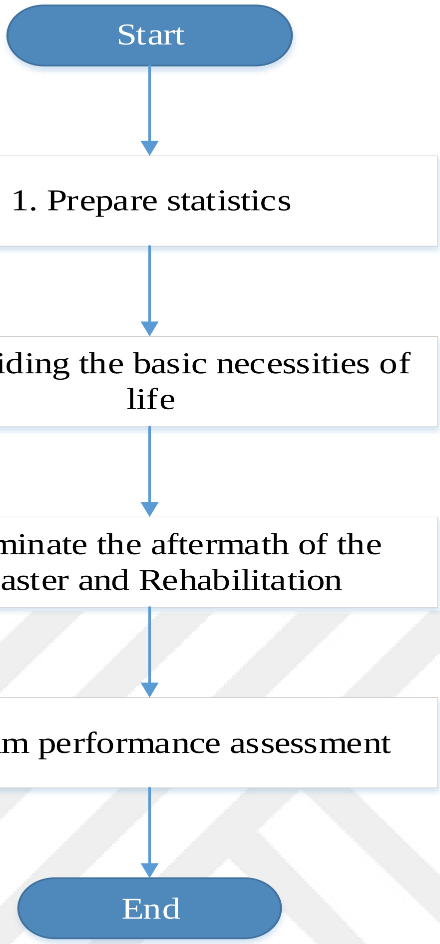

Figure 5.14. Main activities of after disaster stage.

c. Requirements

i. Cell phones, smart devices, PCs, DB, Internet service, RFID, and Statistic software.
ii. Tents, Food, Clean Water, and Medicine.
iii. Trucks, Ambulances, Police cars, Generators, Water Treatment Plants.
iv. Building materials.

d. People

1. Disaster Management Team

- Team Leader

- Team members

2. Supporting

- Police officers
- Paramedics
- Statistic experts.
- Technicians.
- Construction workers.
- Transporters.

3. Volunteers

e. Detailed activities

The activities of the after disaster stage will be discussed in detail below in accordance with the main activity diagram in Section (5.1.3-b):

i. Depending on continues feedback, the team leader declares the disaster over. However, the disaster team, supporting team, and civilian volunteers should stay on standby mode 72 hours after this announcement in anticipation of other possible follow-ups.
ii. The team leader orders statistics experts to provide statistical reports about the number of people who survived, got injured, are still missing or died as a result, by using RFIDs that are fixed on each person. In addition, they are supposed to calculate the financial damages resulting from the disaster.
iii. The Disaster Management Team is setting up camps for survivors in the evacuation areas until the rehabilitation of the houses and infrastructure on the affected area is completed.
iv. The Disaster Management Team is providing food, clean water, and medicine to survivors. In addition, they also provide electricity and communications.
v. Police officers are protecting damaged buildings, archaeological areas, and government buildings to prevent theft.

vi. The rehabilitation team is eliminating the consequences of the disaster in order to rehabilitate the affected areas. In addition, they also start the rehabilitation process on vital infrastructure such as water, electricity, gas, housing and restoration of basic services such as Internet, communications.

vii. The maintenance of SDMS is done as follows:

    i. The maintenance of all system devices like sensors, DB, network devices, and PCs.
    ii. Replacement of equipment affected by the disaster.
    iii. Reinstall sensors in the places allocated to them.
    iv. Make a thorough inspection of the system to make sure it is working properly.

v. A table is set for the life of all devices, so that they will be replaced on time in order to continue functioning.

vi. Periodically check all parts of the system and make sure that all devices are working properly

viii. The team leader evaluates the performance of disaster management team, its supporters, civilian volunteers and the percentage of success achieved during whole disaster management process.

ix. Finally, the team leader announces that the disaster is over and orders the disaster team to go back on the standby mode.

Figure 5.15 below shows detailed activities of the system after disaster stage.

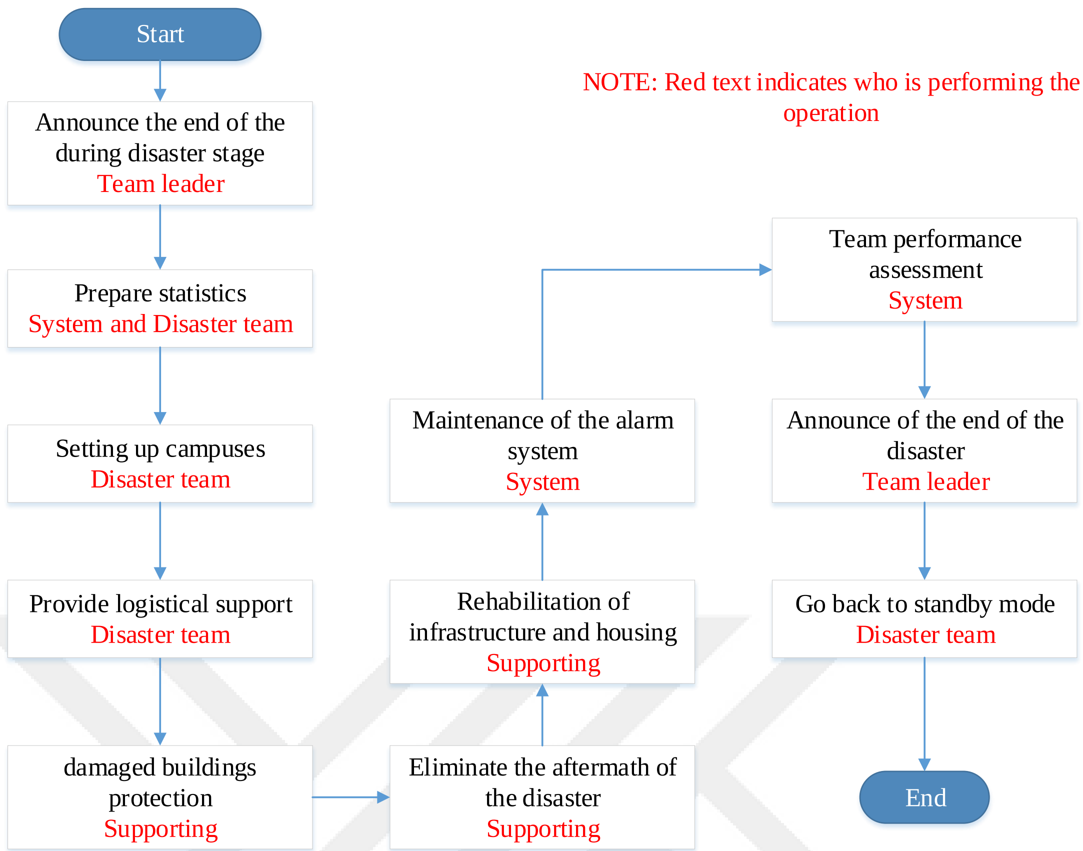

Figure 5.15. Flowchart of detailed activities of after disaster stage.

f. Use Case Diagram of after disaster stage

The use case diagram after the disaster stage was designed in accordance with the recommendations of the Thesis Monitoring Committee and system developer. The purpose of using such diagrams is to illustrate the roles of people, processes and data flow within the system. Figure 5.16 below shows the use case diagram for the after-disaster stage.

1. Statisticians as a support team with the help of SDMS will conduct statistical analysis to determine the number of surviving, injured, missing and dead people, in addition to identifying material losses and damage to infrastructure.
2. Based on the statistical report, the support team and volunteers will provide the survivors with the necessary food, drink, and medicine, as well as suitable places for living.

3. Construction workers as a support team with the help of volunteers will remove the debris caused by the disaster.
4. As a support team, construction workers will rehabilitate infrastructure and housing in the disaster-affected area.
5. Technicians as a support team will rehabilitate the SDMS and its associated equipment with a thorough inspection of all parts of the system to make sure they are working properly.
6. After the completion of the rehabilitation process, the team leader assesses the performance of the risk management team, supporters and volunteers. He will analyze the speed of response and the way to deal better with the disaster. A copy of this report will be sent to the database to be save as historical data training for the future.
7. The team leader announces the end of the disaster and orders the team to back on the standby mode.

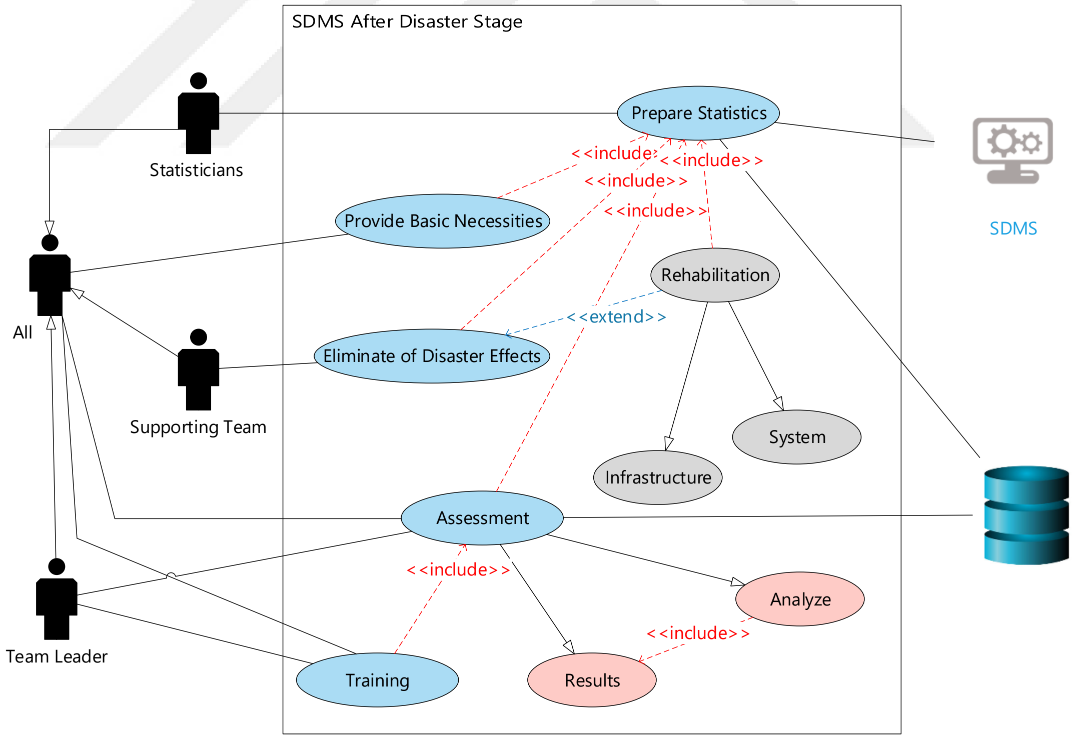

Figure 5.16. Use case diagram of after disaster stage.

CHAPTER 6

DISCUSSION

Natural disasters affect our life and property adversely, as these disasters change the lives of people and their effect may last for a long time [95]. And disasters lead to geographic changes sometimes leading to a complete change in the lives of people or their displacement to other regions. The researcher agrees with this, because of the disasters witnessed by the world and the damage that caused by these disasters.

As it was previously mentioned, the main goal of the DMS is not to eliminate the disaster permanently because this is not possible. However, the goal of a DMS is to minimize the impact of a disaster [96]. This fact was approved by all literature. The weakness of the existing DMSs not related to the technical side only, it is also related with the administrative side. This issue was discussed by [97], where the researcher stressed that the success of the DMS needs to make a change in the administrative structure of this system and make all units of the system linked to one administration and receive orders from only one leader. In addition to linking all units of the system with each other using Information and Communications Technology. The researcher's vision agrees with this view, and the persons responsible for the DMS in Iraq, who were interviewed personally during the preparation of this research, confirm this perspective.

Increasing the readiness of citizens towards disasters as well as increasing their ICT knowledge will contribute in reducing the effect of these disasters [98]. The researcher agrees with this reflection and it will be approved after the implementation of the SDMS. One of the most prominent challenges facing the implementation of the DMS is the high cost of the components of this system; therefore, most researchers in this field rely on conceptual design when trying to apply new ideas to this system [99].

For all previous reasons a conceptual design for an enhanced DMS called Smart Disaster Management System (SDMS) was proposed. In this chapter, the methodology of this thesis will be discussed briefly. Figure 6.1 below shows the methodology of this thesis.

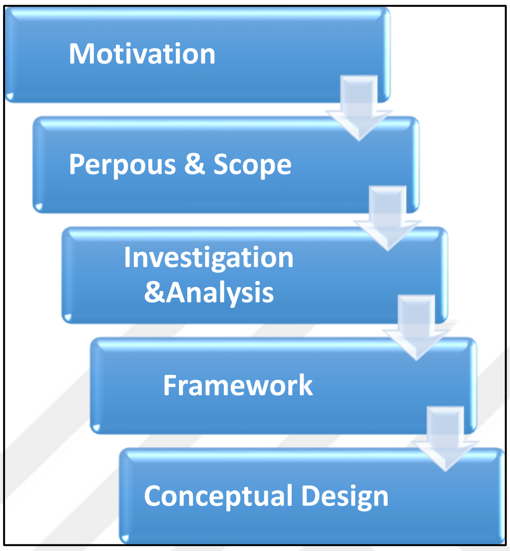

Figure 6.1. Thesis methodology.

The motivations of this study is the disasters that effect the Iraqi citizens. And Iraqi citizens suffer from repeated disasters in addition to their suffering from a lack of readiness towards disasters and the lack of applications in the Iraqi electronic government that provides services to citizens in the event of a disaster. This fact was verified by the personal interviews with the specialist in the disaster field and the E-government field in Iraq.

This research tries to make a combination between DMS and ICT, on the other hand, it tries to enhance the existing DMS by adding the emerging IoT technology to it to make it smarter in order to save people lives and properties, as well as to save efforts, time, and money. Therefore, this research has many scopes; it has the disaster management scope, ICT scope, design scope, human right scope, and saving efforts, time, and money scope. Each one of these scopes has been discussed in detail in (Section 1.3).

In order to declare the research problems, many related literatures were reviewed and hypotheses were clarified. This research includes two groups of hypotheses, the first group test the effect of demographic factors on the readiness of citizens towards ICT. This group consist of six hypotheses. The second group of hypotheses tests the effect of demographic factors on the readiness of citizens towards disasters. This group encompass nine hypotheses.

In order to test the suggested hypotheses, a questionnaire with 11 questions was planned and designed. The questionnaire divided into three groups of question, the first group related to the demographic factors, includes of four questions. The second group of questions related to citizen's ICT knowledge, it consists of two questions. The third group of questions related to citizen's disaster knowledge, contains five questions.

A test sample of questionnaire was distributed among 30 participants to test the reliability of the questionnaire; the feedbacks were coded to be used in the IBM SPSS statistical analysis software. The feedbacks reliability was 73%, which means that the questionnaire is reliable and ready to distribute on a real sample.

The questionnaire was distributed by using two methods, the paper based method and the electronically method. After one month, 514 feedbacks were collected. The paper based feedbacks were coded by using Microsoft Excel software and combined with the electronically feedbacks to be used in the IBM SPSS statistical analysis software. The discussion of the feedback analysis have the following:

A. Demographic factors

As noted in Figure 3.7, the issue about the readiness of citizens towards ICT and Disaster can be considered as dependent factors, while those related to demographics that affect their readiness as independent factors. Figure 4.3 shows that the highest percentage of respondents was 27.7% for those less than 20 years of age. This indicates that youth has more interaction with technology and is willing to develop it further. The percentage of male participants was 63.5%, higher than the female participation rate (Figure 4.4). This is because of the culture of Iraqi society, which allows males to participate in societal activities more than females [100]. The researcher agrees with this fact.

It can also be noted that the proportion of respondents living in cities was 66.1% (Figure 4.5). In addition, it is also clear that people who have the Bachelor's degree make the majority of respondents in the survey by 36.5% (Figure 4.6).It can also be noted that the proportion of respondents living in cities was 66.1% (Figure 4.5). In addition, it is also clear that people who have the Bachelor's degree make the majority of respondents in the survey by 36.5% (Figure 4.6).

B. ICT readiness factors

Most of the Iraqi citizens have good experience in ICT technology [101]; the researcher agrees with this fact and it can also be noted by Figure 4.6, 31% of participants chose “Very Good”, and 35.1% selected “Good” as their responses. However, Figure 3.17 shows that most of them have little experience with E-government applications with 25.9% choosing “Average”, 21.1% “Little” and 17.7% “Very little”.

In addition, statistical analysis showed that Age factor has a positive correlation with citizen experience toward ICT [102] ($r = 0.145$, $p < 0.01$) as shown in Table 4.11, and these results agree with the previous studies [39]. Gender showed positive correlation with citizen experience toward ICT ($r = 0.088$, $p = 0.01$) as shown in Table 4.12, a result that is also in agreement with previous studies [40]. The level of education showed the highest correlation with citizen experience toward ICT ($r = 0.404$, $p < 0.01$) as shown in Table 4.13, also in agreement with previous studies [40].

For the experience with E-government, Age factor showed negative correlation with citizen experience toward E-government ($r = -0.074$, $p = 0.03$) as shown in Table 4.14, which agrees with previous studies [102]. On the other hand, Gender factor has a positive correlation with citizen experience toward E-government ($r = 0.123$, $p = 0.01$) as shown in Table 4.15, which also agrees with previous studies [40]. The level of education also has the highest correlation with citizen experience toward E-government ($r = 0.501$, $p < 0.01$), as shown in Table 4.16, also in agreement with previous studies [40].

C. Disaster readiness factors

For the disaster readiness part, Figure 4.10 shows that 40.5% of citizens are very interested and 33.9% are interested in disasters, which agrees with [102]. However, only 14% of the participants have very good knowledge and 27.5 % have good knowledge about disasters, as shown in (Figure 4.9). In addition, it can be noted from Figure 4.11 that citizens who have very good and good knowledge in disaster management were only 12.3% and 15.2%, respectively, with the rest having little knowledge on this area. Further, the analysis showed that only 26.9% of participants had never been affected by disasters before (Figure 4.12).

Another important finding is that floods are the most common type of disaster to hit Iraqi citizens with a proportion of 59.5% (Figure 4.13). Where floods threaten most of the Iraqi cities that located on the banks of the Tigris and Euphrates in the central and southern regions of Iraq during the melting season of snow and rainfall [103].

Drought comes second with 34.5 %, this is because of the fluctuating weather in Iraq. As the weather is hot and dry in summer, cold and rainy in winter. Where the very high temperatures in the summer season (sometimes it more than 50 Celsius degree) lead to drying of rivers and water bodies [103].

Earthquakes is the least, with only 4.9%. Where it was noticed the high number of times that Iraq was affected by earthquakes in recent years, as Iraq was exposed to 1579 earthquakes in 2018, covering 13 Iraqi governorates, the degree of severity was between medium and high intensity [104].

Correlation analysis showed that Age factor is inversely correlated with citizens' knowledge toward disasters ($r = -0.116$, $p < 0.01$), as shown in Table 4.17. This means that the result is the oppposite of our expectation. Gender factor was found to have positive correlation with citizen knowledge toward disasters ($r = 0.099$, $p = 0.04$) as shown in Table 4.18, which agrees with previous studies [41]. The level of education has the highest correlation with citizen knowledge toward disasters ($r = 0.477$, $p < 0.01$), as shown in Table 4.19, which also agrees with previous studies [41].

Correlation analysis show that Age factor is inversely correlated with citizen awareness toward disasters ($r = -0.130$, $p < 0.01$), as shown in Table 4.20, this means that the result is the oppposite of our expectation. This finding is not in agreement with previous studies [41]. On the other hand, Gender factor shows positive correlation with citizen awareness toward disasters ($r = 0.093$, $p = 0.07$), as shown in Table 4.21. However, the p-value is above our significance level. This means that the result is the opposite of our expectation. The level of education again has the highest correlation with citizen awareness toward disasters ($r = 0.413$, $p < 0.01$), as shown in Table 4.22, and it is in agreement with previous studies [41].

Finally, statistical analysis showed that Age factor has positive correlation with citizens being affected by disasters ($r = 0.033$, $p = 0.109$), as shown in Table 4.23, but it fails to reach significant levels. This means that the result is the oppposite of our expectation. On the other hand, Gender factor has very weak positive correlation with citizens being affected by disasters ($r = 0.017$, $p = 0.323$), as shown in Table 4.24. This means that the result is the oppposite of our expectation. The level of education shows negative correlation with citizens being affected by disasters ($r = -0.13$, $p = 0.302$), as shown in Table 4.25. Since the p-value is bigger than 0.05. This means that the result is the oppposite of our expectation.

The next stage after the feedback analysis stage is the system framework design. The framework works to clarify the characteristics of the system and its dimensions, as it analyzes the three dimensions of the system (definition, abstraction and implementation) [105]. In addition to clarifying the components of the DMS and the relationships within the system.

Previous related works that tried to propose similar ideas about smart DMS were focused on different sides. Therese (2010) focused on the use of smart devices in the communication methods [106]. However, the author neglects other parts of the system like the modification of the administrative side. While Mitchell (2010) focused on the monitoring of climate by using the DMS in order to take the necessary precautions to reduce the effect of disasters [107]. However, he did not mention the procedures that should be applied during and after disaster.

The Unified Modeling Language (UML) was used to visualize the framework; this visualization will help developers in software development, because UML can be used as a software-developing standard [108]. Therefore, the conceptual design of the SDMS was made by using UML diagram.

The conceptual design of the SDMS consists of three different scenarios, where a UML diagram was proposed for each stage of disaster (before disaster, during disaster, and after disaster). For each one of these stages two activity diagrams were applied, one diagram is for the main activity, and the other one is for the activity in detail. Then a use case diagrams were applied for each one of these stages.

During the disaster stage there are three special cases (Flooding, Forest fire, and Earthquake), each one of these cases has different scenario in some levels. In order to inform the people included in this stage as well as to declare functions of this stage, a use case diagram was included.

In order to affirm the differences between the SDMS and other smart disaster management system, as well as to show the contribution of this system, a table was prepared in the next chapter. The (table 7.1) shows how the SDMS proposed in this study depends on the ICT technology especially the IoT devices in order to provide real-time data to the decision makers, as well as to save the effort, time, and money.

CHAPTER 7

FINDINGS AND CONCLUSION

This study aims to increase the citizen readiness towards disaster management in E-government application by applying Internet of Things (IOT) technologies. To achieve this objective a framework of enhanced DMS is proposed, the enhanced system is called Smart Disaster Management System (SDMS). This framework will serve as a guideline for developers to develop similar systems. On the other hand, this research, through its seven chapters, answered the research questions in (Section 1.4).

The purpose of this Chapter is to clarify what was observed in the research, as well as to make a summary of this work. The rest of this Chapter is organized as follows: The findings of this research is presented in Section 7.1, thesis contribution will be discussed in Section 7.2, after that the limitations of the thesis will be discussed in Section 7.3; the future work will be presented in Section 7.4. Finally, the conclusion of this Chapter will be in Section 7.5.

7.1. Findings

The information discovered during the course of this research was not limited to answering the research questions in Section 1.4, but additional information was obtained which will be clarified later in this Section. The findings of this thesis will be as follows:

a. Interviewing experts:

As mentioned in Section 4.1.2, interviews were conducted with pollution experts at the Iraqi Ministry of Environment in Baghdad to identify the types of disasters that threaten the life of the Iraqi citizen and the readiness of the Iraqi citizen towards disasters. In addition, the interviews conducted with ICT experts and those responsible for implementing the E-government project at the Ministry of Science and Technology in Baghdad in order to determine the level of readiness of the Iraqi citizen to use ICTs, specifically E-government applications related to disasters. As well as the interviews, that conducted with the developers to determine the way of designing the framework by identifying the requirements of users and clarifying the tasks and people executing the missions and the material needs to be required by the system, in addition to the use of diagrams to describe the way of workflow within the system.

b. The impact of ICT on citizen readiness:

As discussed in Section 4.3-B, according to the results of the feedback analysis, most of the Iraqi citizens have good experience in ICT technology. However, most of them have low experience in E-government applications. In addition, the research approved that age, gender, and level of study of the citizen has a positive impact on citizen readiness towards ICT.

Age has a negative impact on citizen readiness towards the use of E-government applications. However, gender and level of study have a positive impact on citizen readiness.

In Section 4.3-b, the analysis of feedbacks shows that although 40.5% of citizens are very interested in disaster, and 33.9% are interested in disasters. There are only 14% who have very good knowledge about disasters, and 27.5 % have good knowledge about disasters.

c. Identify types of disasters that threaten the life of the Iraqi citizen:

The statistical analysis of feedbacks shows that floods are the most common type of disaster for Iraqi citizens with 59.5%. Drought comes second with a percentage of 34.5 %, and Earthquakes with 4.9%. Other types of disasters have a very low percentage, where Forest Fires has 0.8%, and tornadoes have 0.4%, this means that these types of disasters do not pose a real danger to the Iraqi citizen.

d. The application of a framework to implement the SDMS:

This thesis success in using the framework as a tool to make sure of implementing the SDMS in order to satisfy the thesis motivation in (Section 1.2) . The framework has contributed to ensuring the implementation of the enhanced system by applying the investigation then the analysis and finally the design for the proposed system.

e. SDMS Functioning Illustration:

This description is regarding how the proposed system works; this explanation has facilitated the design of the framework for the SDMS. The following provides summary, and how the enhanced system works:

1) The system senses any abnormal situation in the area being monitored by sensors. The system then sends the sensor data to the data center for comparison with the historical data stored in the database.
2) If the data send corresponds to one of the types of disasters described in Section (3.3.1/a). The system will send an alarm message to the team leader who will activate the disaster mode of the system.
3) The SDMS will provide a DMS depending on ICT; this system contains three stages as shown in Figure 5.1. these stages are as follows:

   i. Before disaster stage: Where all physical and moral measures are taken and remain in a standby mode for any type of disaster (Section 5.1.1).
   ii. During disaster stage: Where each type of disaster is handled by the disaster management team and its supporters with high accuracy and speed according to a pre-prepared plan, in order to save lives and reduce property losses (Section 5.1.2).
   iii. After disaster stage: Where rescue and ambulance operations are carried out in addition to disaster recovery and rehabilitation of infrastructure and property. Moreover, restore the disaster-affected area to the normal situation as soon as possible (Section 5.1.3).

f. Examine the applicability of the SDMS:

The following points can be the most significant findings of this research because these points will answer the research question in (Section 1.4):

a) This research is able to develop an enhanced system of disaster management called Smart Disaster Management System (SDMS). Based on ICT especially the Internet of things and Artificial intelligence.
b) This study is able to prepare and explain a conceptual design for SDMS in order to define all the requirements of this system as well as the activities of the system to provide a clear vision for the developers to implement the system.
c) This investigation is able to visualize all system participants as well as the activity of each participant by using the UML diagrams (Use case diagram and Activity diagram).
d) The implementation of SDMS will increase the citizen readiness towards ICT and Disasters because it will facilitate the use of the system applications and it will make the citizens more interested in disasters (Questions 1 and 2). Therefore, the SDMS will satisfy the end-user (Question 3).

7.2. Research Contribution

After completing all parts of this research, the contribution of this thesis can be summarized as follows:

1. Clarification and scientific proof of the problem of citizens in terms of lack of readiness towards the use of ICTs and disasters by conducting a questionnaire form and making the statistical analysis of the feedbacks.
2. Identify the common disaster types that affect Iraqi citizen, these types are (Flooding, Droughts, and Earthquakes).
3. In order to provide a clear vision to developers and readers, and implementers a detailed scenario was prepared for three types of disasters.
4. Propose an enhanced DMS called SDMS based on ICT, as well as the use of IoT and AI technology. In order to reduce the loss of life and property resulting from

disasters, in addition to saving time, effort and money by adding the smartness to all stages of the enhanced disaster management system.

5. Provide a clear vision to system developers by preparing a conceptual design for the SDMS, which includes a UML diagram (Use case Diagram and Activity Diagram). It also define all the system requirements and participants, as well as the declaration of duties of each participant.

The enhanced system contains many additions and features to facilitate the use of system applications in addition to reducing the proportion of errors caused by human decisions. Table 7.1 below, shows the differences between SDMS and the current disaster management system.

Table 7.1. Differences between SDMS and the current system.

	Current System	SDMS
Continuous monitoring using WSN	No	Yes
Real-time data	No	Yes
Using of AI in decision making	No	Yes
Using of ICT in alarming	No	Yes
Using of IoT in detect location and statistics	No	Yes
Using of IoT in remote control of power sources	No	Yes

7.3. Limitations

This research is limited to explain the problem of low readiness of Iraqi citizens towards ICT especially the use of E-government applications, as well as their low readiness towards disaster as a test sample. This study tries to find a solution to raise the readiness of citizens using modern scientific methods . The researcher hopes to expand the sample to include other countries. However, limited time and resources prevented the sample in this regard.

7.4. Future work

In this study, there are many issues that can be taken as future work, these are as follows:

1. The implementation of the SDMS.
2. Test the SDMS in a real disaster and make an evaluation for the disaster team performance.
3. Disasters are divided into two types, natural disasters, and man-made disasters. In this research, the natural disasters were defined. The future work of this research can be the definition of man-made disasters and find novel methods to use ICT to manage this type of disaster.
4. Increase the test sample to include more countries.
5. Prepare scenarios for the rest types of disasters.

7.5. Conclusion

The globe is exposed to various types of disasters, some of these disasters are natural and some are man-made. These disasters result in great loss of life and property. Over the years, researchers have tried to control these disasters and reduce their losses. This research discussed the possibility of using the information and communications technology especially E-government applications, and the Internet of Things in disaster management, where Iraq was taken as a sample for this research. The inception was with the motivation of this research. The repeated disasters to which Iraq was exposed and what resulted from these disasters are severe damage to life and property, as a result of the defect in the DMS in Iraq. All these reasons have motivated the researcher to find a way to improve this system using information and communications technology, therefore started the literature review, where many works of literature were reviewed and concluded, in order to declare the research problem and set the hypotheses for this research.

After setting hypotheses, a questionnaire form was prepared, the questionnaire, of course, was in the Arabic language because the research sample was the Iraqi citizens.

The questionnaire was distributed to the participants using the traditional method and the modern method, where it was printed on paper and distributed to the participants, in addition to using Google forms to distribute the questionnaire to the participants electronically. The received feedbacks were translated into the English language and coded to be used in statistical analysis, then the SPSS software for statistical analysis was used to analyse feedbacks. The results show that Iraqi citizen has lack of readiness towards the use of E-government applications as well as they have a lack of readiness towards disasters. The statistical analysis also shows that there are three types of disasters, which are affecting the Iraqi citizen (Flooding, Droughts, and Earthquakes).

The concluding part of this research is proposing an enhanced DMS called Smart Disaster Management System (SDMS) in order to increase the readiness of Iraqi citizens by applying recent ICT technologies like IOT and AI to handle disasters. Where a conceptual design for the SDMS is prepared, this conceptual design contains a scenario for each stage of the disaster management system's stages (before disaster, during disaster, and after disaster). A UML diagrams is prepared for each stage to explain the participants, activities, and position of each person within the system. In addition, another UML diagram is also prepared for the special cases of during disaster stage (Flooding, Forest fire, and Earthquake) to further explain the activities of these cases.

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