College of Engineering

COMP 491 – Computer Engineering Design

Project Proposal

"Ülgen": Residence Activity Monitor and OR Solutions to Disasters

Spring 2023

Participant Information:

Name	ID	Email	Phone
Kaan Turkmen	***	***	***
Can Usluel	***	***	***
Halil Doruk Yildirim	***	***	***
Bumin Aybars Inci	***	***	***

Project Advisor: Didem Unat

Abstract

The earthquakes, which occurred on 6th February in Gaziantep and Kahramanmaraş and which affected 10 provinces, and their aftermath has left all of us, both as a team and as a nation as a whole, devastated. The turmoil within the region during the immediate aftermath of the disaster, alongside poor planning, poor communication and inadequate carrying out of regulations caused this disaster to be much more damaging than it could have been. The meaningless and preventable amount of loss and casualties we as a nation suffered have been by far the largest motivation of the project we are planning to complete during this semester.

We want to create a functional, applicable and efficient application that can be used in such times of disaster that will both give authorities more accurate information regarding the whereabouts of victims of such disasters while also giving them a chance to coordinate rescue operations in an effective and quick manner. We are planning to gather data from the users' local networks to assess how many people were within the household during the time of the earthquake. We are aware that it is highly likely that victims of such disasters cannot access the internet or any messaging systems, let alone their electronic devices, as they may get caught within the disaster at an unexpected time, and thus plan to create a system which does not require any input from the user to function. We aim to gather their data and store them in a secure and confidential way periodically, making sure that they can be accessed during time of crisis. With this gathered data, we aim to create operational research (OR) solutions and then visualize these solutions for the authorities to use in a dynamic and efficient manner. Our secondary objective is towards creating a range of features which benefit the users directly, such as in the way of creating profiles as a way of having, and thus granting authorities, more information, guides on immediate actions to take during and in the aftermath of such disasters, and other vital information regarding emergency services, gathering and shelter locations and more.

Our primary goal is improving upon one of the fronts in which we as a nation were unsuccessful to carry out properly during the disaster, which are coordination and information gathering, and thus cost us in human life. Time gained during coordination efforts and gathering information is time gained carrying out operations that will save the lives of those trapped under the rubble. As we inhabit a region with one of the most active fault lines, and earthquakes with catastrophic consequences are a possibility, we must aim to minimize the damage caused by such natural disasters that may occur in the foreseeable future; as similar disasters are highly anticipated by experts and are expected to affect major cities such as İstanbul, Bursa and Balıkesir [1].

TABLE OF CONTENTS

Section 1 Introduction

1.1 Concept

The main objective for our project is to develop a mobile application that assists both the victims before, during and in the aftermath of an earthquake while also assisting the officials and authorities in rescuing said victims after such a disaster happens. We aim to achieve this objective by creating a trustworthy, effective and easy-to-use platform that everyone can benefit from.

According to the Turkey Earthquake Hazard Map, published by AFAD in 2018, almost all of Turkey is prone to earthquakes. Two major fault lines, the East and North Anatolian Fault lines, cover the country and put the entire region at risk of a disaster. Recently, on February 6th, two catastrophic earthquakes hit the regions of Gaziantep and Kahramanmaraş, taking the lives of over 45,000 people and leaving millions homeless and devastated. The damages were particularly severe due to many factors such as unsatisfactory construction and regulation practices and poor crisis management, communication, coordination and distribution of manpower. All of these fronts must be resolved swiftly and effectively if such a catastrophe is to be avoided in the future. We plan to improve upon how officials gather the data of victims of such disasters and then act upon said data in the most optimal way; in moments of crisis, both gathering such information swiftly and distributing manpower correctly saves lives beyond measure. This was not the first major earthquake within our region, nor will it be the last; with public awareness at such a high level during this time period, we believe tackling these issues in our project to be incredibly important and timely.

We plan on achieving our objectives by creating an application that will collect data from users via their local network to assess whether they were within their household during the time of crisis. We recognize that in these scenarios it is likely that victims often have limited access to the internet and their mobile devices, if any, and thus, we will design our app to be able to operate without any user input necessary. We plan to securely store the information of users within a Kafka regularly, so it may be available during emergencies. We plan to deliver this information to officials with visualizations such as heat mapping and allowing them to assess the situation effectively by creating OR solutions for rescue operations and manpower distribution efforts. The methodology will be further discussed later on in our proposal. Secondarily, we plan to provide features aimed specifically for the users, such as setting up individual-specific profiles so more accurate information can be accessed, and guidelines and resources on what to do during and afterwards a crisis such as an earthquake.

The main expected outcome of our project is to create an application that is potentially lifesaving during times of crisis. We hope to create a system that benefits both civilians and officials during such times, minimizing casualties. We hope our efforts towards this objective is recognized and more efforts towards preventing losses during and after such disasters are made, from every segment of society; from citizens to building contractors, from NGOs to government officials.

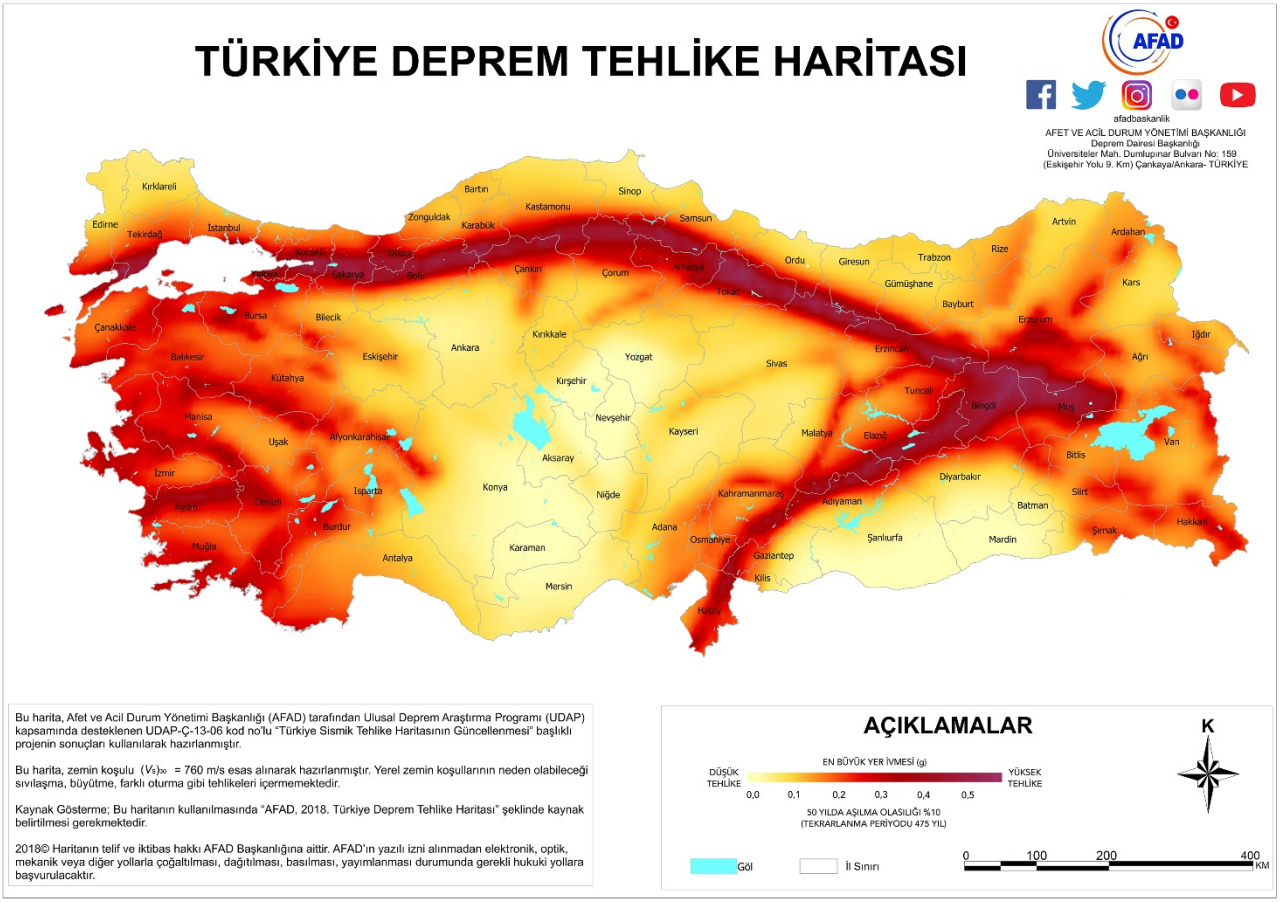
1.2 Objectives

The expected outcome of our project is as follows; to create an application available to every segment of society that is easy-to-use, trustworthy, secure and most importantly lifesaving. We want to create a system that can be usable during times of crisis and disaster that benefits both civilians and officials. One of our two main methods to achieve these outcomes is gathering data from users regarding their last activity (mainly whether they were connected to their local network or not) during moments of crisis to more accurately assess how many people were within the household at the time. Another goal is creating fast and efficient OR solutions with said data in order to assess the situation alongside visualizations such as heat mapping and to aid in the distribution of manpower to these areas in the most effective way possible. We also plan to add features within the app that users can benefit from during these emergencies. We plan for our backend to communicate with our interface with the use of cloud computing services. One of our main objectives for this project is to create a reliable and feasible solution, as these qualities are absolutely essential due to the nature of our project; we plan to achieve these qualities with the use of certain technologies which will be discussed further in our Methodology (2.1).

1.3 Background

In Turkey, on the 6th of February, 2023, two earthquakes with magnitudes of 7.8 and 7.5, centered in Gaziantep and Kahramanmaraş caused destruction in 10 provinces and affected many more [2]. Despite all the efforts to save as many lives as possible from the officials and many organizations, the death toll is officially recorded to be above 45,000 and counting [3]. This devastating disaster left millions dislocated [4] and grieving for their loved ones. There are many reasons why the death toll and damage is so severe, such as poor construction practices, failure to carry out proper regulation for disaster resilient buildings [5], and not getting help to those who need it in time due to poor coordination and planning [6]. While earthquakes are destructive, Turkey especially is an area that is very susceptible to earthquakes and thus, an area where precautions must be maximized. Despite many advancements in the detection and monitoring of earthquakes within the recent years [7], the immediate countermeasures in order to minimize the damages of these catastrophes are left much to be desired. To combat the aftermath of such disasters, there are apps that aim to guide and assist civilians during times of crisis in Turkey, such as “AFAD Acil”, made by the Ministry of Interior, and “Güvendeyim” made by AKUT. “AFAD Acil” aims to connect those affected by such disasters with officials to let them know of their situation and location via internet communication, while “Güvendeyim” aims to assist users in letting their loved ones know of their location and wellbeing via SMS. Both applications also have some general information and guidance for disasters, such as displaying the closest gathering area [8][9]. These applications are very optimistic in that they operate based on the assumption that the ones affected by the disaster have access to the internet or a text messaging service respectively. In reality, it is highly likely that victims of such disasters have no access to their mobile device, let alone the internet or messaging services, so a solution must be found in which no input from the user is required during or after the occurrence of the disaster.

Turkey is a region with many geological fault lines that have been active for millions of years and will continue to be troubled by natural disasters such as earthquakes, as is the case for the region since the beginning of civilization [10][11]. The tectonic structure and seismic nature of the region showcases the importance of effective countermeasures of such disasters and if we are to prevent, or at least lessen the effects of, further catastrophes within the region in the future, these issues must be tackled with forethought and dedication.



"AFAD, 2018. Turkey Earthquake Hazard Map. Source: [12]"

Section 2 S/T methodology and associated work plan

2.1 Methodology

Our overall plan of action for how we will complete the aforementioned objectives are as follows; our first step begins with thorough analysis and research of the background of our project. We will first scour through existing apps with similar aims as us and analyze and list what is missing and what we can create that will benefit others. After this extensive research, we will set out a proper outline for our project and iterate over general approaches for our problem. We want to set up a proper workflow between members to make sure our work is dynamic and consistent throughout the way. We are planning to have many workflows in parallel shared between group members, while making sure we can work with each other and help each other in an effective way. We want to conform to the agile development methodology all throughout our project, thus, we are planning to constantly adapt changes and improve our project over time. The main flows we will go through in this project are UX/UI design, Cloud development, Backend, Mobile development and OR implementation. Please see the work packages provided (2.2) for the

distribution of these flows within our team. To improve the general user experience of our application, we will conform and go through the steps of development which ensures that the main principles of user experience are met. We will do this with exploratory user research, persona making, conduction of interviews, user journey maps and various other techniques to ensure the creation of a proper user interface and experience. For our cloud services, we plan to use an Amazon Elastic Compute Cloud cluster alongside Spring Boot for our backend, AWS Relational Database System alongside PostgreSQL for our database and an Apache Kafka cluster to periodically store the data in real time. The combination of these technologies ensures our collection and storing of the users' local network data periodically, which is vital for our project. We are planning to create our backend using Python and Spring Boot microservices. Testing methods, such as chaos testing, will be deployed to ensure the application can safely operate at times of distress, as reliable use during such moments is a top priority for our project. Our main focus will be Android devices, as Android has about 80% of the market share for mobile operating systems in Turkey [13], and user variance and quantity is very vital for our application, we thought it best that we should focus on Android development as it would give us the greatest reach to the population. For solving the problem of logistics and optimization of distribution during moments of crisis, we plan to use Google OR-Tools and create an optimal algorithm for this cause. We are planning to add more features with these tools as we iterate through our project. Many iterations of implementations for both our interface and backend will be made throughout the semester.

2.2 Work Package Descriptions

Work package number	**1**	Start date or starting event:		**Week 1**	
Work package title	**Background Research**				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	1	1	1	1	N/A

Objectives

- Researching Previous Crisis/Earthquake Application Ideas.
- Creating Outline of the Project.
- Research of Our Projects Potential Network Solutions.
- Designing Project Architecture.
- Cost Estimation of the Designed Architecture (AWS, Google Cloud etc.)
- Google OR Idea Exploration.

Description of work

T1.1 (w1) Understanding the Requirements

Starting the analysis of other application ideas to avoid overlap with developing existing solutions to disasters. Then, creating an outline for the project and researching applicable technologies to achieve the final solution. Understanding needs of the project and estimating architecture cost. Finalizing the architecture according to the Agile principle.

Deliverables

D1.1 (w1) Concrete Plan to Follow while Designing the Application.

Milestones

M1.1 (w1) Project Features are Finalized.

Work package number	**2**	Start date or starting event:		**Week 2**	
Work package title	**UX/UI Design**				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	1	1	8	4	N/A

Objectives

- Creating an application and interface which adheres to and positively satisfies the principles of User Experience (UX) Design
- Conducting user researches and other methods of exploration/evaluation to iteratively improve upon the application

Description of work

T2.1 (w1-w4) User Experience/Interface Initial Design Phase

Framing a proper design goal. Conducting exploratory research for user experience. Persona initialization. Creating user flows. Establishing the initial prototype: Wireframing a consistent, easy-to-use, intuitive and visually pleasing interface.

T2.2 (w4-w7) Evaluative Research and Improvement Phase

Testing phase of the interface and constant reiterations of interface based on added features and improving upon the interface and experience based on feedback and evaluative research.

Deliverables

D2.1 (w2) Properly laying out a design goal

D2.2 (w3) Planning of exploratory user research

D2.3 (w4) Persona creations

D2.4 (w5) Conducting and analyzing user interviews

D2.5 (w6) User Journey map

D2.6 (w7) User Flow charts

D2.7 (w8) Wireframing and Interface design

Milestones

M2.1 (w4-w8) Bi-weekly interface implementations

Work package number	**3**	Start date or starting event:		**Week 2**	
Work package title	**Cloud**				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	10	0	0	0	N/A

Objectives

- Designing Solid Backend, Database, and Kafka to Handle Spiking Traffic.
- Creating an Environment for the Team to Easily Test and Deploy their Technologies.

Description of work

T3.1 (w1-w10) Creating Publicly Available Backend

Creating an AWS EC2 cluster that will run dockerized Spring Boot backend for the mobile application to use. The team will try to estimate if the given instance type is enough, or upgrade is needed. Also, the tests will be performed to ensure the capacity of the users we can handle.

T3.2 (w1-w10) Creating Publicly Available PostgreSQL

Creating an AWS RDS instance that will be used to store user credentials for authentication purposes. This relational database will be accessible from our local machines in the development phase, however, the access will be restricted when we finish the implementation.

T3.3 (w1-w10) Creating Publicly Available Apache Kafka

Creating an Apache Kafka cluster to store incoming real time data such as location or number of users in the local network.

Deliverables

D3.1 (w10) Access to the AWS Console.

Milestones

M3.1 (w5) EC2, PostgreSQL and Kafka are available and ready to be upgraded by Agile principles.

Work package number	**4**	Start date or starting event:		**Week 2**	
Work package title	**Backend**				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	10	2	0	0	N/A

Objectives

- Implementing a Backend which can Handle spiking Traffic.
- Achieving Security to Prevent Malicious People to Access Sensitive Data.
- Handling Communication Between Multiple Backend Services (Python or Micro Services).

Description of work

T4.1 (w2-w10) Creating Spring Boot Microservices

For now, it is aimed to build a backend using micro services. After we progress through the project, this will be discussed and final backend design will be reworked using the needs of the project. Backend should be strong enough to deal with failures. This will be tested using Chaos Testing.

T4.2 (w7-w10) Creating Python Internal Backend

Internal Backend will be developed for the Google OR. This Python backend will not be publicly accessible, and will be only accessed by the Spring Boot backend. Using this backend, we will create accurate and fast computations using Google OR.

Deliverables

D4.1 Source Code containing Spring Boot Backend.

D4.2 Source Code containing Python Backend.

Milestones

M4.1 (w4) Backend is now functional and ready to be used by the Mobile Team.

M4.2 (w10) Backend is now tested using Chaos Tests.

Work package number	**5**	Start date or starting event:		**Week 2**	
Work package title	**Mobile**				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	1	1	4	10	N/A

Objectives

- Creating the Android mobile application.
- Implementation of user-friendly interfaces.
- Implementation of heat mapping.
- Implementation of additional helpful features.

Description of work

T5.1 (w2) Creating the mobile application

Establishing a mobile application according to initial design decisions from the UX/UI Design team.

T5.2 (w2-w11) Implementation of User-Friendly Interface

User interface of the mobile application will be smooth and user-friendly. This interface will not plainly ask inputs and give outputs. The aim is increasing the user interactions as much as possible.

T5.3 (w9-w11) Implementation of Heat Mapping

Detailed heat maps will be mounted into the mobile application. In this part API will be provided by Google OR team. Heat map will show last locations of mobile devices in disastrous situations.

T5.3 (w5-w11) Implementation of Additional Helpful Features

Additional helpful features will be implemented such as screens which will display informative instructions during disasters.

Deliverables

D5.1 (w11) Source Code containing mobile application implementation.

Milestones

M5.1 (w2,w5,…,w11) Bi-weekly mobile application updates

Work package number	6	Start date or starting event:		Week 2	
Work package title	Google OR				
Participant number	1	2	3	4	5
Participant name	Kaan	Can	Doruk	Aybars	N/A
Weeks per participant	0	8	2	0	N/A

Objectives

- Implementation of the algorithm that will be used with Google OR
- Implementation of the solution of the projects topic using the algorithm and Google OR

Description of work

T6.1 (w1-w12) Implementation of Google OR

Starting with the implementation of the algorithm which will be used on the solution of our project's topic. The algorithm will mainly focus on the optimized supply distribution in the areas that are affected by natural disasters. Following the implementation of the algorithm, Google OR's API will be used to generate output for the backend. During the development phase, we will be searching features that we can optimize, and we will be adding new optimized features as we progress through the weeks.

Deliverables

D6.1 (w12) Source Code containing Google OR implementation.

Milestones

M6.1 (w3-w4) Generating a realistic output in a test environment such as minimized distance between two cities to understand Google OR API.

M6.2 (w5-w12) Implementing Google OR into our project.

2.3 Demonstration

Our plan for measuring the performance of our project is through vigorous stages of testing of multiple types. The main way we will do this regularly throughout the project is the unit testing and chaos testing we will perform on our application afterwards each design iteration and feature implementation. It is absolutely vital for our application to not crash during critical moments such as data collection and visualization, so testing against bugs and crashes will be done strenuously. Since the human interaction side of our application is also of great importance, we will conduct interviews regarding our project with participants, surveying their responses. These interviews will also include testing of the application and its features, at least in a simulative way, from our participants. Both exploratory and evaluative research will be done afterwards such interviews to iteratively improve upon our design and the experience that the user will have with the application. Since we are creating a project which will potentially be used in an extremely stressful scenario, by both citizens and authorities, creating a positive and beneficial experience while using the application is absolutely crucial, and thus we will use the aforementioned techniques to ensure this outcome. We will include all of our fieldwork, findings and results, both qualitative and quantitative, regarding our application and a demo of it for our final demonstration.

2.4 Impact

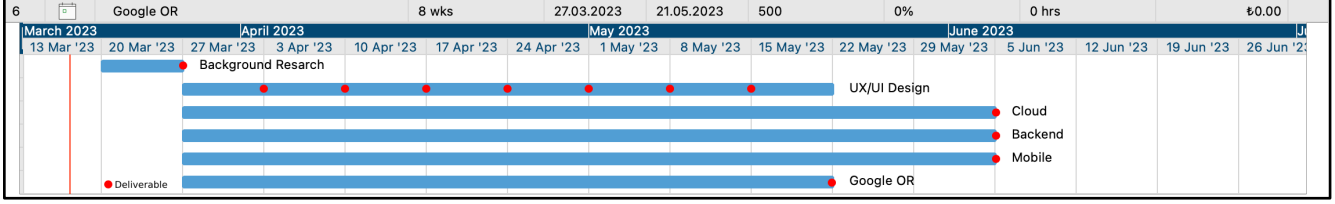
Our main expectation impact-wise for our project is to create an application that is able to save lives in moments of crisis. We want to showcase how using emerging technologies in a novel and effective way can create solution methods for problems which took much greater power and work previously. Working with such technologies in a transformative way can help us advance in every subject and thus, as a whole; we would like to create such an example and hopefully inspire others to produce such solutions. Group-wise, we would all like to further experience how to get through hardship through dedication, communication and teamwork. We would like to objectively improve upon a product we are working on iteratively and see our vision come to fruition in the end. We would like to further learn and experience the industry standard development strategies and methods in order to become better developers.

2.5 Risk analysis

Generally, the risk of failure is attached to any project, and this one is no exception. However, through dedication and hard work, we plan to get through any problem we may face and adjust ourselves, may it be expectation or lifestyle, to create a project in which we are content with. More specifically, one of the areas we see as a risk is the subject of data privacy. As we are planning to collect data from our user's local network, and that is sensitive data, we must successfully encrypt their information while also making sure that they are not inaccessible during emergencies; we see this as one of the main challenges we will face during our project. Another area of concern is being able to create and use an optimal algorithm for the problems of distribution that may be faced during such disasters. The fact that, if this app is to come to life, the speed of the gathering of user data and the algorithm for the OR solutions being optimal or not is directly associated with how many people will potentially be rescued in time makes this an exceptional, concerning and crucial problem.

2.6 Gantt Chart

#	Task Name	Duration	Start	End	Priority	Completion	Work	Cost
1	Background Resarch	1 wk	20.03.2023	26.03.2023	500	0%	0 hrs	₺0.00
2	UX/UI Design	8 wks	27.03.2023	21.05.2023	500	0%	0 hrs	₺0.00
3	Cloud	10 wks	27.03.2023	4.06.2023	500	0%	0 hrs	₺0.00
4	Backend	10 wks	27.03.2023	4.06.2023	500	0%	0 hrs	₺0.00
5	Mobile	10 wks	27.03.2023	4.06.2023	500	0%	0 hrs	₺0.00
6	Google OR	8 wks	27.03.2023	21.05.2023	500	0%	0 hrs	₺0.00



Section 3 Economical and Ethical Issues

The biggest realistic constraint for our application is the question of how “accurate” the data we are collecting is at the end of the day. We are planning to create an estimate of how many people were within a household by analyzing their local network activity at the time, but is the accuracy of this data enough to justify such an estimation, especially when the subject at hand is this sensitive? Is this the most effective way to gather the immediate knowledge of victims of such disasters, or is there a better, more efficient way to guide and handle rescue operations? As the data that will be delivered will be highly dependent on how many users the application has, does this bear any implications regarding the authenticity of the data in the cases that a low count of users is present? Would the data be disregarded in this case, or would there be a separate way of analyzing the data, if so, how? As the topic of our project is extremely sensitive, saving lives during times of disaster, the constraints of ethics are very high and thus should be thought out with great consideration. Regarding the economic dimension of our project; this idea is clearly not “economically viable”, as there is no source of income and a service is provided, but there is no aim to monetize such an application within our group in the first place. Similar apps such as “AFAD Acil” and “Güvendeyim” also have no way of monetary gain, as monetary gain should not be in the list of priorities for such applications.

We believe that our proposal of our project showcases how it adheres to the scope of engineering ethics. We will now discuss the scope of engineering ethics and provide how we believe our proposal conforms with them. According to the IEEE Code of Ethics [14] and ACM Software Engineering Code of Ethics and Professional Practice [15], we as engineers and developers should first and foremost act according to and hold paramount the interest, safety and health of the public. As aforementioned in our objectives for this project, our top priority is to create an application that is secure, trustworthy and lifesaving. Another important scope of engineering ethics is to protect the privacy of others, which we discussed in the Risk Analysis (2.5) section as being one of our main challenges and something we must successfully complete if we were to consider creating such an application. The IEEE Code of Ethics also states that engineers should improve the understanding of individuals and society of emerging technologies and their implications. We discussed in our Impact (2.4) section that one of our top priorities is how we would like to showcase and thus hopefully inspire others on how using emerging technologies can positively impact our lives, and thus help us advance as a whole. According to engineering ethics, software engineers should also ensure that their creations are of the highest standard. This also, is one of our top priorities, especially when the subject we are working about is this sensitive, as we also discussed before. It is because we want to make something fit to the highest of standards that we wish to test our project in many ways such as user interviews and rigorous testing. In conclusion, we believe our motive behind making this application and our projected plan of creating this application discussed in this proposal cannot be regarded as unethical regarding ethics and specifically engineering ethics.

Section 4 References

1. BIA News Desk, “Marmara fault line is about to crack, warns geologist Prof. Naci Görür.” bianet.org https://m.bianet.org/english/life/257519-marmara-fault-line-is-about-to-crack-warns-geologist-prof-naci-gorur

2. Communications and Publishing, “The M7.8 and M7.5 Kahramanmaraş Earthquake Sequence struck near Nurdağı, Turkey (Türkiye) on February 6, 2023.” usgs.gov https://www.usgs.gov/news/featured-story/m78-and-m75-kahramanmaras-earthquake-sequence-near-nurdagi-turkey-turkiye

3. Elif Ince, Leila Sackur, “As Turkey's earthquake death toll grows, so does anger at government.” nbcnews.com https://www.nbcnews.com/news/world/turkey-earthquakes-death-toll-anger-erdogan-ak-party-amnesty-rcna71400

4. UN News, “1.5 million now homeless in Türkiye after quake disaster, warn UN development experts.” news.un.org https://news.un.org/en/story/2023/02/1133717

5. Thomas Johnson, “Turkey earthquake: Experts believe collapse of buildings was preventable.” newcivilengineer.com https://www.newcivilengineer.com/latest/turkey-earthquake-experts-believe-collapse-of-buildings-was-preventable-15-02-2023/

6. Güney Yıldız, “Three Things That Went Wrong In Turkey's Earthquake Response.” forbes.com https://www.forbes.com/sites/guneyyildiz/2023/02/21/three-things-that-went-wrong-in-turkeys-earthquake-response/?sh=5daea6c75bd4

7. Z. Li, “Recent advances in earthquake monitoring I: Ongoing revolution of seismic instrumentation,” *Earthquake Science*, vol. 34, no. 2, pp. 177–188, 2021. https://doi.org/10.29382/eqs-2021-0011

8. AFAD, “AFAD Acil Mobil Uygulaması.” afad.gov.tr https://istanbul.afad.gov.tr/afad-acil-mobil-uygulamasi

9. AKUT, “Güvendeyim.” akut.org.tr https://www.akut.org.tr/guvendeyim

10. Leanne Abraham, Henry Fountain, K.K. Rebecca Lai, “How Turkey’s Anatolian Fault System Causes Devastating Earthquakes.” nytime.com https://www.nytimes.com/interactive/2023/02/06/world/turkey-earthquake-faultlines.html

11. A. M. C. Şengör, O. Tüysüz, C. İmren, M. Sakınç, H. Eyidoğan, N. Görür, X. Le Pichon, C. Rangin, “The North Anatolian Fault: A new look,” *Annual Review of Earth and Planetary Sciences*, vol. 33, no. 1, pp. 37–112, 2005. https://doi.org/10.1146/annurev.earth.32.101802.120415

12. “Turkey's New Earthquake Hazard Map İs Published.” afad.gov.tr https://en.afad.gov.tr/turkeys-new-earthquake-hazard-map-is-published

13. “Mobile Operating System Market Share Turkey.” statcounter.com https://gs.statcounter.com/os-market-share/mobile/turkey

14. “IEEE code of Ethics”. IEEE. https://www.ieee.org/about/corporate/governance/p7-8.html

15. “Software engineering code - ACM ethics.” Association for Computing Machinery's Committee on Professional Ethics, https://ethics.acm.org/code-of-ethics/software-engineering-code/