Al Imam Mohammad Ibn Saud Islamic University
College of Computer and Information Sciences
Information Technology Department

SYSTEM FOR MONITORING WATER IN TUUNELS BY USING IOT (SALEK)

By:
Group 178

عبدالاله بن عبدالله العتيبي
Abdulelah Abdullah Alotaibi
ababmotaibi@sm.imamu.edu.sa
441022758

عبدالله عمران العمران
Abdullah Omran Alomran
Aboalomran@sm.imamu.edu.sa
441015405

محمد منصور بن قاسم
Mohammed Mansour Bin Gasem
mbingassem@sm.imamu.edu.sa
440012501

Supervised by:
D.*Fahad Omar Suliman Alomary*

Fall 2023

Abstract

The problem of high water levels in tunnels during rainy periods is a critical issue that affects traffic flow and causes many problems and damages. The Kingdom of Saudi Arabia is among the countries that suffer severely from this problem, especially in the winter season when frequent rains occur. Therefore, measuring the water level in tunnels during rainy periods is an important and vital project to maintain the safety and smoothness of traffic, through the use of available modern technologies, such as the Internet of Things and wireless sensor networks. These technologies include installing sensors in tunnels to measure water levels and transmitting the collected data to the cloud via wireless communications. When water levels in tunnels are detected, warning notifications are sent to relevant individuals to take necessary actions. Additionally, this technology can be used to collect and analyze data to identify tunnels that are experiencing more problems than others, and thus determine the necessary steps to improve these tunnels and reduce the likelihood of problems occurring in the future. In summary, measuring the water level in tunnels during rainy periods is a vital and necessary project to maintain the safety and smoothness of traffic and identify the necessary steps to improve rainwater-related problems in the Kingdom of Saudi Arabia.

Keywords:

{IoT , water level , sensers , Application}

Abstract (Arabic)

تعتبر مشكلة ارتفاع منسوب المياه في الأنفاق خلال فترات الأمطار قضية حرجة تؤثر على تدفق حركة المرور وتسبب العديد من المشاكل والأضرار. وتعد المملكة العربية السعودية من الدول التي تعاني بشدة من هذه المشكلة، خاصة في فصل الشتاء الذي يكثر هطول الأمطار. لذلك يعد قياس منسوب المياه في الأنفاق خلال فترات الأمطار مشروعا مهما وحيويا للحفاظ على سلامة وانسيابية حركة المرور، من خلال استخدام التقنيات الحديثة المتاحة، مثل إنترنت الأشياء وشبكات الاستشعار اللاسلكية. وتشمل هذه التقنيات تركيب أجهزة استشعار في الأنفاق لقياس مستويات المياه ونقل البيانات التي تم جمعها إلى السحابة عبر الاتصالات اللاسلكية. عند الكشف عن مستويات المياه في الأنفاق ، يتم إرسال إشعارات التحذير إلى الأفراد المعنيين لاتخاذ الإجراءات اللازمة. بالإضافة إلى ذلك ، يمكن استخدام هذه التقنية لجمع وتحليل البيانات لتحديد الأنفاق التي تواجه مشاكل أكثر من غيرها ، وبالتالي تحديد الخطوات اللازمة لتحسين هذه الأنفاق وتقليل احتمالية حدوث مشاكل في المستقبل. وخلاصة القول إن قياس منسوب المياه في الأنفاق خلال فترات الأمطار يعد مشروعا حيويا وضروريا للحفاظ على سلامة وانسيابية الحركة المرورية وتحديد الخطوات اللازمة لتحسين المشاكل المتعلقة بمياه الأمطار في المملكة العربية السعودية

List of Abbreviations

- IoT Internet of Things
- Sen Sensors
- Dash Dashboard

Table of Contents

List of Figures

List of Tables

Chapter One: Introduction

1 Introduction

1.1 Introduction

The problem of flooding in tunnels, which is a vital and important problem facing many cities around the world. Tunnels are the main route for urban traffic and provide an important means of public and private transport. However, the occurrence of flooding in tunnels can cause traffic disruption and a risk to public safety, IoT technology is one of the modern solutions, where sensors installed in tunnels will be used to measure the level of water height and send the data extracted from it to the database. By analyzing this data, stakeholders can determine the water level in the tunnels, predict flooding, and then take action to reduce damage and improve traffic,This project is a good example of how technology can be used to solve problems of everyday life and improve the quality of life in cities. This project is also technically and scientifically challenging.

Therefore, many cities around the world face the problem of traffic disruption in tunnels due to flooding, and this represents a risk and a vital problem for public safety. This risk and problem is due to the lack of an effective system to monitor and analyze the water level in the tunnels, which leads to the inability to predict the occurrence of floods and take the necessary measures to reduce damage , This situation causes a great danger to human life and property, and leads people to risk their lives and safety by passing through the tunnels without knowing whether the tunnels are flooded or not. This reflects how ignorant many people are about the condition of the tunnels and how dangerous it is.

While analyzing similar systems, we found , Surface water monitoring systems: The importance of an integrative approach to surface water monitoring systems, which includes quality and quantity models of water. A framework is proposed to integrate all approaches into water monitoring including sample techniques and predictive models to provide comprehensive information on environmental assessment. The project aims to achieve unified and sustainable water management through the implementation of integrated water monitoring systems, and proposes the use of integrated semi-mechanical models, data science and artificial intelligence to integrate the discrete model approach. The project recommends that water monitoring be carried out based on an integrated approach to improve its performance and achieve sustainable and unified water management.

Moreover, our project is characterized by relying on modern technologies such as the Internet of Things, machine learning and smart sensors, by placing sensors in tunnels and linking them with the competent authorities to analyze data, measure the level of water rise and send notifications in case of danger.

The remainder of this section 1.2 discusses its Problem Definition. In section 1.3 and 1.4 we will see the local and global impact. in Section 1.5 and 1.6 explore project scope, aims and objectives for starting the project. Section 1.7 and 1.8 included the Alternative Solutions and methodology to be followed. Sections 1.9, 1.10, and 1.11 covered the Project Timeline for developing this system, the expected Report Structures, at the end in you will see the Summary.

1.2 Problem Definition

Many cities around the world face the problem of flooding tunnels during periods of heavy rains, and this leads to several economic and social problems. Heavy rains lead to the accumulation of water in tunnels and cause flooding, endangering the lives of the community, closing roads and streets, and destroying public and private property.

The problem requires effective solutions to monitor the level of water rise in tunnels during periods of heavy rains, and this requires the use of modern technologies to detect water accumulation and alert the competent authorities quickly and accurately. In addition, proposed solutions to the problem should include actions to reduce flood damage and improve worker and community health by improving tunnel design, traffic and public transport regulation and improved sanitation.

1.3 Local Impact

Many people suffer from the problem of flooding tunnels, therefore, our project monitoring the level of water height in tunnels can improve the safety of workers and reduce the damage caused by floods, it can also improve public services and public transportation services and reduce damage to people's vehicles.

1.4 Global Impact

Since this project is about monitoring the level of water rise in tunnels during rain, it can reduce economic losses, and improve public safety and community health.

1.5 Project Scope

In this project, it aims to design and develop a monitoring system that uses sensors to measure the water level inside the tunnels and send the data to a central control unit for analysis and presentation to operators. Sensors are installed on the tunnel walls and software is developed to display and analyze the measured data from the sensors. The sensors are then connected to the central control unit and conveniently installed inside the tunnels. The system is tested to ensure that it works properly to the specified specifications.

The limits of this project is that only the competent authorities and trained to deal with the use of the system in emergency situations can benefit from it.

1.6 Aims and Objectives

The aim of building this system is to help the concerned sectors such as (Civil Defense, Traffic and the Ministry of Municipal and Rural Affairs and Housing) in facilitating traffic in tunnels and reducing injuries and risks resulting from rain and floods.

Objectives:

- Absorb the largest number of problems of drowning and blockages and work to solve them as soon as possible.

- Facilitate the movement of vehicle owners during rain and torrential rains.

- Warning people about closed tunnels and staying away from them.

1.7 Alternative Solutions

Alternative to the suggested system is displayed in the following in table 1.

Table 1.1. Alternative Solutions.

Name of Sloution	**Advantage**	**Disadvantage**
Precautionary closure of some tunnels in case of expected rainfall.	The safety of the public is being fully ensured. There is no cost associated with implementing this solution.	Traffic obstruction, causing congestion.
Monitoring the tunnel by traffic officers.	Easy to implement, can be applied in multiple locations.	It is not considered a permanent and safe solution. Human error is possible. It is difficult to accurately detect the rate of water level increase.

After researching alternative solutions, we found that water level in tunnels can be measured through several methods, but they are traditional methods that are not accurate in measurement and come with a high cost compared to their quality. Therefore, it is important to solve this problem by using modern technologies, as we are currently doing.

1.8 Method / Approach

In this type of project, we plan to use agile methodology because it’s flexible and it suits our project’s needs.

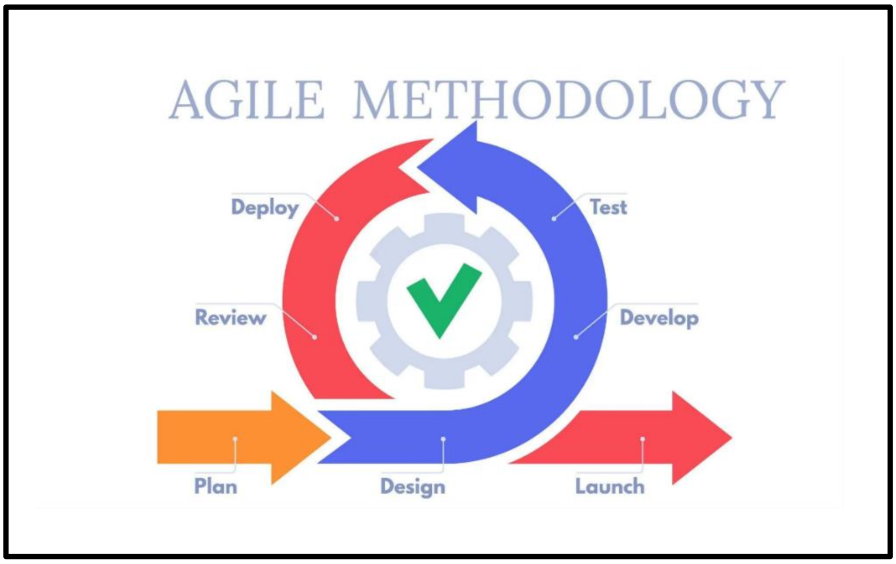
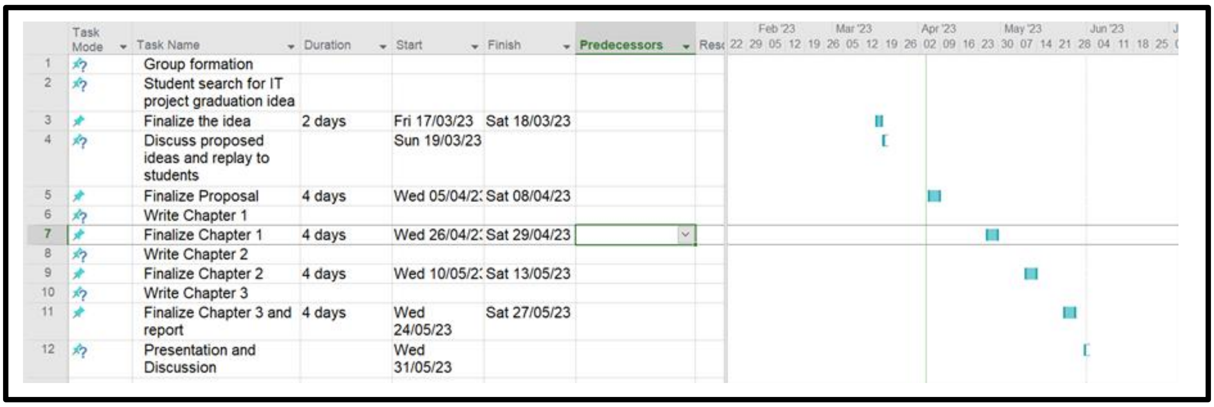


Figure 1.1. agile methodology.[1]

In chapter 1 for this project the team need to plan determine requirements, tools, techniques, project scope, aims, objectives, alternative solutions, method, and finally the project timeline. In chapter 2, the team will perform a literature review, including an introduction, background, and related work. In chapter 3, the project team will undertake a design determining system perspective and the system analysis requirements elicitation techniques, Dashboard , system requirement and last but not least the system design.

1.9 Project Timeline

This is the estimated project Timeline:



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Group formation				
2		Student search for IT project graduation idea				
3		Finalize the idea	2 days	Fri 17/03/23	Sat 18/03/23	
4		Discuss proposed ideas and replay to students		Sun 19/03/23		
5		Finalize Proposal	4 days	Wed 05/04/2:	Sat 08/04/23	
6		Write Chapter 1				
7		Finalize Chapter 1	4 days	Wed 26/04/2:	Sat 29/04/23	
8		Write Chapter 2				
9		Finalize Chapter 2	4 days	Wed 10/05/2:	Sat 13/05/23	
10		Write Chapter 3				
11		Finalize Chapter 3 and report	4 days	Wed 24/05/23	Sat 27/05/23	
12		Presentation and Discussion		Wed 31/05/23		

Figure 1.2. Project Timeline

1.10 Report Structure

Our project composed of three chapters as follows:

Chapter 1 Introduction : In this chapter, the problem was well stated, and both the global and local impacts were explored. We present several possible alternatives in relation to the goal and scope. We believed the agile approach to be the ideal fit for our project, on which it would be executed, and the project's timetable.

Chapter 2 :Literature Review Describe the scientific context of the project problem, highlighting its importance of the project in its contribution to improving traffic flow and public safety, the background of this field leading up to the problem, and the definitions of related work that has been done to address the same project problem and compare the various approaches taken.

Chapter 3 System Analysis and Design : we will talk about techniques and system requirement functional requirement and non- functional requirement and user interface (UI) and system design.

1.11 Summary

In this project, the water level monitoring system inside the tunnels is designed using sensors and linked to the dashboard, the sensors are placed on the walls of the tunnels and then the data is sent to the dashboard for analysis and alarms are issued in case of exceeding the permissible level. The system aims to avoid potential damage and keep people safe in the tunnels.

Chapter Two: Literature Review

2 Literature Review

2.1 Introduction

In the previous chapter, the problem was identified and, described the problem area and the objectives to be achieved through the proposed system. An action plan was drawn up on the project, the division of tasks, a time frame for working on the various stages of the project, and a review of alternative solutions, which were not good for solving the proposed problem.

This chapter will present the problem is studied in more detail and the history of the problem is reviewed by making a study on the problem, searching for previous solutions to the same problem, and the work related to this project. By reviewing previous research and projects and the systems that were used to solve the problem and identifying the strengths and weaknesses of those solutions, in the end, we make a comparison of those solutions through some basic points with the proposed system to reach the best possible solutions for the proposed system , With the advancement of technology and the emergence of many modern technologies today, their use has become mandatory due to the potential of these technologies in facilitating, improving, and developing user experience in many ways.

During our examination of the Kingdom’s roads and its infrastructure, we discovered that it lacks these modern technologies, as many drivers of vehicles and logistic services suffer from problems related to the closure and submergence of some roads and bridges, which may lead to stumbling of some projects and roads and increase pressure on other roads, and another problem appears that we have. It is overcrowded and the reason for this is the lack of artificial intelligence techniques and the Internet of Things on the site.

In the Background, we talked about the Internet of Things, and we were able to express its usefulness in the world in general and particular in our project. In the background, we touched on several points, starting with the importance of the problem, then the history of the Internet of Things and its basic concept. Finally, we mentioned its subsections.

Also n the related works, and after reviewing several research papers and scientific articles, a summary of the scientific papers was made and analyzed based on the contributions of the researchers in their scientific papers and the methods used to solve the problem, in addition to the results they obtained through their scientific research. We will begin by making a general summary for each separate scientific paper, and then we will create several tables to focus on the aforementioned points, such as the methods used, the results, and the contributions. Then we will compare their work to ours and determine whether the problem was solved completely, partially, or not at all. After that, a table was created to classify the scientific papers according to their methods used, focusing on the similarities and differences between them, as well as their shortcomings.

In conclusion, the most important points in the background, related work, and the importance of our project were summarized, and we talked about our next step in the summary.

2.2 Background

The Internet of Things helps people live and work smarter and gain complete control over their lives. The IoT not only provides smart devices to automate homes but is also critical for businesses. The Internet of Things provides businesses with real-time insight into how their systems are working, delivering insights into everything from machine performance to supply chain and logistics operations.

The IoT enables companies to automate processes and reduce labor costs. It also reduces waste and improves service delivery, makes goods cheaper to manufacture and deliver, and provides visibility into customer transactions.

The Internet of Things (IoT) is one of the most important technologies in everyday life and will continue to grow in importance as more and more companies realize the potential of connected devices to maintain their competitiveness.
Therefore, our project to measure the level of water rise in tunnels in the Kingdom of Saudi Arabia using the Internet of Things (IoT) is of great importance in the field of water management and infrastructure development. The following project background covers the required points.

2.2.1 The importance of problem

The problem began to worsen with the increasing growth of the cities in the kingdom and the increase of the population, which led to a higher load on the infrastructures, especially the water drainage and the tunnels, as well as to an increase in traffic accidents in the tunnels because they were not able to drain the water quickly, endangering the lives of the population and causing a huge increase in traffic congestion.

Problems associated with drainage tunnels impact health, the environment, and the economy, as increased flooding causes tunnel infrastructure to fail, endangers motorists and pedestrians, and affects businesses and the economy surrounding the tunnels, Here, through the implementation of the concept ofthe Internet of Things, we can contribute to solving the problem.

2.2.2 The history of of internet of Things

The concept of endowing physical objects with sensors and intelligence was first discussed in the 1980s, when some university students decided to modify a Coca-Cola vending machine so that its contents could be controlled remotely. But the technology was bulky and progress waslimited.

The term 'Internet of Things' was coined in 1999 by computer scientist Kevin Ashton. While working at Procter & Gamble, Ashton proposed tagging products with radio frequency identification (RFID) crisps to track them through the supply chain.

He reportedly incorporated the then buzzword 'Internet' into his proposal to get executives' attention. And the term stuck.
Over the next decade, public interest in IoT technology began to grow as more and more connected devices hit the market.

In 2000, LG announced the first smart refrigerator; in 2007, the first iPhone was launched; and in 2008, the number of connected devices exceeded the number of people on Earth.

In 2009, Google began testing driverless cars, and in 2011, Google's Nest smart thermostat was launched, enabling remote control of central heating.

2.2.2 The fundamental concept of internet of things

Sensors: sensors are electronic devices that generate electrical, optical, or digital data derived from a physical condition or event. The data thus generated is electronically converted by another device into an information output that helps intelligent devices and humans make decisions.

Networks: the signals picked up by the sensors are transmitted through networks with all the different components of a typical network, including routers, bridges in different topologies, including LAN, MAN and WAN. The connection between the different parts of the networks and the sensors can be done through different technologies, including Wi-Fi, Bluetooth, Low Power Wi-Fi, Wi-Max, normal Ethernet, Long Term Evolution (LTE), and the new promising technology Li-Fi (which uses light as a communication medium between the different parts of a typical network, including sensors).

Cloud-based platforms: IoT devices use cloud-based platforms to store and process data.

2.2.3 Subsections

Our project seeks to use IoT technology to measure the level of water rise in tunnels. This can be accomplished utilizing a variety of sensors and technology.

Sensors: We will use many sensors to detect the water level, locate the tunnel, and connect the sensors to the server.

Networks: To enable remote monitoring and control, you must connect the sensors. Sensor data can be sent to the cloud using Wi-Fi, Bluetooth, and other wireless technologies.

Cloud: cloud computing services can be used to store and easily access data received from sensors located anywhere on the Internet. Cloud computing can also be used to analyze, send, and display data in the dashboard.

Dashboard: After assessing the data and establishing the projected time to reach a specified threshold requiring preventive steps, the data will be displayed.

As shown in the figure 2.1 below, the whole prosses of our project in the field of internet of things.

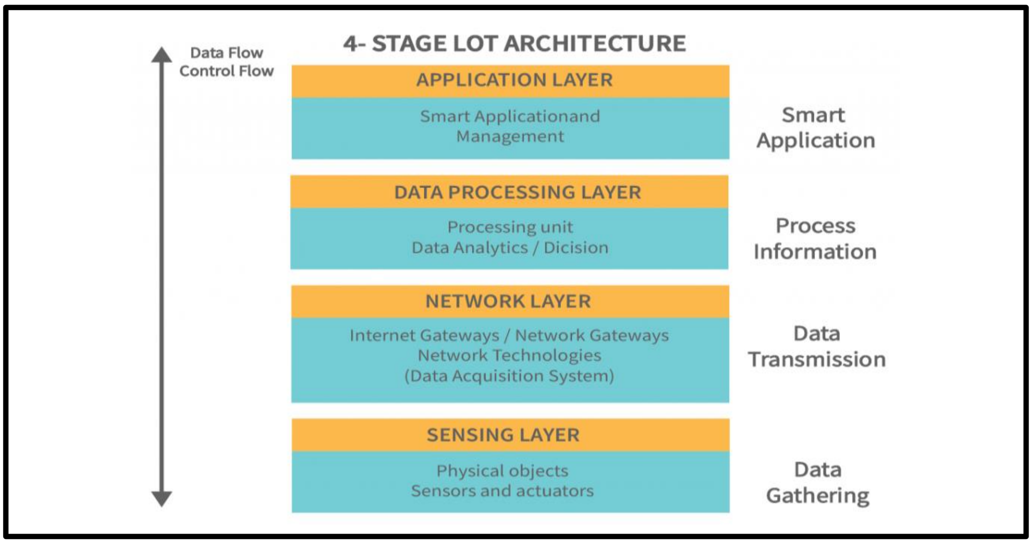


Figure 2.1: prosses of internet of things.[2]

2.3 Related Work

In the related works, and after reviewing several research papers and scientific articles, a summary of the scientific papers was made and analyzed based on the contributions of the researchers in their scientific papers and the methods used to solve the problem, in addition to the results they obtained through their scientific research. We will begin by making a general summary for each separate scientific paper, and then we will create several tables to focus on the aforementioned points, such as the methods used, the results, and the contributions. Then we will compare their work to ours and determine whether the problem was solved completely, partially, or not at all. After that, a table was created to classify the scientific papers according to their methods used, focusing on the similarities and differences between them, as well as their shortcomings.

1- According to A. C. D. S. Júnior, R. Munoz, M. D. L. Á. Quezada, A. V. L. Neto, M. M. Hassan and V. H. C. D. Albuquerque, in his scientific paper on IEEE entitled " Internet of Water Things: A Remote Raw Water Monitoring and Control System"

This study aims to develop a new online system called Internet of Water Things (IoWT) to monitor and manage water resources. The system is based on a server-less architecture and the Internet of Things Architectural Reference Model. The system is tested in a simulation environment using electronic devices such as level sensors, temperature sensors, and rain gauges. The data is collected and analyzed, and the system's memory allocation is found to have minimal impact on efficiency. In a real case, the system is connected to a water well, and the data is transmitted through a 3G network and processed. The proposed IoWT system has the potential to complement traditional water resource management tools and help in decision-making.

This research is based on the DSR methodology and is divided into five stages (Figure 2.2): investigation of the problem, design of the solution, validation of solutions, implementation of the solution, and evaluation of the solution. The study focuses on developing a system for capturing raw water from tubular wells using level sensors, temperature sensors, and water meters. The data is collected every minute and sent every hour to the IoTW system, which processes and stores water resource data. The IoTW system is the main objective of this study, and the research explains how the system was developed. The study also considers data traffic and the cost of operating the system, leading to data being sent every hour instead of every minute.

Figure 2.2. Cycle of design science research.[3]

2- According to Y. Sudriani, V. Sebestyén and J. Abonyi, in his scientific paper on IEEE entitled " Surface water monitoring systems – the importance of integrating information sources for sustainable watershed management "

This study emphasizes the importance of an integrative approach to water monitoring systems that includes both water quality and quantity models. A framework is proposed to incorporate all water monitoring approaches, sampling techniques, and predictive models to provide comprehensive information about environmental assessment. The study concludes that model-based approaches, such as verification and fusion of data, have the potential to improve the performance of water monitoring systems. The study recommends the integration of separate modeling approaches through integrated semi-mechanistic models, data science, and artificial intelligence. The overall goal is to achieve standardized water management by implementing integrated water monitoring systems.

3- According to JINQIU PAN1 , (Student Member, IEEE), YUE YIN1 , (Student Member, IEEE), JIAN XIONG 1,2, (Member, IEEE), WANG LUO3 , (Member, IEEE), GUAN GUI 1,2, (Senior Member, IEEE), AND HIKMET SARI1,2, (Fellow, IEEE) for their scientific paper on IEEE entitled " Deep Learning-Based Unmanned Surveillance Systems for Observing Water Levels "

The scientific paper titled proposes an unmanned surveillance system that uses deep learning-based technology to monitor water levels in rivers and reservoirs in real-time. The traditional surveillance systems require human employees to manually read water levels, which is expensive and time-consuming. The proposed system consists of a remote measuring station equipped with a video camera, water analyzer, 4G router, distribution box, and solar panel, which transmits real-time data to a monitoring center for processing (shown in figure 2.3) The monitoring center provides users with a map-based web service to monitor water conditions, stream flows, and water quality in real-time. The paper evaluates different methods, including difference method, dictionary learning, and deep learning, to measure water levels, and the experimental results show that the deep learning-based method performs best in terms of accuracy and stability. The proposed system aims to prevent flood disasters by forecasting water levels and to be used for environmental monitoring during low water flow. The paper emphasizes the importance of comprehensive and dependable water resource management, especially in areas with unevenly distributed water resources, leading to floods and droughts annually.

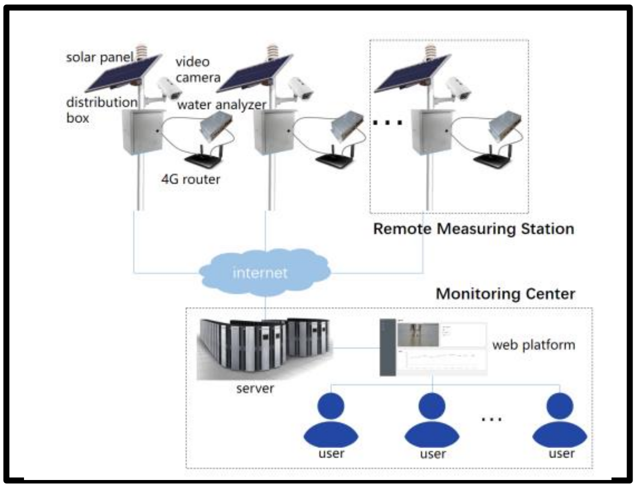


Figure 2.3 . Components of the proposed system.[4]

4- According to YUYUE XU 1,2, SAIHUA GU 1,2, ZIJUN YIN1,2, JING LIN1,2, JIANWEI ZHAO1,2 , XIAOYUN ZHU1,2, AND LING YAO 3,4 for their scientific paper on IEEE entitled " Obtaining Accurate Water Level Measurements in Lakes: Analysis of Changes in ICESat Altimetry Accuracy With Buffer Changes"

This scientific paper discusses the use of the Ice, Cloud, and land Elevation Satellite (ICESat) data to obtain accurate water level measurements in lakes by identifying lake water footprints (LWFs). The study analyzes the effects of using inside and outside buffers to obtain lake water masks (LWMs) for seven different lakes. The accuracy of the ICESat water level was compared with in situ measured data using the root mean square error (RMSE) evaluation. The study concludes that the altimetry accuracy can be improved by using the outside buffer, which is particularly relevant for relatively narrow lakes. Overall, the paper provides insights into the factors driving changes in altimetry accuracy in relation to the buffer setting, and offers recommendations for improving the accuracy of water level measurements in lakes.

2.3.1 Subsections

After summarizing all the scientific papers, it is now possible to create a table consisting of the conclusions for each paper. Then we can identify the gap between their research and our current research and determine whether these papers solved our problem or not.

Table 2.1. Details of the contributions of the papers.

Papers	Contribution	Method	Result
Internet of Water Things: A Remote Raw Water Monitoring and Control System.	emonstrate that IoT computational systems can be developed to help the management of water resources reliably, using a standardized reference architecture that can be understood by several researchers and developers.	The authors have used a simulation methodology or tests capable of guaranteeing performance of the IoT application for efficient management of water resources named as the Internet of Things of Water (IoTW).	Their architecture requires few hardware resources and can be rapidly developed using market tools.
Surface water monitoring systems – the importance of integrating information sources for sustainable watershed management.	It highlights the most influential variables that increase the efficiency of water monitoring systems and emphasizes the neglect of single measurements that integrate monitoring activities.	The authors describes four categorized methods for describing the dynamic of water quantity and quality in freshwater: white-box model, light-gray-box model, dark-gray-box model, and black-box model.	Efficient water modeling approach combined with a data acquisition system, cross-validation information measurement, and data integration can improve the performance of water monitoring systems.
Deep Learning-Based Unmanned Surveillance Systems for Observing Water Levels.	The paper proposes an unmanned surveillance system using deep learning-based technology to monitor water levels in rivers and reservoirs.	Different methods including difference method, dictionary learning, and deep learning-based technology are evaluated to measure water levels.	Experimental results show that the proposed system provides better accuracy and stability compared to other methods.
Obtaining Accurate Water Level Measurements in Lakes: Analysis of Changes in ICESat Altimetry Accuracy With Buffer Changes.	Evaluation of the impact of buffer zone setting on the accuracy of altimetry for lakes of different sizes, specifically in obtaining accurate water level measurements using ICESat data.	The authors discusses the methods for obtaining accurate water level measurements in lakes using the Ice, Cloud, and land Elevation Satellite (ICESat) data.	The study concludes that the altimetry accuracy can be enhanced by using the outside buffer, which is particularly relevant for relatively narrow lakes. Additionally, the study found that the change in the range of altimetry accuracy was affected by the number of lake water footprints (LWFs) obtained.

2.3.1.1 Research gaps

After reviewing the details of the papers, we now identify the research gaps to determine whether our problem has been solved or not, or whether there is any similarity between our research and theirs. In the first scientific paper, the Internet of Things was used, which is similar to what we did, but they used it to control and manage water resources. The unique thing about this research or the use of the Internet of Things is that it can benefit our work. In the second paper, the discussion focused on the most influential variables that increase the efficiency of water monitoring systems, and four methods were used to describe the dynamics of water, which is important to us and we benefited from it. In the third paper, they talked about the accuracy and stability of water monitoring systems using deep learning, and in the last paper, they talked about improving the accuracy of water level measurement.

There are significant gaps between their scientific research and ours, as they focused on measuring water in various places, but there is no scientific research that talks about measuring water levels in tunnels to prevent them from flooding. This gap has become important for our project to research and work on.

2.3.1.2 Research categories

In this stage, we will create a table that shows the categories of research according to their similarities, differences, and shortcomings.

The first and second scientific papers were classified into one category named (Category A) because they describe water monitoring in general and the most influential variables that increase the efficiency of water monitoring systems, as well as managing water resources.

The third and fourth scientific papers were also classified into one category named (Category B) because they describe measuring water level and its accuracy.

Tabel 2.2. Research categories.

Categorize	Similarities	Differences	Shortcomings
Category A (Papers 1 & 2)	Monitoring and managing water monitoring systems.	The first paper consists of a contribution that it is possible to develop accounting systems to assist in managing and monitoring water resources. Meanwhile, the second paper highlighted the most influential variables that increase the efficiency of water monitoring.	In the first paper, due to the high operating cost of the system, the data was sent to IOTW every hour instead of every minute, which was deemed impractical. In the second paper, I believe there are no shortcomings.
Comment :	After reviewing and examining the classification of the two scientific papers, we concluded that managing water resources through IoT is a common and vital topic, and using IoT technology to collect large and accurate data about water resources and control their usage is an effective and sustainable approach. It is also noteworthy that water monitoring is considered an important integrated approach.		
Category A (Papers 3 & 4)	Both papers focus on the accuracy of water measurements using different methods.	In the third paper, several methods were used to measure water levels, but the results showed that the deep learning-based method performed better in terms of accuracy. However, in the fourth paper, satellite data for land elevation, clouds, and ice were used to infer lake surface levels.	The third paper focused on areas with unevenly distributed water resources, while the fourth paper employed external methods that may affect the accuracy of the measurement.
Comment :	Accuracy is essential for water monitoring, and there are different methods for measuring water levels, some of which are practical, while others are not. For example, in the third paper, multiple methods were used to determine the most accurate approach. Therefore, it is crucial to choose an appropriate method for accurate water monitoring.		

2.4 Summary

Throughout this chapter we have covered several key points.

In the background section, the target audience are those responsible for the roads and infrastructure of the Kingdom of Saudi Arabia, but they are not necessarily specialized or educated in the technical field, so they were prepared by providing many information and points about the importance of the problem in this field and the history that leads to this problem. List definitions of key concepts in this field.

In the relevant work section, we compare the current methods and infrastructure with modern systems, research and papers that mentioned and solved problems related to or centered around our project, and this is the main point of the chapter, so it was taken care of as many projects and systems that use different methods to solve the problem of this project were presented But it lacks artificial intelligence. The papers are summarized, highlighting their contributions, methods, and results, and identifying research gaps.
Finally, to clarify the differences between these systems, a table was made to review the characteristics of each system.

The next chapter (System Analysis) will fully summarize the system requirements. It includes system perspective, requirements elicitation technique, system requirements which include (functional requirements, non-functional requirements), user interface prototype and system design which

Chapter Three: System Analysis and Design

3 System Analysis and Design

3.1 Introduction

The previous chapter was a review of the literature, which discussed the background and some similar projects and related works.

This chapter will discuss system analysis and design and provide supporting information on data collection using techniques such as questionnaires.

The chapter will be organized as follows, a system perspective that will talk about comparing our project with existing projects in real life or scientific papers and whether our idea is completely independent and self-contained or not in the next point, we will talk about requirements elicitation techniques, which consist of functional requirements, which are the basic functions that the system performs. And the Non-functional system requirements are several software features that can act as requirements. And the prototype of the user interface will be presented to the client and built according to the functional and non-functional requirements of the system.

Finally, the chapter will talk about system design, which includes four paragraphs (architectural design, class diagram, sequence diagram, database design (if any)). In architectural design, it deals with the presentation of hardware and software components and their interfaces to create a framework for computer system development. Describe the interfaces that the application must support. In a class diagram, a diagram helps to represent a machine, process, or various objects using abstract lines, symbols, and sometimes letters.

There is also a sequence diagram, which shows the interaction between the elements during a time sequence and depicts the objects and items that are included in a specific programming scenario, and the sequence of messages exchanged between the objects to implement the scenario correctly. In conclusion, database design is the design of the database structure and tables required to store and transmit data between the database and the system.

3.2 System Perspective

Our project aims to design and develop an innovative system that utilizes Internet of Things (IoT) technologies and advanced sensors to monitor water levels in tunnels, predict flooding risks, and send notifications to relevant authorities. From a system perspective, the system can be divided into the following subsystems:

Data Collection: This part consists of a set of sensors installed on the tunnel walls and strategically distributed to measure water levels. These sensors may include hydrostatic pressure gauges, ultrasonic level sensors, or any other suitable type of sensor for the application.

Communication and Networking: After collecting data from the sensors, it is transmitted to a central processing unit via a reliable and secure wireless communication network. This network may use technologies such as Lora WAN, NB-IoT, or Sigfox, depending on the project's specific requirements and availability.

Data Processing and Analysis: The aggregated data from the sensors is analyzed in the central unit using advanced predictive algorithms and machine learning to determine when a flooding risk may occur. This analysis may involve identifying trends, temporal patterns, and sudden changes in water levels.

Alerts and Notifications: Upon identifying flooding risks, the system sends warning notifications to relevant authorities, such as urban administrations, emergency response teams, and tunnel management entities. These notifications may include information about the location, expected time of flooding, and any recommendations for immediate intervention.

Control and Monitoring: The system allows relevant authorities to track the tunnel's status and water levels in real-time and control maintenance and operational processes. This may involve monitoring and control using mobile applications or centralized control panels to facilitate access to information and make appropriate decisions.

Relying on these core components, the system provides a comprehensive and integrated solution for monitoring water levels in tunnels, predicting flooding risks, and sending emergency notifications to relevant authorities. This project aims to improve safety and security for users and stakeholders and minimize potential damages resulting from flooding incidents.[10]

3.3 Requirements Elicitation Techniques

A questionnaire is a research tool used to gather information from respondents by presenting them with a series of questions or prompts. It can include a combination of closed-ended questions with predetermined response options and open-ended questions that allow respondents to provide detailed explanations. The concept of research questionnaires was first introduced in 1838 by the Statistical Society of London.

A research questionnaire can collect data in both qualitative and quantitative formats. While a questionnaire can be used independently, it is often a part of a survey, which encompasses a comprehensive set of questions. A Google Form was used to publish the questionnaire. There were 550 respondents and 169 answers. (shown in the figures the questions and the answer after analyses in appendix).

3.4 System Requirement

3.4.1 Functional Requirement

• The system should accurately measure the water level.

• The system should send data to the dashboard.

• The system should data analysis

• The system should display data.

• The system should locate the tunnel.

• The system should send the data to the competent authorities.

• The system should make predictions for the future.

• The system should classify expenditures according to the water level.

• The system should display general ratings.

3.4.2 Non-Functional Requirement

•Usability:

- The system should be easy to use, simple and interactive.
- The user interface should be designed in such a way that novice users with little knowledge can easily access and use this system.
- The system pages should have a simple design for easy navigation.

•Security:

- The user should not be able to change any data.

•Reliability:

- Data sent from the system must be accurate and valid.

•Performance:

- Warning messages and alerts in critical cases must be sent in a short time within 3 seconds of recording the emergency.
- Graphs must be labeled to display ticket data correctly.

3.4.3 Use case diagram

Use cases were developed originally to support requirements elicitation and now incorporated into the UML. Each use case represents a discrete task that involves external interaction with a system. Actors in a use case may be people or other systems. Represented diagrammatically to provide an overview of the use case and in a more detailed textual form،we will start by listing the diagram and then we will start analyzing it.[11]

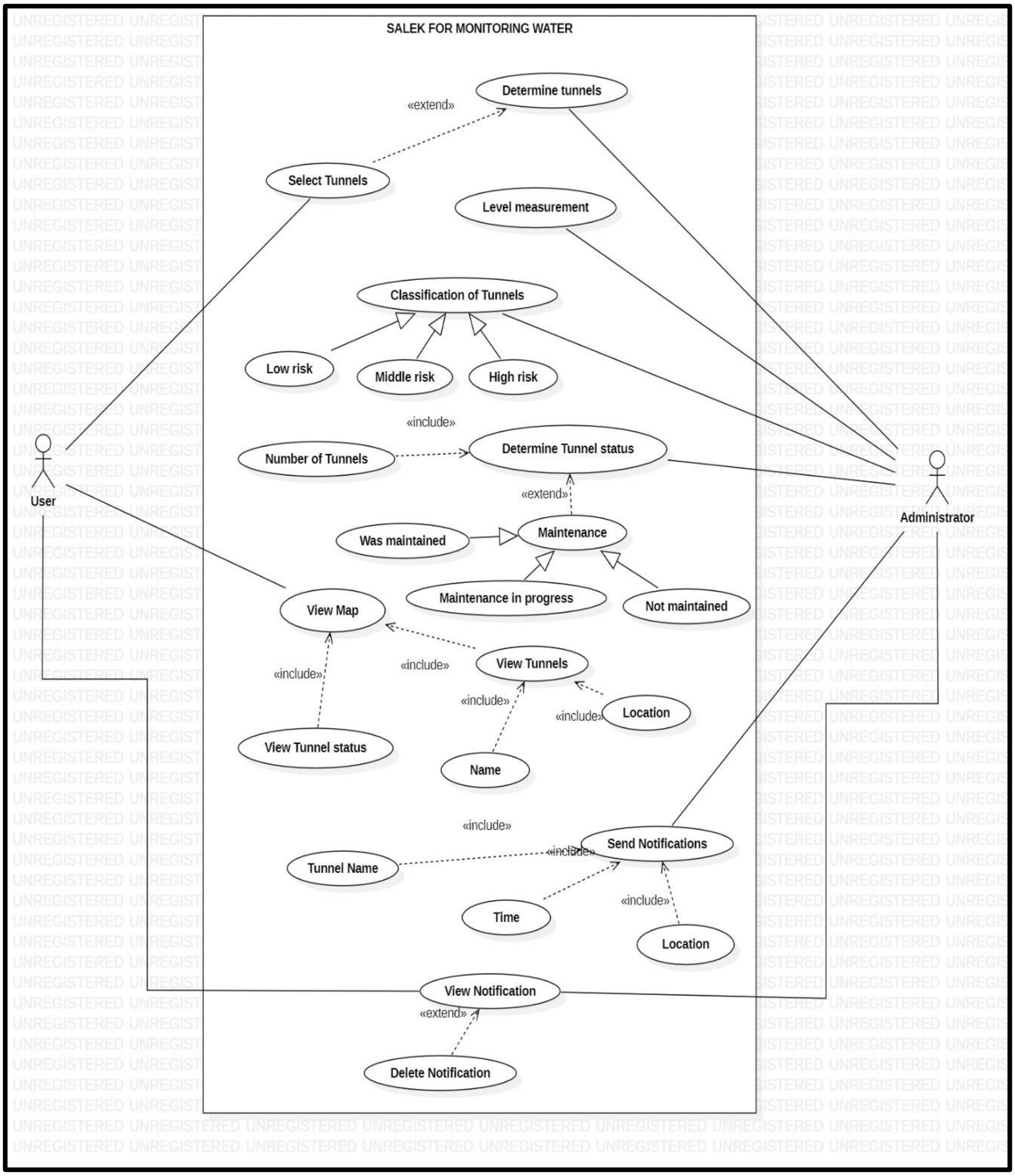


Figure 3.1. Use case diagram.

3.4.4 Use case description

After presenting the diagram, we will now start listing a description of the main use case (that need clarification) by tables which is classification of tunnel use case , Determine Tunnel use case , Determine Tunnel status use case , and send notification use case , it includes Use case name, scenario, Brief description, Actors, Preconditions, Postconditions and Flow of activities.

Table 3.1. Description of Determine Tunnel status use case.

Use case name:	Determine tunnel status.	
Scenario:	Determine the total tunnels number under coverage, and the number of tunnels that have been maintained.	
Brief description:	The administrator determines the total number of tunnels, and determines the maintenance, which includes whether the tunnel has been maintained, so that if the water level decreases after it was middle or high risk, the system includes it and that it (was maintained), and during a decrease in the water level,(maintenance in progress), and in the state of rest It is (Not maintained).	
Actors:	Administrator.	
Flow of activities:	1-Actor: - The encoder measures the level of the tunnel. -Connect it with SALEK system.	2-System: -Configure the tunnel status. - Show the tunnel to the user.

Table 3.2. Description of Determine Tunnel use case.

Use case name:	Determine Tunnel.	
Scenario:	The administrator determines the location of the tunnels, which allows the user to choose the tunnel and display it on the map.	
Brief description:	Tunnels are identified and connected to the SALEK system, so that appear on the website for the user, and he can know it is status.	
Actors:	Administrator, some case (User).	
Flow of activities:	1-Actor: -Administrator set the tunnel location -Connect it with SALEK system.	2-System: -Configure the tunnel status. - Show the tunnel to the user.

Table 3.3. Description of classification of tunnel use case.

Use case name:	Classification of tunnel.	
Scenario:	After measuring the water level from the sensor, the administrator classifies the status of the tunnel.	
Brief description:	The administrator classifies the tunnel into three levels, low risk: indicated in green color in the user interface, middle risk: indicated in yellow color in the user interface, high risk: indicated in red color in the user interface.	
Actors:	Administrator	
Flow of activities:	1-Actor: -Administrator classifies the tunnel status -Administrator Determine what level it is.	2-System: -Set the tunnel status - Show the tunnel to the user

Table 3.4. Description of send notification use case.

Use case name:	Send notification.	
Scenario:	The administrator sends notifications to the user to inform him of the current tunnel status.	
Brief description:	In the event of a change in the current tunnel status (tunnel classification), the administrator sends notifications to the user to inform him of the tunnel status. The notification includes the tunnel name, location, notification content and the time of the change, as well as the user's ability to delete the notification, knowing that there is a search box for notifications according to the date	
Actors:	Administrator.	
Flow of activities:	1-Actor: - The administrator sets the tunnel classification. -Connect it with SALEK system.	2-System: -Configure the tunnel status. - Sending notifications to inform the user.

Table 3.5. Description of view map use case

Use case name:	View map	
Scenario:	The user can view the map and view the tunnels within the scope of the system and their conditions.	
Brief description:	The user browses the map and looks at the tunnels that are within the scope of the system that were presented by the administrator, and the user can see the name of the tunnel, its status, and its location.	
Actors:	Administrator, User	
Flow of activities:	1-Actor: -Administrator set the tunnel status. -Connect is with SALEK system.	2-System: - Displays the map. - Show the tunnel to the user.

3.5 User Interface Prototype

user interface sketch, or sketch, is a mock-up of a graphical user interface that you create while you design an application.

You create sketches by adding drawing elements to the sketching editor. You can also add existing images, parts, and other sketches to a user interface sketch. Use sketching to design web-based and rich-client applications. The sketching tool uses an inheritance-based architecture that makes creating and modifying design artifacts fast and efficient. You can also use sketches to create storyboards.

When you create a sketch, you can insert a reusable set of elements, called a part, into the sketch. Using parts in sketches is an efficient way to create sketches because if you later change a part, the change is automatically reflected in every sketch that includes that part, we have designed the user interfaces that are expected to be in the future, and in each interface, we have achieved some of the requirements mentioned above.[12]

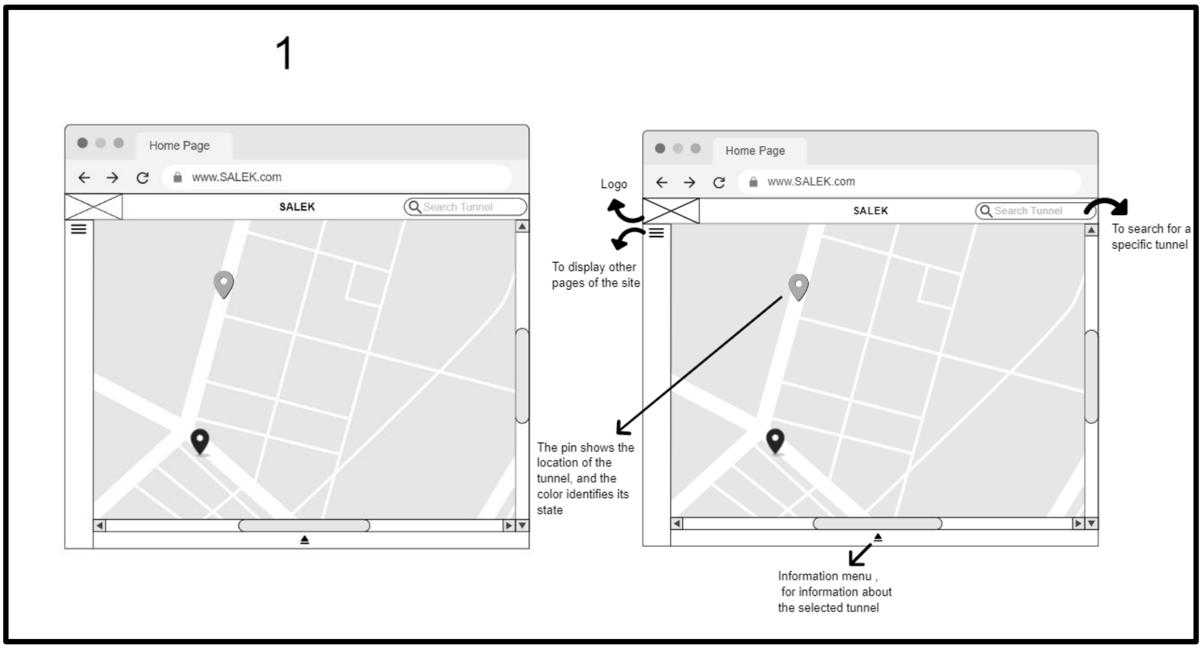


Figure 3.2. Home page interface.

In this user interface we achieved Show tunnel and determine tunnel requirements.

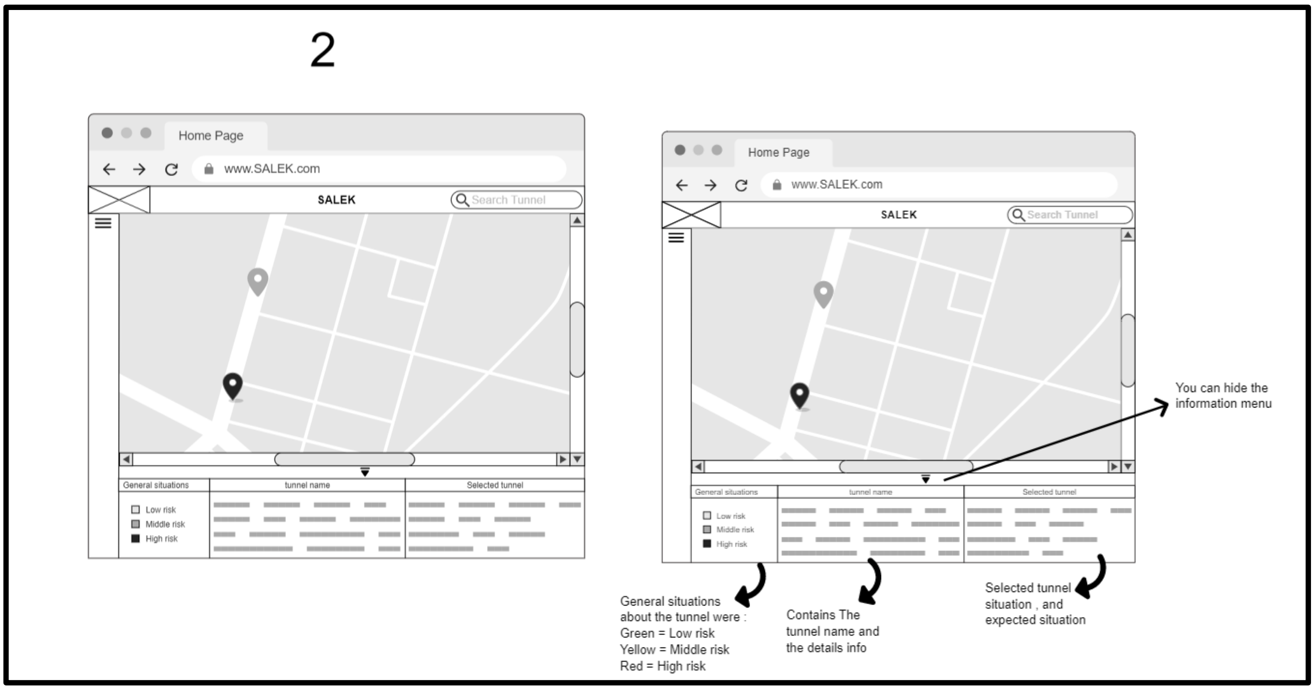


Figure 3.3. Home page with tunnel details interface.

In this user interface we achieved data analysis and display data requirements.

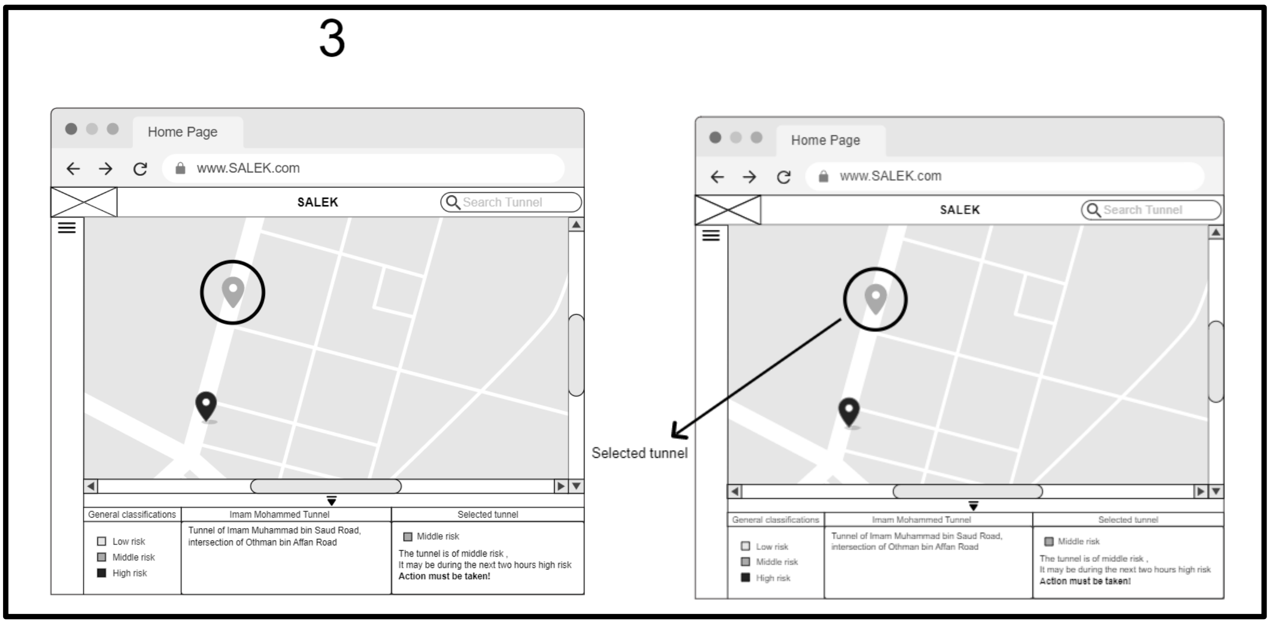


Figure 3.4. Home page with select tunnel interface.

In this user interface we achieved determine tunnel location and display data requirements.

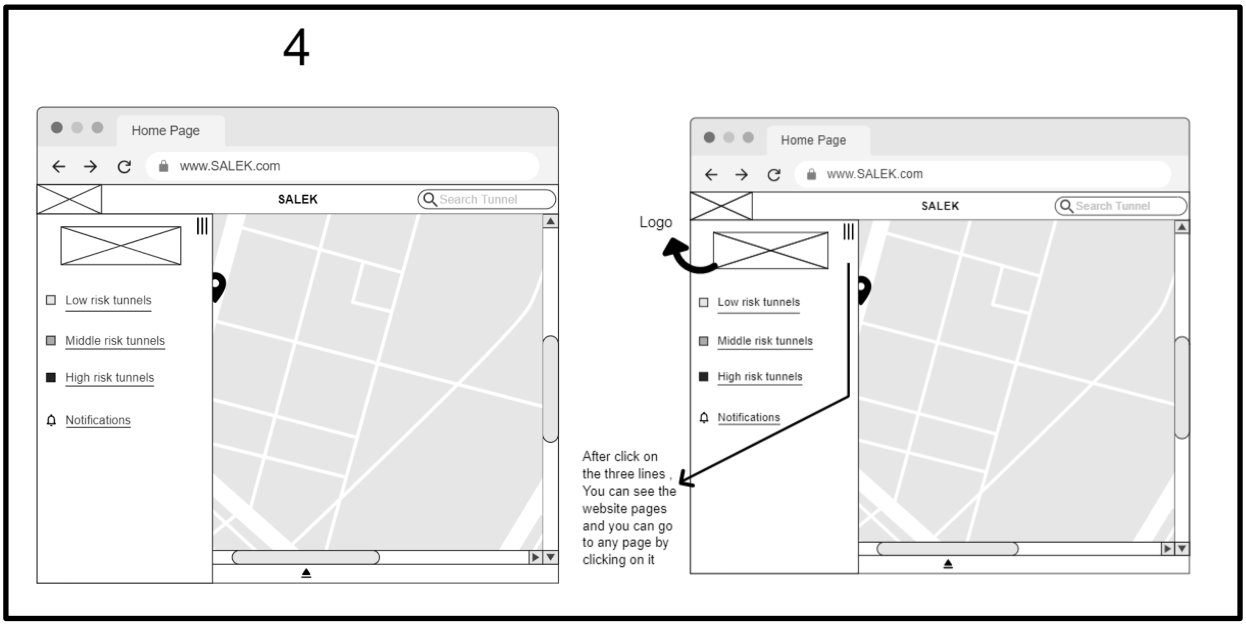


Figure 3.5. Display general pages.

In this user interface we achieved display general pages and accurately measure the water level requirements.

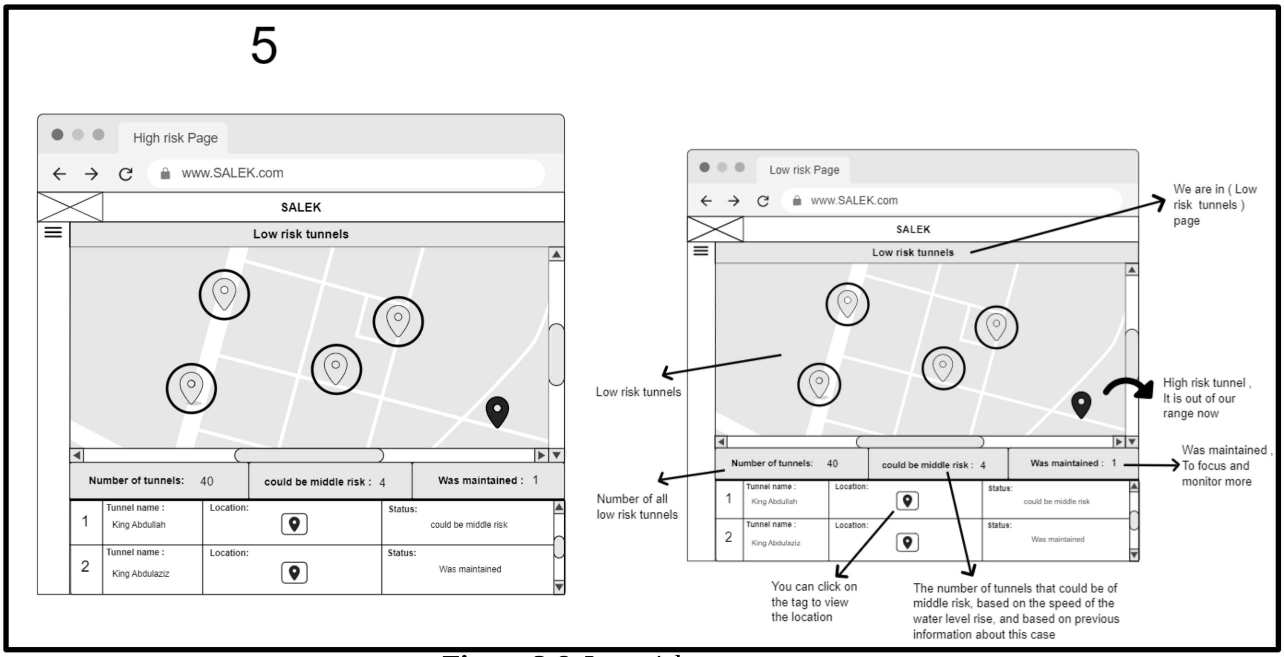


Figure 3.6. Low risk page.

In this user interface we achieved display general pages and accurately measured the water level requirements, classification of expenditures according to the water level.

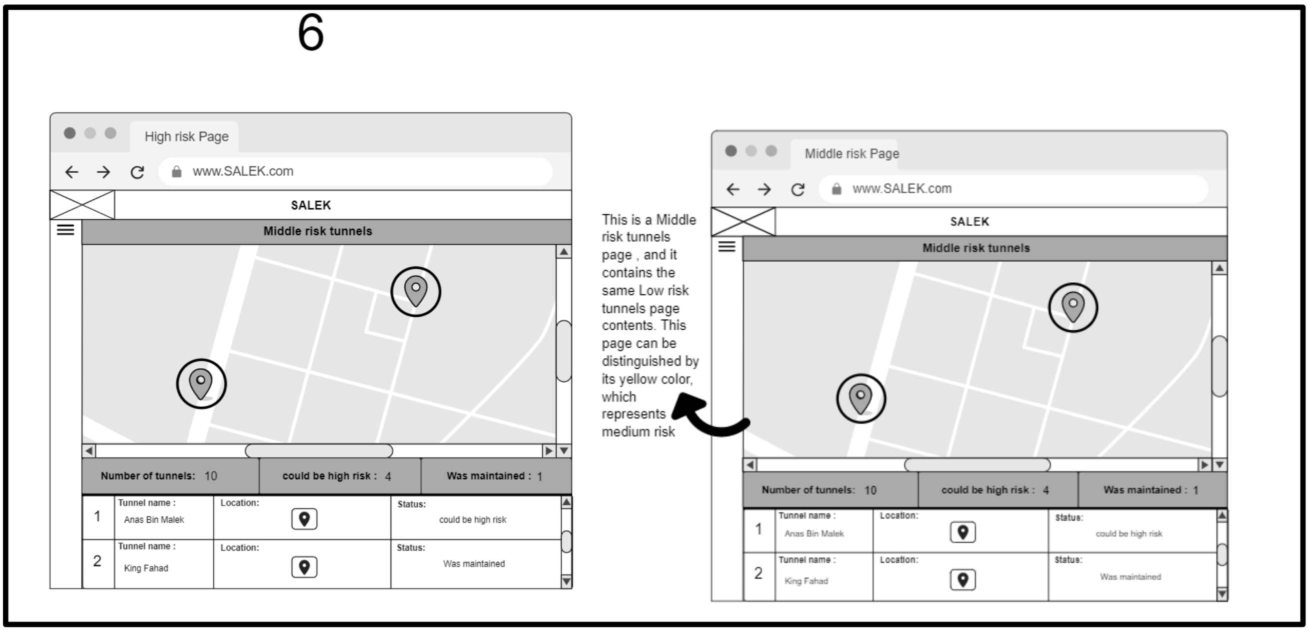


Figure 3.7. Middle risk page.

In this user interface we achieved display general pages and accurately measure the water level requirements.

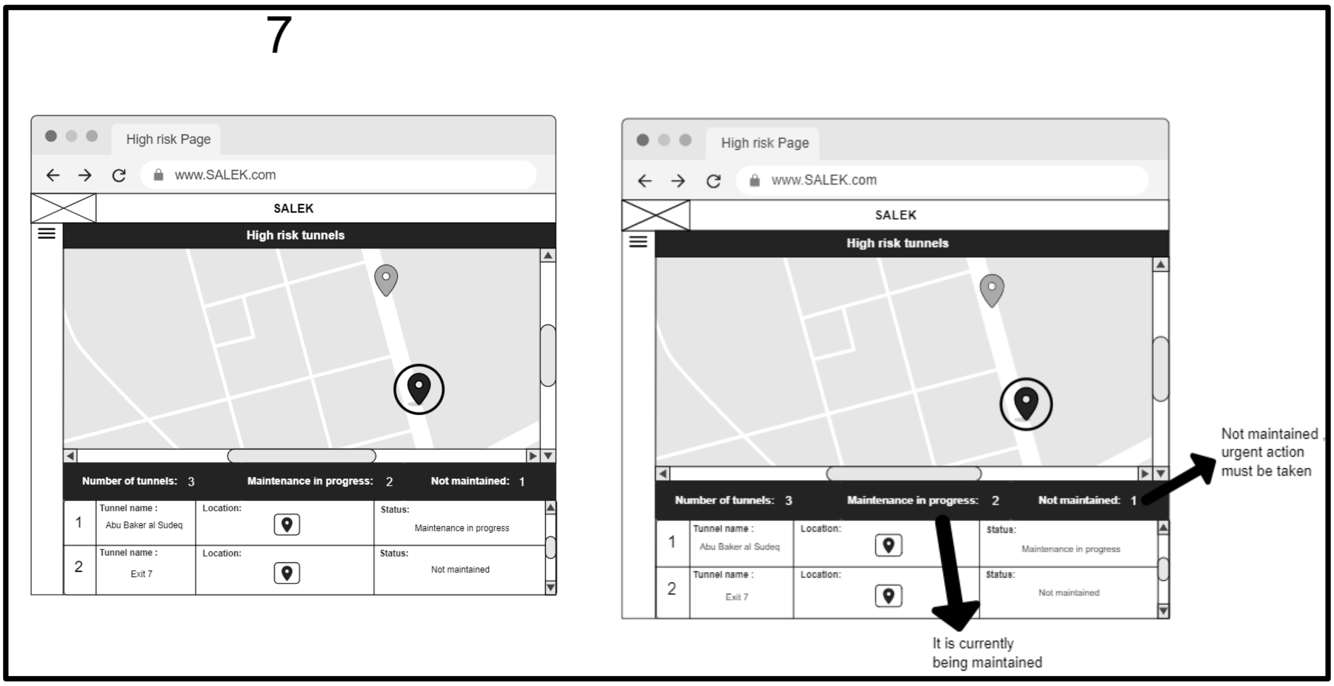


Figure 3.8. High risk page.

In this user interface we achieved display general pages and accurately measured the water level requirements, classification of expenditures according to the water level.

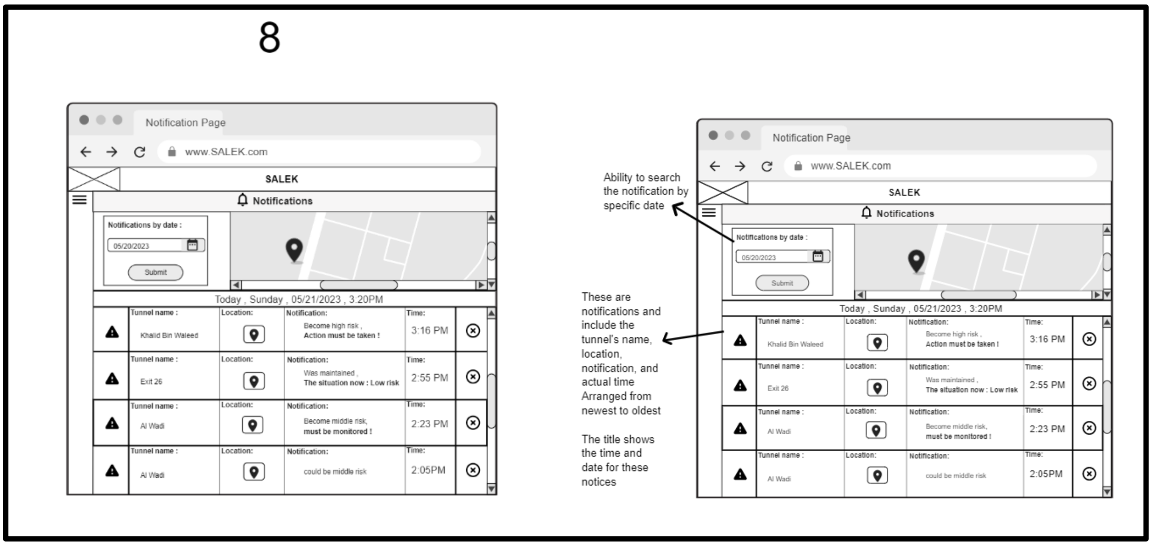


Figure 3.9. Notification page.

In this user interface we achieved dashboard measurement and the changes over tunnels requirements.

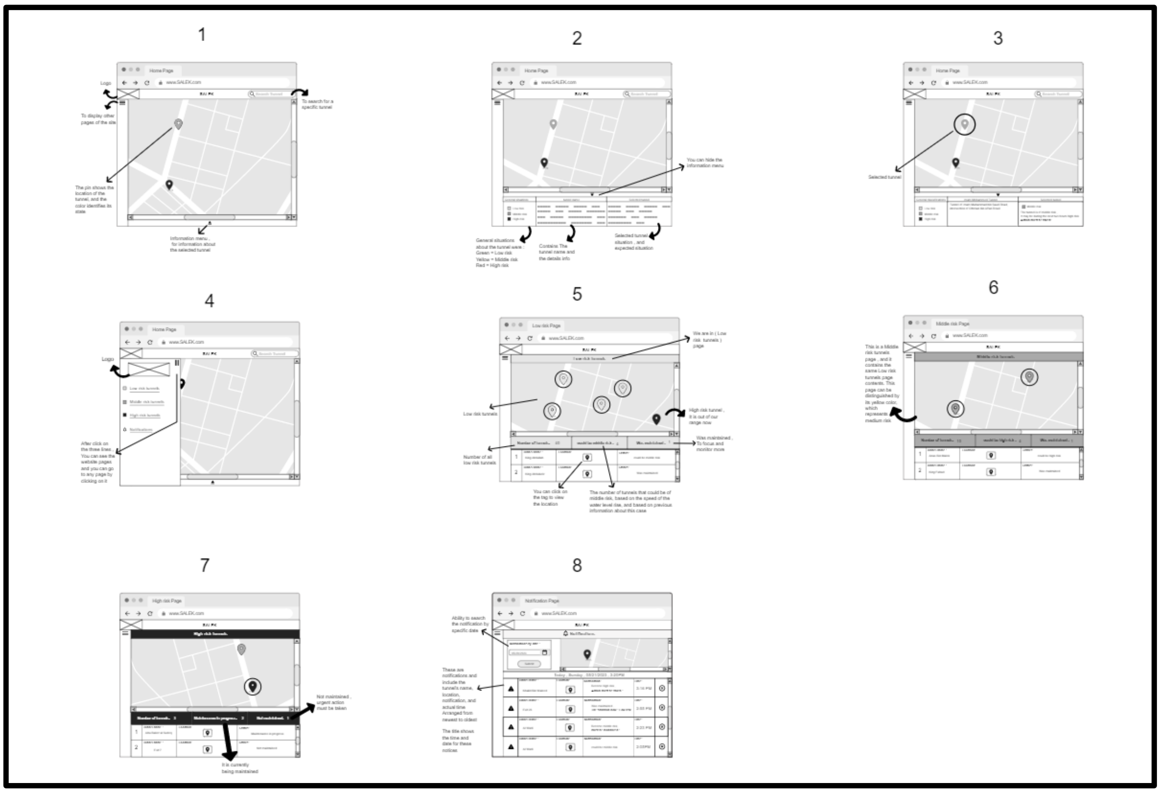


Figure 3.10. General structure interfaces.

3.6 System Design

3.6.1 Architectural Design

As shown in Figure 3.11, architecture design of the proposed system.

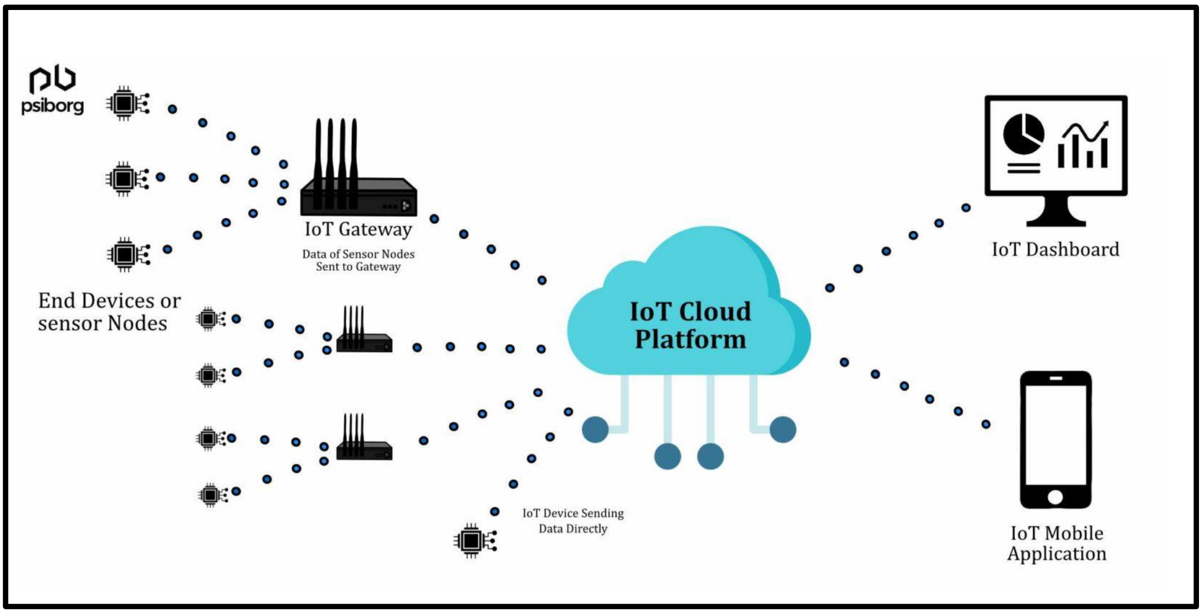


Figure 3.11. architecture design.[13]

Hardware:

- Arduino Uno board.
- Arduino jumper wires.
- Breadboard - large size.
- Variable resistor.
- Male to male jumper wire set.
- Male to female jumper wire set.
- Water level sensor.
- 40 pin headers.
- Personal Computer has minimum core 1,5GHz, 2GB of RAM and 1GB graphics card. For smooth and good use, at least dual core 2,2 GHz CPU, 3–4 GB of RAM and 1,5 GB GPU, to browse the website.
- or Smartphone.
- or Tablet.
- Network.

Software:

- Arduino software.
- Mobile application or web page for displaying the dashboard.
- HTML.
- CSS.
- PHP.
- JavaScript.
- Flutter.
- java.

3.6.2 Class Diagram

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects, the class diagram was divided into three classes, tunnel class (it is a sensor), Dashboard class and the low risk class and Middle risk class are inherited from it , and User class (could be website) .The relationships between them are clarified.[14]

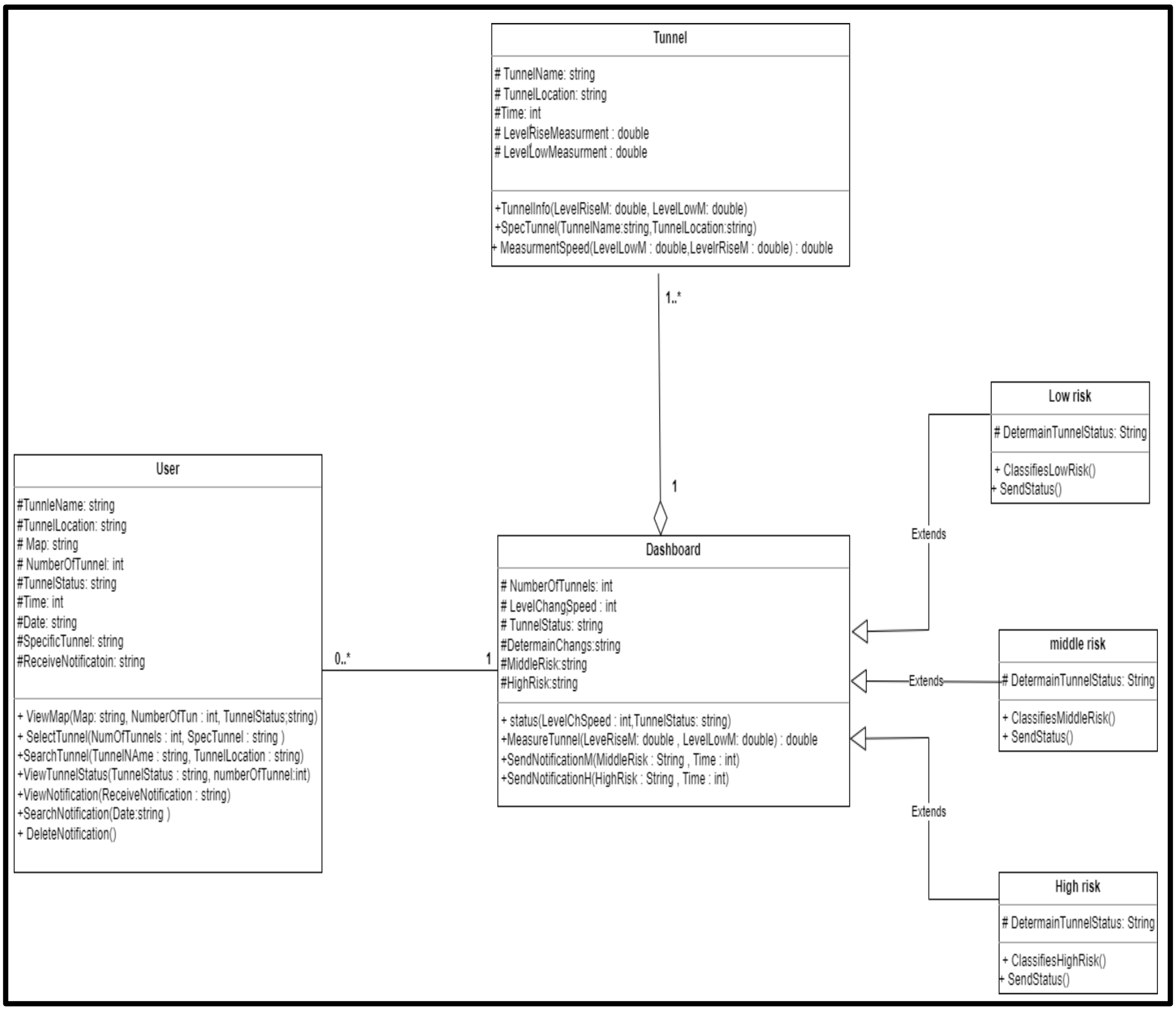


Figure 3.12. Class diagram.

3.6.3 Sequence Diagram

The sequence diagram shows the interactions of objects in the system arranged in a chronological order. It also depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out certain functions. Sequence diagrams are sometimes called event diagrams or event scenarios, As we will use it to illustrate some methods (Class diagram), the following methods have been chosen to clarify their details: ViewTunnelStatu(), SendNotificaton(), SelectTunnel().

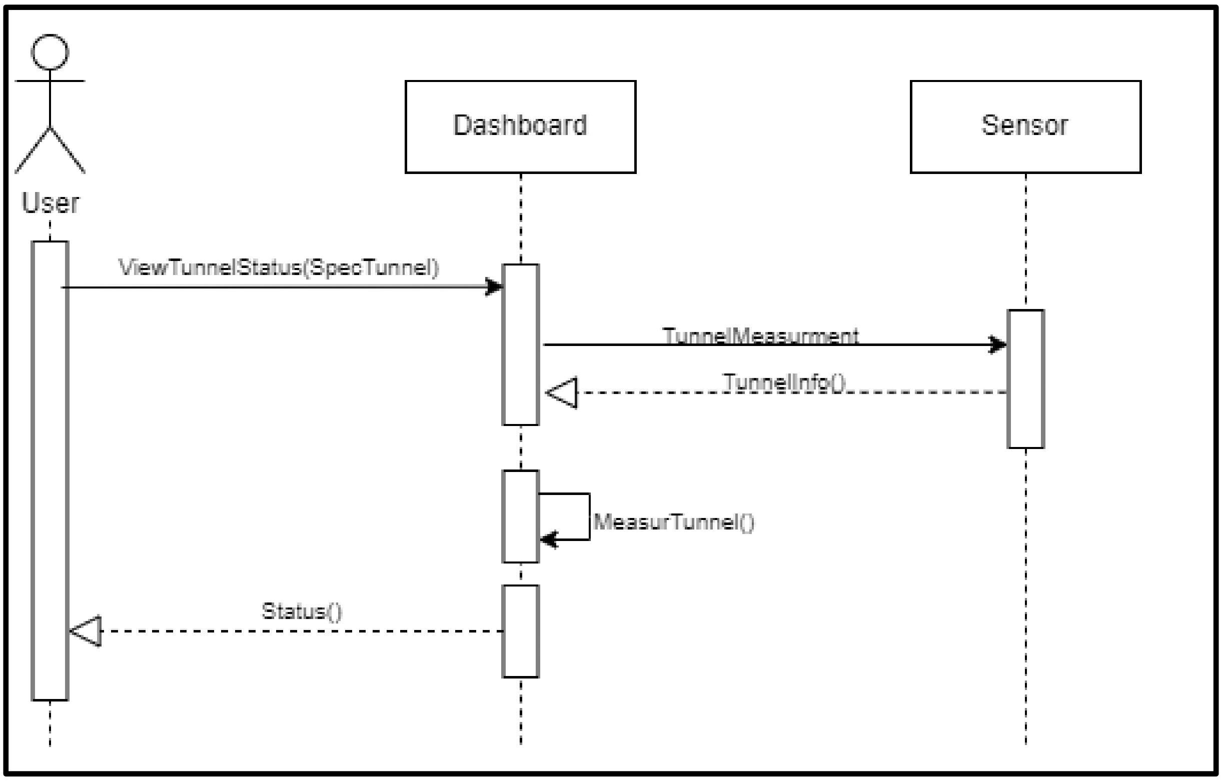


Figure 3.13. ViewTunnelStatu() Sequence Diagram.

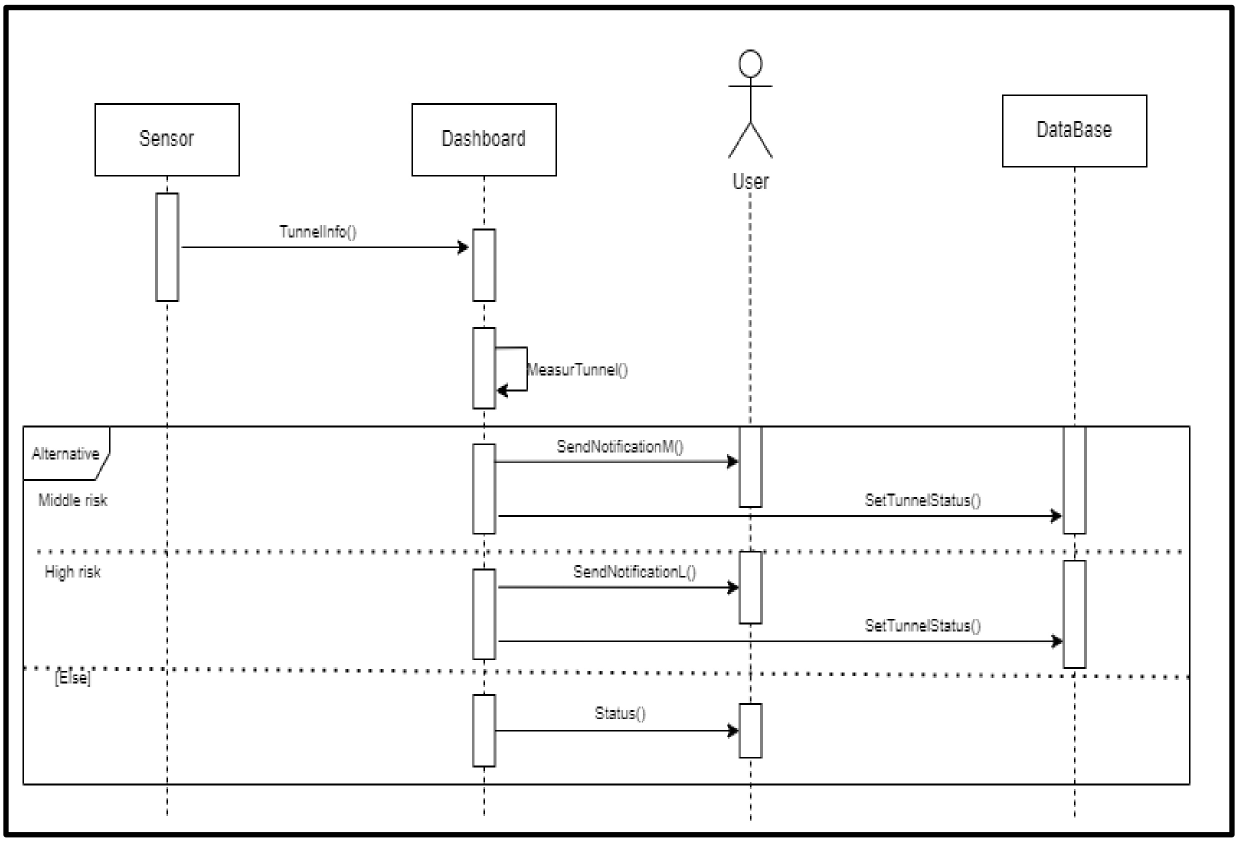


Figure 3.14. SendNotificaton(),Diagram.

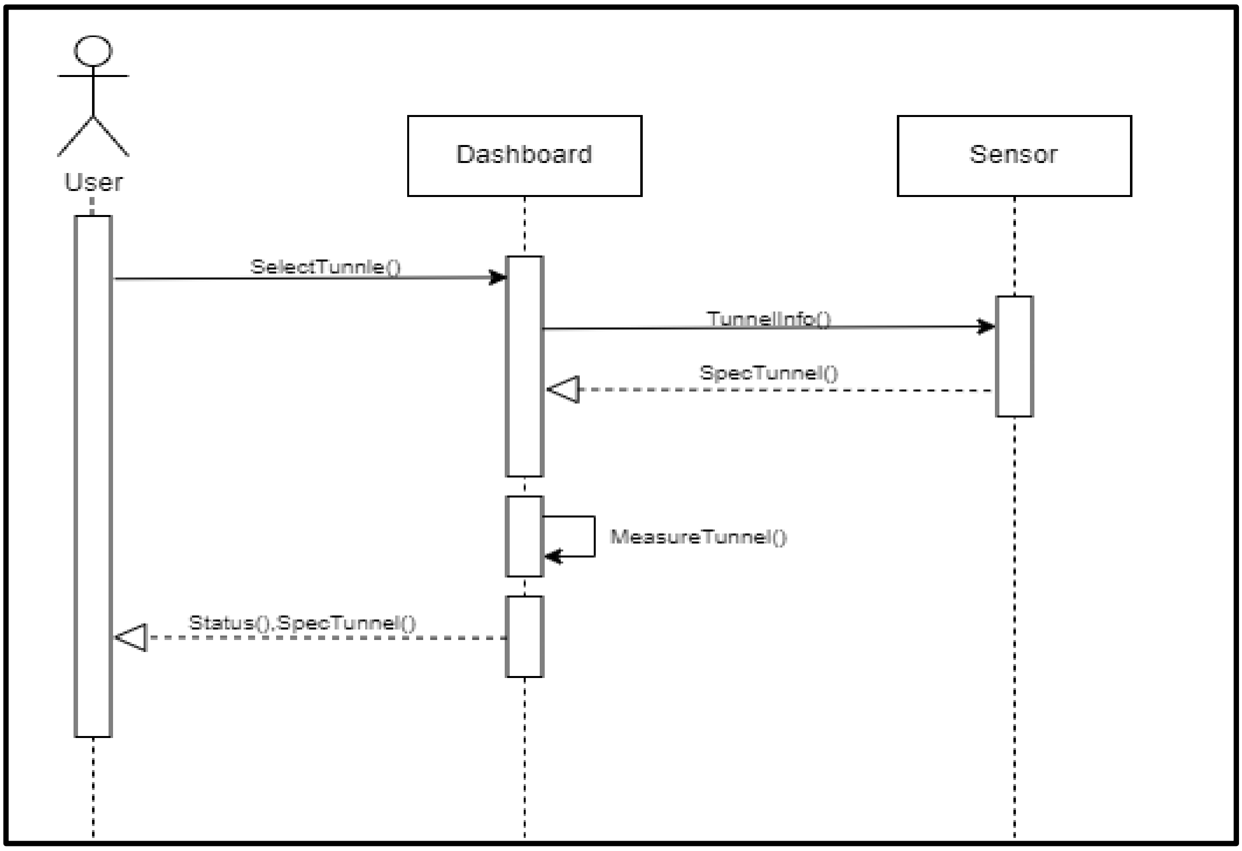


Figure 3.15. SelectTunnel() Sequence Diagram.

3.6.4 Database Design (if any)

An Entity Relationship (ER) Diagram is a type of flowchart that illustrates how “entities” such as people, objects or concepts relate to each other within a system. ER Diagrams are most often used to design or debug relational databases in the fields of software engineering, business information systems, education and research. Also known as ERDs or ER Models, they use a defined set of symbols such as rectangles, diamonds, ovals and connecting lines to depict the interconnectedness of entities, relationships and their attributes. They mirror grammatical structure, with entities as nouns and relationships as verbs[15].This is our ER diagram as shown:

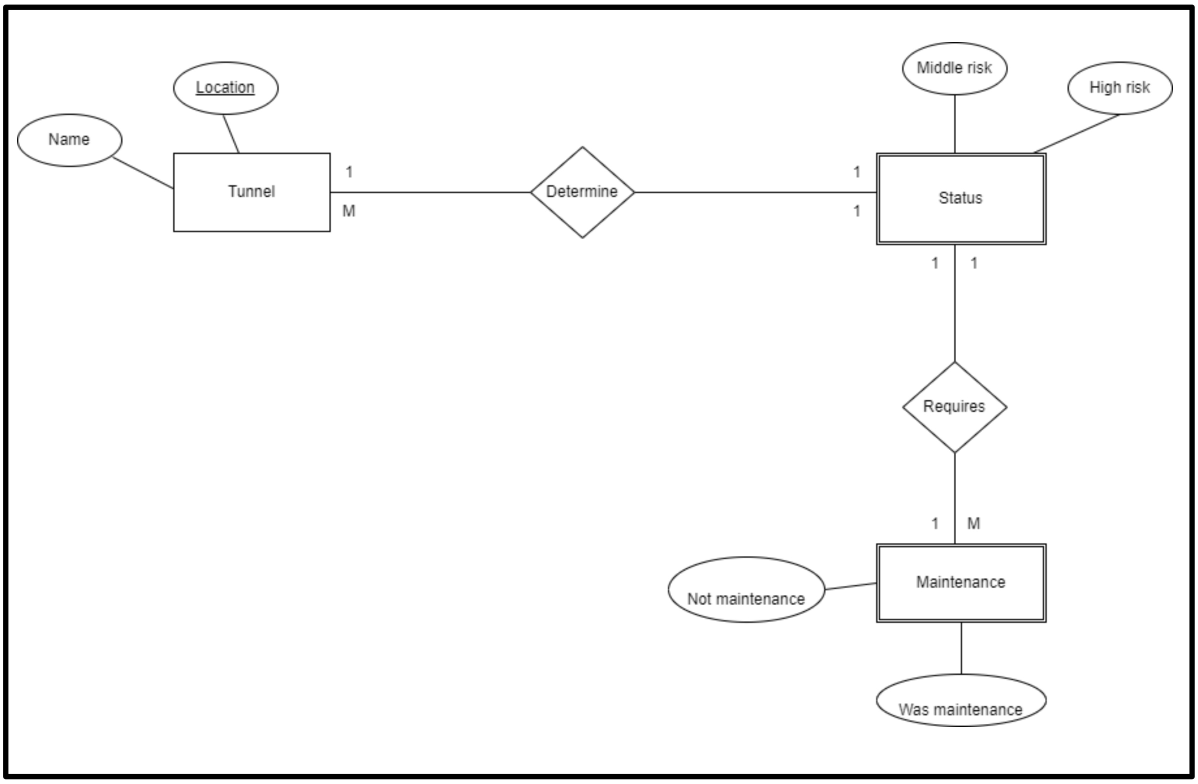


Figure 3.16. ER diagram.

3.7 Summary

The system features provide an easy way to measure the water level inside the tunnels.

This system focuses on accurate measurement of the water level inside the tunnels, sending the data to the dashboard, conducting analyzes and studies on the data, and displaying the tunnels at the competent authorities on three levels (low, middle, and high), where low means that the tunnel contains water, but with a low, non-hazardous percentage.

middle It indicates that the water has risen in the tunnel and has become almost dangerous to the citizens and the necessary measures must be taken.

A high-level means that the tunnel has reached dangerous levels, and people must be prevented and warned from approaching it.

The system requirements were divided into functional and nonfunctional requirements followed by a user interface prototype and system design

References

1.https://mobile-jon.com/2021/04/05/applying-the-agile-methodology-to-the-modern-workplace/amp/

2. https://www.interviewbit.com/blog/iot-architecture/

3. It was taken from the same scientific paper listed below : A. C. D. S. Júnior, R. Munoz, M. D. L. Á. Quezada, A. V. L. Neto, M. M. Hassan and V. H. C. D. Albuquerque, "Internet of Water Things: A Remote Raw Water Monitoring and Control System," in IEEE Access, vol. 9, pp. 35790-35800, 2021, doi: 10.1109/ACCESS.2021.3062094.

4. It was taken from the same scientific paper listed below : J. Pan, Y. Yin, J. Xiong, W. Luo, G. Gui and H. Sari, "Deep Learning-Based Unmanned Surveillance Systems for Observing Water Levels," in IEEE Access, vol. 6, pp. 73561-73571, 2018, doi: 10.1109/ACCESS.2018.2883702.

5. Saudi Digital Library Access provided by : Consortium – Saudi Arabia SDL.

6. A. C. D. S. Júnior, R. Munoz, M. D. L. Á. Quezada, A. V. L. Neto, M. M. Hassan and V. H. C. D. Albuquerque, "Internet of Water Things: A Remote Raw Water Monitoring and Control System," in IEEE Access, vol. 9, pp. 35790-35800, 2021, doi: 10.1109/ACCESS.2021.3062094.

7. Y. Sudriani, V. Sebestyén and J. Abonyi, "Surface water monitoring systems – the importance of integrating information sources for sustainable watershed management," in IEEE Access, doi: 10.1109/ACCESS.2023.3263802..

8. J. Pan, Y. Yin, J. Xiong, W. Luo, G. Gui and H. Sari, "Deep Learning-Based Unmanned Surveillance Systems for Observing Water Levels," in IEEE Access, vol. 6, pp. 73561-73571, 2018, doi: 10.1109/ACCESS.2018.2883702.

9. Y. Xu et al., "Obtaining Accurate Water Level Measurements in Lakes: Analysis of Changes in ICESat Altimetry Accuracy With Buffer Changes," in IEEE Access, vol. 8, pp. 81090-81100, 2020, doi: 10.1109/ACCESS.2020.2991228.

10. A. Bhat, “Questionnaires: The ultimate guide, advantages & examples,” QuestionPro, [Online]. Available: https://www.questionpro.com/blog/what-is-a-questionnaire/. [Accessed 29 May 2023].

11.We use StarUML to draw the figure https://staruml.io/

12. We use Untitled Diagram to draw the figure https://app.diagrams.net/#

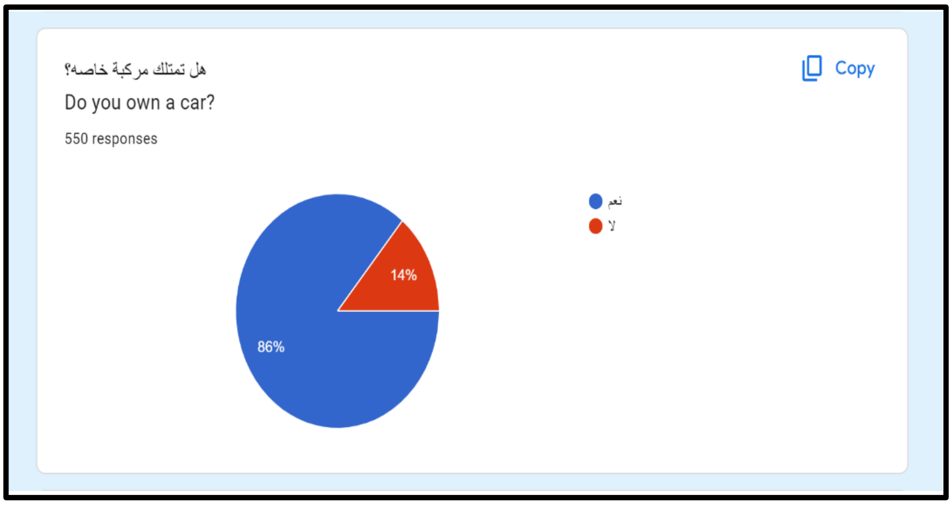
13. https://psiborg.in/iot-platform-and-iot-gateway/

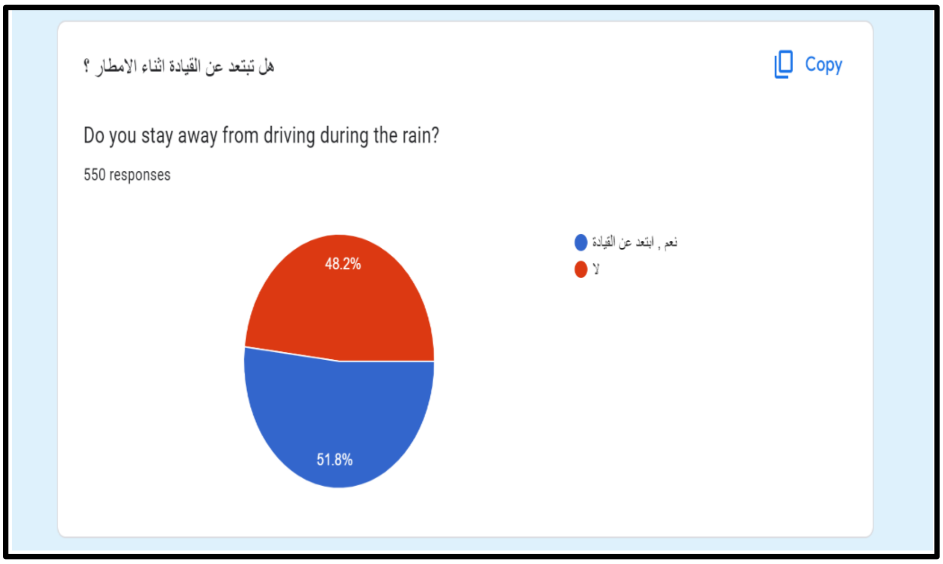
14. We use Untitled Diagram to draw the figure https://app.diagrams.net/#

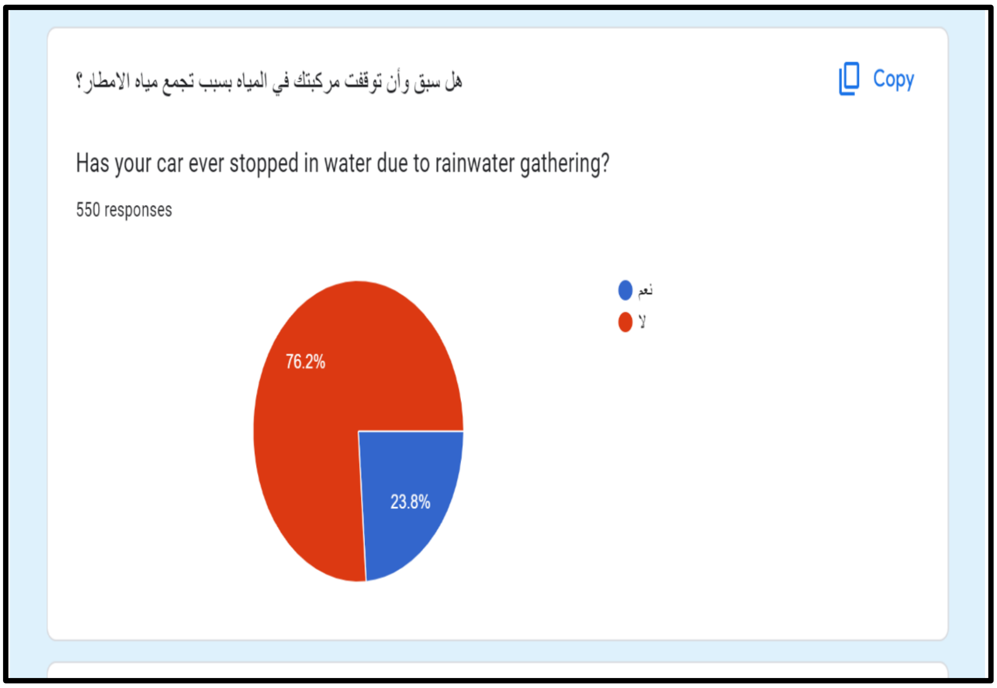
15. https://www.lucidchart.com/pages/er-diagrams

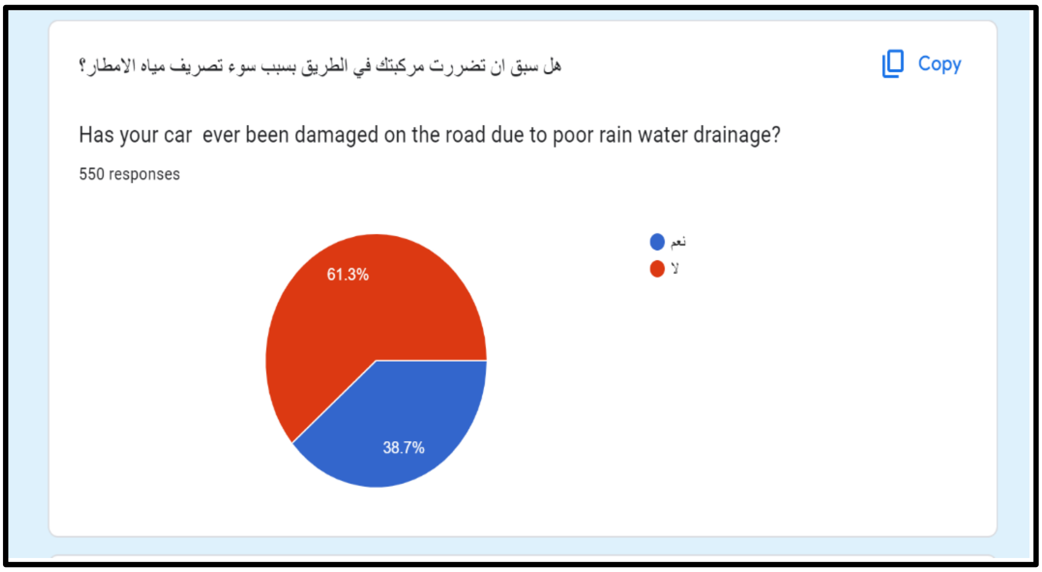
Appendix

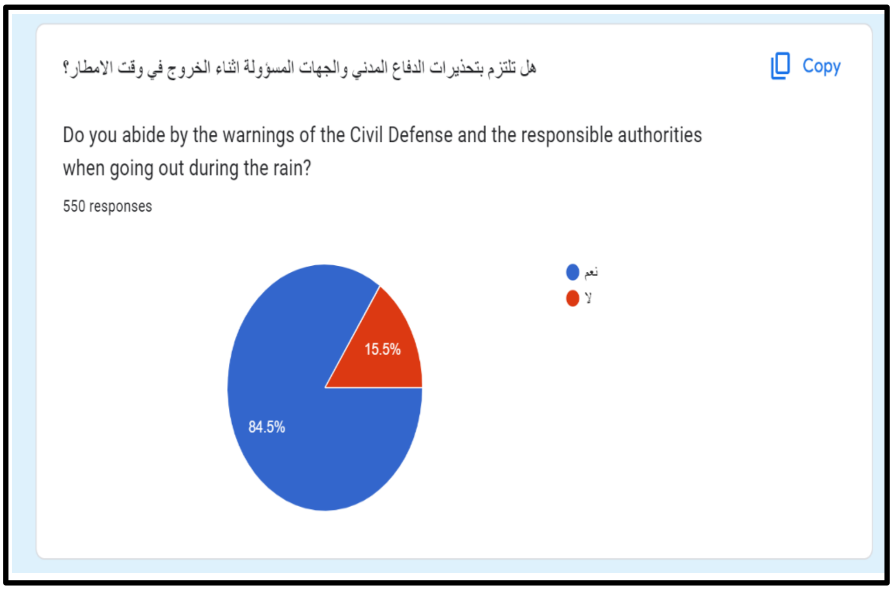
A. Miscellaneous

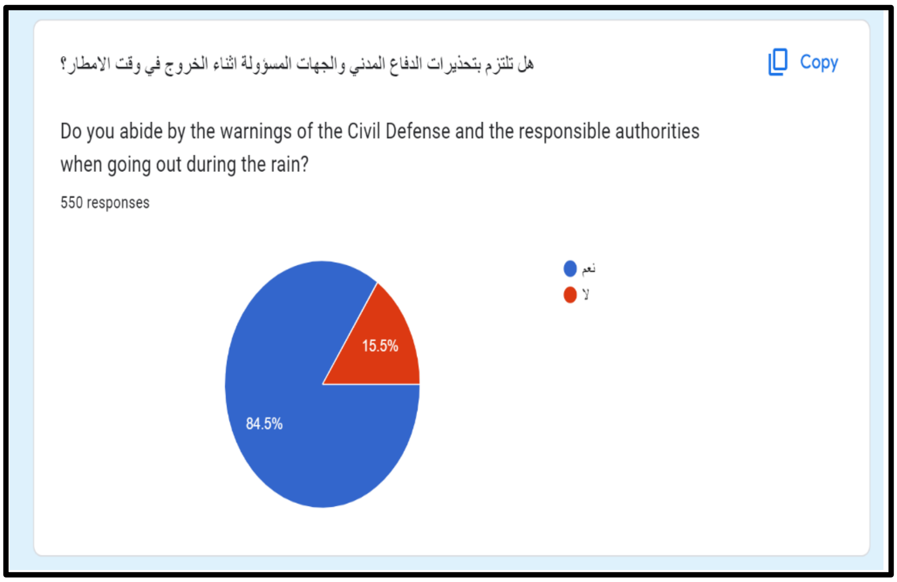





هل سبق وأن توقفت مركبتك في المياه بسبب تجمع مياه الامطار؟
Copy
Has your car ever stopped in water due to rainwater gathering?
550 responses
نعم
لا
76.2%
23.8%


هل سبق ان تضررت مركبتك في الطريق بسبب سوء تصريف مياه الامطار؟
Copy
Has your car ever been damaged on the road due to poor rain water drainage?
550 responses
نعم
لا
61.3%
38.7%


هل تلتزم بتحذيرات الدفاع المدني والجهات المسؤولة اثناء الخروج في وقت الامطار؟
Copy
Do you abide by the warnings of the Civil Defense and the responsible authorities when going out during the rain?
550 responses
نعم
لا
15.5%
84.5%

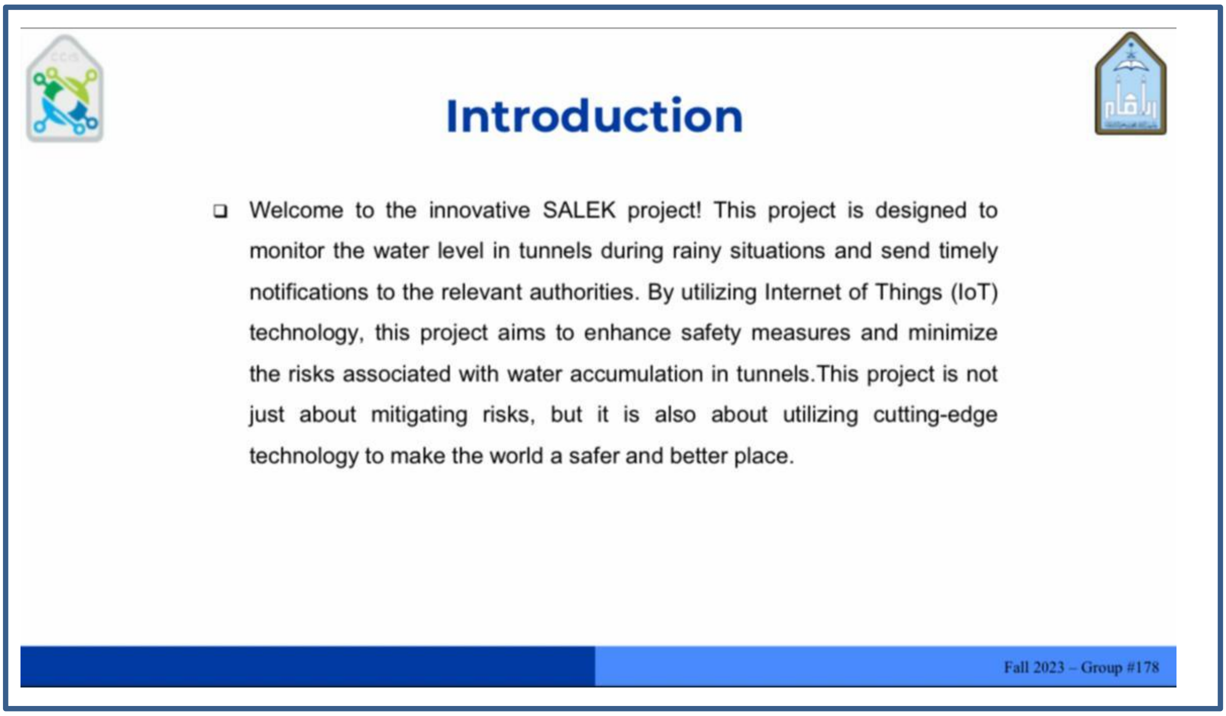

هل تلتزم بتحذيرات الدفاع المدني والجهات المسؤولة اثناء الخروج في وقت الامطار؟
Copy
Do you abide by the warnings of the Civil Defense and the responsible authorities when going out during the rain?
550 responses
نعم
لا
15.5%
84.5%

Presentation slides

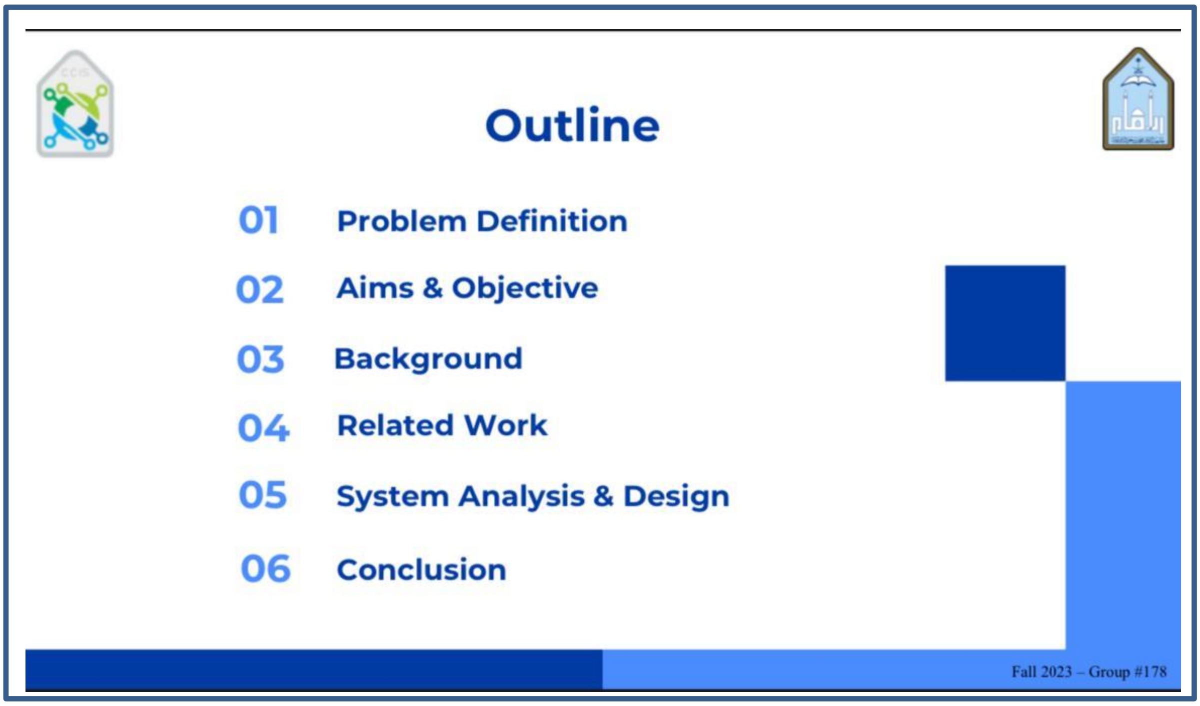
Page 1 :


SALEK
For monitoring Water
Supervisor : Dr.Fahad Omar Alomary
Made by : Mohammed Mansour Bin Gasem – Abdulelah Abdullah Alotaibi – Abdullah Omran Alomran
Fall 2023 – Group #178

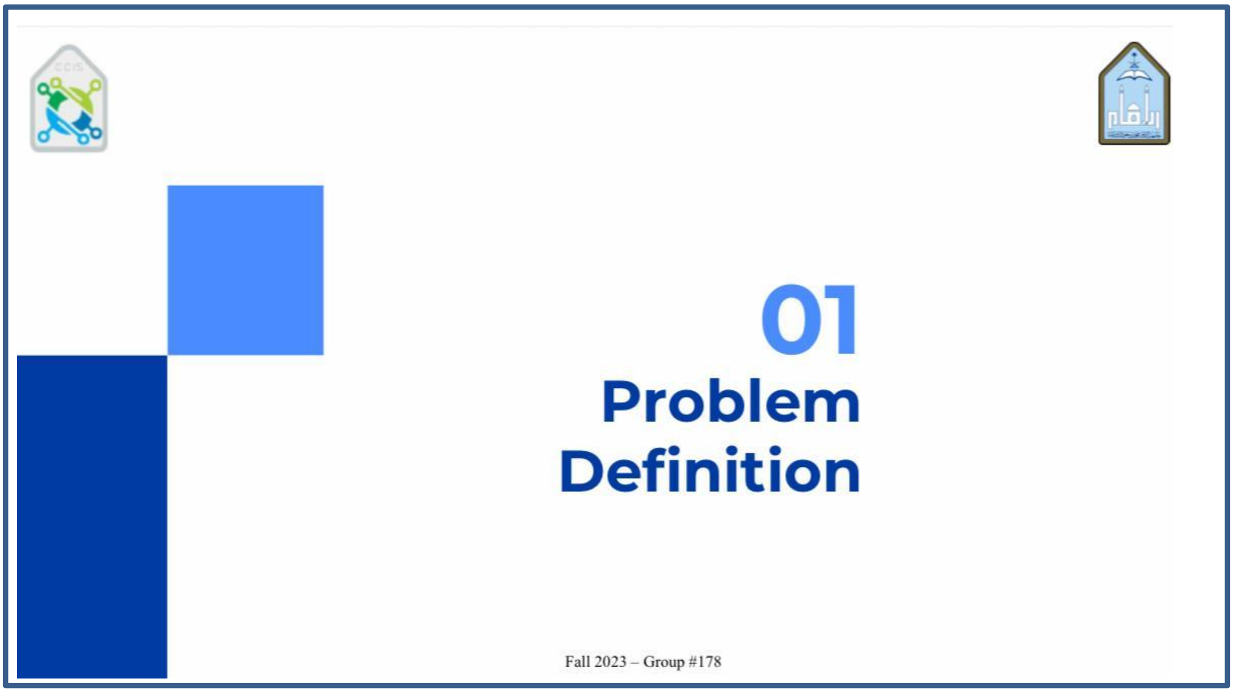
Page 2 :


Introduction
Welcome to the innovative SALEK project! This project is designed to monitor the water level in tunnels during rainy situations and send timely notifications to the relevant authorities. By utilizing Internet of Things (IoT) technology, this project aims to enhance safety measures and minimize the risks associated with water accumulation in tunnels.This project is not just about mitigating risks, but it is also about utilizing cutting-edge technology to make the world a safer and better place.
Fall 2023 – Group #178

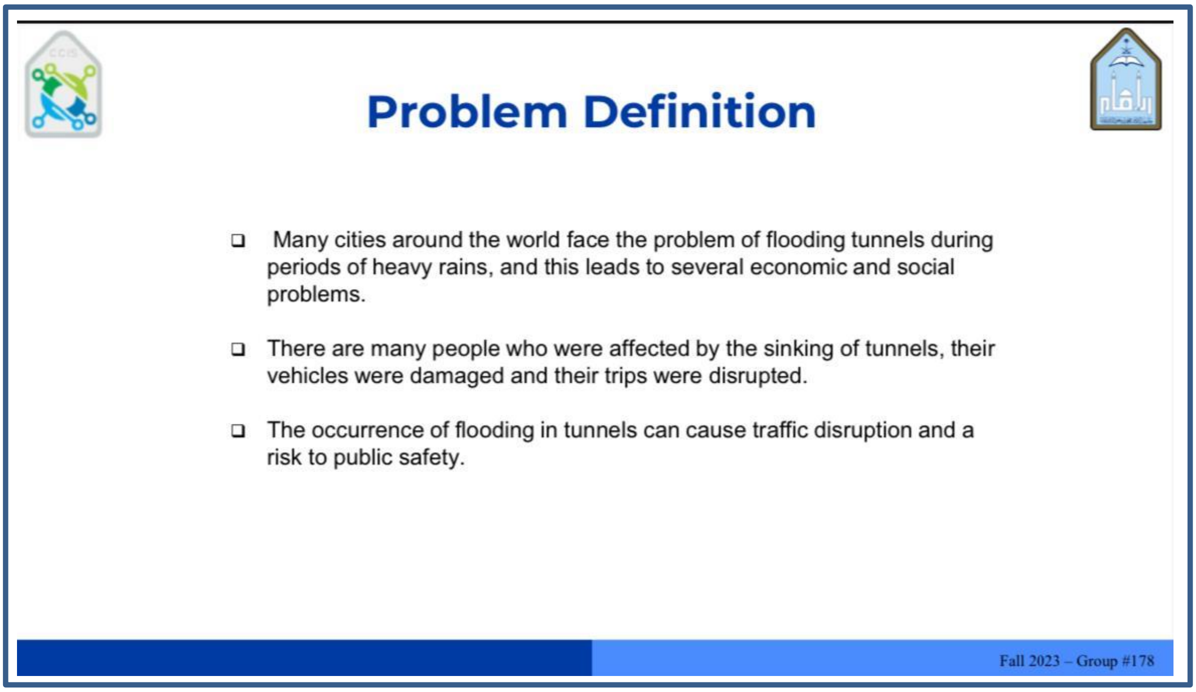
Page 3 :


Outline
01 Problem Definition
02 Aims & Objective
03 Background
04 Related Work
05 System Analysis & Design
06 Conclusion
Fall 2023 – Group #178

Page 4 :


01
Problem
Definition
Fall 2023 – Group #178

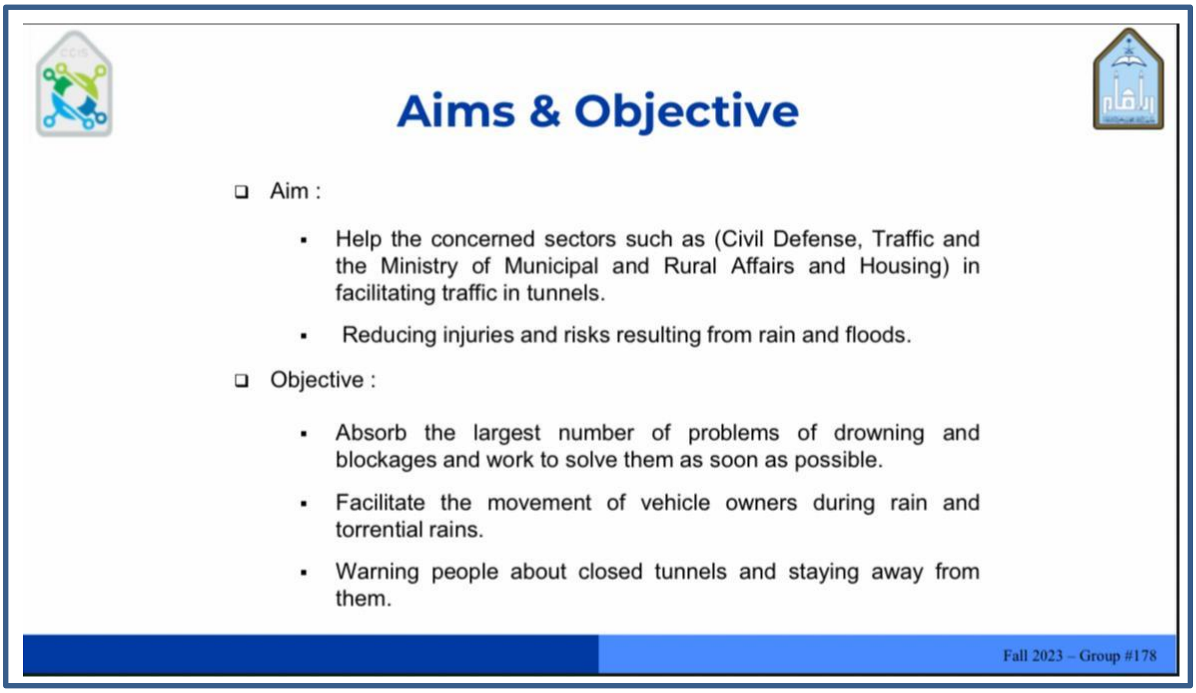
Page 5 :


Problem Definition
Many cities around the world face the problem of flooding tunnels during periods of heavy rains, and this leads to several economic and social problems.
There are many people who were affected by the sinking of tunnels, their vehicles were damaged and their trips were disrupted.
The occurrence of flooding in tunnels can cause traffic disruption and a risk to public safety.
Fall 2023 – Group #178

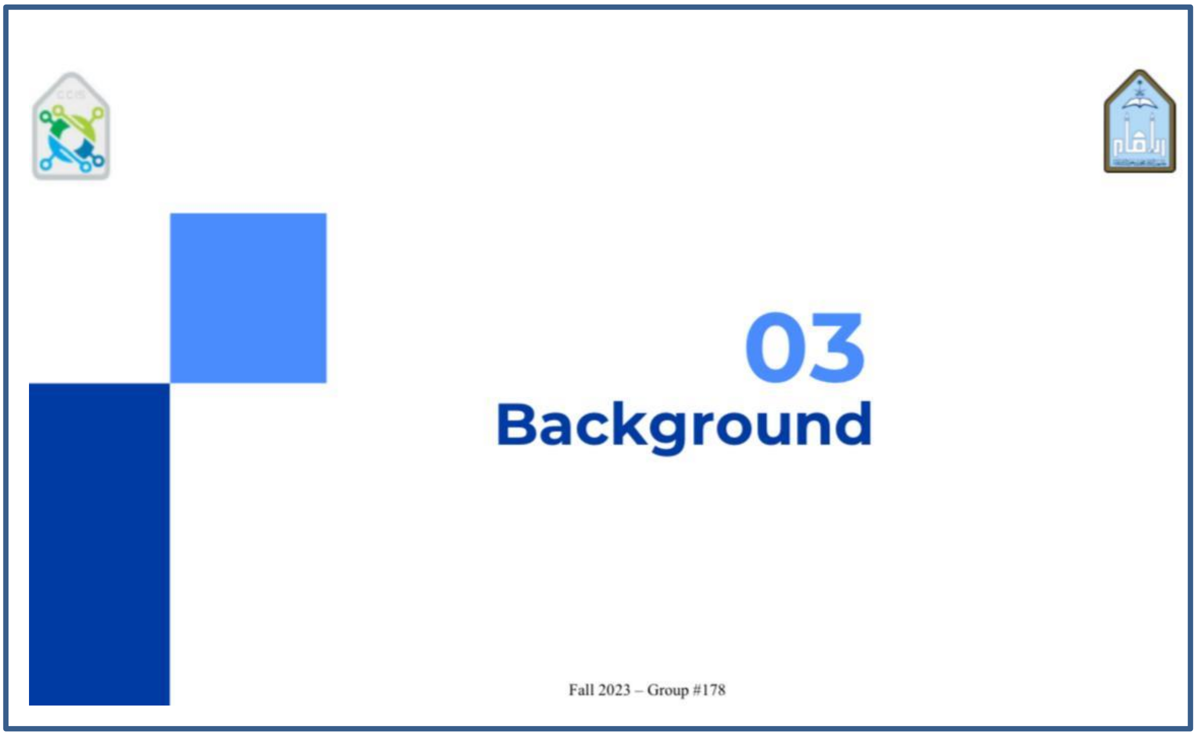
Page 6 :


02
Aims &
Objective
Fall 2023 – Group #178

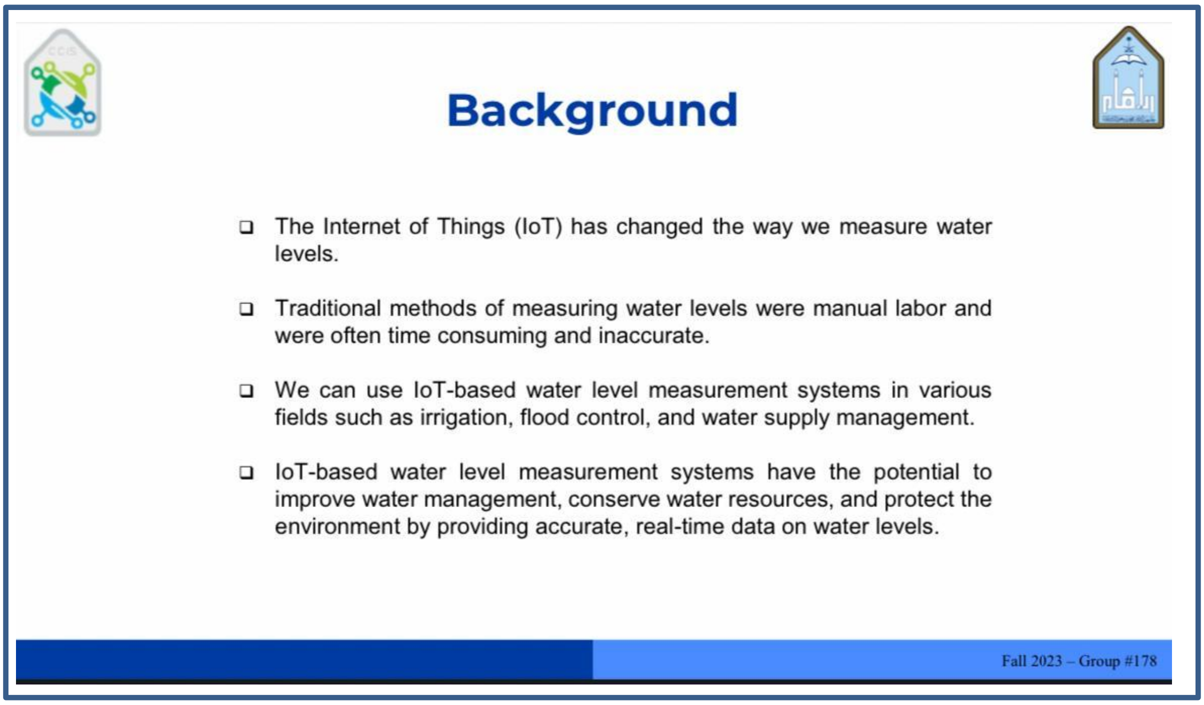
Page 7 :


Aims & Objective
Aim :
Help the concerned sectors such as (Civil Defense, Traffic and the Ministry of Municipal and Rural Affairs and Housing) in facilitating traffic in tunnels.
Reducing injuries and risks resulting from rain and floods.
Objective :
Absorb the largest number of problems of drowning and blockages and work to solve them as soon as possible.
Facilitate the movement of vehicle owners during rain and torrential rains.
Warning people about closed tunnels and staying away from them.
Fall 2023 – Group #178

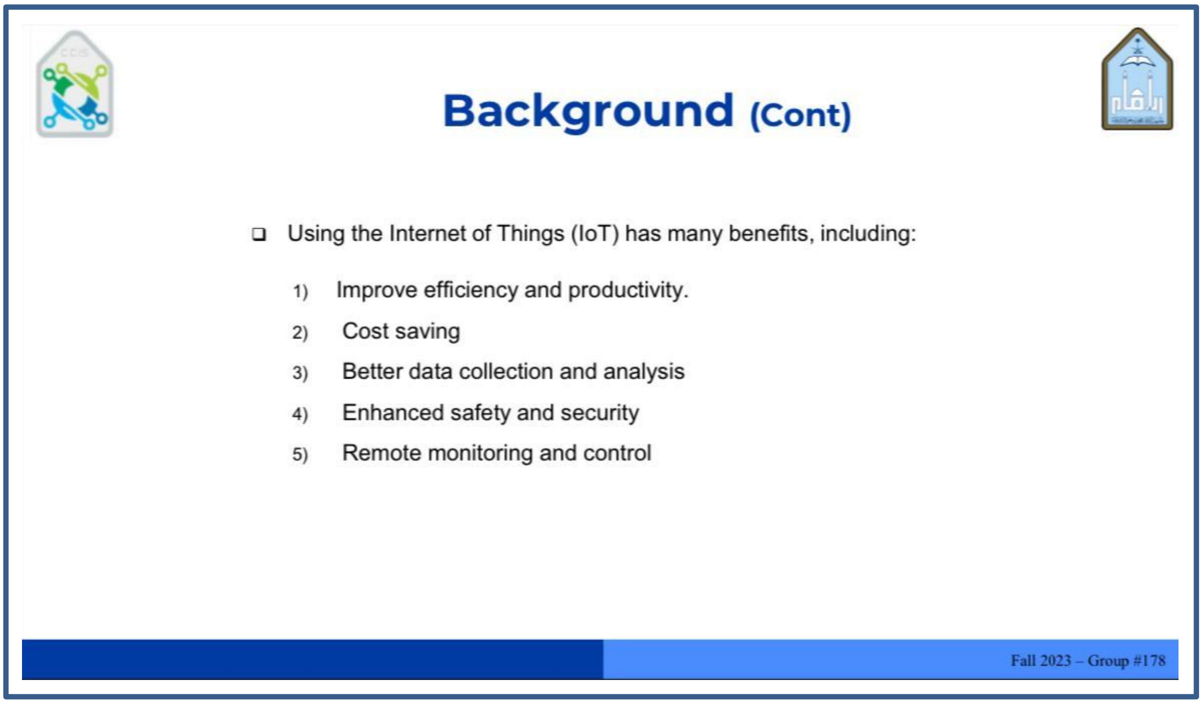
Page 8 :


03
Background
Fall 2023 – Group #178

Page 9 :

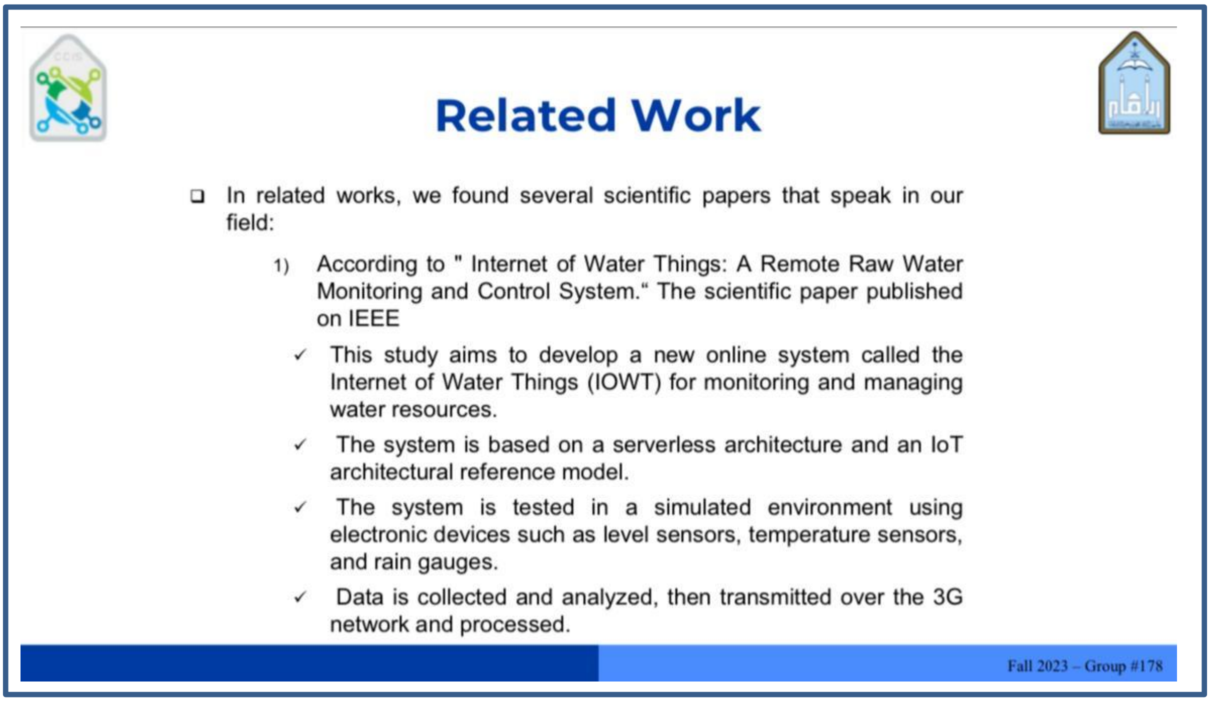


Page 10 :

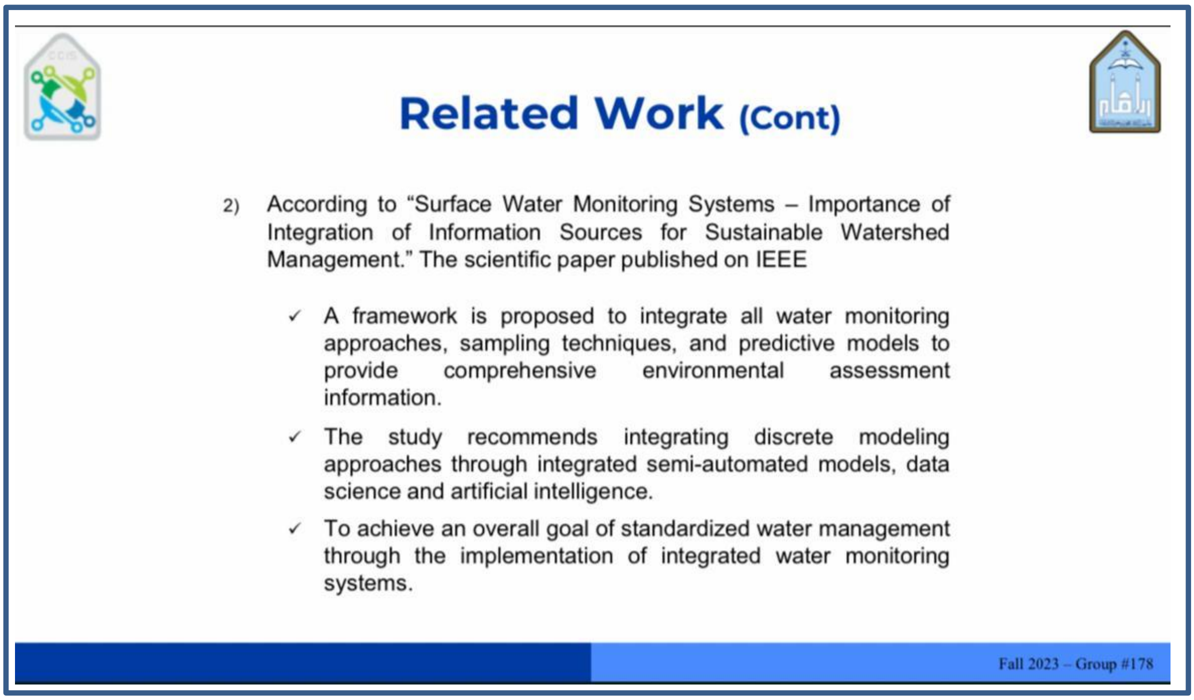


Page 11 :

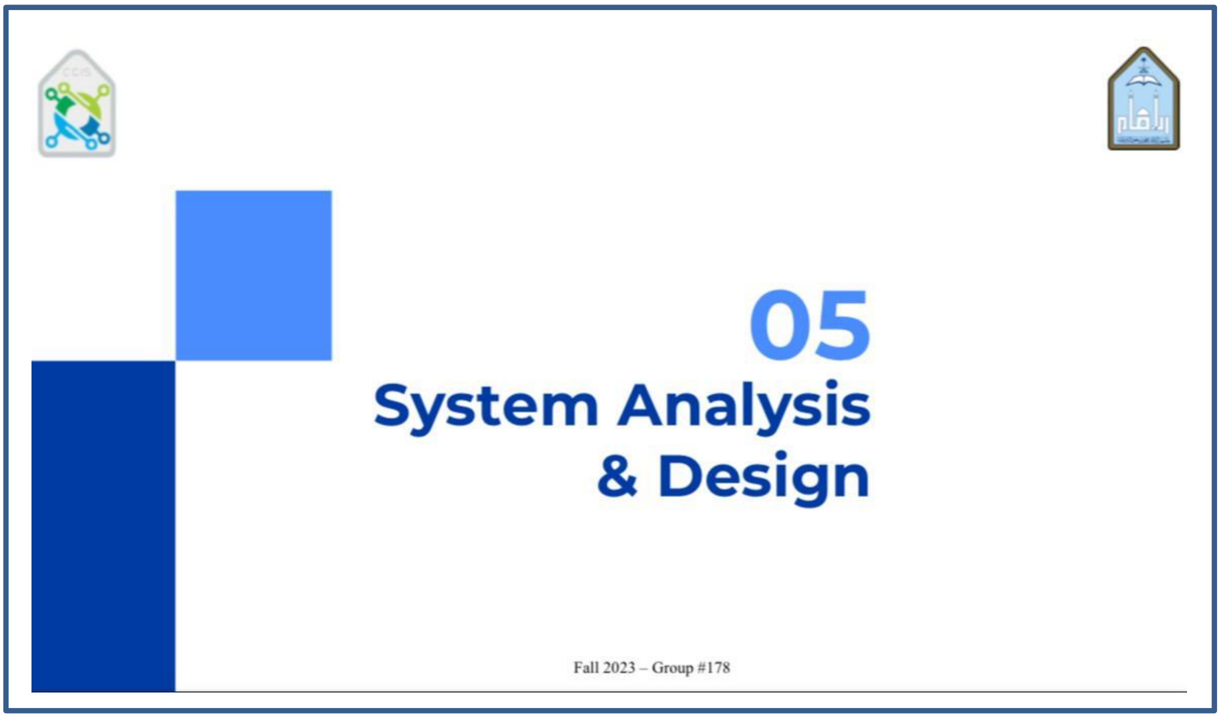
Page 12 :



Page 13 :



Page 14 :



Page 15 :

System Analysis & Design

Use case diagram :

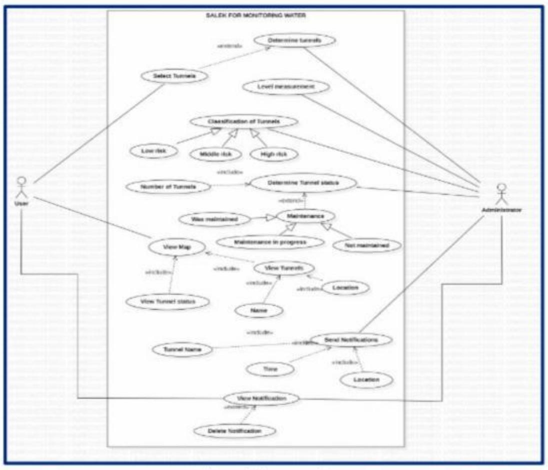


Figure 1. Use case diagram.

Fall 2023 – Group #178

Page 16 :

System Analysis & Design (Cont)

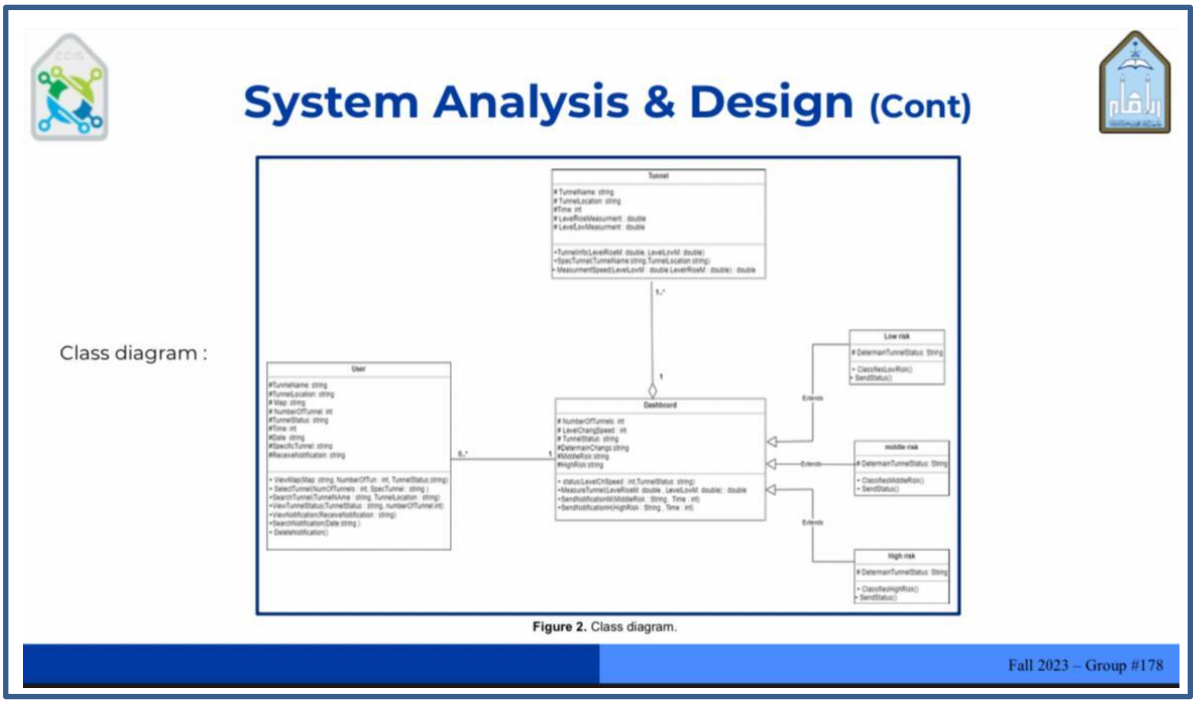
Descrirtion of send Notification use case :

Tabel 1. description of send notification use case.

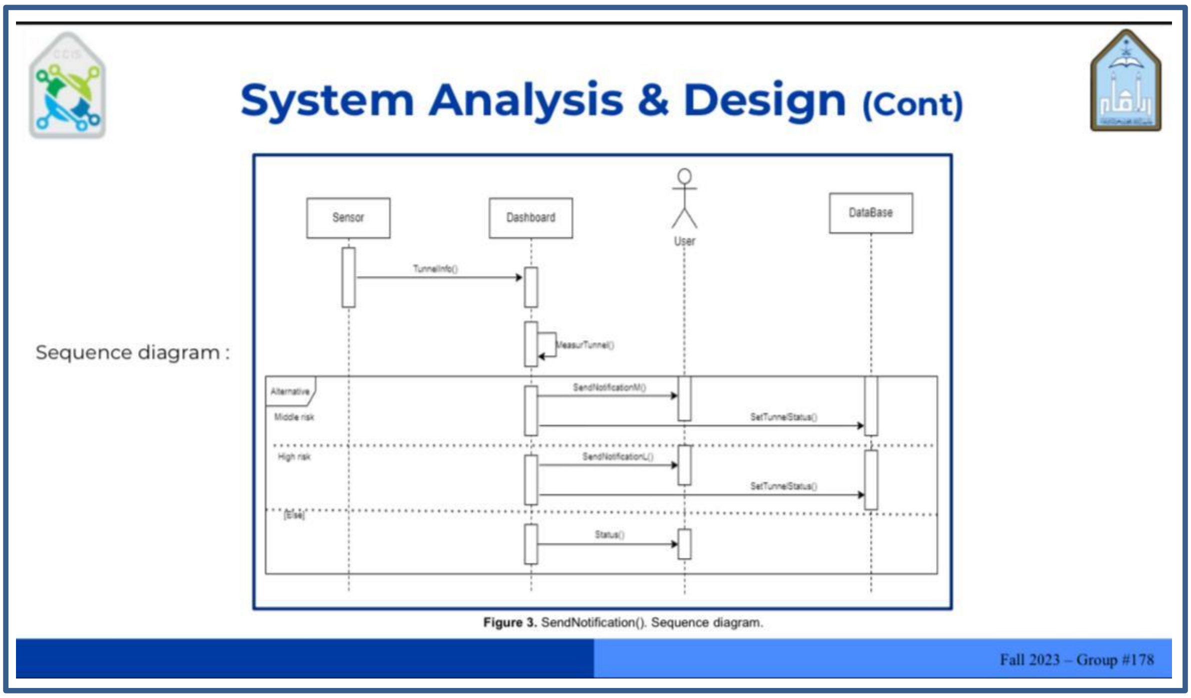
Use case name:	Send notification.	
Scenario:	The administrator sends notifications to the user to inform him of the current tunnel status.	
Brief description:	In the event of a change in the current tunnel status (tunnel classification), the administrator sends notifications to the user to inform him of the tunnel status. The notification includes the tunnel name, location, notification content and the time of the change, as well as the user's ability to delete the notification, knowing that there is a search box for notifications according to the date	
Actors:	Administr ator.	
Flow of activities:	1-Actor: - The administrator sets the tunnel classification. -Connect it with SALEK system.	2-System: -Configure the tunnel status. - Sending notifications to inform the user.

Fall 2023 – Group #178

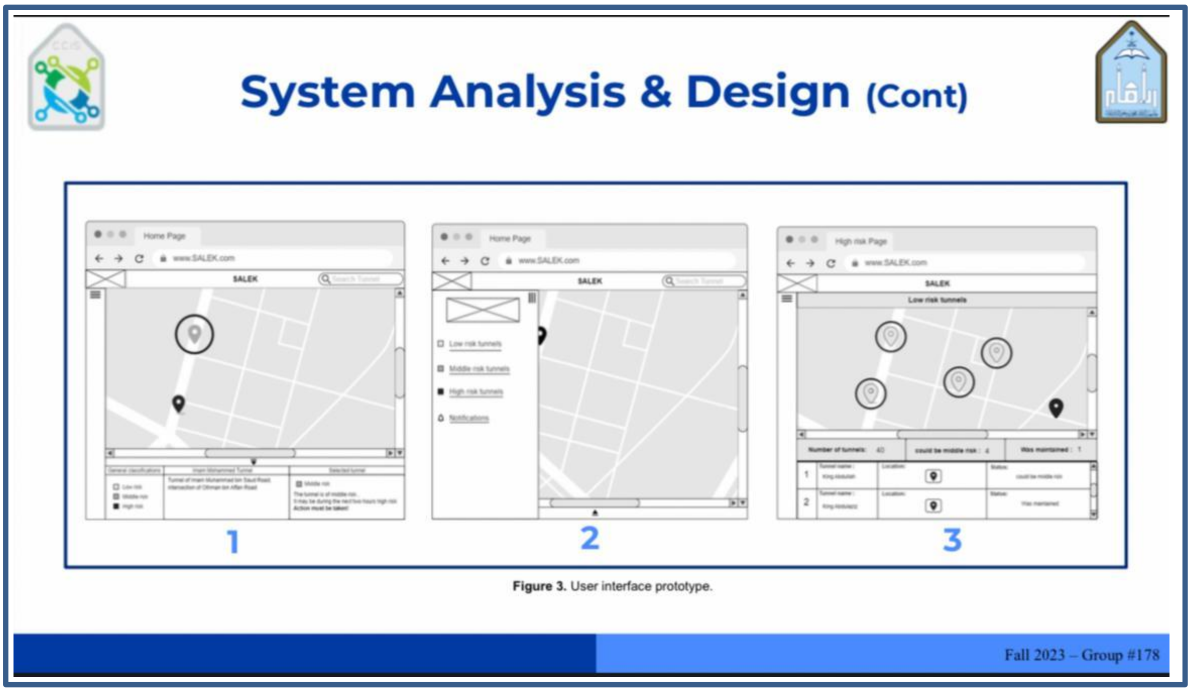
Page 17 :



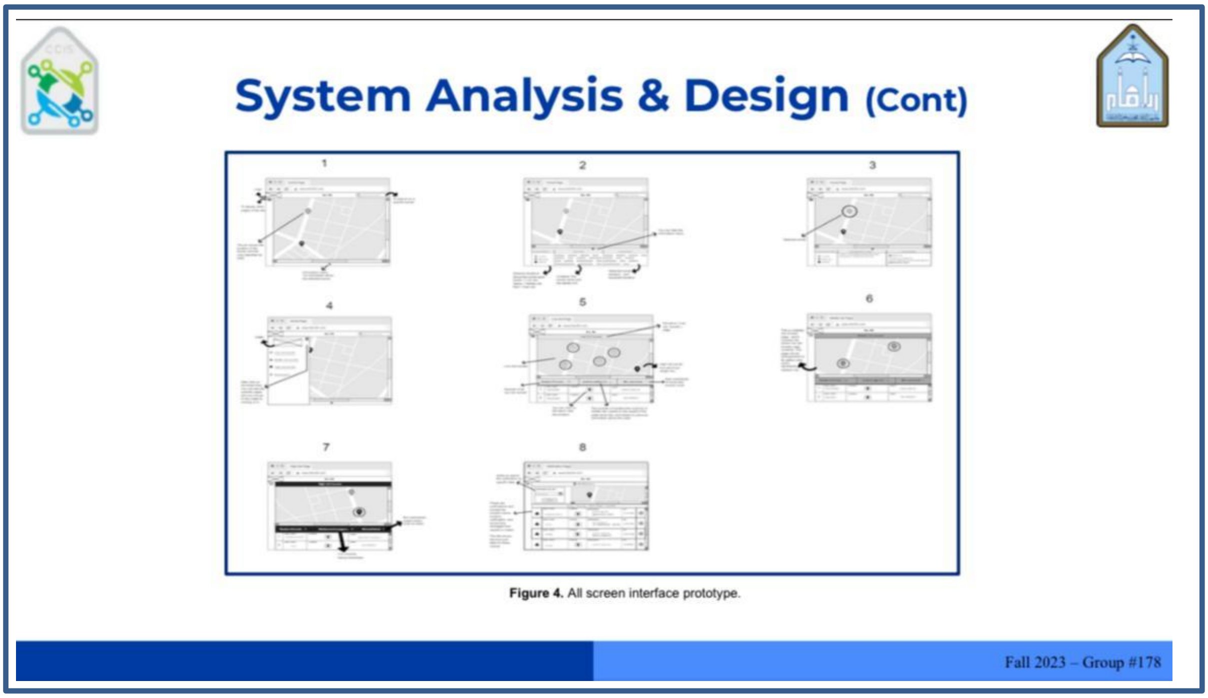
Page 18 :



Page 19 :

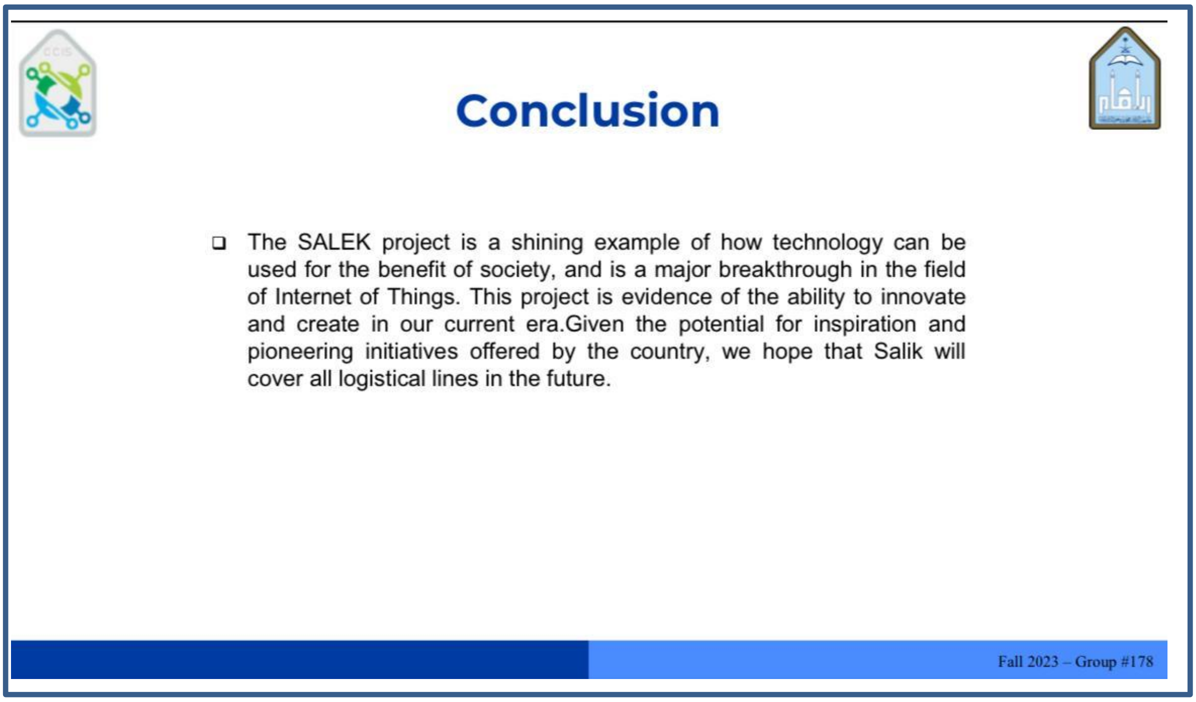


Page 20 :

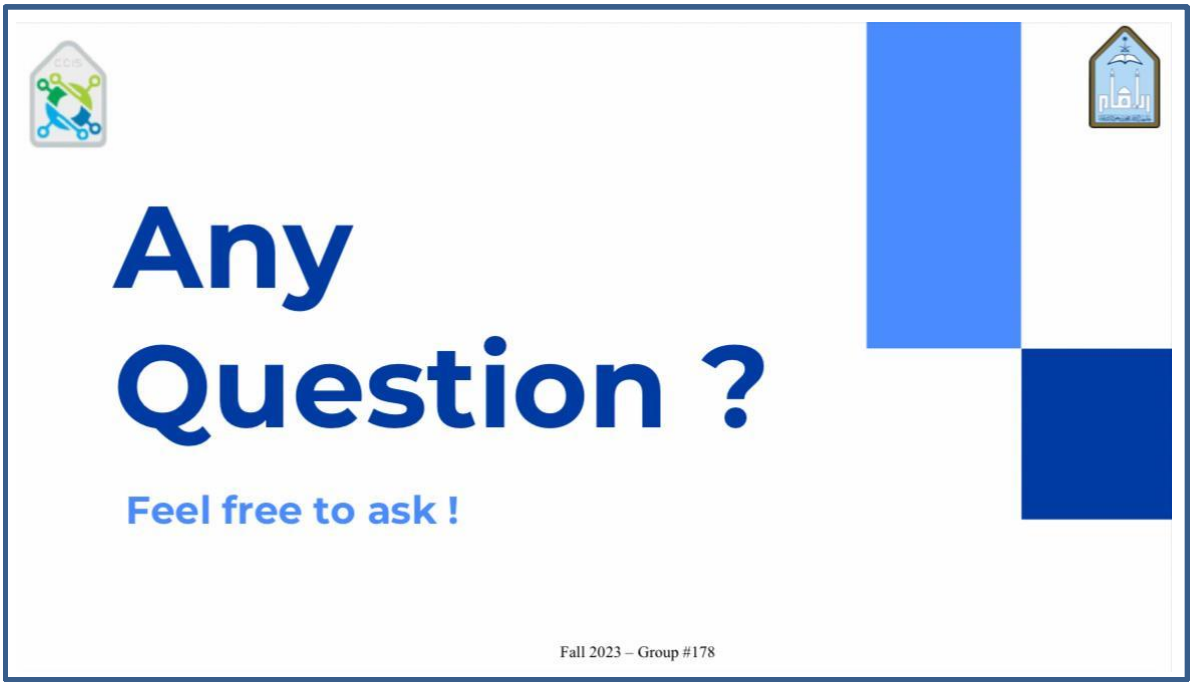


Page 21 :

Page 22 :



Page 23 :



Page 24 :

Weekly meetings

Meeting number 1 :

IT492-Weekly Meeting Form

General Information			
Project Title	**SALEL for Monitoring water**		
Group No.	**178**	**Meeting No.**	**1**
Date	**19/3/2023**	**Time**	**12:10**

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
The supervisor has been contacted and possible ideas have been discussed, narrowing down the scope of the projects. An agreement has been reached to have the next meeting on Tuesday, March 21, 2023 at exactly 12:30 PM to discuss the final idea and deliver the final idea to the department.

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 2 :

IT492-Weekly Meeting Form

General Information			
Project Title	**SALEL for Monitoring water**		
Group No.	**178**	**Meeting No.**	**2**
Date	**21/3/2023**	**Time**	**12:30**

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
The final project has been agreed upon and its name has been determined to be "SALEL for Water Monitoring"

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 3 :

IT492-Weekly Meeting Form

General Information			
Project Title	**SALEL for Monitoring water**		
Group No.	**178**	**Meeting No.**	**3**
Date	**2/4/2023**	**Time**	**12:20**

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
We discussed the proposal file regarding the method of writing the background and methodology.

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 4 :

IT492-Weekly Meeting Form

General Information			
Project Title	SALEL for Monitoring water		
Group No.	178	**Meeting No.**	4
Date	30/4/2023	**Time**	12

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
We reviewed the proposal and chapter 1, recording errors with the supervisor, taking some advice, and extending the time for the submit until the errors are modified and reviewed

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 5 :

IT492-Weekly Meeting Form

General Information			
Project Title	SALEL for Monitoring water		
Group No.	178	**Meeting No.**	5
Date	7/5/2023	**Time**	10:05

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
The proposal and chapter 1 were reviewed and submitted, and approval was taken to start in chapter 2

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 6 :

IT492-Weekly Meeting Form

General Information			
Project Title	SALEL for Monitoring water		
Group No.	178	Meeting No.	6
Date	21/5/2023	Time	12

Attending Students			
Student Name		ID	Signature
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
We talked about the last chapter, and some information was explained and clarified, and we agreed on a type of information collection, which is a questionnaire.

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	

Meeting number 7 :

IT492-Weekly Meeting Form

General Information			
Project Title	**SALEL for Monitoring water**		
Group No.	**178**	**Meeting No.**	**7**
Date	**24/5/2023**	**Time**	**12**

Attending Students			
	Student Name	**ID**	**Signature**
1	Abdulelah Abdullah Alotaibi	441022758	Abdulelah
2	Abdullah Omran Alomran	441015405	Abdullah
3	Mohammed Mansour Bin Gasem	440012501	Mohammed

Discussed Topics and List of Accomplished Tasks
The questions included in the questionnaire were approved and permission was taken to publish them.

Upcoming Tasks	Responsibility

Supervisor Name	Dr. Fahad Alomary
Signature	