الجمهوريـة الجزائـريـة الديمقراطيـة الشعبيـة
République Algérienne Démocratique et Populaire
وزارة التعليـم العالـي والبحـث العلمـي
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique

Nº Réf : ……

Centre Universitaire
Abd Elhafid Boussouf Mila

Institut des Sciences et Technologie **Département de Mathématiques et Informatique**

Mémoire préparé en vue de l'obtention du diplôme de Master

En : Informatique
Spécialité : Sciences et Technologies de l'Information et de la Communication (STIC)

Scream to Survive(S2S) : Intelligent System to Life-Saving in Disasters Relief

Préparé par : -BOUZERAA Yehya
-SERRAR Aissa

Devant le jury

Dr. Mohammed LALOU.	**MCA**	**C.U.Abd Elhafid Boussouf**	**Président**
Dr. Nardjes BOUCHEMAL.	**MCA**	**C.U.Abd Elhafid Boussouf**	**Rapporteur**
Mr. Samir SELMANE.	**MAA**	**C.U.Abd Elhafid Boussouf**	**Examinateur**

Année Universitaire : 2019/2020

Acknowledgments

First we want to thank Almighty God, For giving us the strength and patience to accomplish this humble work.

We would like to express our deepest appreciation to our supervisor Mme. Bouchemal Nardjes for her enthusiasm for the project, for her support, encouragement and patience.

We would like to extend our sincere thanks to the committee members, Dr. Lalou Mohammed and Mr. Selmane Samir for accepting to judge this work.

Special thanks to our families for the support and for offering a suitable atmosphere to complete our dissertation.

Dedication

I dedicate this modest work to the most cherished beings in my life,
my family to whom I must thank them very much for their moral
and material support, understanding, tenderness, love and sacrifice.
To my very dear mother.
To my sisters.
To my dear friends.
To all my teachers from primary School till today.
To all members of my family.
To all my section colleagues.
To all who know me.

Yehya

Dedication

I dedicate this modest work my family and my friends.

Aissa

Abstract

Disasters are becoming more and more common around the world, making the use of technology important to guarantee people's lives as much as possible. One of the most modern advances of recent years is how AI is used in disaster relief. Researchers propose works based on new technologies (IoT, Cloud Computing, Blockchain, etc.) and AI concepts (Machine Learning, Natural Language Processing, etc.). But these concepts are difficult to exploit in low and middle socio-demographic index (SDI) countries, where most disasters happen in. In this paper we propose S2S intelligent system, based on voice recognition to life saving in disaster relief. Generally, a disaster victim is enable to access to his Smartphone and ask help, with this system, saying "help" will be enough to automatically send alerts to the nearest Emergency Operation Services (EOS). S2S is composed of two parts: Intelligent application embedded in citizens and victims Smartphones, and S2S System for the Emergency Operation Services.

لقد أصبحت الكوارث أكثر شيوعًا حول العالم ، مما يجعل التكنولوجيا مهمة لضمان حياة الناس قدر الإمكان. أحد أحدث التطورات في السنوات الأخيرة هو كيفية استخدام الذكاء الاصطناعي في الإغاثة في حالات الكوارث. يقترح الباحثون أعمالًا تستند إلى التقنيات الجديدة مثل إنترنت الأشياء، والحوسبة السحابية، و Blockchain، وما إلى ذلك ومفاهيم الذكاء الاصطناعي (التعلم الآلي، ومعالجة اللغة الطبيعية، وما إلى ذلك). لكن من الصعب استغلال هذه المفاهيم في البلدان ذات المؤشر الاجتماعي-الديمغرافي المنخفض والمتوسط ، خاصة وأن معظم الكوارث تحدث فيها.

في هذه الأطروحة نقترح نظام S2S الذكي، القائم على التعرف على الصوت لإنقاذ الحياة في الإغاثة في حالات الكوارث. بشكل عام، يمكن لضحية الكارثة الوصول إلى هاتفه الذكي وطلب المساعدة، باستخدام هذا النظام، ستكون كلمة "انقذني" كافية لإرسال تنبيهات تلقائيًا إلى أقرب مركز للحماية المدنية. يتكون S2S من جزأين: تطبيق ذكي مضمن على الهواتف الذكية للمواطنين والضحايا، ونظام S2S لخدمات عمليات الطوارئ.

Les catastrophes sont de plus en plus courantes dans le monde, ce qui rend la technologie importante pour garantir le plus possible la vie des gens. L'une des avancées les plus modernes de ces dernières années est la façon dont l'IA est utilisée dans les secours en cas de catastrophe. Les chercheurs proposent des travaux basés sur les nouvelles technologies (IoT, Cloud Computing, Blockchain, etc.) et les concepts d'IA (Machine Learning, Natural Language Processing, etc.) Mais ces concepts sont difficiles à exploiter dans les pays à faible et moyen indice socio-démographique (IDS), d'autant plus que la plupart des catastrophes surviennent. Dans cette thèse, nous proposons le système intelligent S2S, basé sur la reconnaissance vocale pour sauver des vies dans les secours en cas de catastrophe. Généralement, un sinistré est autorisé à accéder à son Smartphone et à demander de l'aide, avec ce système, dire aide suffira à envoyer automatiquement des alertes aux centres des opérations d'urgence les plus proches. S2S est composé de deux parties: Application intelligente embarquée sur les smartphones des citoyens et des victimes, et Système S2S pour les services d'opérations d'urgence.

Contents

List of Figures

List of Tables

General introduction

In recent decades, mobile devices and Internet have seen great developments, which have facilitated a human's lives and made their livelihoods easier, so the difficult thing became easy and the distant became close, people today look like they live in one small village, they do what was —before— a dream or impossible. But this is not at all, dealing with modern technology differs from one country to another and from one person to another. Some of them took advantage of it in good ways and made it a reason for their development and prosperity, and some of them did the opposite.

Among the greatest uses of modern technology, there are mobile devices and applications related to human's life, whether those that alert him to dangers in order to avoid them, such as "Disaster Alert [1]," or those that guide him to ways of survival in the wilds and forests such as "Cairn [2]," or those that benefit from a drop of blood and saves him from death, such as "Blood Donor [3]," in addition to other useful applications that help during emergencies and disasters.

It is noticeable that Algerian authorities don't have a mobile application that can help citizens during emergencies. We strive to be one of the contributors to enrich the technological community in a beneficial way. For that, we proposed a solution called "Scream to Survive".

S2S (Scream to Survive) is based on voice recognition and it is composed of two parts: Smartphone Intelligent Application installed on the citizen Smartphone and a desktop system installed on the Emergency Operation Services (Civil Protection).
The Smartphone intelligent application based on the voice recognition, is justified by the fact that an individual already in crisis could not be able to signal urgency to intervention team. This is a most helpless situation where affected people need help, but they do not have the ability to look for it.

Furthermore, Smartphone attracts the users and increasing its popularity worldwide due to its powerful processing and wireless network capabilities. It enables users to communicate and share information in an easy convenient way.

Our thesis consists of six chapters organized as follows:

- Disasters: concepts and definitions.
- Civil Protection.
- Related Work.
- Analysis and identification of needs.
- Tools and Implementation.
- Implementation.

Chapter 1

Disasters: concepts and definitions

1.1 Introduction

In this chapter, we will provide definitions and concepts about disasters, their types, and disaster management. Also,we will show the link between disaster management and national development.

1.2 Concepts

A Disaster

There are many different definitions of disaster. In Oxford dictionary, a disaster is *"a sudden accident or a natural catastrophe that causes great damage or loss of life".* While the United Nations Department of Humanitarian Affairs define a disaster as a serious disruption of the functioning of society, causing widespread human, material or environmental losses. Landsman in [4] define it as any event, typically occurring suddenly, that causes damage, ecological disruption, loss of human life, deterioration of health and health services, and which exceeds the capacity of the affected community on a scale sufficient to require outside assistance.

Most such definitions tend to reflect the following characteristics:

- Disruption to normal patterns of life. Such disruption is usually severe and may be sudden, unexpected, and widespread.
- Human effects such as loss of life, injury, hardship, and adverse effect on health.
- Effects on social structure such as destruction of or damage to government systems, buildings, communications, and essential services.
- Community needs such as shelter, food, clothing, medical assistance, and social care.

Disaster is an emergency of such severity and magnitude that the resultant combination of deaths, injuries, illness, and property damage cannot be effectively managed with routine procedures or resources, causing by the impact of a natural hazard in a vulnerable community.

In countries around the world, natural disasters have been much in the news. For example: Indonesia tsunami in 2004, Wenchuan (China) earthquake in 2008, freezing rain disaster in

southern China in 2008, devastating 2011 earthquake in Japan, flood disaster in India in 2013. China severe flood in 2016, 2018 Earthquake and Tsunami in Indonesia and the 2019 tropical cyclone in Mozambique, Zimbabwe, Malawi. The Figure 1.1 displays the number of disasters in the last 2 decades.

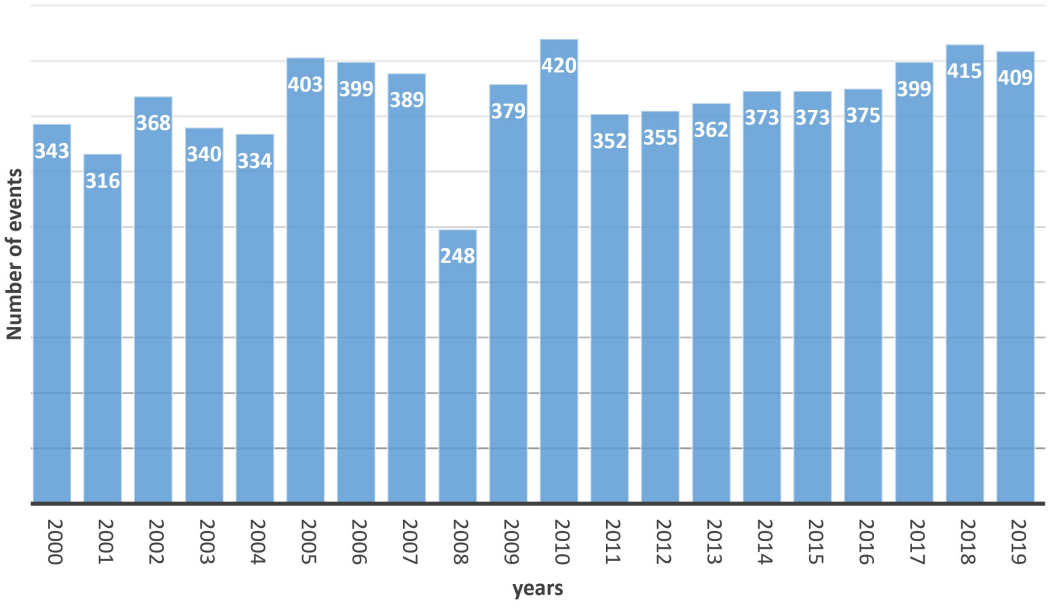

Figure 1.1: The increase in disasters from 2000 to 2019

B Natural hazard

Natural Hazard is a rare or extreme event in the natural or human made environment that adversely affects human life, property or activity to the extent of causing a disaster. It is essential to make a distinction between hazards and disasters, and to recognize that the effect of the former upon the latter is essentially a measure of the society's vulnerability.

C Vulnerability

Vulnerability is the susceptibility of a population specific types of event. Vulnerability is also associated with the degree of possible or potential loss from a risk that results from a hazard at a given intensity. The factors that influence intensity include demographics, the age, and resilience of the environment, technology, social differentiation and diversity as well as regional and global economics and politics.

Disaster mainly occurs when vulnerability and hazard meet. The interaction and association of such phenomena is depicted in the following figure:

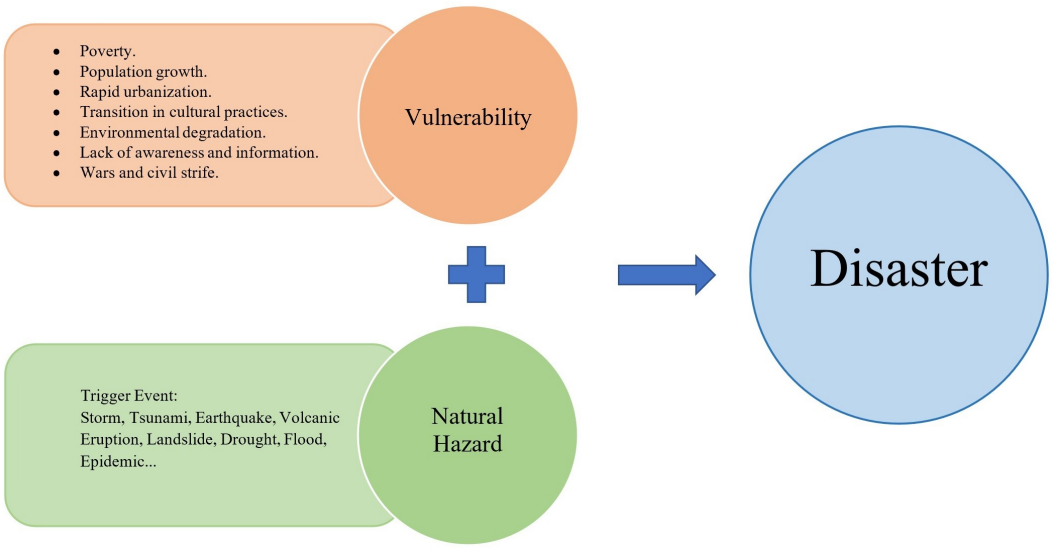

Figure 1.2: Vulnerability and natural hazards cause disasters

1.3 Disaster classification

Disasters are typically classified into distinct categories based on the cause of the hazard as either natural or human-induced:

A Natural hazard

Natural hazard Occurs as the result of action of the natural forces and tend to be accepted as unfortunate, but inevitable. The natural disasters result from forces of climate and geology. Natural disasters are perhaps the most “unexpected” and costly overall in terms of loss of human lives and resources. The following figure represents the number of natural hazard in 2018 classified by type:

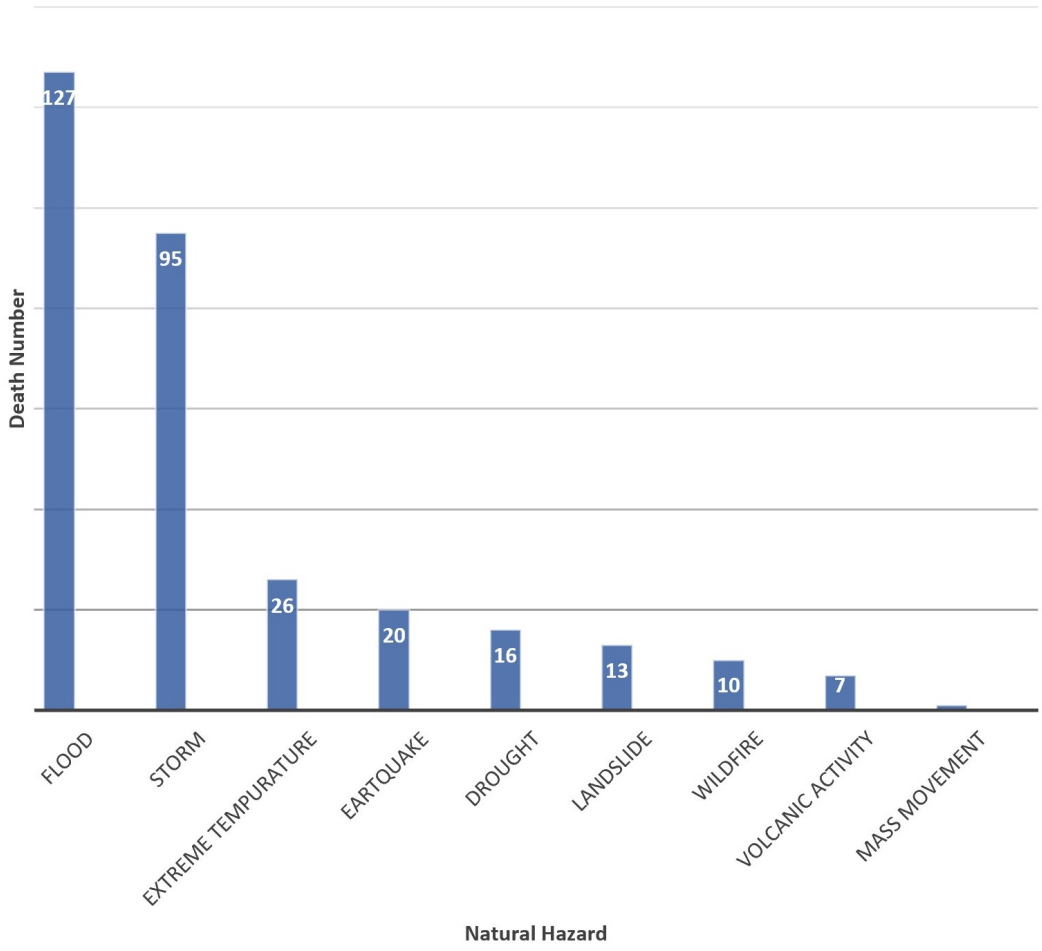

Figure 1.3: Number of deaths according to disaster types

B Man-made disasters

This category of disasters result from human actions or technological failures. Human activity has increasingly affected an environment's natural ecology and contributed to the manifestation of these disasters. For example, human activities (e.g., agricultural or other practices) that result in deforestation have led to landslides and drought. Similarly, the settlement of communities in flood zones or close to beaches and coastal areas has increased the human effect of floods and tsunamis. Most human activities directly responsible for creating disasters are related to technology or industry. Technological advances can and have resulted in creating both intentional and unintentional disasters. A technological disaster is attributed, in part or entirely, to human intent, error, negligence, or involves a failure of a manufactured system. An example of this is the 2010 Gulf of Mexico Oil Spill disaster, which resulted in the immediate death of 11 workers.

The following table shows a list of natural and human made disaster with characteristics and special problems for disaster management, classified into sudden and progressive occurrence according to the time of warning before the disaster:

			Characteristics	Special problem areas for disaster management
Natual disasters	Sudden occurrence and mono-causal	Tsunami	The velocity of the wave depends on the depth of water where the seismic disturbance occurs. Warning time depends on the distance from the point of wave origin.	Timely dissemination of warning. Effective evacuation time-scale. Search and rescue and recovery problem.
		Earthquake	Earthquake-prone areas are well identified and well known. Major effects arise mainly from land movement, fracture, or slippage.	Severe and extensive damage. The difficulty of access and movement. Recovery requirements may be very extensive and costly.
		Volcanic eruption	The volcanic blast can destroy structures and environmental surroundings. It can cause many other disasters like fire, explosion ...	Access during eruption. Timely and accurate evacuation decision(s).
	Progressive occurrence multi-causal	Landslide	Damage to structures and systems can be severe. Rivers may be blocked, causing flooding.	Difficulties of access and movement in affected areas. Search and rescue
		Drought	Periods of drought can be prolonged. Area(s) affected may be very large.	Response requirements may be extensive and prolonged.
		Flood	The speed of onset may be gradual or sudden. There may be seasonal patterns of flooding.	Difficulties of access and movement. Rescue medical and health difficulties.

		Epidemic	Disaster-related epidemic arises generally from the disrupted living conditions which follow disaster impact. Epidemic may arise from food sources and water.	Loss of medical and health resources during disaster impact may inhibit response capability.
		Tropical cyclone	Tends to conform to seasonal pattern. Major effects arise mainly from destructive force winds, storm surge and flooding from intense rainfall.	Assessing effects and needs may be difficult, especially due to bad weather following the impact of main disaster and to problems of access and movement caused by high damage levels.
Man-made disasters	Sudden occurrence and mono-causal	Fire	Fire threat tends to be seasonal. Effects can be very destructive, especially in loss of buildings, timber, and livestock.	Maintaining adequate community awareness and preparedness. The arsonist problem is difficult to counter.
		Major accident	Usually violent in nature. Can have limited or widespread effect. Speed of onset usually rapid.	Unexpected nature of accidents may pose problems of reaction and response time. Identifying victim may be difficult in some cases.
		Civil unrest	Usually the responsibility of police, paramilitary, and armed forces. However, other emergency services such as fire services, medical authorities, and welfare agencies become involved. Violent and disruptive activities occur.	Overloading of resource organizations because of demands of civil unrest incidents, in addition to normal commitments. Difficulty of integrating "peacetime" resource organizations with "military type" operations which are necessary to deal with violent civil unrest.

Table 1.2: Types of disasters.

1.4 Disaster threats

Disaster's effects generally fall into the following categories:

A Infrastructure damage

Damage may occur to houses, business centers, hospitals, and transportation services. The local health infrastructure may be destroyed, which can disrupt the delivery of routine health services to an affected population. People who vacate damaged housing and other buildings may be without adequate shelter. Roads may be impassible or damaged, hindering relief efforts, limiting access to needed medical supplies and care, affecting the distribution of food throughout the country, and increasing the risk of injuries as a result of motor vehicle incidents. Environmental hazards can cause a disruption to utility services (e.g., power, telephone, gas) and to the delivery of basic services. The Table 1.3 elucidates the cost of damage caused by disasters in 2018, by type of disaster:

Natural disaster	**Cost of damage (in Billion U.S Dollars)**
Storm	**70.8)**
Wildfire	**22.8**
Flood	**19.7**
Drought	**9.7**
Earthquake	**7.1**
Landslide	**0.9**
Volcanic activity	**0.8**

Table 1.3: The cost of damage caused by different disasters in 2018

B Human impacts

Injury or death are the most immediate effects of disasters on human health. In the wake of a disaster and the ensuing infrastructure and societal damage, morbidity rates for a variety of illnesses may increase as populations become displaced and relocated to areas where health services are not available. Or populations can find themselves in areas not equipped to handle basic needs at the level necessary to manage a surge of patients. Damage to infrastructure can lead to food and water shortages and inadequate sanitation, all of which accelerate the spread of infectious diseases. Loss of family member, social support networks, or displacement can result in psycho-social problems. Proper management of dead bodies also becomes a challenge and every effort should be taken to identify the bodies and assist with final disposal in accordance with surviving family member wishes and the religious and cultural norms of the community. The following bar chart show the number of deaths from natural disaster between years 2000 and 2019:

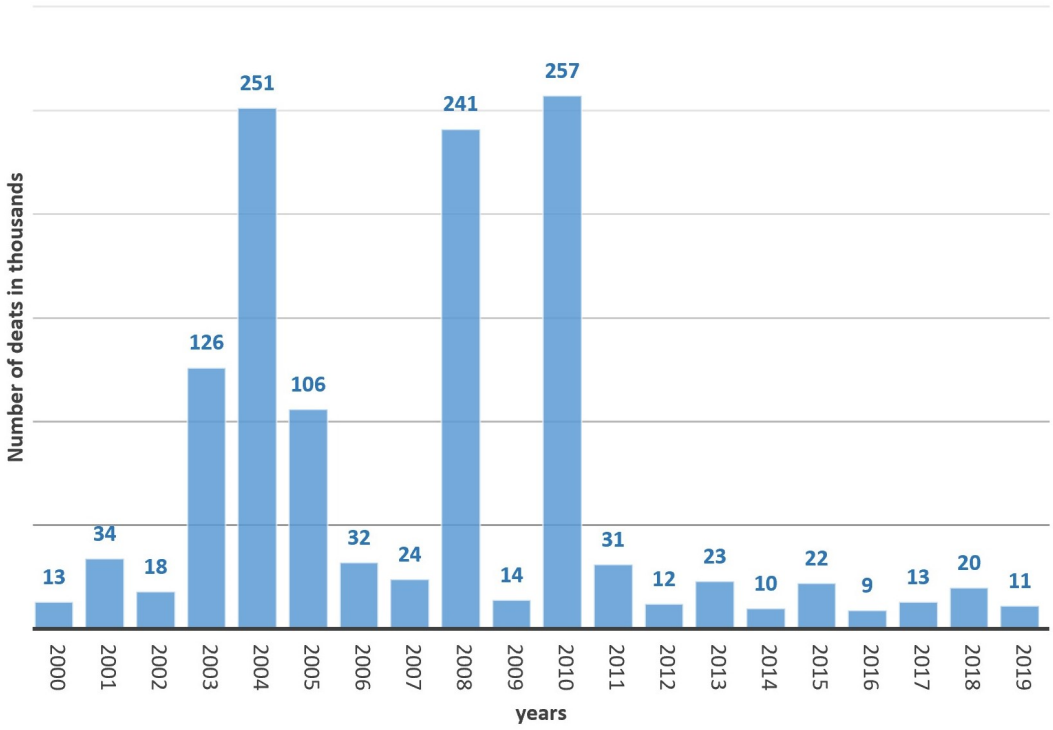

Figure 1.4: Number of deaths from natural disaster between years 2000 and 2019

C Environmental hazards

During natural or human-induced disasters, technological malfunctions may release hazardous materials into the community. For example, toxic chemicals can release and be dispersed by strong winds, seismic motion, or rapidly moving water. In addition, disasters resulting in massive structural collapse or dust clouds can cause the release of chemical or biologic contaminants. Flooded or damaged sewers or latrines may force people to use alternative methods for disposing human waste, potentially introducing additional environmental hazards into a community. Increase in vector populations, such as mosquitoes or rodents can pose a risk to human health, as can stray animals displaced by the disaster.

1.5 Disaster management

As per Disaster Management Act, 2005, "disaster management" means a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

- Prevention of danger or threat of any disaster.
- Mitigation or reduction of risk of any disaster or its severity or consequences.
- Capacity-building.
- Preparedness to deal with any disaster.
- Prompt response to any threatening disaster situation or disaster.
- Assessing the severity or magnitude of effects of any disaster, evacuation, rescue and relief.

- Rehabilitation and reconstruction.

Disaster Management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

1.6 Disaster cycle

Disasters are often thought of as happening in a cyclical manner, consisting of four phases: preparedness, response, recovery, and mitigation.

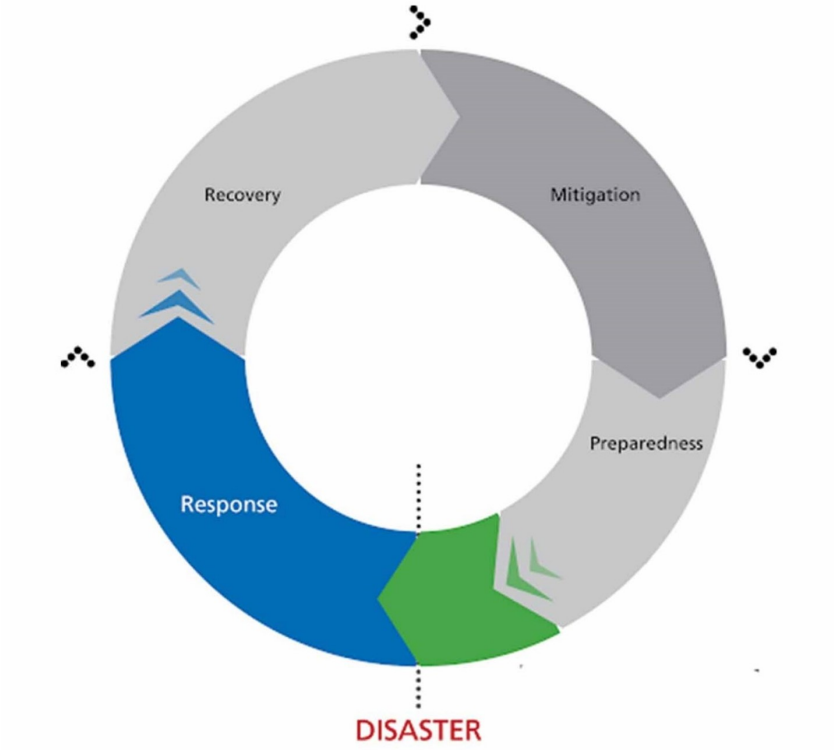

Figure 1.5: The 4 phases of disasters management.

A Preparedness

The preparedness phase includes the development of plans designed to save lives and to minimize damage when a disaster occurs. Disaster prevention and preparedness measures should be developed and put in place long before a disaster strikes. Preparedness plans should be developed based on the identification of potential disasters and the related risks associated with those disasters. When possible, this should include hazard mapping to specify locations at high risk for specific disasters. The plan should include training of health personnel, community members, and other potential first-responders, as well as establishing systems for communicating warnings to the community.

B Response

The response phase is the actions taken to save lives and prevent further damage in a disaster. This phase begins immediately after a disaster has struck. During the response phase, plans developed in the preparedness phase are put into action. While some disasters last only for a few seconds (e.g., earthquakes, explosions), others might last for several days, weeks, or even months (e.g., floods, droughts). The primary focus of the response phase is to provide relief and take action to reduce further morbidity and mortality. Such actions include providing first aid and medical assistance, implementing search and rescue efforts, restoring transportation and communication networks, conducting public health surveillance, and evacuating people who are still vulnerable to the effects of the disaster. Also, during this phase necessary supplies, including food and water, are distributed to survivors.

C Recovery

The recovery phase includes the actions taken to return the community to normal following a disaster. Actions during this phase include repair and maintenance of basic health services, including sanitation and water systems; repair, replace or rebuild property; and the proper management of dead bodies. Proper care of dead bodies is necessary to help minimize the psychosocial effects on families. The management of dead bodies involves a series of activities that begin with the search for corpses, in situ identification of bodies, transfer to a facility serving as a morgue, delivery of the body to family members, and assistance from local health authorities for the final disposal of the body in accordance with the wishes of the family and the religious and cultural norms of the community. Documenting the cause of death, manner of death, and relationship to the disaster is important to better understand the human health effects of a disaster.

D Mitigation

The mitigation phase is the sustained action or development of policies that reduce or eliminate risk to people and property from a disaster. During the mitigation phase, identified risks and population vulnerabilities are carefully reviewed to develop strategies to prevent re-occurrence of the same type of disaster in the future or limit the effect from such disasters. Existing preparedness plans are reviewed and revised to enhance the preparation efforts. A few examples of activities that could take place during the mitigation phase are building or strengthening dams and levees, establishing better and safer building codes, purchasing fire insurance, and updating land use zoning.

‘

1.7 Disaster management and national development

populations in low-income countries, those where large percentage of the population still live in extreme poverty, or score low on the human Development Index are more vulnerable to the effects of natural disasters.

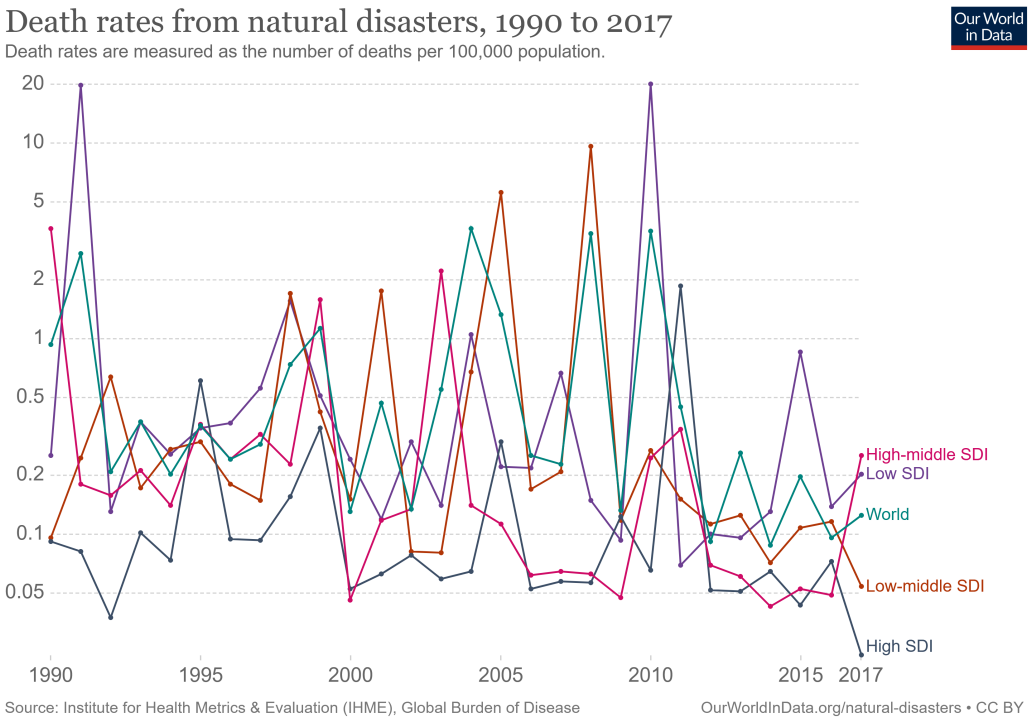

Figure 1.6: Link between poverty and deaths from natural disasters (Death rates from natural disasters)

We see this effect in the visualization shown in Fig. This chart shows the death rates from natural disasters the number of deaths per 100,000 population of countries grouped by their socio-demographic index (SDI). SDI is a metric of development, where low-SDI denotes countries with low standards of living. What we see is that the large spikes in death rates occur almost exclusively for countries with a low or low-middle SDI. Highly developed countries are much more resilient to disaster events and therefore have a consistently low death rate from natural disasters.

1.8 Conclusion

This chapter contains details about disasters, firstly , we have given some definitions and concepts about disasters, secondly, we have enumerated types of disasters, then, we have finished with disaster management.
The next chapter will be about the Civil Protection in Algeria.

Chapter 2

Civil Protection

2.1 Introduction

In this chapter, we will give a brief overview of the Civil Protection and its directorates. Also, we will present the organization of each directorate.

2.2 Civil Protection

Civil protection refers to all emergency management tasks taken by federal, state and governments. It encompasses all civilian measures to protect the population against the impacts of serious emergencies, disasters and wars.

In Algeria civil protection is responsible for the protection of people, property and the environment. It was created under the decree number 64_129 of April 15^{th}, 1964.

Algerian civil protection has the mission of emergency relief to victims of accidents, disasters or catastrophes and their evacuation to hospitals. It also has the task of preparation of the safeguard and the organization of emergency resources, the fight against fire, the prevention and assessment of risks to civil security.

2.3 Organization

The General Directorate of Civil Protection consists of 4 directorates and one General Inspection:

- Directorate of Prevention.
- Directorate of Organization and Coordination of Relief.
- Directorate of Personnel and Training Management.
- Directorate of Logistics and Infrastructure.

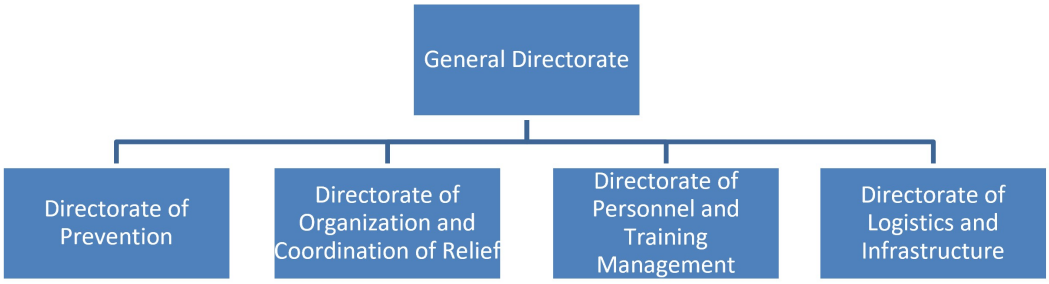

Figure 2.1: Organigram of Civil Protection in Algeria

A Directorate of Prevention

This directorate takes care of the activities developed by the civil protection for the studies and definition of general rules and safety standards applicable in terms of prevention in the different sectors. It studies and follows-up measures taken against major risks. It consists of 3 sub-directorates:

- Sub-Directorate of Major Risks.
- Sub-Directorate of Studies Regulation.
- Sub-Directorate of Statistics.

B Directorate of Organization and Coordination of Relief

It is responsible of studying and definition of means and rules for organization, preparation and implementation of relief operations. It organizes first aid operations in major risks. This directorate consists of 4 sub-directorates:

- Sub-Directorate of Operational planning.
- Sub-Directorate of Operations.
- Sub-Directorate of Communication and Operational Links.
- Sub-Directorate of Medical relief.

C Directorate of Personnel and Training Management

It is responsible of management and distribution of human resources, definition of training policy and setting of educational programs and definition of rules and conditions of their implementation. It consists of 3 sub-directorates:

- Sub-Directorate of Personal Management.
- Sub-Directorate of Social Actions.
- Sub-Directorate of Training.

D Directorate of Logistics and Infrastructure

It takes care of studying and implementation of infrastructure and equipment programs, which set and execute budget forecasts and define and control the conditions of the management and maintenance of civil protection infrastructure and equipment. It consists of 4 sub-directorates:

- Sub-Directorate of Budget and Accounting.
- Sub-Directorate of Infrastructure.
- Sub-Directorate of Equipment and Logistics.

2.4 Civil Protection Directorates of Wilaya

In Algeria, each wilaya has its own directorate, its resources and specialties which change from one wilaya to another. So, there is 48 civil protection directorates (CPD), and each one has specialized section:

- RIGDE (Recognition and Intervention Group in Danger Environments).
- Aquatic Rescue (divers nautical rescuers).
- Sections specialized in technological and chemical risks.
- Clearance rescue units (rescuers specializing in natural disasters).
- USAR Urban Search and Rescue Units.
- Civil protection air group (for sensitive missions such as escorts of seriously injured or forest fires ...).
- Motorcyclists (rapid intervention units).
- Technical Unit (composed of heavy trucks and vehicles specialized in the repair and extraction of vehicles).

2.5 Relief Operations

Relief operations start when a citizen falls in an emergency case, peoples around him try to ask help from civil protection using phone numbers.

Agent in civil protection center receive calls for help from citizens or emergency warnings from coordination center (center of coordination between different Algerian authorities). Agent try to get full information about emergency from citizens or coordination center. Generally, the information is about:

- Type of emergency to precise which group of rescues should intervene in this emergency case.
- Exact location.

- Exact time of emergency accident.
- Medical information (Chronic diseases...) to know victim who needs special measures.

After getting basics emergency information, officer triggers alert to rescue groups who are interfering directly to emergency location taken needed means according to emergency type, after take all emergency information, they try to save victims and take them to hospital.

2.6 Relief Operations Problems

In rescue operations, officers, agents and citizens are exposed to many problems that can inflict death on victims.
These are some of the most common and severe problems:

- In one second, we can save or lose lives. Victims spend significant time looking for a way to connect to the Civil Protection Center, and because of the stress, it will take a long time for officers to collect enough information about the emergency, they will waste more time on the road between the center and the accident location.
- In many cases, officers receive false or incomplete information about the emergency, so the more accurate information is, the more effective rescue operation will be.
- The rescue operation requires good coordination between officers and volunteers near the accident.
- Agents need an effective way to send urgent instructions to people around the accident.

2.7 Conclusion

In this chapter we gave a brief overview of The civil Protection and its directorates. Also we present the organization of each directorate.
In the next chapter, we will see how new technologies helped in disaster management.

Chapter 3

Related Work

3.1 Introduction

Disaster management demands fast and effective action, often in life-threatening situations. It requires collaboration between numerous people and groups: the personnel at an incident site, in the emergency vehicles, at the command and dispatch centers, at hospitals, etc. In addition, major incidents like train accidents, industrial accidents and chemical spills are characterized by having too few resources for the amount of work to be carried out. The dynamic changes in the situation, including the position of victims, professionals, vehicles and other resources, make it extremely difficult for anyone to obtain and maintain a situational overview, both on superior and specific levels.

3.2 New technologies for disaster management

Emerging technologies present greater opportunities to make emergency management systems intelligent, protected, and efficient. Today, artificial intelligence (AI), Internet of Things (IoT), cloud computing and blockchain offer the potential to generate, transmit and read emergency-related data for better connection and decision-making in disasters management.

A Blockchain

Blockchain technology has become popular since the introduction of bitcoin as a digital currency in 2008. This technology supports peer to peer version of electronic cash that allows online payments to be sent directly from one part to another without any intermediary financial institution [5]. A Blockchain is a shared, distributed, tamper-resistant database that every participant on a network can share, but no one controls it entirely. It has two fundamental features: The Blockchain is public. Anyone can view it at any time because it resides on the network and not within a single governing institution, which has the responsibility of maintaining and recording of any event. It is also encrypted. Encryption is one of the most important functioning/feature of Blockchain. Even though the information and records of all the events, transactions or communication are present in the network and available for everyone, it uses encryption involving private and public keys in order to provide better security.

Blockchain technology can be a boon in the area of disaster management as it can behave as

the central system of all the operations. All the respective parties can come together and join the blockchain network making it a transparent and distributed way of help provision. A blockchain solution empowers the key players/associations during disaster management to communicate adequately and follow up on time. It enables the associations to utilize their current ecosystem to facilitate a service and distribute on this system. All transactions are recorded on the system. The record once generated cannot be edited or tampered once created. This way blockchain provides a secure environment. This leads to a generation of trust, which supports governance and accountability.

Sadaqa [6] is a system empowers Donors to donate money to fundraising organizations or send money for goods (clothing, toys, food), to solicitors who then distributes it to the people who are in need of charity. In this system, the block content stores the Recipients identity, Donors identity, amount of funds to send, and conditions of a contract, which contains the estimated price and quantity of goods to be supplied to the Recipients address.

B Machine learning and data mining

Machine learning is a branch of computer science (more precisely artificial intelligence) that is concerned with developing methods and algorithms that learn characteristics and patterns from available data in order to make predictions. The main focus of ML is to develop methods that can build models that describe data (and preferably underlying mechanisms) faithfully. Practical examples of ML application are e-mail spam filters: these software tools embodied into e-mail servers are able to automatically identify spam e-mails with great accuracy. The 'logic' behind these filters is learned automatically by analyzing content of e-mails and the users' behaviors, [7].

Data mining is a feature of the conversion of data into some knowledgeable information. This refers to the process of getting some new information by looking into a large amount of data available. Using various techniques and tools, one can predict the information that is required from the data, only if the procedure followed is correct. This is helpful in various industries to extract some required information for future analysis by recognizing some patterns in the existing data in databases, data warehouses, etc.

DM and ML is helpful in prevention of different threats posed by man-made disasters, example of ML and DM application: detecting terrorist threats by analyzing data circling on computer networks and social media networks, or face recognition at crowded setting. Some other systems are using DM in preparedness operations, combining spatial data and evacuee behaviors in order to identify potential threats safe areas. It can be used also to augment the using of social media on detection of damage areas, by collecting different geo-tagged photos posted in social media.

The approach proposed in [7] is based on analyzing social media posts to assess the footprint of and the damage caused by natural disasters through combining machine learning techniques for semantic information extraction with spatial and temporal analysis (local spatial auto-correlation) for hot spot detection.

C Ad hoc networks

Ad hoc network is a group of "locally-available" devices that can connect and talk to each other directly whenever needed without the need of any router or server. This network breaks when the connected devices go out of the network i.e. disconnect from the network, so the network breaks with the closing of the Ad hoc connection [8]. The problem with traditional networks is that they need a central equipment responsible for controlling in the flow of data. This is why networks are often disrupted in disasters because this central equipment is disrupted.

Authors in [8] propose a model for the disaster survivor detection based on extremely critical disaster situation where Ad hoc network architecture can successfully trace and locate thousands of people in critical circumstances. The emphasis of the research focuses on earth quake based disasters. This model can also be successfully integrated with Telemedicine based infrastructure for emergency response authorities to take necessary measures in a limited span of time.

D Natural Language Processing (NLP)

Natural Language Processing is the technology used to aid computers to understand the human's natural language. Natural Language Processing, usually shortened as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The use of NLP to understand social, political, and economic processes aspects in disaster management has become popular with the increase in the volume of data about human communication, including text, audio, and video [9].

Example of applications include automatic extraction of international events from political context [10], public opinion measurement from social media posts [11], sense of place [12], and community happiness [13]. There are a growing number of uses of NLP methods to understand topics of disasters [14, 15].

3.3 Intelligent systems based on new technologies in disaster management

Emerging technologies present greater opportunities to make emergency management systems intelligent, protected, and efficient. Today, Internet of Things (IoT) and cloud computing potential to generate, transmit and read emergency-related data for better decision-making in crises.

Internet of Things (IoT) refers to a system of interconnected objects having unique identity and connecting using standards protocols, this objects can be real entity such as mechanical devices, sensors, home appliance, vehicles, etc. or virtual entity like intelligent software agents and virtual data. These objects are connected in order to collaborate and collect more data and share it easier. In addition, IoT has adequate potential to realize complex decision support systems by delivering the required services in a more precise, organized and intelligent manner [16].

Cloud computing is providing different facilities and amenities like databases, servers, storage, applications, etc. through the Internet. Instead of storing data in local storage on a

hard drive, cloud computing helps us in storing and saving data on a remote database. Given that the device we are using has access to the internet, it will have access to the data as well.

As it relates to emergency management, IoT can be used to enhance data collection from the physical environment and quickly communicate this data to different city departments. During a crisis, IoT technology can help by continually updating which evacuation routes are no longer available and what transit options are up and running, for safer, faster mass people movement, [17]. Say there's a fire in a building or a stadium: IoT-powered systems can help direct individuals to all approved exits, while providing updates on which to avoid, [18].

Authors in [19] proposed an approach based on the ant system algorithm and Internet of Things. IoT was used to consider smoke concentration, temperature carbon monoxide concentration. Then, they apply ant colony algorithm for intelligent evacuation. The purpose of intelligent evacuation is achieved. Furthermore, based on the research foundation of building data model construction, intelligent evacuation application, indoor location, shortest path solution and other issues, an intelligent evacuation system for large public buildings based on mobile terminal is constructed.

The proposed project in [20] is based on the powerful spatial analysis function of GIS, and uses the IoT, sensor network and artificial intelligence algorithm to analyze events in the intelligent space processing system, to support the development of intelligent evacuation systems for large public buildings. Large public building intelligent evacuation system takes mobile terminal as carrier, and install sensors, RFID tags, etc. in the interior space of the building, aiming to provide technical services such as emergency evacuation guidance and escape rescue for the personnel in the disaster.

In [21], the sensor network, which will be installed around 47 volcanoes that the Japanese government has selected for around-the-clock observation, will measure several different variables. In addition to the seismic activity that almost always occurs before an eruption, the sensors will monitor gas emissions, topography changes, and vibrations in the air caused by rocks and ash spewing from the volcano. The information gathered by the sensors will be transmitted via LoRa [22], gateways to manned monitoring stations located 5-10 km away from the volcanoes. LoRa, also known as LoRaWAN, operates using a chirp spread spectrum radio scheme, sending data through a series of gateways that serve as a bridge between the sensors and network servers.

BRINCO [23] system is the first IoT-enabled beacon that is designed to notify its user about possible earthquake or tsunami in personal-aware mode. The sensor system comprises of accelerometer, signal processing unit and audio alarm units. It works as follows. If it perceives a vibration of the ground, it sends this information to the BRINCO Data Center (BDC), a private cloud service. This DC assimilates this information with other seismic networks information to obtain its perception. Finally, if the judgment is good enough, it makes alarming sound and sends push notifications to it users smart phone (Android or iOS) instantly. Further, this information can be shared among the local as well as global community utilizing social network sites.

BRCK It is versatile IoT-enabled device meant to be used in poor infrastructures. This gives it power to connect with low connectivity areas where 2G communication still exists. It is also empowered with its private cloud service where environment data could easily be transmitted and fetched on. It is capable to work with solar energy, hence very much suitable for disastrous

sites where flawless power is a main constraint. The rugged design makes BRCK the most suitable product to be deployed in disaster management scenario. Users having smart phone can easily connect with it and share the information to other WiFi-enabled local devices.

A Discussion

Intelligent systems have some characteristics making them difficult to apply in middle and low SDI countries, where infrastructures are also poor. We present bellow some of these characteristics.

Data cannot be effectively collected

How to realize the integration of disaster data becomes an urgent and necessary key problem. AI related data include meteorological data, urban waterlogging data, socio-economic data, and other sources, and the amount of data is huge. Furthermore, as the data come from different departments such as water conservancy, meteorology, urban management, operators and Internet, the spatial and temporal scales are not compatible with each other, and the format standards are not unified, which poses a great obstacle to the AI for natural disasters, [24, 25].

Incomplete information

Decision is a question of timing, and this is particularly prominent in intelligent systems because of the sudden, rapid evolution of disasters. Short time emergency decision face the restriction of personnel, resources, information and other factors, therefore, decision information is discredited and incomplete, [26, 27]. How to deal with the incomplete information constraint is a difficult problem faced by intelligent systems.

Data unavailability

Intelligent information processing techniques based on AI and machine learning such as big data mining, remote sensing and GIS are promising methods, especially when applied with a combination of conventional forecasting approaches working to update dynamic demand information. However, its application is constrained due to the lack of data availability from governments concerning risk and safety issues during the urgent and limited time after unconventional emergency events have occurred. From this perspective, the access to open source data from governments should be properly unimpeded, [28].

Prediction problem

In emergency situations there is an inherent demand uncertainty, requiring a large scale of data sources to explore the characteristics of the target prediction case. A great deal of crucial information required for demand predictions is difficult to obtain in the hours immediately after an emergency event. Additionally, in order to save as many lives as possible, analysis of large-scale data requires information processing techniques and methods to be rapid and efficient, making the demand prediction problem based on information processing techniques unique and challenging.

3.4 Mobile applications for disaster management

There are plenty of mobile applications that can help during disasters, the following are some of the most successful ones.

A FEMA (Federal emergency Management Agency)

The FEMA App [29] provides timely alerts and useful information to help you and your loved ones stay safe before, during and after disasters. Receive and share real-time notifications about disasters, severe weather, and other emergencies for up to five locations nationwide. This simple and easy-to-use resource also provides safety information, emergency preparedness tips, and disaster assistance.
Stay informed:

- Receive real-time and reliable alerts about disasters, severe weather, and other emergencies for the places that matter to you.
- Safety and preparedness information available in English and Spanish.

Stay safe:

- Locate open emergency shelters in your area.
- Know what to do before, during, and after disasters, including wildfires, hurricanes, earthquakes, tornadoes, volcanoes, and more.

Stay connected:

- Share real-time alerts with loved ones via text, email, and social media.
- Find Disaster Recovery Centers nearby where you can talk to a FEMA representative in person.

B Disaster Alert

Disaster Alert [1] is put out by the Pacific Disaster Center. One of the best components of this app is the world map using different icons to show all the current disaster alerts around the globe.

This app provides individuals, families, and their loved ones with the information they need to stay safe anywhere in the world. Disaster Alert offers near real-time updates about 18 different types of active hazards as they are unfolding around the world.

With Disaster Alert, you can customize early warning alerts, view situational analysis reports, and access modeled hazard impacts for select hazards in a single, easy-to-use map interface. Disaster Alert's continuous stream of new information is automatically derived from only scientifically verified sources. When no official source is available, alerts are updated manually, presenting a small lag in time.

C eQuake (earthquake alerts)

eQuake is an earthquake early-warning app uses a network of seismic sensors to detect earthquakes. When an earthquake occurs, the servers send the user an early-warning notification that alerts the user of expected shaking in the area.

Another feature of eQuake is its capability to use your phone as a sensor which contributes to the earthquake warning system improving the coverage of seismic detection. The sensor mode only works when the device is charging and connected to a WiFi network.

This app provides a map of recent earthquakes that have occurred worldwide which uses USGS (United States Geological Survey) databases for the latest information.

D I-REACT

I-REACT aims to develop a solution through the integration and modelling of data coming multiple sources. Information from European monitoring systems, earth observations, historical information and weather forecasts will be combined with data gathered by new technological developments created by I-REACT. These include a mobile app and a social media analysis tool to account for real-time crowd-sourced information, drones to improve mapping, wearables to improve positioning, as well as augmented reality glasses to facilitate reporting and information visualization by first responders. With this approach I-REACT will be able to empower stakeholders in the prevention and management of disasters. Citizens will be involved in reporting first-hand information, policymakers will be supported in the decision-making process, and first responders will be equipped with essential tools for early warning and response.

E Red Cross Apps

An organization known to extend assistance during emergencies and disasters, the Red Cross is now into the mobile fever and has developed several apps that will make them accessible to people in need of their assistance.

- **First aid** provides information about the most common first aid assistance that can be given during emergencies and how to properly handle different cases.
- **Emergency** helps keep you and your loved ones safe by allowing you to monitor more than 35 different emergency and severe weather alerts.
- **Tornado** provides alerts issued by the National Oceanic and Atmospheric Administration (NOAA).
- **Hurricane** provides information about hurricane conditions in your local area and, at the same time, lets other people know that you are safe. The app will send alerts even if the power is out in your area.
- **Earthquake** provides notifications when the disaster strikes. Even when the power is out, it will allow you to find help and inform others if you are safe.
- **Flood** alerts you about flooding in your local area and provides you with information about evacuations and whether it is safe to return home.

3.5 Conclusion

In this chapter, we discussed some of the existing technologies and we mentioned some mobile applications that can help during emergencies.
In the next chapter we will analyze and identify the needs of the system to be realized.

Chapter 4

Analysis and identification of needs

4.1 Introduction

In this chapter we will analyze and identify the needs of the system to be realized. In the beginning, we will give an overview about Unified Modeling Language (UML), then, we will define the specifications that contain all the objectives of this project. after that, we will present the use case diagram of the system and its textual description together with some UML diagrams.

4.2 Unified Modeling Language (UML)

A Definition

Unified **M**odeling **L**anguage (UML) is a standerd vidual modeling language intended to be used for:

- modeling business and similar processes,
- analysis, design, and implementation of software-based systems.

UML is a common language for business analysts, software architects and developers used to describe, specify, design, and document existing or new business processes, structure and behavior of artifacts of software systems. UML can be applied to diverse application domains (e.g., banking, finance, Internet, aerospace, healthcare, etc.) It can be used with all major object and component software development methods and for various implementation platforms (e.g., J2EE, .NET) [30].

B Types of UML diagrams

UML uses elements and associates them in different ways to form diagrams that represent static, or structural aspects of a system, and behavioral diagrams, which capture the dynamic aspects of a system. There are 13 Diagrams in UML: Class Diagram, Component Diagram, Composite Structure Diagram, Object Diagram, Package Diagram, Activity Diagrams, Communication Diagram, Interaction Overview Diagram, Sequence Diagram, State Machine Diagram, Timing Diagram, Use Case Diagram [31].

Next we will define briefly the diagrams that we used for our system.

Use case diagram

Represents a particular functionality of a system, created to illustrate how functionalities relate and their internal/external controllers (actors).

Sequence diagram

Sequence Diagram Shows how objects interact with each other and the order of occurrence. They represent interactions for a particular scenario.

Class diagram

Class Diagram The most commonly used UML diagram, and the principal foundation of any object-oriented solution. Classes within a system, attributes and operations and the relationship between each class. Classes are grouped together to create class diagrams when diagramming large systems.

4.3 Drafting of specification

A Project display

S2S system combines the use of smartphones, widely spread even in developing countries, and voice recognition to help victims. Generally, a disaster victim is unable to access to his smartphone and ask help, with this system, saying ”help” will be enough to send automatically alerts to the nearest Emergency Operation Services (Civil Protection in Algeria).
The essential feature of this system is the ability to analyze victims voices, words, sentences, etc., in order to detect the emergency situation and immediately transmit victims GPS location, identification, etc. In Civil Protection side, after the first alert, the system save victim's GPS coordinates and collect instantly all near users locations (potential victims). It proceed to alert staff, family contacts and eventually nearest volunteers registered in the system. S2S is composed of 3 essential applications:

S2S Citizen is a mobile application for citizens and volunteers, this application collects voices, words or sentences said by the victim, the smartphone converts them into text in order to deduce the emergency or risk situation and its type if possible. Then, the application sends an alert message containing victim's information, his last location and risk type to the Civil Protection (EOS) and favourite contacts.

In S2S Citizen, there is a feature for volunteers where they can receive emergency information from EOS and try to help before the Civil protection agents arrive.

S2S Agent is a mobile application for Civil Protection agents, with this applications agents can reach the exact location of victims.

S2S EOS is a dashboard that allows officers and employees to receive alerts sending by victims and select the appropriate action plan according to emergency type. They can consult all medical and personnel information from database and send help to the exact location of the victim.

The system collects all near citizens positions. This information will be very useful for victims relief (earthquake for example). Furthermore, the system sends victims location to nearest volunteers and family contacts to increase surviving chance.

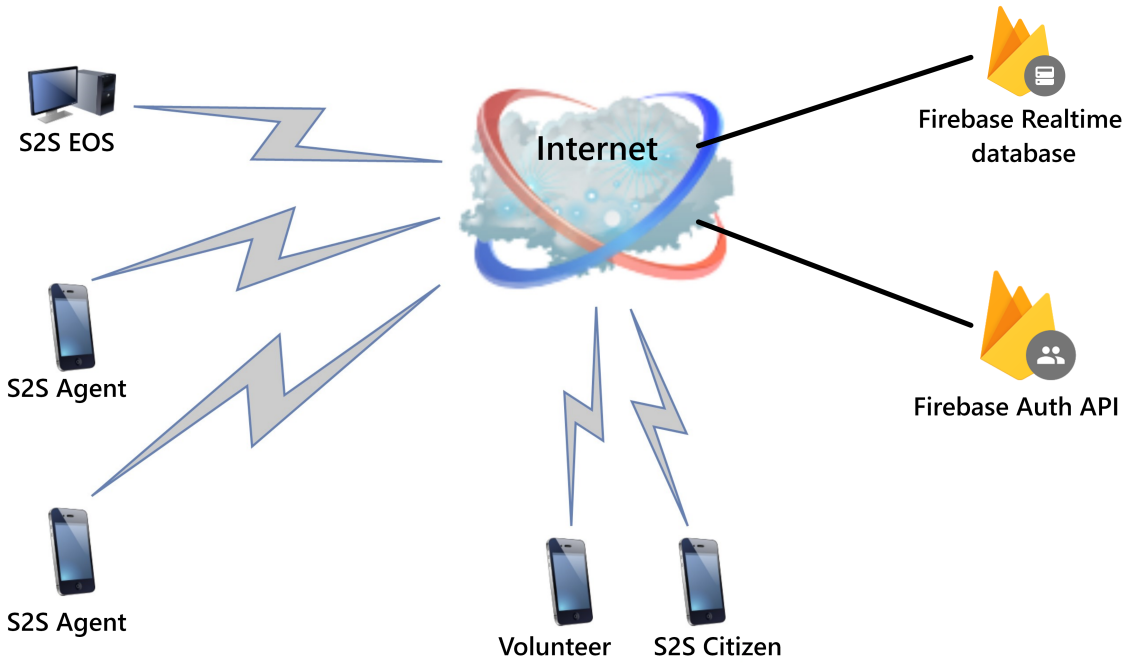

Figure 4.1: Global architecture of S2S

B Actors and functional requirements

S2S system four users, they are citizen, volunteer, administrators (emergency administrator and Management administrator), and agent.

- Citizen is any human being who has smartphone, he can:
  - Register in S2S Citizen.
  - Edit his personal and medical data.
  - Delete his account.
  - Sign in to S2S Citizen.
  - Send emergency information manually or using voice detection.
  - Cancel emergency sending.
- Emergency administrator can:
  - Receive emergency information and trigger alert.
  - Activate/Deactivate crisis mode.
  - Send emergency information to volunteers.

  - Send warning notification.
  - Search citizen.

- Management administrator can:
  - Send awareness campaign notification.
  - Search citizen.
  - Manage (add/ edit/ delete) citizen account.

- Volunteer is a citizen, but he can:
  - Receive emergency information.
  - Confirm/Cancel volunteering.

- Agent can:
  - Search citizen.
  - Consult emergency information.

C Use case diagram

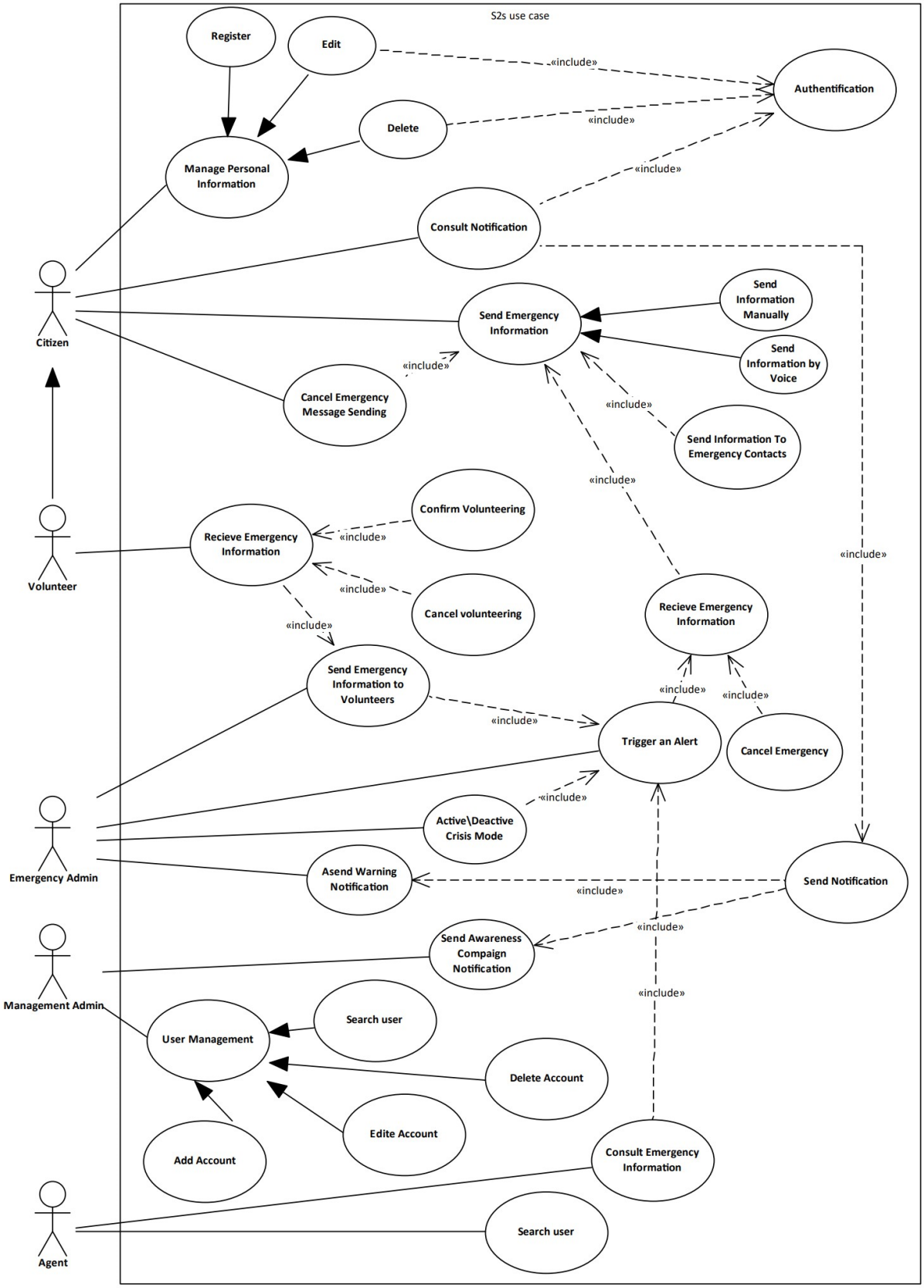

Figure 4.2: Use case diagram of the system

D Register (citizen)

Textual description of register (citizen).

Actor	**Citizen**		
Precondition	The citizen is not registered.		
Post-condition	The system creates a new account for the citizen with personal and medical information.		
Nominal Scenario	1	The citizen asks to register.	
	2	The System shows registration form.	
	3	The citizen inserts personal information.	
	4	The system verifies the existence of the citizen.	
	5	The system creates a new account for the citizen.	
	6	The system shows medical information form.	
	7	The citizen inserts medical information.	
	8	The system saves medical information.	
	9	System confirms new account creation.	
Optional Scenario	10	The citizen requests addition to volunteering list.	
	11	The system checks the existence of the citizen in the volunteering list.	
	12	The system marks the citizen as a formed volunteer.	
	13	The system confirms adding as formed volunteer.	
Alternative scenario	A	5	The system informs the citizen that he is already registered.
	B	12	The system marks the citizen as a simple volunteer.
		13	The system confirms adding as a simple volunteer.

Table 4.1: Textual description of Register (Citizen).

Sequence diagram of register (citizen)

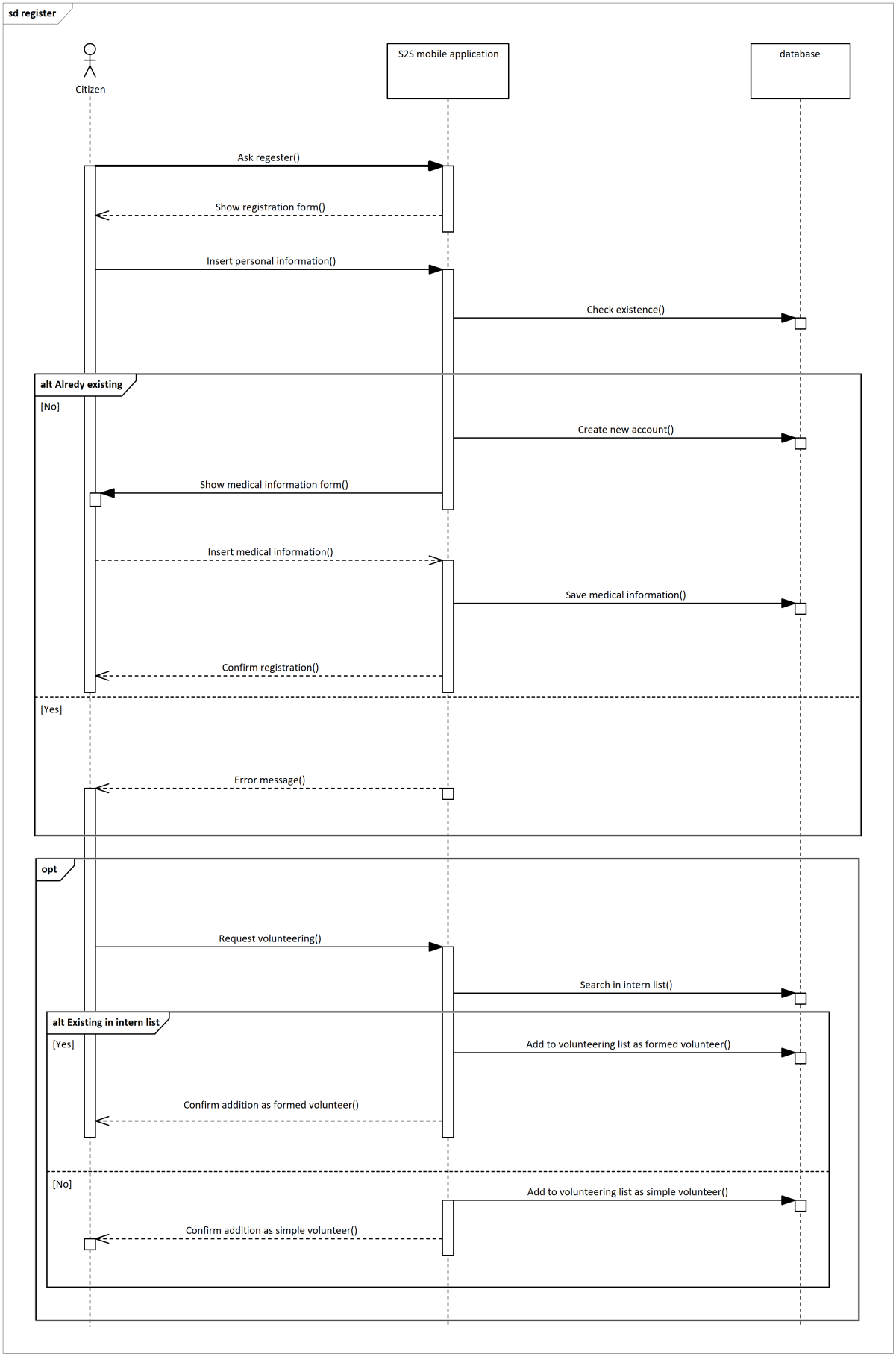

Figure 4.3: Sequence diagram of register (citizen).

E Sign in

Textual description of sign in

Actor	**Citizen**	
Precondition	The citizen already has an account.	
Post-condition	The system displays the citizen's home page.	
Nominal Scenario	1	The citizen asks to sign in using email and password.
	2	The System checks the existence of the account.
	3	The system display the citizen's home page.
Alternative scenario	3	The system asks the citizen to retry or register.

Table 4.2: Textual description of Sign in (citizen)

sequence diagram of sign in

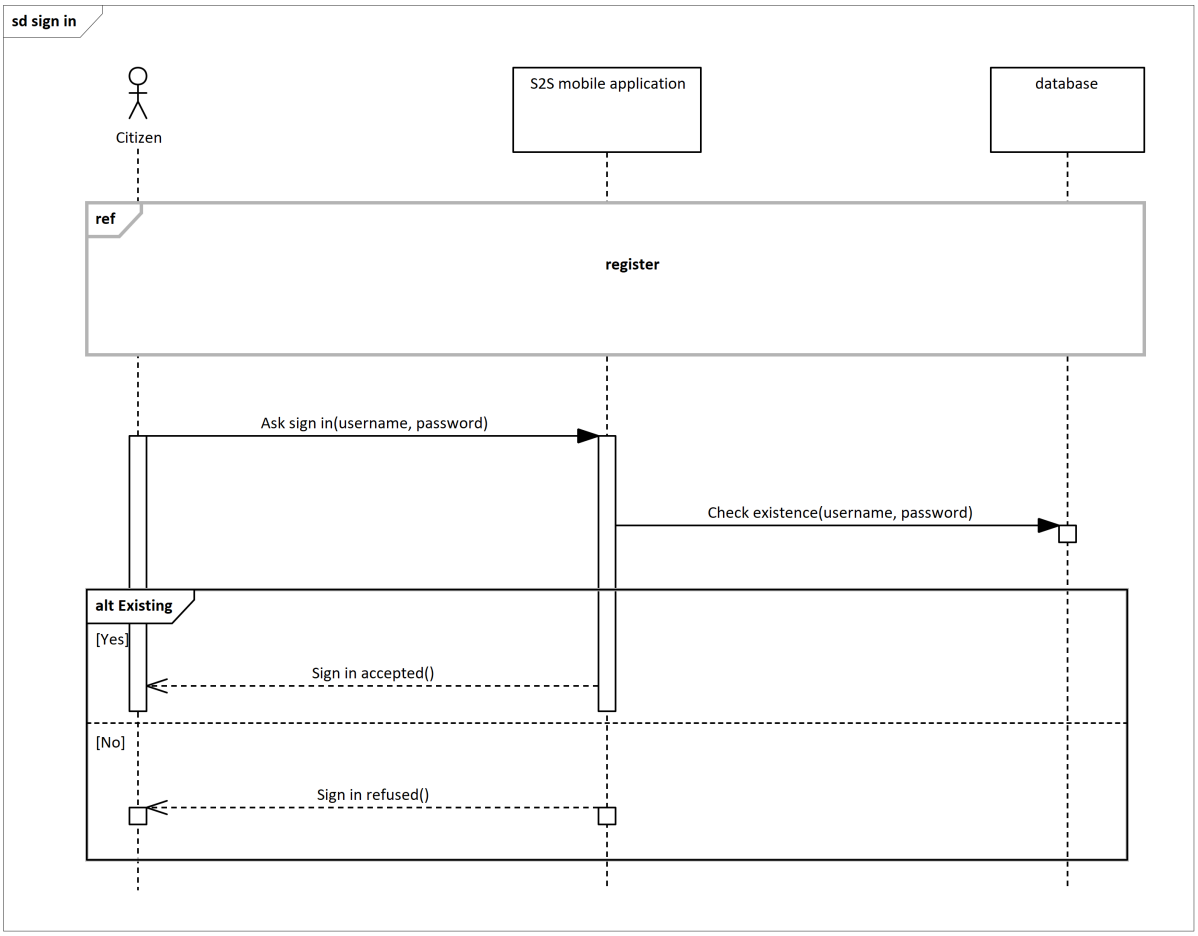

Figure 4.4: Sequence diagram of sign in.

F Edit information (citizen)

Textual description of edit information (citizen)

Actor	**Citizen**	
Precondition	The citizen is identified.	
Post-condition	The system edits the citizen's information.	
Nominal Scenario	1	The citizen requests editing his information.
	2	The System fetches citizen's data from database.
	3	The system display citizen's information.
	4	The citizen inserts new information.
	5	The system asks for confirmation.
	6	The citizen confirms editing.
	7	The system saves new information.
	8	The system sends edit confirmation message.
Alternative scenario	7	The citizen cancels editing.
	8	The system returns to edit page.

Table 4.3: Textual description of Edit information (Citizen)

Sequence diagram of edit information (citizen)

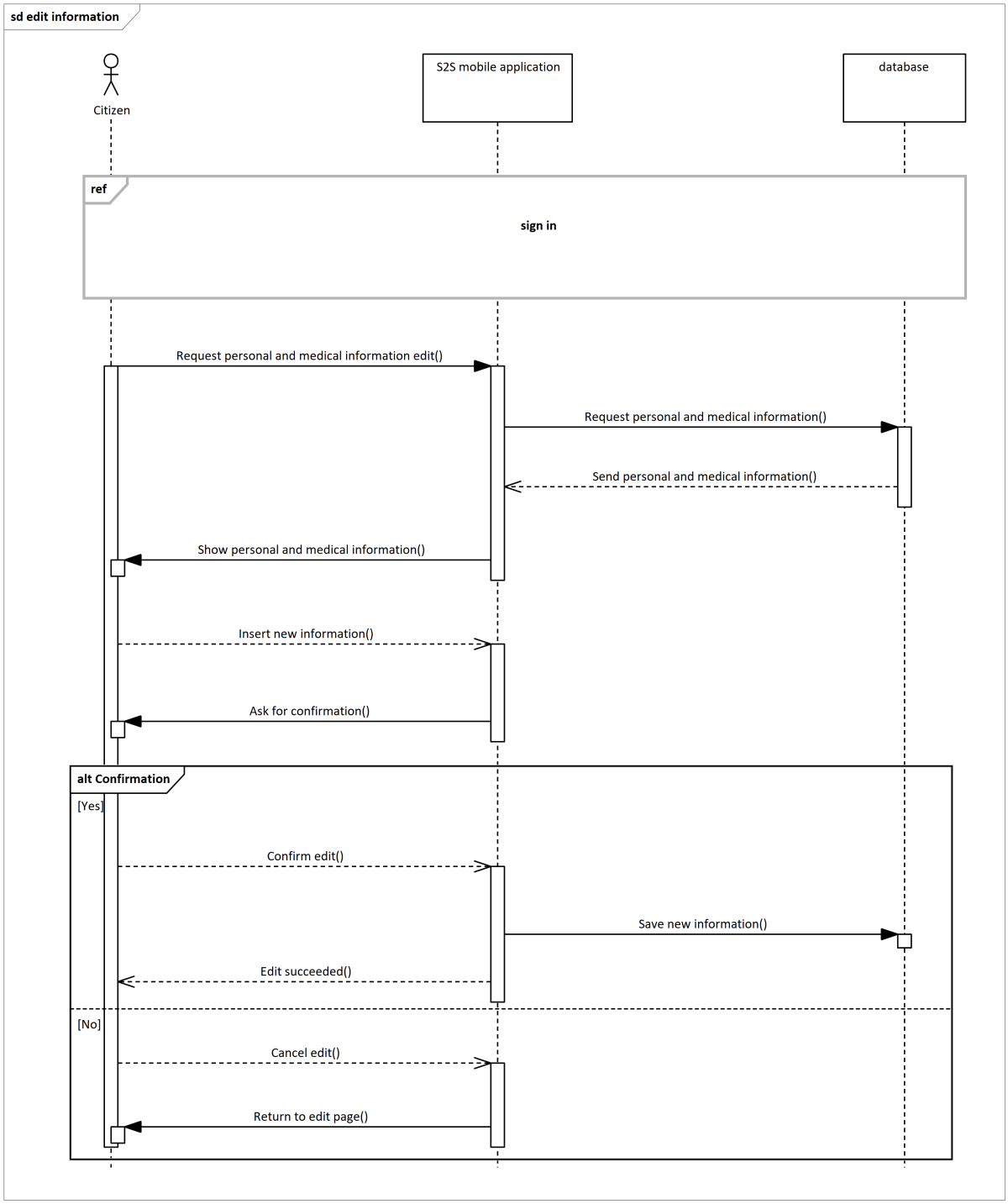

Figure 4.5: Sequence diagram of Eeit information (citizen).

G Consult notifications (citizen)

Textual description consult notifications

Actor	**Citizen**	
Precondition	The citizen is identified. Notification list is not empty.	
Post-condition	The system displays notification details.	
Nominal Scenario	1	The system shows the list of notifications.
	2	The citizen selects one notification.
	3	The system fetches notification details from database.
	4	The system displays notification details.

Table 4.4: Textual description of Consult notifications

Sequence diagram of consult notifications (citizen)

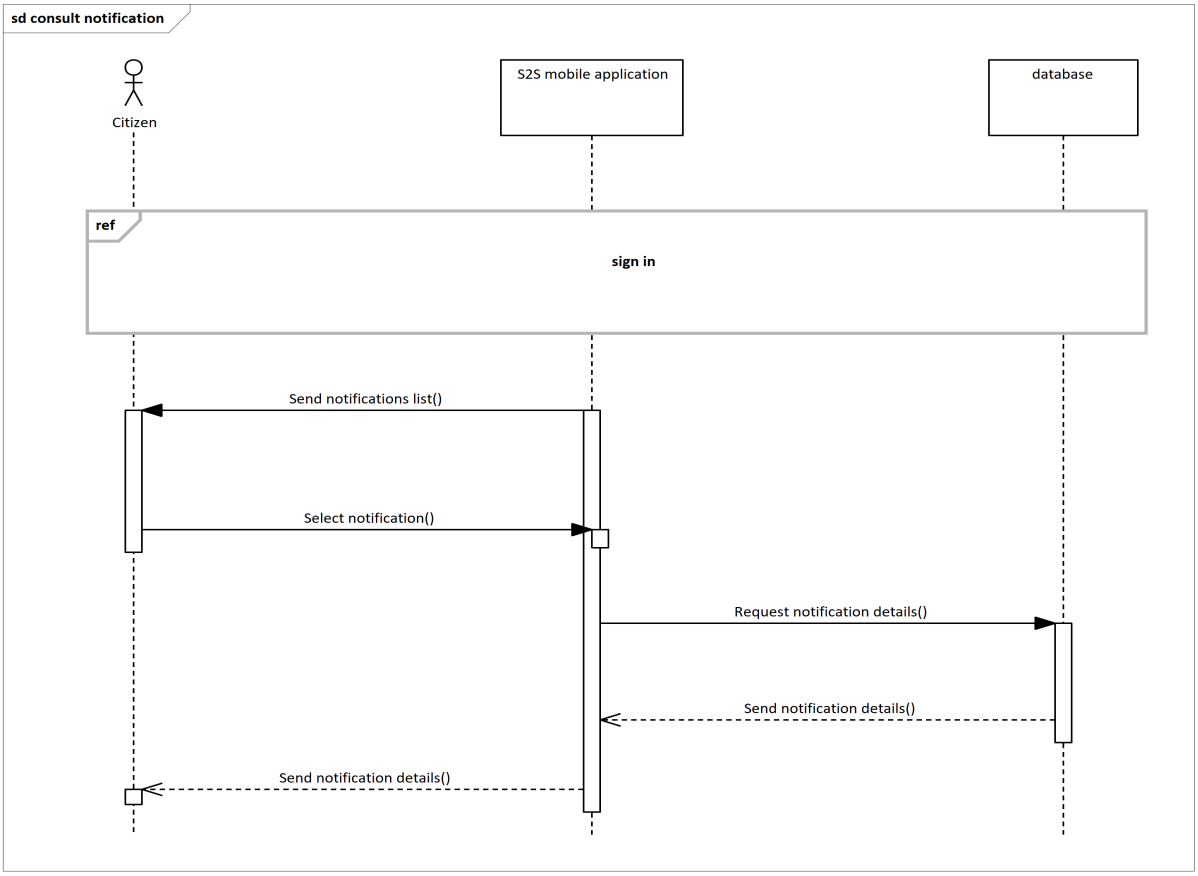

Figure 4.6: Sequence diagram of consult notifications (citizen)

H Send emergency information (citizen)

Textual description of send emergency information (citizen)

Actor	**Citizen**		
Precondition	The citizen is in emergency case.		
Post-condition	The system informs EOC and contacts.		
Nominal Scenario	1	The citizen screams (send emergency alert).	
	2	The System detects the emergency case using voice.	
	3	The system asks for confirmation.	
	4	The citizen confirms sending.	
	5	The system sends the emergency information to EOC.	
	6	The system sends emergency information to citizen's contacts.	
Alternative scenario	A	1	The citizen Requests alert form.
		2	The system sends alert form.
		3	The citizen inserts emergency information.
	B	4	The citizen cancels sending.

Table 4.5: Textual description of Send emergency information (Citizen).

Sequence diagram of send emergency information (citizen)

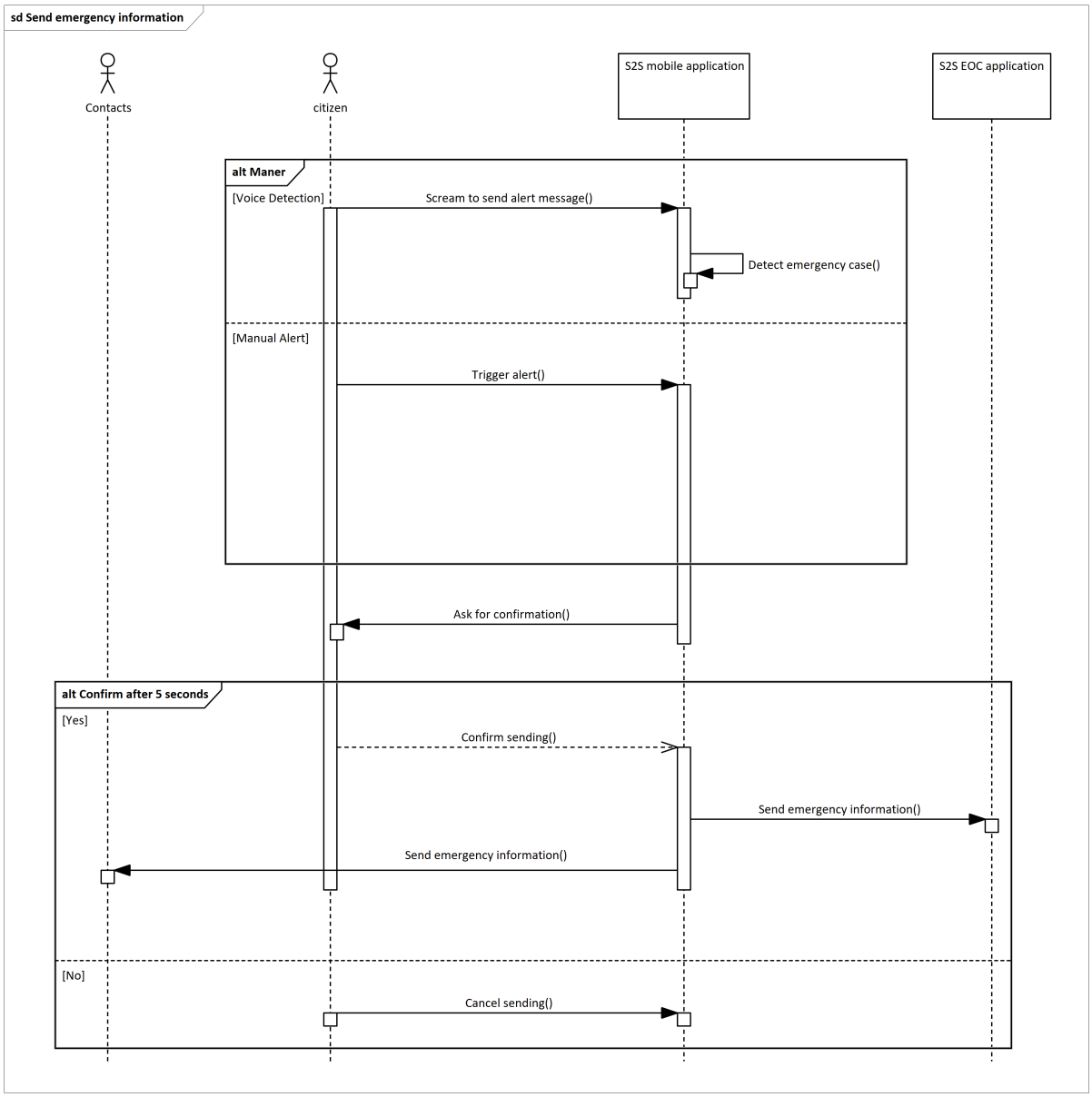

Figure 4.7: Sequence diagram of send emergency information (citizen)

I Confirm/Cancel volunteering (Volunteer)

Textual description of confirm/cancel volunteering (Volunteer)

Actor	**Volunteer**	
Precondition	Emergency message had sent by the emergency administrator	
Post-condition	The volunteer confirms or cancels volunteering.	
Nominal Scenario	1	The system sends emergency details.
	2	The volunteer confirms volunteering.
	3	The system sends confirmation message to the EOC.
Alternative scenario	1	The volunteer cancel volunteering.
	2	The system sends cancellation message to the EOC.

Table 4.6: Textual description of Confirm/Cancel volunteering

Sequence diagram confirm/cancel volunteering (Volunteer)

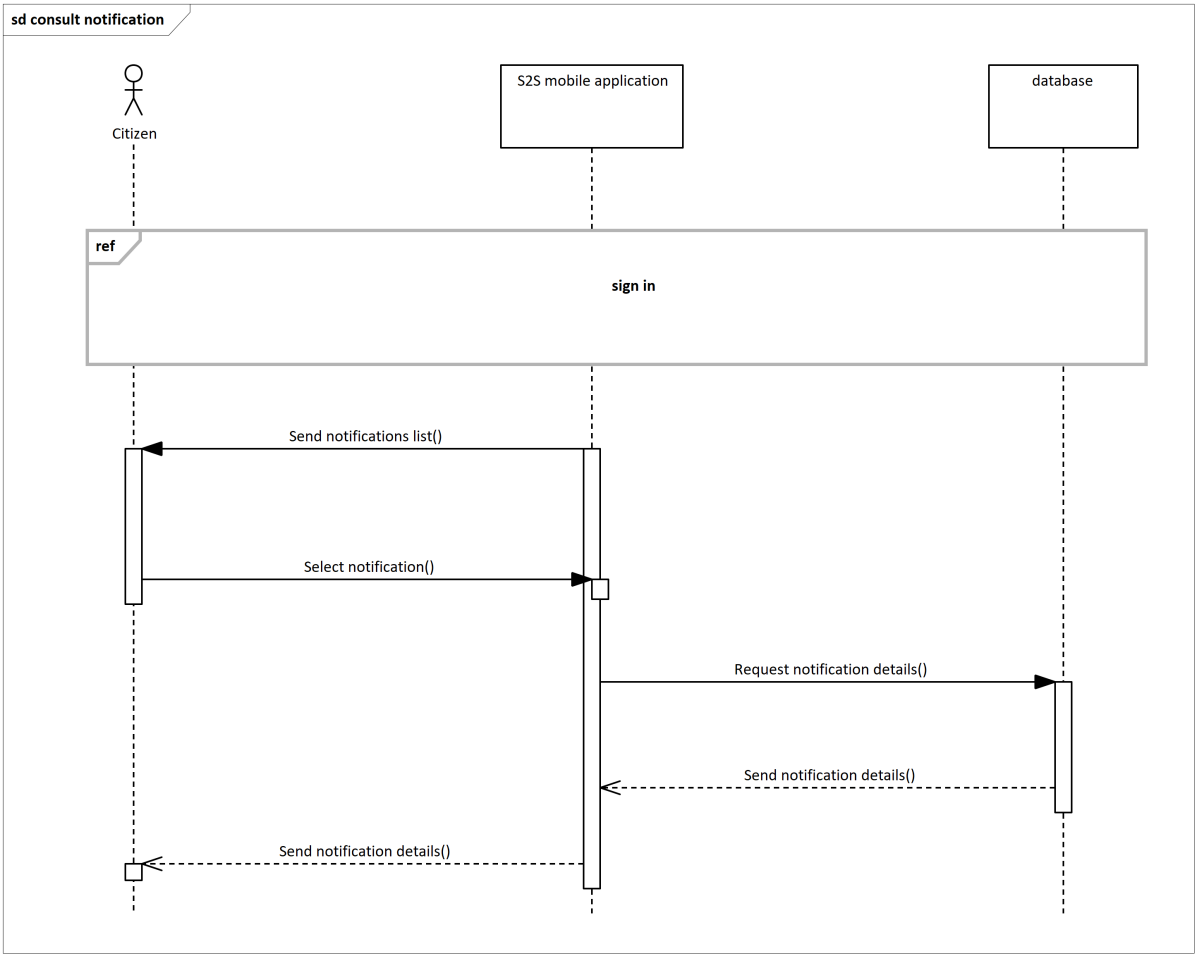

Figure 4.8: Sequence diagram of confirm/cancel volunteering (Volunteer)

J Search citizen (administrator)

Textual description of search citizen (Administrator)

Actor	**Administrator/Agent**	
Precondition	Administrator/Agent is identified.	
Post-condition	The system displays citizen's information.	
Nominal Scenario	1	The Administrator/agent requests search form.
	2	The system sends search form.
	3	The Administrator/agent select criteria and citizen's information.
	4	The system fetches matching data from database.
	5	The system displays the fetched data.
	6	The Administrator/agent selects one citizen.
	7	The system recovers citizen's information and displays it.
Alternative scenario	4	The system displays message "No matching result".

Table 4.7: Textual description of administrator searchs for a citizen

Sequence diagram search citizen (Administrator)

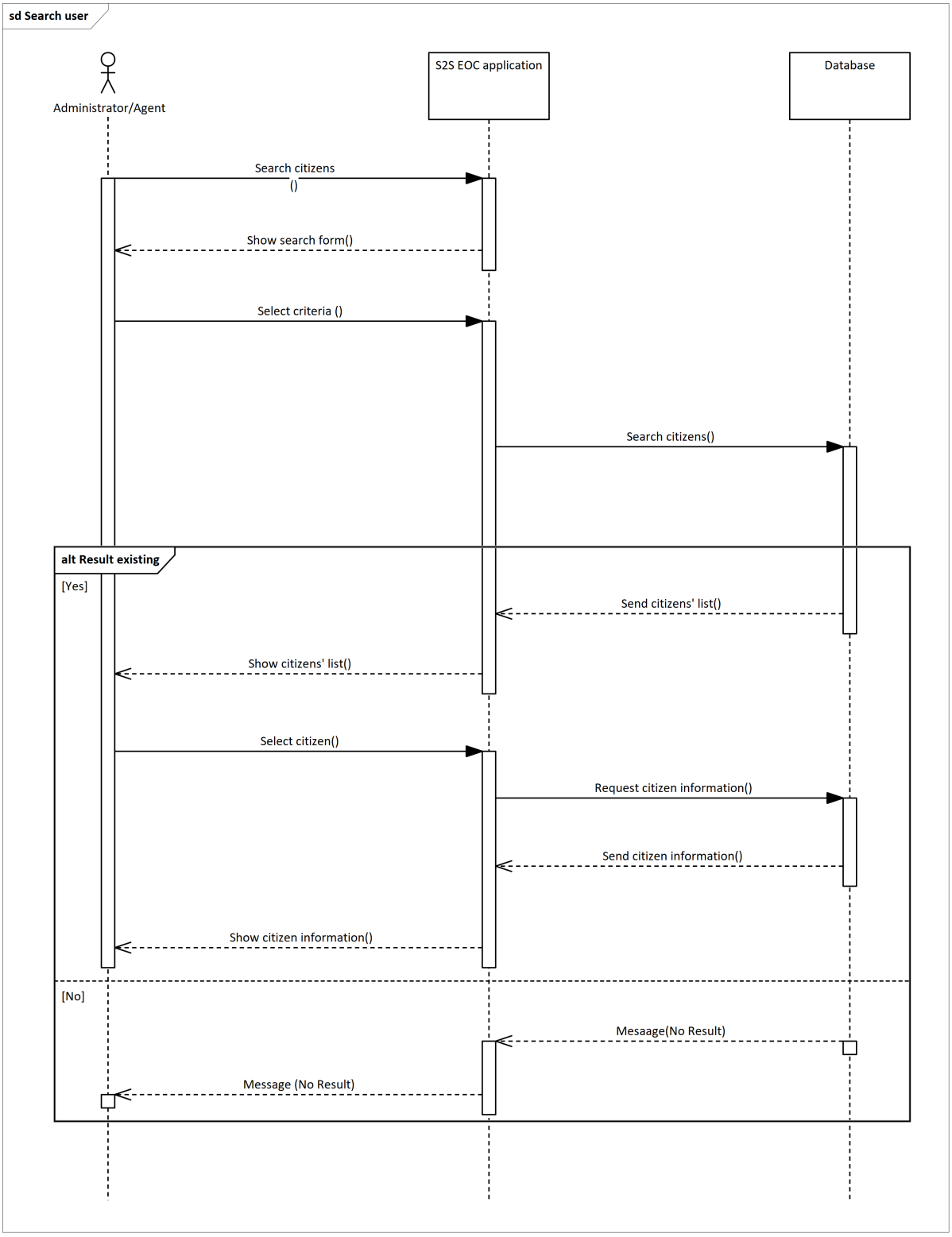

Figure 4.9: Sequence diagram of search citizen (Administrator)

K Delete citizen (administrator)

Textual description of Delete citizen (administrator)

Actor	**Management administrator**	
Precondition	Management administrator is identified and searched for the wanted citizen	
Post-condition	The system deletes the citizen	
Nominal Scenario	1	The management administrator requests to delete the citizen.
	2	The system demands confirmation.
	4	The system removes the information of the citizen from database.
	5	The system displays confirmation message.
Alternative scenario	1	The management-agent cancels suppression.
	2	The system returns to citizens' information page.

Table 4.8: Textual description of Management administrator deletes citizen

Sequence diagram delete citizen (administrator):

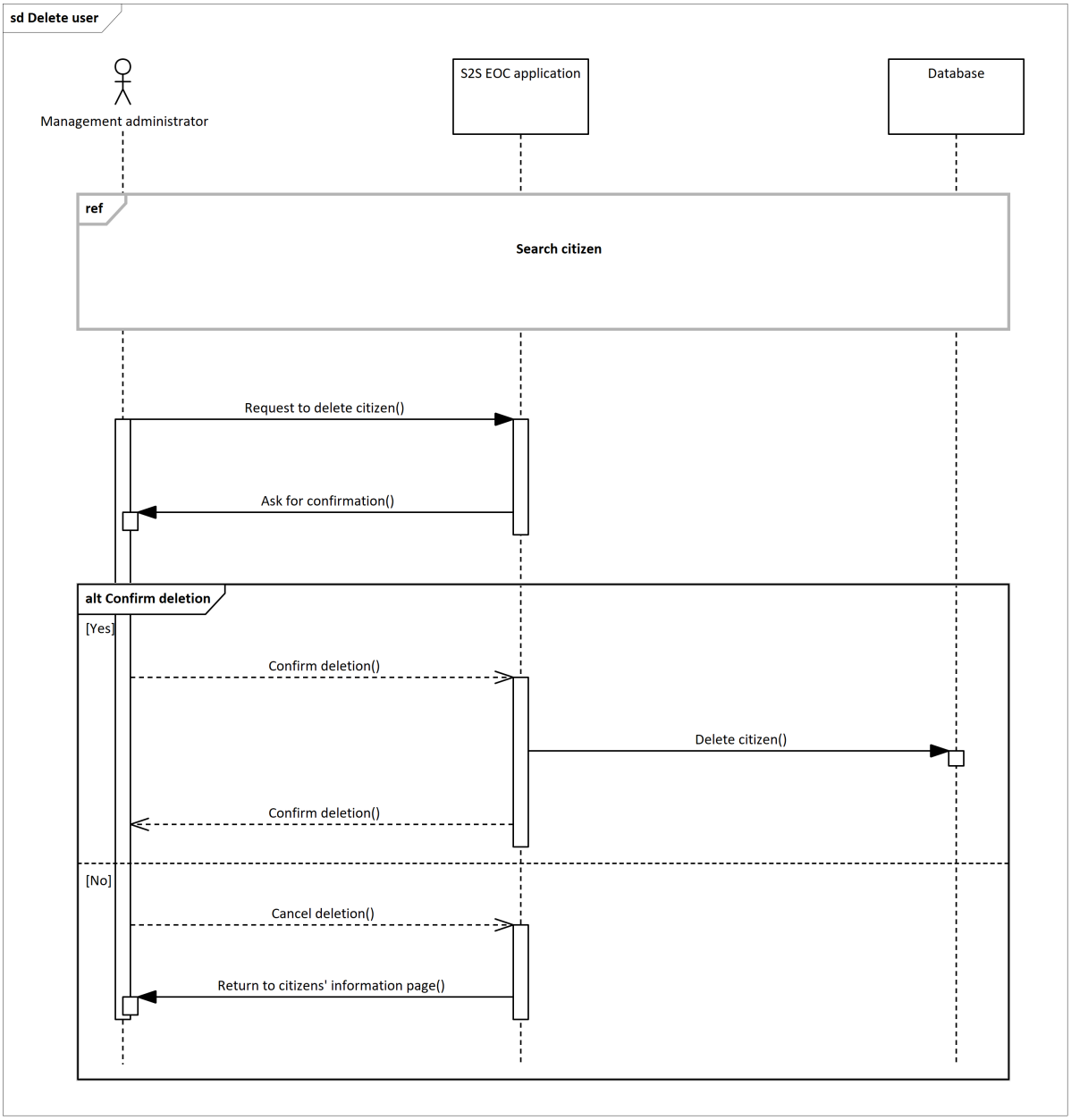

Figure 4.10: Sequence diagram of delete citizen (administrator)

L Activate crisis mode (administrator)

Textual description of Activate crisis mode (administrator)

Actor	**Emergency administrator**		
Precondition	The Emergency administrator is identified.		
Post-condition	The system displays list of citizens' locations		
Nominal Scenario	1	The emergency administrator activates crisis mode.	
	2	The system requires confirmation.	
	3	The emergency administrator confirms activation.	
	4	The system requests citizens' locations in crisis zone.	
	5	The citizen application sends location to EOC.	
	6	The system displays citizens' locations.	
	7	The emergency administrator disables crisis mode.	
	8	The system demands confirmation.	
	9	The emergency administrator confirms deactivation.	
	10	The system disables crisis mode.	
Alternative scenario	A	3	The emergency administrator cancels activation.
	B	9	The emergency administrator cancels deactivation.
		10	the system returns to crisis mode.

Table 4.9: Textual description of administrator activates crisis mode

Sequence diagram of activate/deactivate crisis mode (administrator)

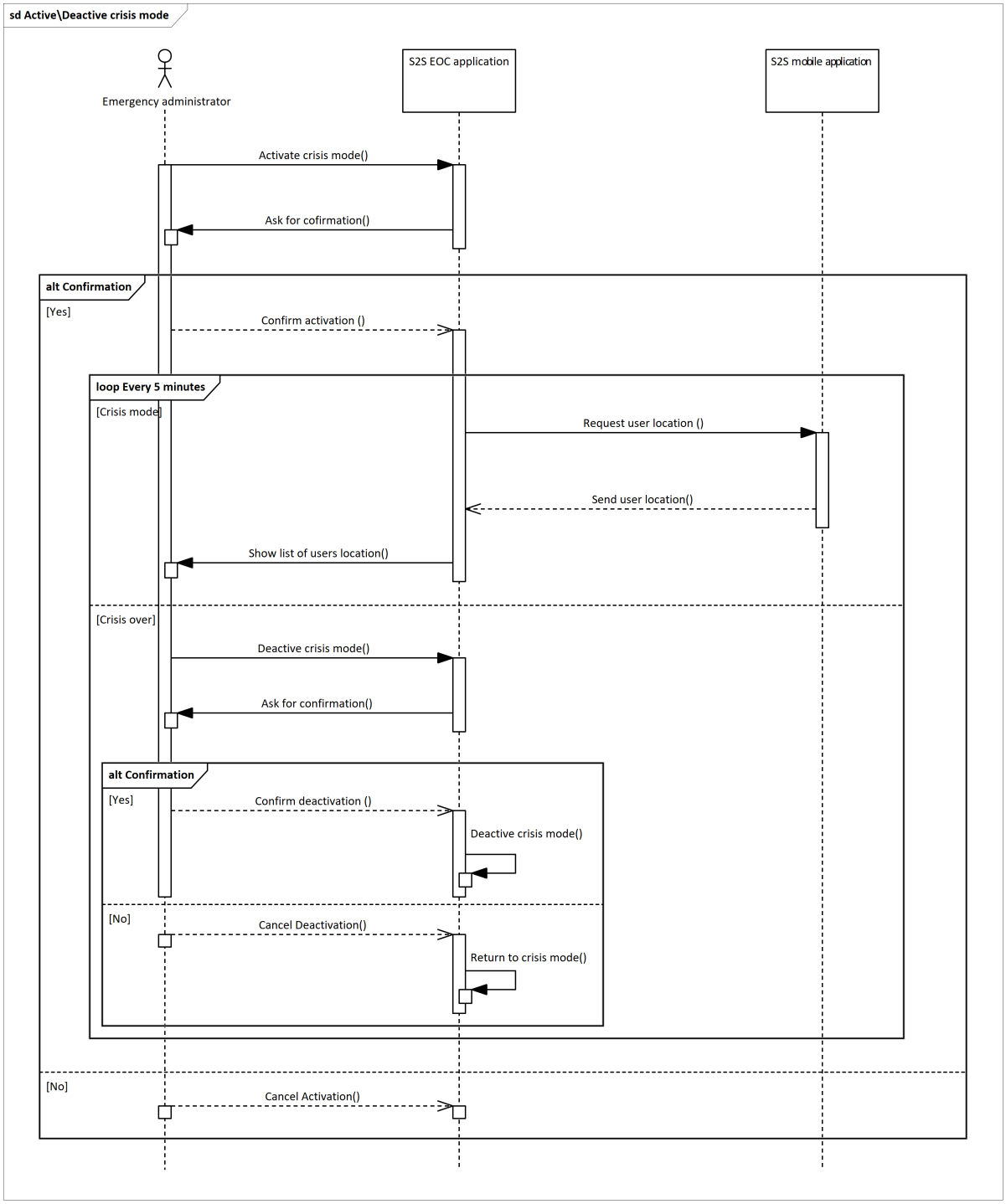

Figure 4.11: Sequence diagram of activate/deactivate crisis mode (administrator)

M Receive and trigger alert (administrator)

Textual description of receive and trigger alert (administrator)

Actor	**Emergency administrator, agent, citizen, volunteer**	
Precondition	The Emergency administrator is identified and emergency has sent by a citizen.	
Post-condition	The Emergency administrator triggers alert and inform agents and volunteers.	
Nominal Scenario	1	The System displays emergency information and asks confirmation to trigger alert.
	2	The emergency administrator confirms alert triggering.
	3	The system fetches data from database.
	4	The system displays citizen's information.
	5	The system sends emergency information to agent.
Optional scenario	6	The emergency administrator requests to send emergency information to volunteers.
	7	The system sends emergency information to volunteers.
Alternative scenario	2	the emergency administrator cancels the alert.

Table 4.10: Textual description of administrator receives emergency and triggers alert

Sequence diagram of receive and trigger alert (administrator)

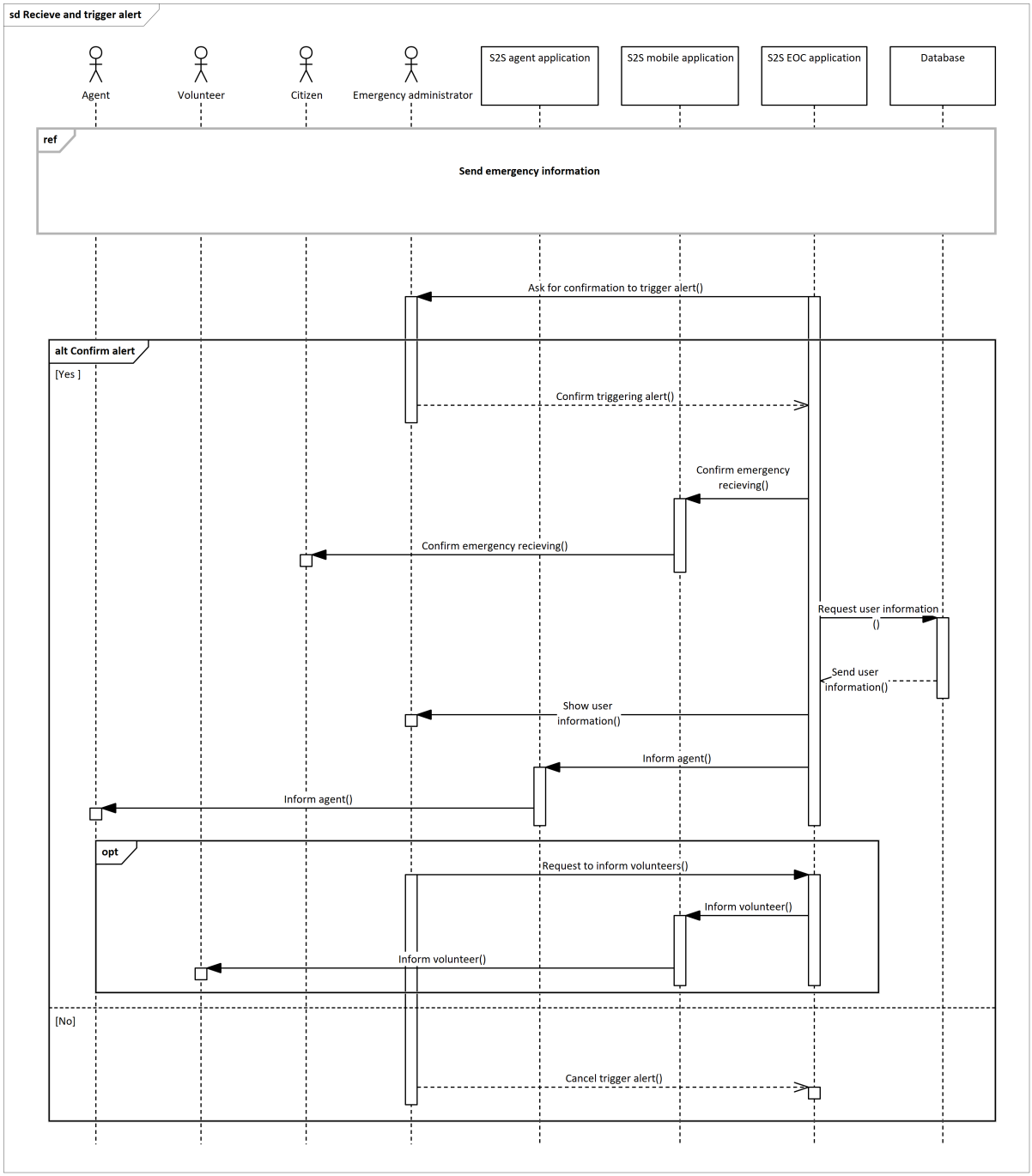

Figure 4.12: Sequence diagram of receive and trigger alert (administrator)

4.4 Detailed conception

The class diagram is considered as the most important part of object-oriented modeling. Indeed, conception precisely construct and document classes of the system.

A Class diagram conception

Class	Codification	Description	Type
Citizen	idCitizen	Id of the citizen, auto-incremental	int
	firstName	First name	String
	lastName	Last name	String
	email	Email	String
	phoneNumber	Phone number	String
	password	Password	String
	address	Address of the citizen	Address
	birthDate	Birth date	Date
	bloodType	Blood type	BloodType
	gender	Gender	gender
	height	Height	float
	weight	Weight	float
ChronicDisease	idChronicDisease	auto-increment value	int
	title	The label of the disease	String
CitizenLocation	idLocation	auto-increment value	int
	dateTime	Date and time	DateTime
	latitude	Latitude	Double
	longitude	Longitude	Double
Contact	idContact	Id of the contact	int
	address	Address of the contact	Address
	firstName	First name of the contact	String
	lastName	Last name of the contact	String
	phoneNumber	Phone number of the contact	String
	relationship	The relationship between the citizen and the contact	String
Volunteer	idCertificate	The id of certificate if the citizen had an internship in Civil Protection	String
	isTrusted	The citizen will be marked as trusted volunteer if he already has a certificate	boolean

Notification	idNotification	The id of notification	int
	title	The title of the notification	String
	content	The content of the notification	String
	type	The type of notification	String
	creationDate	Th time when the notification is sent	DateTime
Emergency	idEmergency	The id of the emergency	int
	time	The time of the emergency	DateTime
	location	Location of the emergency	Location
	isConfirmed	Whether the emergency is confirmed or not	boolean
	maner	The manner of the emergency	String
	type	The type of the emergency	String
Administrator	idAdmin	The is of the administrator	int
	firstname	The first name of the administrator	String
	lastname	The last name of the administrator	String
	username	the username of the administrator	String
	email	The email of the administrator	String
	password	the password of the administrator	String
Intern	idCertificate	The id of the certificate given to acitizen after finishing the internship	String
	firstname	The first name of the intern	String
	lastname	The last name of the intern	String
Center	addressCenter	The address of the center	Address
	idCenter	The id of the center	Int
	nameCenter	the name of the center	String
Agent	firstname	The first name of the agent	String
	lastname	The last name of the agent	String
	idAgent	The id of the agent	int
	password	The password of the agent	String

Table 4.11: Class diagram conception

B Class diagram

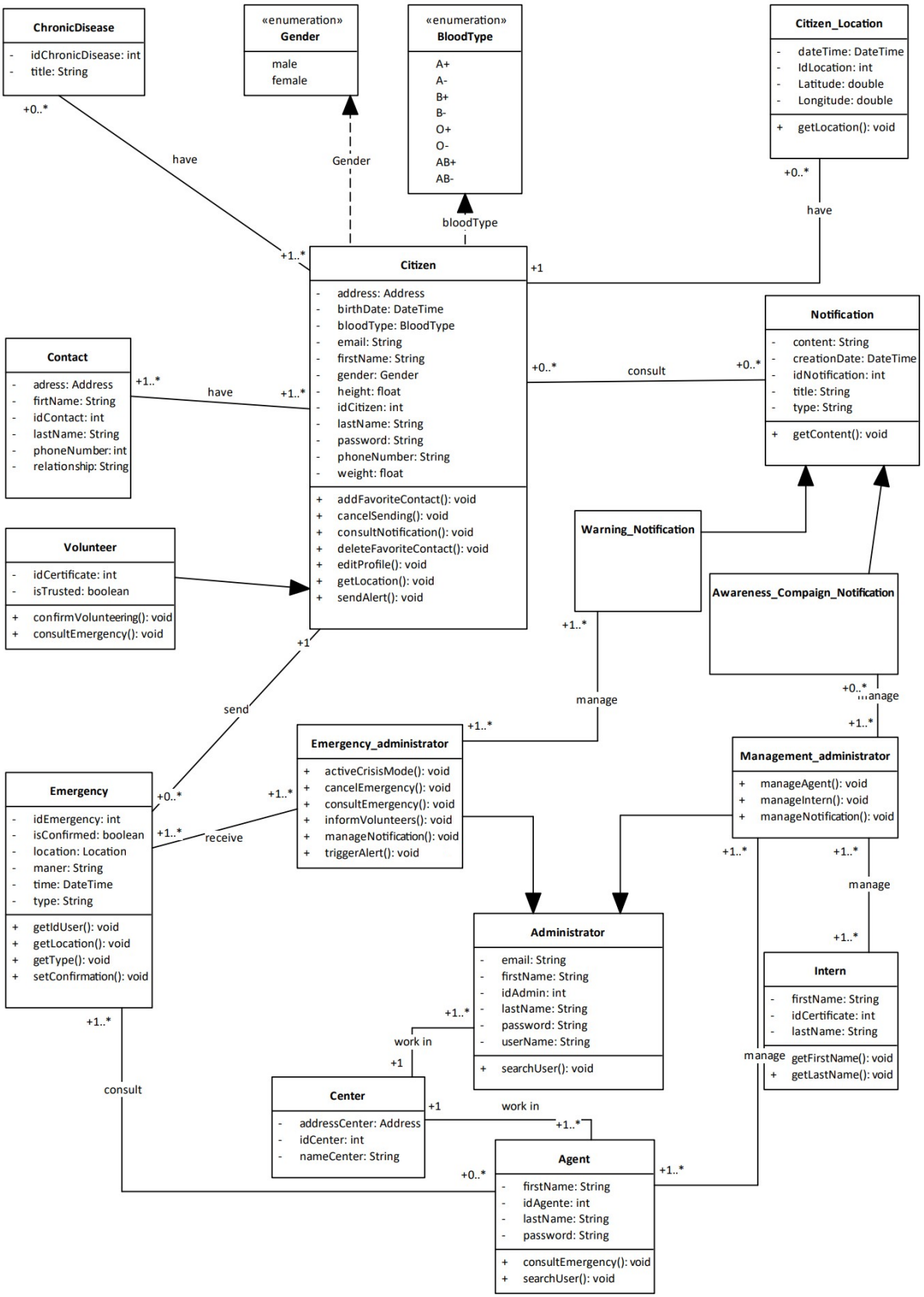

Figure 4.13: Class diagram

4.5 Conclusion:

In this chapter we have presented the textual description of use case, sequence diagrams,and class diagram of our application.
The next chapter will be about the tools and programming languages that we used to develop this application.

Chapter 5

Tools and Implementation

5.1 Introduction

This chapter represents the last part of this thesis, it deals with the phase which aims at the implementation of our application. We begin, first of all, by describing the tools and technologies used to develop our application. Then we mention a free solution to deploy it. Finally, we give some code snippets and screenshots of the app then we share our future perspectives and the upcoming updates for this application.

5.2 Tools and Technologies

From conception to testing and deployment we used numerous tools and technologies, in this section, we try to overview all of them starting with the tools that we used for the tools used for conception and writing the thesis, going to the tools and technologies that we have used for development.

A UML

UML, short for Unified Modelling Language, is a standardized modelling language consisting of an integrated set of diagrams, developed to help system and software developers for specifying, visualizing, constructing, and documenting the artifacts of software systems, as well as for business modelling and other non-software systems [30].

B Enterprise Architect

Enterprise Architect is a visual modelling and design tool based on the OMG (Object Management Group) UML. It provides a wealth of tools a modeler can use to create models that comply with a wide range of formal and informal modelling languages. One of these languages is the Unified Modelling Language (UML).

C LaTeX and Overleaf

LaTeX is a tool used to create professional-looking documents. It is based on the WYSIWYM (what you see is what you mean) idea, meaning you only have focus on the contents of your document and the computer will take care of the formatting. Instead of spacing out text on a

page to control formatting, as with Microsoft Word or LibreOffice Writer, users can enter plain text and let LaTeX take care of the rest.

Overleaf is an online LaTeX and Rich Text collaborative writing and publishing tool that makes the whole process of writing, editing and publishing scientific documents much quicker and easier.

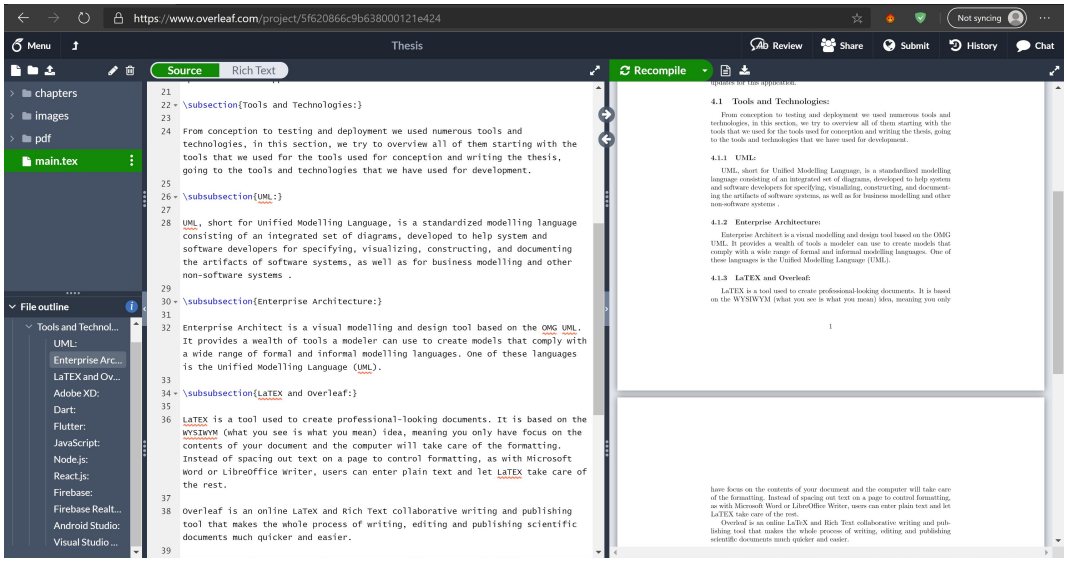

Figure 5.1: Overleaf running online on Microsoft Edge

D Adobe XD

XD is Adobe's tool for helping user experience and user interface designers prototype and wireframe new mobile and web applications.

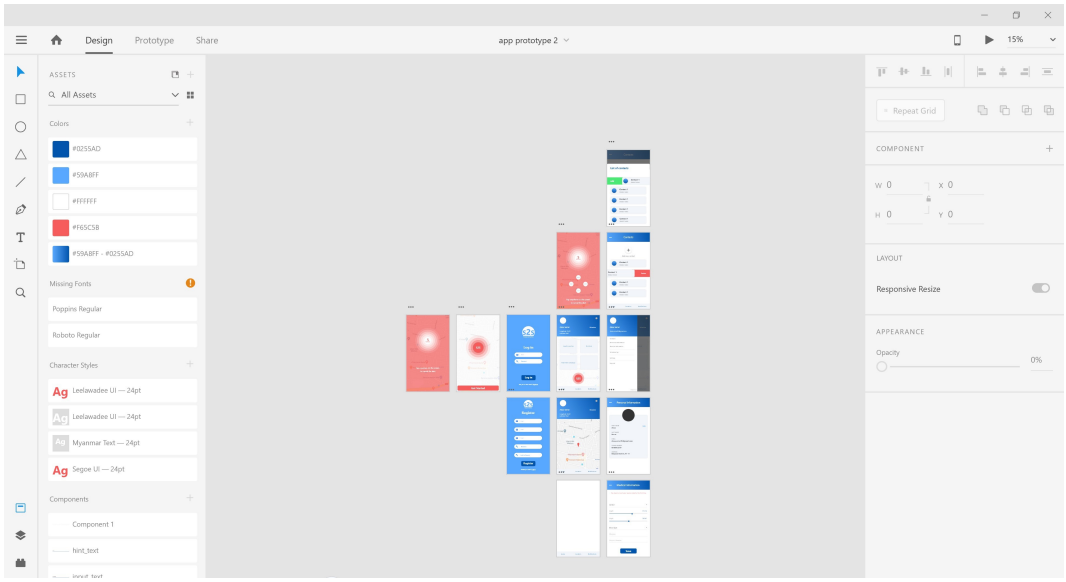

Figure 5.2: Adobe XD working on Windows 10

E Dart

Dart is a client-optimized language for fast apps on any platform, made by Google, it is:

- **Optimized for UI:** Develop with a programming language specialized around the needs of user interface creation.
- **Productive development:** Make changes attractively, use hot reload to see the result instantly in your running app.
- **Fast on all platforms:** Compile to ARM and x64 machine code for mobile, desktop, and backend. Or compile to JavaScript for the web.

F Flutter

Flutter is Google's mobile app SDK that gives developers an easy way to build and deploy visually attractive, fast mobile apps on both Android and iOS platforms. Flutter is an app SDK for building high-performance, high-fidelity apps for iOS, Android, and web from a single codebase [32].

G JavaScript

JavaScript is a lightweight, interpreted, or just-in-time compiled programming language with first-class functions.While it is most well-known as the scripting language for Web pages, many non-browser environments also use it such as Node.js, Apache CouchDB and adobe Acrobat. JavaScript is a prototype-based, multi-paradigm, single-threaded, dynamic language, supporting OOP, imperative, and declarative styles [33].

H Node.js

Node.js is a JavaScript runtime built on Chrome's V8 JavaScript engine [34].

Node.js is a cross-platform JavaScript runtime environment that allows developers to build server-side and network applications with JavaScript.

I React.js

React. js is an open-source JavaScript library that is used for building user interfaces specifically for single-page applications. React allows developers to create large web applications that can change data, without reloading the page. The main purpose of React is to be fast, scalable, and simple.

J Firebase

Firebase is a Backend-as-a-Service (Baas). It provides developers with a variety of tools and services to help them develop quality apps, grow their user base, and earn profit. It is built on Google's infrastructure. Firebase is categorized as a NoSQL database program, which stores data in JSON-like documents.

K Firebase Realtime Database

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in Realtime to every connected client. When you build cross-platform apps with

our iOS, Android, and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data[35].

L Android Studio

Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA . On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps [36].

Android Studio offers a complete, integrated IDE experience for Flutter using Dart and Flutter plugins.

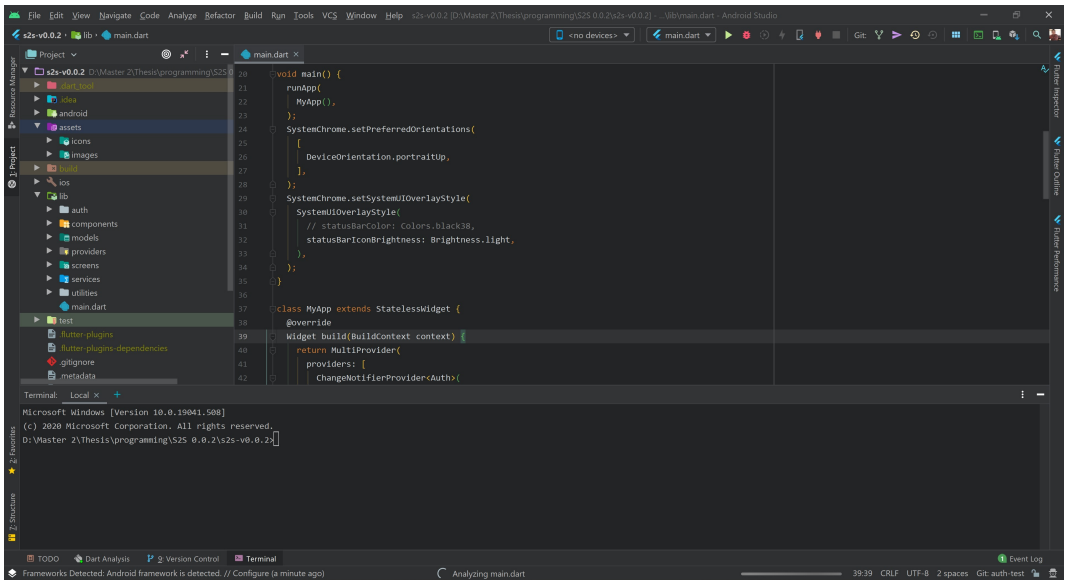

Figure 5.3: Android Studio v4.0.1

M Visual Studio Code

Visual Studio Code is a lightweight but powerful source code editor which runs on user desktop and is available for Windows, macOS and Linux. It comes with built-in support for JavaScript, TypeScript and Node.js and has a rich ecosystem of extensions for other languages [37].

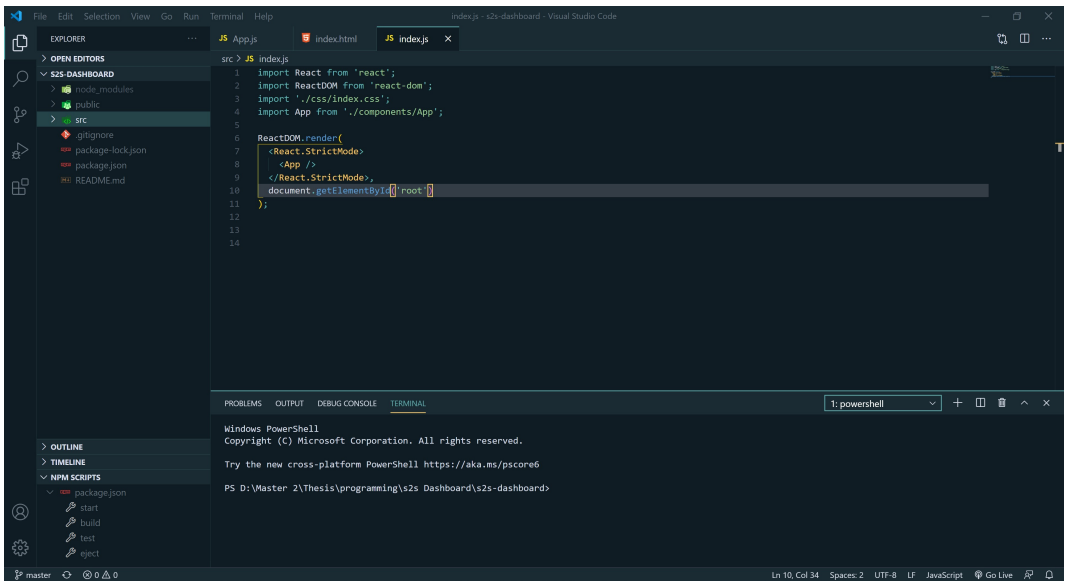

Figure 5.4: Visual Studio Code v1.49.0

N Git/GitHub

Git is a distributed version control system, which means that the entire codebase and history is available on every developer's computer, which allows for easy branching and merging.

GitHub is a website and cloud-based service that helps developers store and manage their code, as well as track and control changes to their code.

GitHub (or other Version Control systems) lets developers safely work through **branching** and **merging**.

With **branching**, a developer duplicates part of the source code (called the repository). The developer can then safely make changes to that part of the code without affecting the rest of the project. Then, once the developer gets his part of the code working properly, he can **merge** that code back into the main source code to make it official.

All of these changes are then tracked and can be reverted if needed.

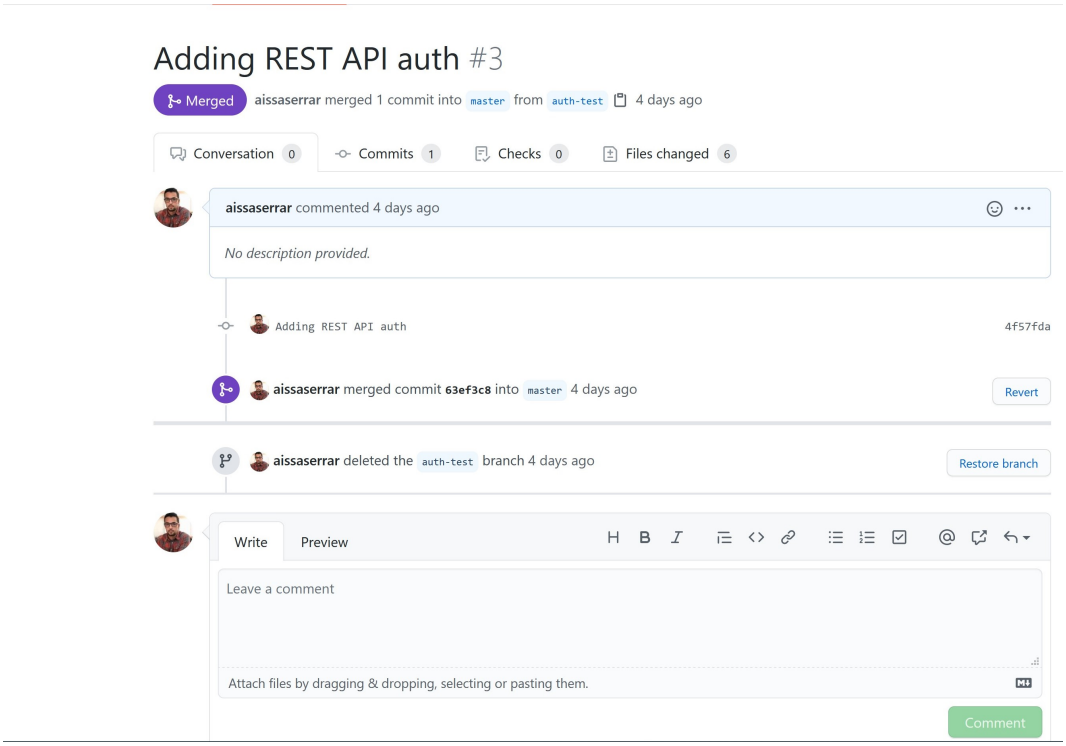

Figure 5.5: Example of merge in GitHub

O CodeMagic (CI/CD provider)

CI, short for Continuous Integration, is a software development practice in which all developers merge code changes in a central repository multiple times a day. **CD** stands for Continuous Delivery, which on top of Continuous Integration adds the practice of automating the entire software release process.

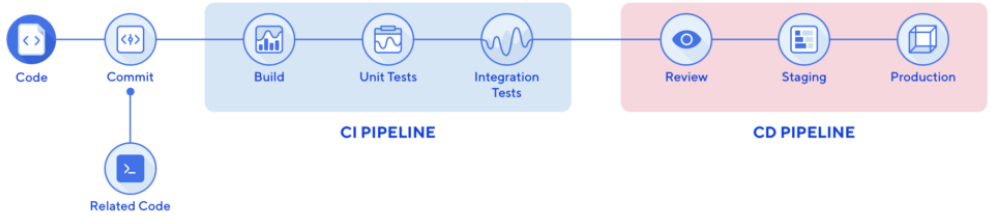

Figure 5.6: CI/CD pipeline

To speed up the development process of our Flutter app we use CodeMagic, which is the dedicated CI/CD solution for Flutter apps. With CodeMagic, you can get your Flutter apps tested and released with zero configuration and no pain, also you get iOS build even you are a non-macOS user.

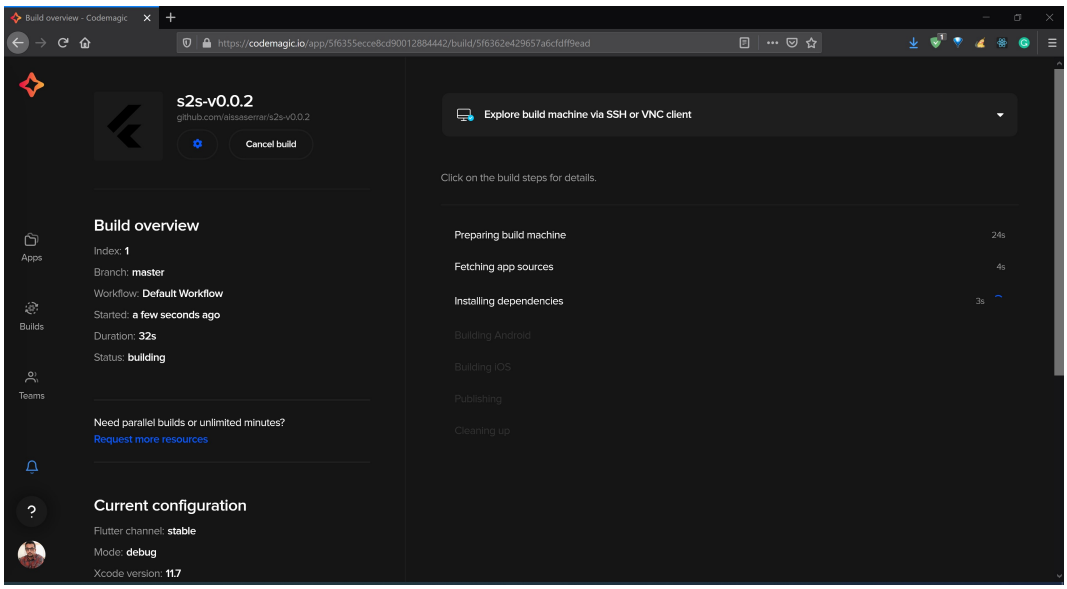

Figure 5.7: Running build on CodeMagic website

5.3 Conclusion

This chapter was a summary of the tools and programming languages that we chose to implement S2S system.
The next chapter will be purely about implementation process of main feature of the system.

Chapter 6

Implementation

6.1 Introduction

This chapter represents the last part of this thesis, it deals with the phase which aims at the implementation of our applications. We begin, first of all, by demystifying how voice processing works in S2S Citizen, then, we will show some screens of the different mobile applications.

6.2 Voice processing

S2S Citizen mobile application uses voice commands to send emergency, to achieve this we used a Dart package called speech_to_text [38], which is a library that exposes device specific speech recognition capability. This library returns text, we take this text and compare it with a dictionary of words and phrases to detect the emergency.

6.3 S2S Citizen

It is the application that the citizen use, here we will describe some screens of the application: Splash Screen, Authentication screens, home screen, Personal information screen, medical information screen, Contact screen, and Volunteering screen if the citizen is a volunteer.

A Splash screen

Splash screen is the first screen the citizen sees when he installs the application for the first time, it allows him to send anonymous emergency alert without authentication, Figure 6.2 represents alert screens, it allows the citizen to cancel sending the alert.

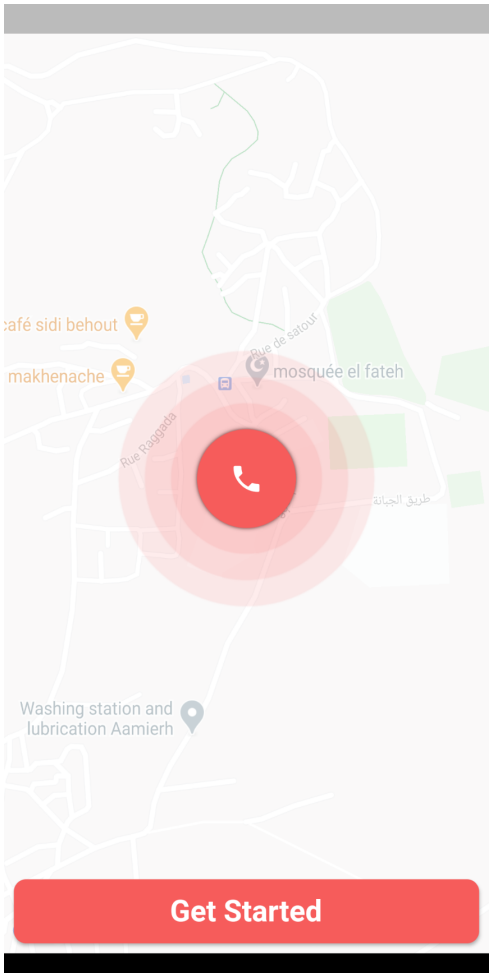

Figure 6.1: S2S Citizen splash screen

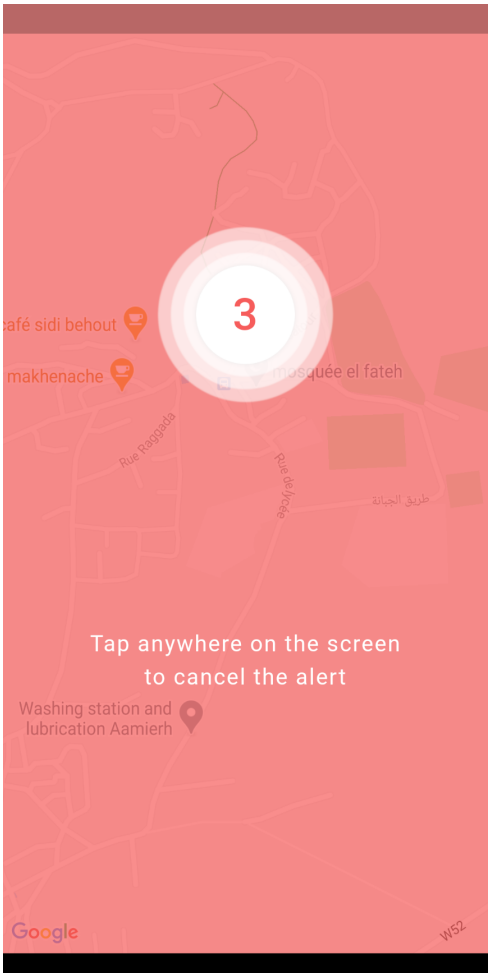

Figure 6.2: S2S Citizen alert screen

B Authentication screens

Figure 6.3 is Register screen where the citizen can register in S2S system using his personal information such as: First name, Last name, Email and password to secure his account.
Figure 6.4 is Login screen, the citizen can log in the application if he is already registered.

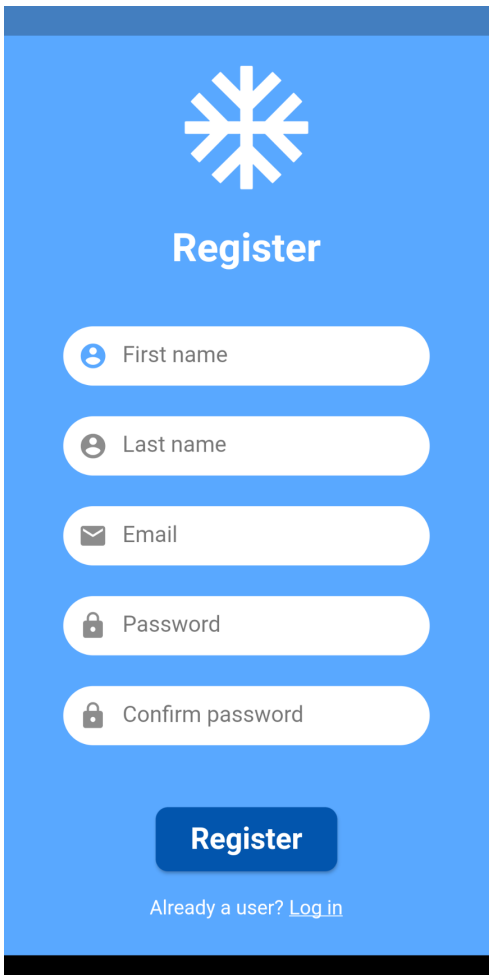

Figure 6.3: S2S Citizen register screen

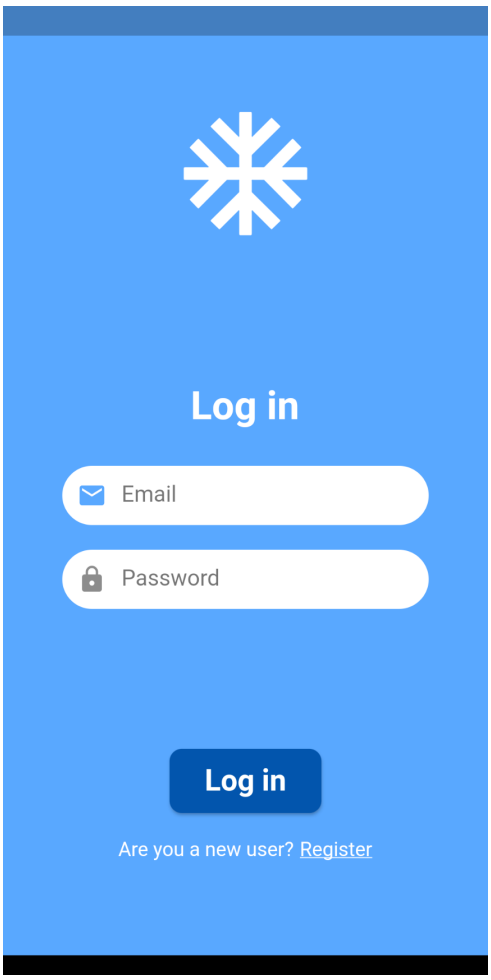

Figure 6.4: S2S Citizen login screen

C Home screen

After the citizen logs in, he sees the home screen (Figure 6.5) from which it he can navigate to other screens using side navigation drawer, also he can manually send an alert by taping the red button.

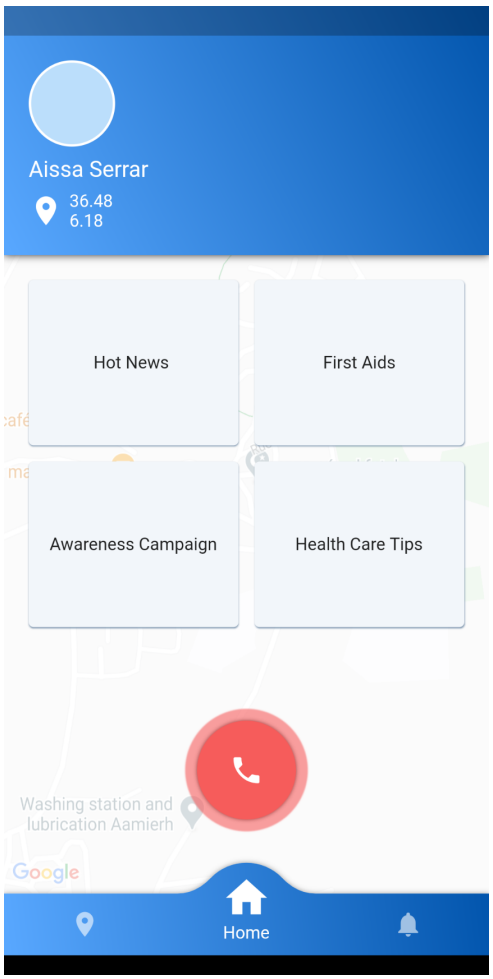

Figure 6.5: S2S Citizen home screen

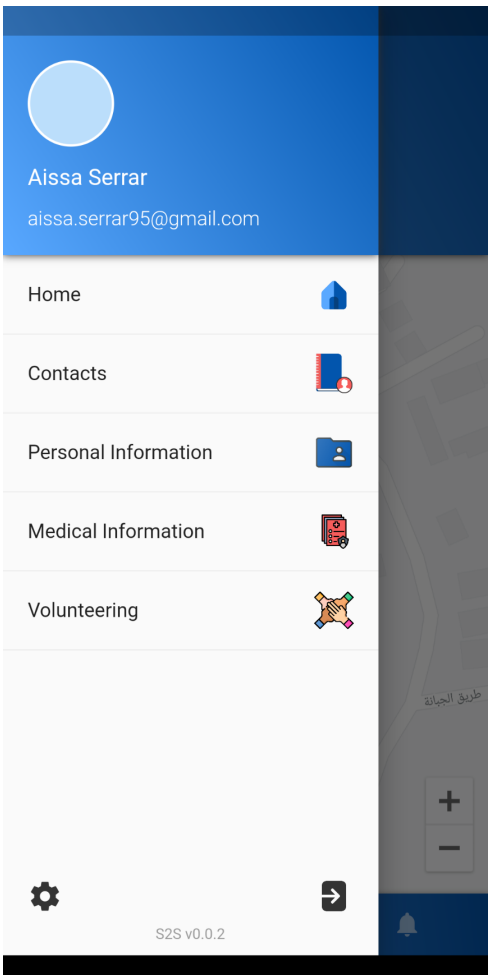

Figure 6.6: S2S Citizen navigation

D Personal information screen

In this screen the citizen can check and edit his personal information.

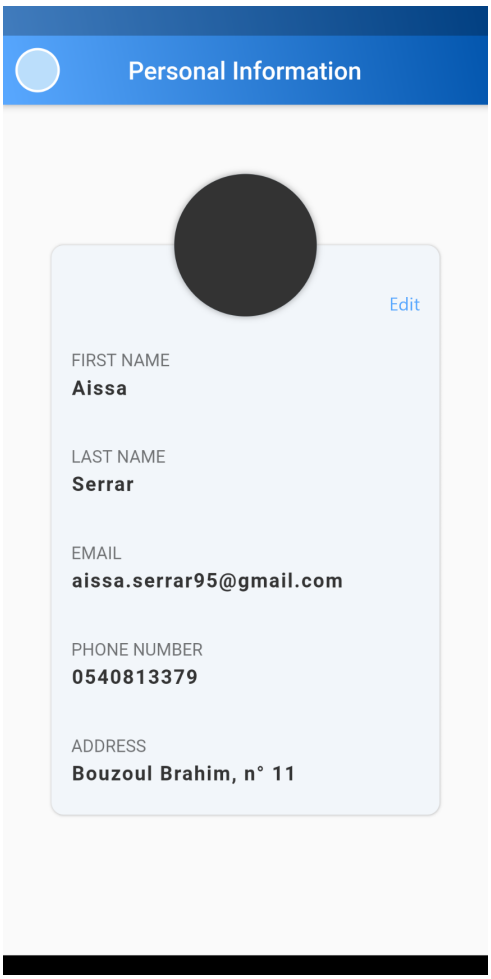

Figure 6.7: S2S Citizen personal information screen

E Medical information screen

In this screen, the user can insert, consult and edit his medical data.

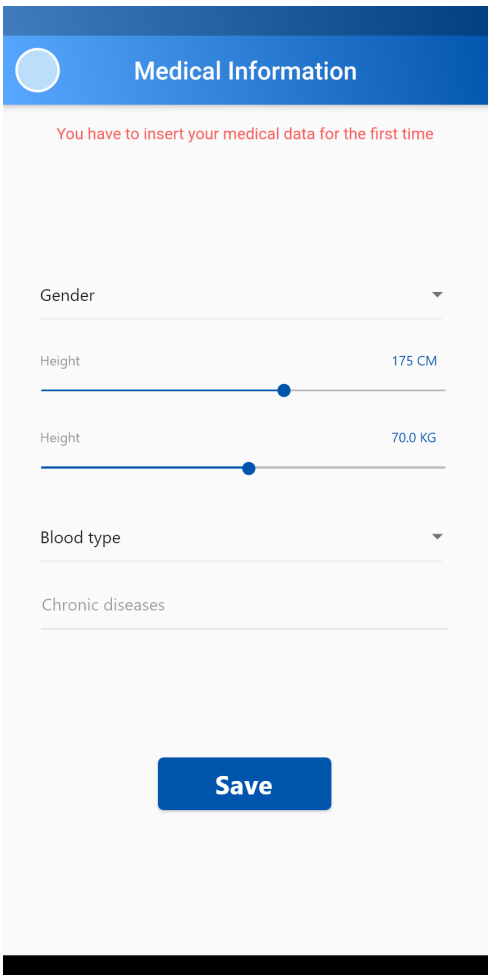

Figure 6.8: S2S Citizen medical information screen

F Contact screen

Those screens allows the citizen to manage his favorite contacts.

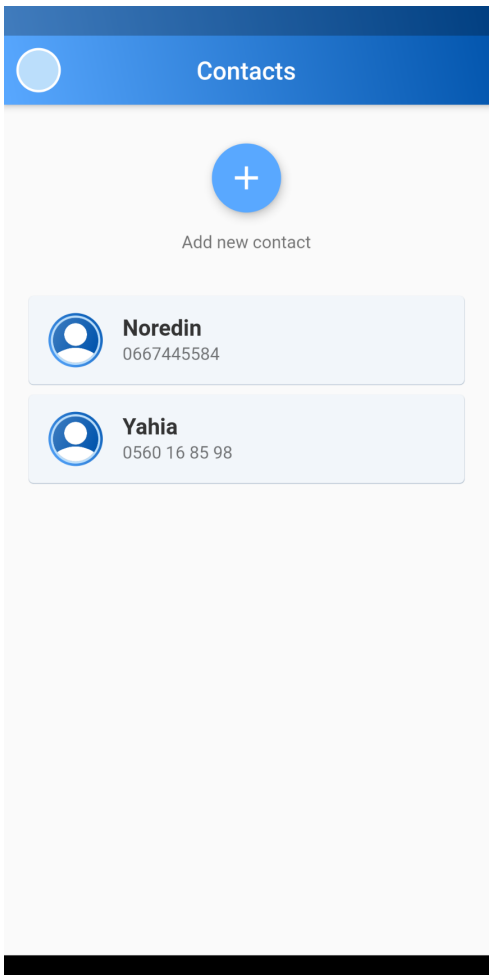

Figure 6.9: S2S Citizen list of favourite contact

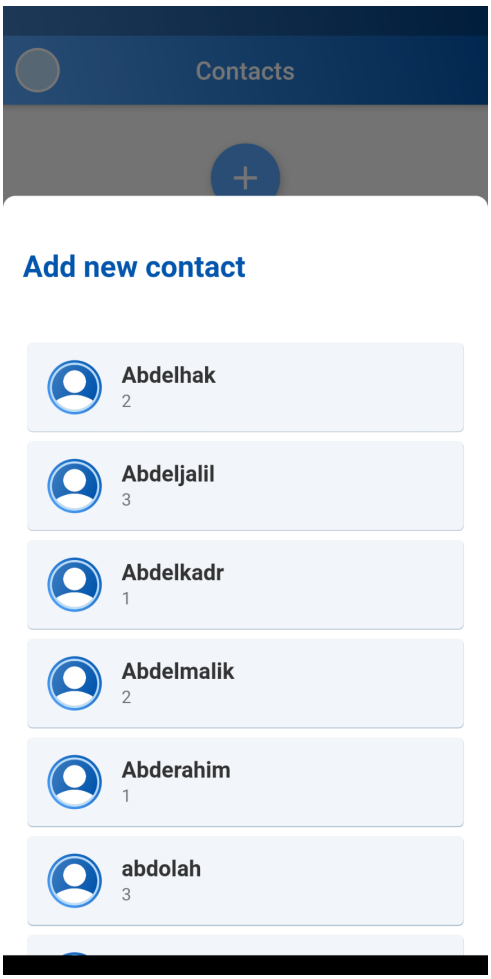

Figure 6.10: S2S Citizen add favourite contact

G Volunteering screen

When the citizen is tagged as a volunteer, he has an extra tab in his home screen, it gives him the possibility to get the best route to arrive at the emergency location.

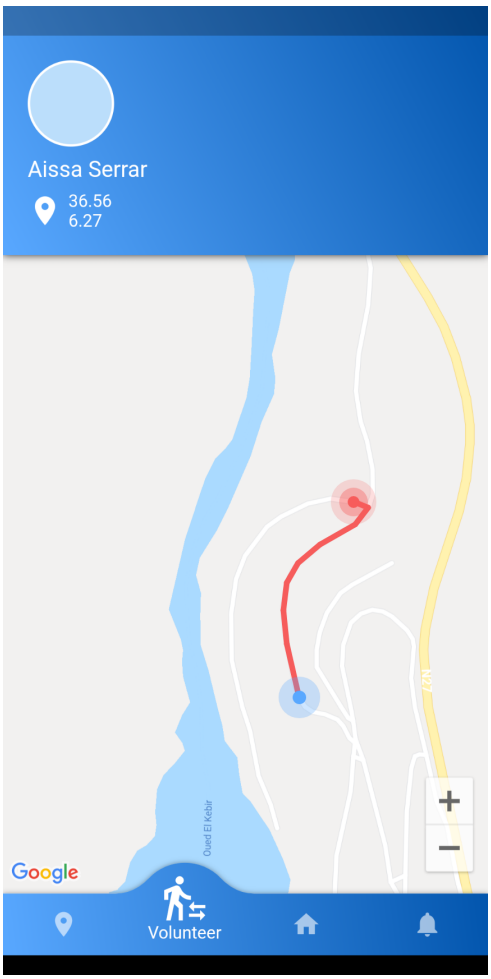

Figure 6.11: S2S Citizen volunteer screen

6.4 S2S Agent

S2S Agent is a mobile application for the agents of the Civil Protection, it allows them to receive the exact victims' locations. This app consists of two screens, Login Screen, and Map screen.

A Login screen

The login screen allows the agent to authenticate and access map screen (Figure 6.13).

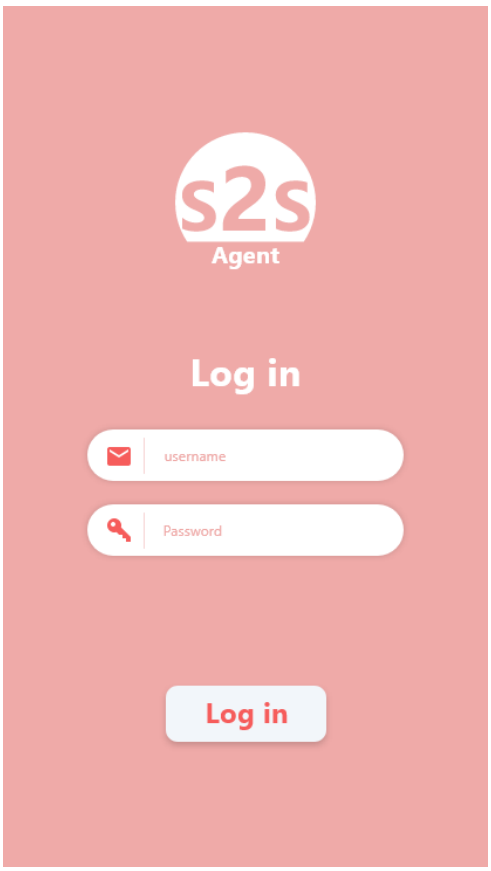

Figure 6.12: S2S Agent login screen

B Map screen

Map screen allows the agent to see the location of emergency.

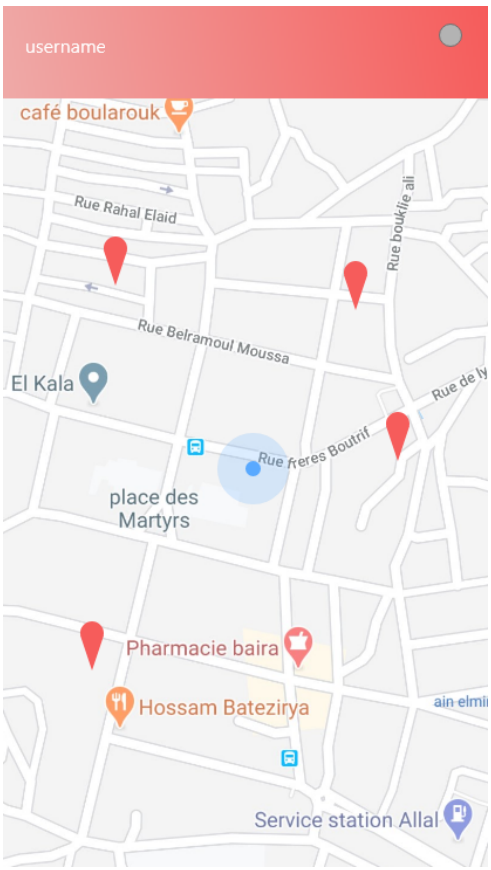

Figure 6.13: S2S Agent login screen

6.5 S2S EOS

S2S EOS is the application for the Civil protection, administrators can manage citizens and agents accounts, also they can receive emergency alerts from citizens and decide what action is next. Next we show two of the most important screens of this app.

A Receive emergencies

The administrator receives emergencies from citizens, and he has the ability to activate crisis mode.

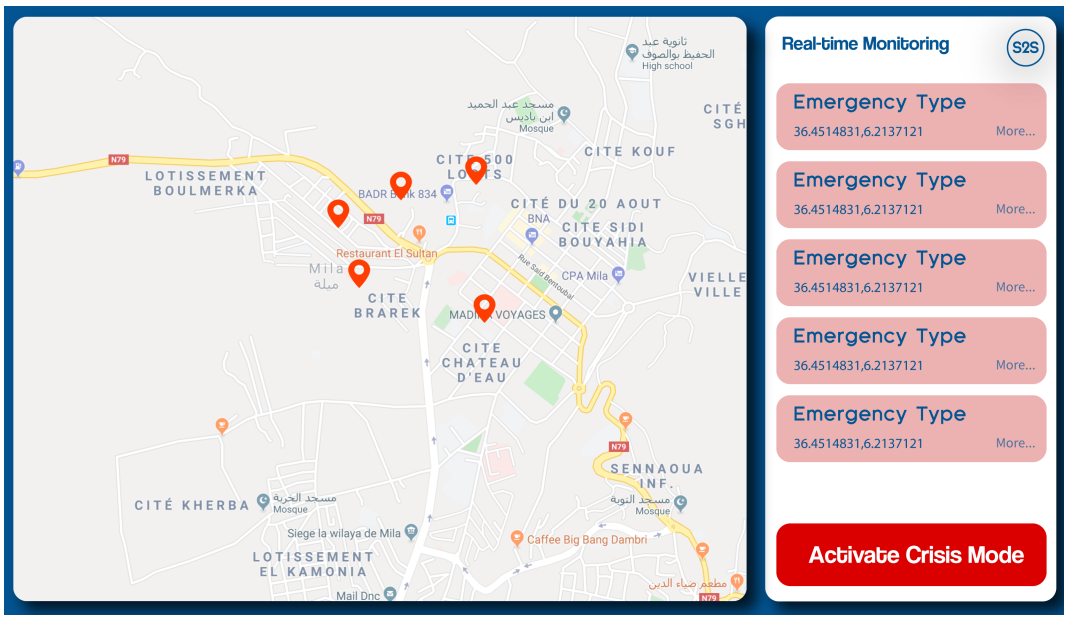

Figure 6.14: Receive emergency screen

B Receive emergencies

The administrator monitoring emergencies and volunteers during crisis mode.

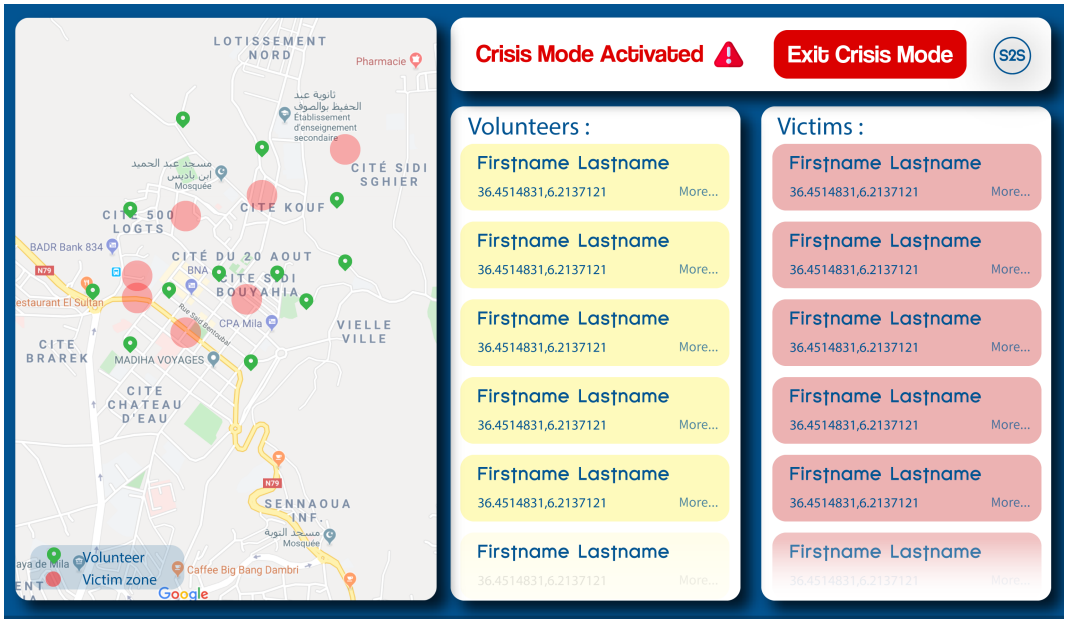

Figure 6.15: Crisis mode monitoring

6.6 Conclusion

In this chapter we present some aspects of the implementation of S2S apps. We enriched it with some screens of our applications.

General conclusion

The objective of this thesis is to develop an intelligent system for disaster management to help in rescue operations.

To realize this project, we studied several disaster management systems, as well as analyzed rescue operations in Algeria. We noticed that Algerian civil protection does not use any application, but they use only phone calls in rescue operations.

We proposed in this thesis an intelligent system called S2S system, composed of two mobile applications and one web application: mobile application for citizens to send his alert to civil protection center. A web application to receive alerts. The second mobile application is to help agents in rescue operations.

The main feature of this system is the use of phone voice sensors to analyze sounds surround victims in order to detect risks and send alerts to civil protection centers.

Finally, we like to mention that there are a lot of ideas we want to realize in the future. For example, we can use other phone sensors and not only voice sensors, that helps our system to analyze more information and make its predictions more accurate. We can also develop our system to be compatible with companies and buildings.

Bibliography

[1] Google Play. Disaster alert. [Online]. Available: https://play.google.com/store/apps/details?hl=en&id=disasterAlert.PDC

[2] ——. Cairn: Hiking outdoor trail safety. [Online]. Available: https://play.google.com/store/apps/details?id=com.cairnapp.cairn&hl=en

[3] ——. Blood donor. [Online]. Available: https://play.google.com/store/apps/details?id=com.cube.arc.blood&hl=en

[4] *Community emergency preparedness: a manual for managers and policy-makers.* WHO Geneva, 1999.

[5] K. R. L. Marco Iansiti. The truth about blockchain. [Online]. Available: https://hbr.org/2017/01/the-truth-about-blockchain

[6] Sadaqa. Sadaqa welfare fund. [Online]. Available: https://sadaqa.org.au/

[7] A. Zagorecki, D. Johnson, and J. Ristvej, "Data mining and machine learning in the context of disaster and crisis management," *International Journal of Emergency Management*, 2013.

[8] Unknown, "Unknown," *Unknown*, Unknown.

[9] G. K. A. Kongthon, C. Sangkeettrakarn and C. Haruechaiyasak, "Implementing an online help desk system based on conversational agent," *MEDES '09: The International Conference on Management of Emergent Digital EcoSystems. France: ACM. doi:10.1145/1643823.1643908*, 2009.

[10] B. M. S. B. O'Connor and N. A. Smith, "Learning to extract international relations from political context," *the 51st Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*, 2013.

[11] B. R. R. B. O'Connor, R. Balasubramanyan and N. A. Smith, "From tweets to polls: Linking text sentiment to public opinion time series," *the 4th International AAAI Conference on Weblogs and Social Media*, 2010.

[12] B. Adams and M. Raubal, "Identifying salient topics for personalized place similarity," *Research@Locate*, 2014.

[13] G. S.-O. N. Ramirez-Esparza, C. K. Chung and J. W. Pennebaker, "Cross-cultural constructions of self-schemas: Americans and mexicans," *Journal of Cross-Cultural Psychology, vol. 43, no. 2, pp. 233–250*, 2012.

[14] Y.-R. Lin and D. Margolin, "The ripple of fear, sympathy and solidarity during the boston bombings," *EPJ Data Science, vol. 3, no. 1, p. 31*, 2014.

[15] M. R. M. M. A. Cohn and J. W. Pennebaker, ""linguistic markers of psychological change surrounding september 11, 2001," *Psychological Science, vol. 15, no. 10, pp. 687–693*, 2004.

[16] A. B. Roberto Minerva and D. Rotondi, "Towards a definition of the internet of things (iot)," *IEEE Internet Initiative*, 2015.

[17] P. P. Ray, M. Mukherjee, and L. Shu, "Internet of things for disaster management: State-of-the-art and prospects," *IEEE Access, Volume 5*, 2017.

[18] J. Seto. Using ai and iot for disaster management. [Online]. Available: https://azure.microsoft.com/es-es/blog/using-ai-and-iot-for-disaster-management/

[19] H. Jiang, "Mobile fire evacuation system for large public buildings based on artificial intelligence and iot," *IEEE Access, Digital Object Identifier 0.1109/ACCESS.2019.2915241*, 2019.

[20] S. jin Liu and G. qing Zhu, "The application of gis and iot technology on building fire evacuation," *Procedia Engineering 71:577-582*, 2014.

[21] J. Morra. Wireless sensor networks monitor active volcanoes in japan. [Online]. Available: https://www.electronicdesign.com/technologies/iot/article/21801235/wireless-sensor-networks-monitor-active-volcanoes-in-japan

[22] W. G. Wong. Lorawan is made for iot. [Online]. Available: https://www.electronicdesign.com/industrial-automation/article/21805274/lorawan-is-made-for-iot

[23] The Atmel Team. Brinco is a personal early-warning system for earthquakes and tsunamis. [Online]. Available: https://atmelcorporation.wordpress.com/2015/08/03/brinco-is-a-personal-early-warning-system-for-earthquakes-and-tsunamis/

[24] L. Zhou, X. Wu, Z. Xu, and H. Fujita, "Emergency decision making for natural disasters: An overview," *International Journal of Disaster Risk Reduction*, 2017.

[25] X. Wu, Y. Xiao, L. Li, and G. Wang, "Review and prospect of the emergency management of urban rainstorm waterlogging based on big data fusion," *Chinese Science Bulletin 62(9):920-927*, 2017.

[26] Z. Xu and X. Zhang, "Hesitant fuzzy multi-attribute decision making based on topsis with incomplete weight information," *Knowledge-Based Systems 52:53-64*, 2013.

[27] D. Ergu, G. Kou, M. Zhang, and Y. Peng, "Estimating the missing values for the incomplete decision matrix and consistency optimization in emergency management," *Applied Mathematical Modelling 40(1)*, 2015.

[28] X. Zhu, G. Zhang, and B. Sun, "A comprehensive literature review of the demand forecasting methods of emergency resources from the perspective of artificial intelligence," *Natural Hazards 97 97:65–82 © Springer Nature B.V.*, 2019.

[29] FEMA. Fema mobile app. [Online]. Available: https://www.fema.gov/about/news-multimedia/app

[30] Visual Paradigm. What is unified modeling language (uml)? [Online]. Available: https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-uml/

[31] Lucidchart. What is unified modeling language. [Online]. Available: https://www.lucidchart.com/pages/what-is-UML-unified-modeling-language

[32] Flutter.Dev. Flutter - beautiful native apps in record time. [Online]. Available: https://flutter.dev/docs/resources/technical-overview

[33] mozilla MDN web docs. Javascript. [Online]. Available: https://developer.mozilla.org/en-US/docs/Web/JavaScript

[34] nodejs.org. Node.js. [Online]. Available: https://nodejs.org/en/

[35] Google. Firebase realtime database. [Online]. Available: https://firebase.google.com/docs/database

[36] ——. Meet android studio. [Online]. Available: https://developer.android.com/studio/intro

[37] Microsoft. Visual studio code. [Online]. Available: https://code.visualstudio.com/

[38] csdcorp.com. speech_to_text. [Online]. Available: https://pub.dev/packages/speech_to_text