



# Improving Visual pollution in Riyadh City using Artificial Intelligence

Graduation Project, Part-I (SWE 496)  
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## ABSTRACT

Riyadh is the capital and largest city of Saudi Arabia, and is known for rapid urbanization and modernization. Potholes are a common problem in cities like Riyadh, and can pose a serious safety hazard to drivers and pedestrians. This project aims to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes. The project will use data analysis techniques, such as Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the municipality's car camera to detect and locate potholes on the street, upload photos on the map in our website to process potholes, and coding them with color-coded points according to the severity of the pothole, and sending a notification to the municipality to fix it in a certain period of time In the Arabic language. Ultimately, this project has the potential to improve road safety, reduce the cost of repairing vehicles caused by potholes, and reduce reliance on the citizen in determining where to locate potholes.

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## 1. Introduction

Riyadh is the capital and largest city of Saudi Arabia, and is known for rapid urbanization and modernization in recent years. The city has a diverse urban landscape, with a mixture of modern skyscrapers, traditional architecture, and sprawling suburbs, and an important aspect of preserving this urban landscape is the repair of potholes in the road. Potholes are a common problem in cities like Riyadh, and can pose a serious safety hazard to drivers and pedestrians. When left unrepairs, they can damage vehicles and lead to accidents. In addition to safety concerns, potholes can have a negative impact on a city's appearance and overall quality of life. It can make roads look unkempt and unattractive, and can also cause traffic jams and delays.

Therefore, we thought of our project, which aims to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes, by using a technology-based solution to identify potholes in the streets. The project will use several data analysis techniques, including Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the car camera to detect and locate potholes on the street, upload photos on the map in our website to process potholes, and coding them with color-coded points according to the severity of the pothole, and sending a notification. Municipality to fix it in a certain period of time in the Arabic language.

Through this project, we hope to provide Riyadh and maintenance crews with more timely and accurate information about the condition of roads, allowing them to prioritize repairs and allocate resources more effectively. Ultimately, we believe this project has the potential to improve road safety, reduce the cost of repairing vehicles caused by potholes, and reduce reliance on the citizen in determining where to locate potholes

## 2. Domain Analysis

The main aim of our project KASHEF is to develop infrastructure and improve the environmental landscape, and focuses on dispensing with the citizen to identify and discover road potholes, by using a technology-based solution to identify potholes in the streets. The project will use several data analysis techniques, including Jetson Nano and You Only Look Once, to identify images of potholes and their size, by linking them to the municipality's/user car camera to detect and locate potholes on the street, upload photos on the map in our application to process potholes, and coding them with color-coded points (HeatMap), then create a report and send it to Municipality to fix it in a certain period of time.

The next section describes the related products which can be classified as local products and compares it with KASHEF proposed solution based on general features and technologies, aslo to get better understanding of the issue and identify potential solutions We have been reading about the problem thorough research literature[1]

### 2.1 Balady - بلادي

## Description

Balady application is an application used by residents in Saudi Arabia which aims to enhance and elevate the quality of municipal services. The Baladi application provides plenty of services such as the “Capture and Send” which encourages the residents to manually submit issues which they have been see it, and we can see in this figure balady application new launches trial with the services which balady provided to residents.[2]

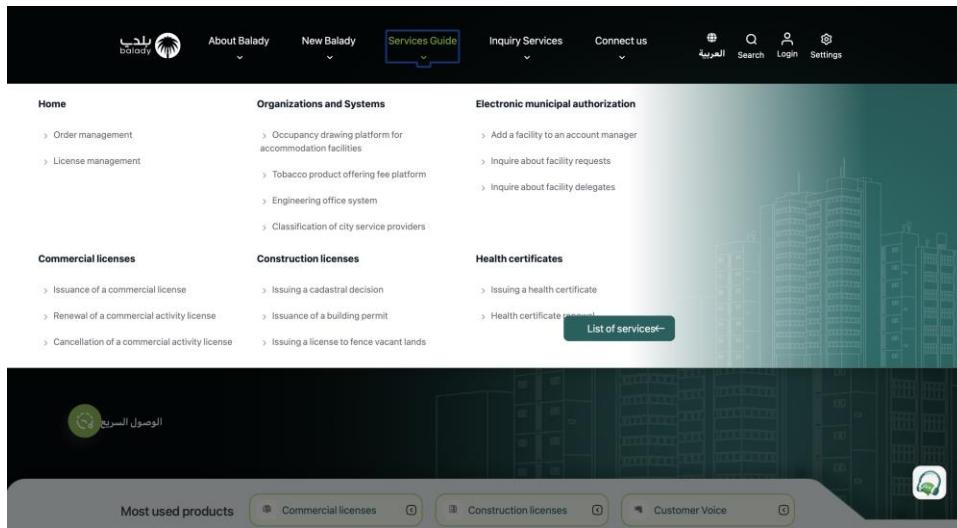


Figure1: Provided Services by Baladi Application

## 2.2 Amana 940

### Description

Riyadh Municipality has provided this service to serve the residents of the city, the Riyadh Municipality Emergency Center established this application in order to provide the latest methods that contribute to the delivery of reports to the Riyadh Municipality[3].



Figure2: Provided Services by Amana 940 Application

### 2.3 MyCity - مدينتي

#### Description

The two cities of the new digital window of the Riyadh Municipality, and include several main services such as submitting a report to the 940 team with the possibility of attaching multimedia. The beneficiary was also able to book an electronic appointment through the application. It also includes electronic services such as requesting the issuance of electronic licenses such as (building license, demolition license, justification license. Etc.) In addition to the possibility of inquiring about electronic requests and transactions through the application, it also includes population and information services that benefit the citizen and resident as knowing the date of transporting waste based on the beneficiary's location and the possibility of searching and going to facilities that can be used such as gardens, food leaving, walkway, parks. Etc.) The application was developed at the General Agency for Digital Transformation and Zakat Cities[4].

The image displays two side-by-side screenshots of a mobile application interface, both showing the time as 1:18 and a battery level of approximately 50%.

**Top Bar:** Both screens feature a top bar with a bell icon, the text "تسجيل الدخول" (Login) with a user profile icon, and a search bar containing the placeholder "ماذا تريده أن تلجز اليوم" (What do you want to be bound today?) with a magnifying glass icon.

**Section Headers:** Below the top bar, there are two main sections: "خدمات الاستعلام" (Information Services) and "الخدمات الالكترونية" (Electronic Services). The "الخدمات الالكترونية" section is currently active.

**Services List:** The electronic services section lists six services, each with a green "طلب خدمة" (Request Service) button:

- إصدار رخصة هدم لبناء غير مرخص** (Issuing a demolition permit for unlicensed construction):  
Description: "خدمة تتيح إصدار رخصة هدم من خلال التعاقد مع مكتب هندسي..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a key icon.
- إصدار رخصة ترميم لبناء** (Issuing a renovation permit for construction):  
Description: "خدمة تتيح إصدار رخصة ترميم لبناء مرخص من الأمانة..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a lamp icon.
- إصدار رخصة تسويير** (Issuing a demolition permit):  
Description: "خدمة تتيح إصدار رخصة تسويير فورية من خلال التعاقد مع مكتب هندسي..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a shovel icon.
- إصدار رخصة هدم لبناء مرخص** (Issuing a demolition permit for licensed construction):  
Description: "خدمة تتيح إصدار رخصة هدم لبناء مرخص من الأمانة..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a key icon.
- إصدار رخصة بناء بالالتزامن** (Issuing a building permit by commitment):  
Description: "خدمة تتيح إصدار رخصة بناء بالالتزامن من خلال التعاقد مع مكتب هندسي..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a hammer icon.
- إصدار رخصة بناء غير مرخص** (Issuing an unlicensed building permit):  
Description: "خدمة تتيح إصدار رخصة هدم فورية لبناء قائم وغير مسلح لدى أمانة الـ..."  
Details: "طلب خدمة" button, "تفاصيل أكثر" link, and a key icon.

**Bottom Navigation Bar:** Both screens feature a bottom navigation bar with icons for "المزيد" (More), "الموعيد" (Appointment), "بلغ 940" (Report 940), "الخدمات" (Services), "الرئيسية" (Home), "المزيد" (More), "الموعيد" (Appointment), "بلغ 940" (Report 940), "الخدمات" (Services), and "الرئيسية" (Home).

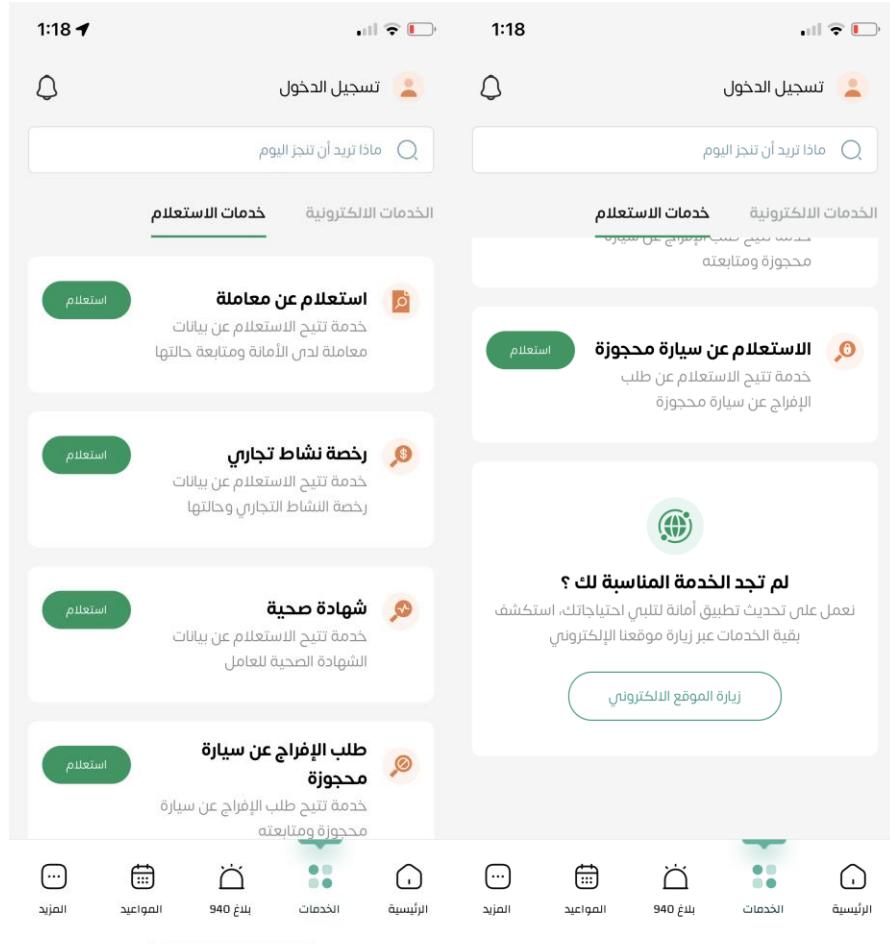


Figure3: Provided Services by MyCity

## Summary

In this table, we compare the main features of our application with Balady and Amana 940 and see what features will be met and what will not and see what application will meet all the features which we choose in this table and we choose this specific features because it's the main features.

*Table 1* compares some related features of the previously mentioned applications and the features that KASHEF system supports. Based on the problem definition and the proposed solution.

TABLE 1: PROPOSED SYSTEM VS EXISTING APPLICATION

MyCity	Amana 940	Balady	KASHEF	Features

<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Repair potholes in the road
			<input checked="" type="checkbox"/>	Automatic detection of potholes
			<input checked="" type="checkbox"/>	Low reliance on citizen
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Detect potholes using camera
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Send complaints to municipal

### 3. Risk/Constraints

The following table demonstrates the risk that could affect the project during its development lifecycle(SDLC). It shows the risk type, which includes

**Schedule:** A limitation placed on a project schedule that affects the start or end date of an activity.

**Technical:** A technology-related condition or event that prevents the project from fully delivering the ideal solution to customers and end-users.

**Product:** Anything that prevents you from making progress towards your product goal.

**Team:** Any outside event on the team member's life that affects the progress of the project.

The table also shows the Likelihood, and severity then it includes the suggested strategies to manage them and avoid its effect

Table 2: Risks

Mangment Study	Likelihood	Severity	Type	Risk/Constraint	No
Arranging the requirements according to importance and	high	high	schedule risk	Inability to achieve the plan due to lack of time	1

implementing the most important requirements first						
Watch tutorial for the method of composition on YouTube or the official site of jetson nano NVIDIA	high	high	Technica l	Limited knowledge of using jetson ano	2	
Participate in courses that explain these techniques and self-learning, and also read books and research that may help the team understand the technology	high	high	product	Difficulty implementing artificial intelligence for example computer vision	3	
Go back to reviewing the SWE312 architecture course to make sure of choosing the most suitable system architecture design	Medium	High	product	Implementation of inaccurate System Architecture design	4	
organize work and avoid delaying	High	Medium	Team	conflict of deliverable deadline and exam date	5	

## **4. Project Plan**

### **1- Methodology**

A waterfall methodology is used in our project to develop our web-based application because it provides a structured approach to software development that enables planning and predicting project timelines and costs. Furthermore, this involves extensive testing at every stage of the process, which ensures that the final product will meet all the requirements and will be of high quality.

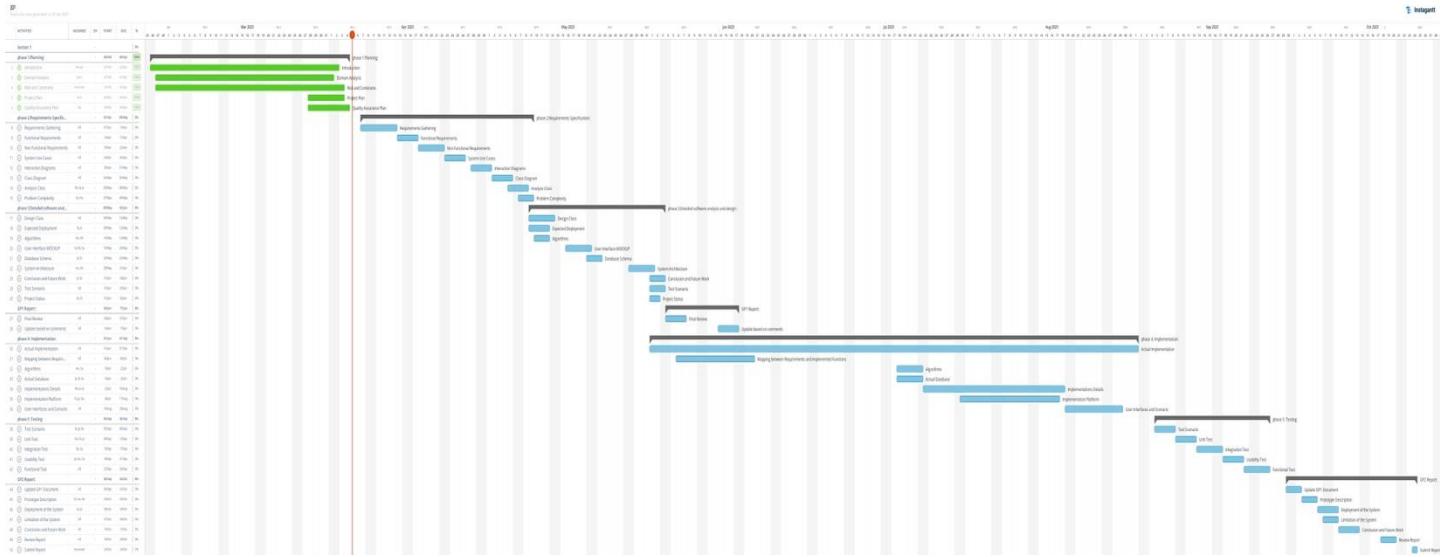
The methodology defines each stage of the project and what is expected of the team at each stage. This eliminates confusion and ensures that everyone is at the same stage. Waterfall methodology is a sequential process in which each stage is completed before moving on to the next. The waterfall methodology may be appropriate for our project because the scope is well-defined, and the requirements are unlikely to change.

### **2- Work plan**

Our team consists of:

Dr.Sara AlMoaiqel - Project Supervisor.  
Monerah Alsubaie - Project Leader.  
Sara Khalid.  
Jouri Alanazi.  
Renad Alsubaie.  
Fai Alotaibi.

The Gantt chart in the figure below depicts the project schedule, which includes all phases, tasks within phases, and the assignment of each task.



*Figure 4: Gantt Chart*

<https://app.instagantt.com/shared/642e048a96a08852acf19a04>

This link for Gantt Chart.

### 3- Tools used for management:

#### 1- for sharing code and monitor progress and updates:

- GitHub: GitHub is a web-based platform for version control and collaborative software development. It allows us to save, manage, and share code. GitHub provides features such as code review, issue tracking, and project management tools, making it an essential tool for many software development teams.

#### 2-for discussion:

- Meet: Meet is a popular video conferencing application developed by Google. It allows users to hold virtual meetings, webinars, and online events with up to 250 attendees. Meet provides a range of features to enhance the video conferencing experience, including Screen sharing, Recording, Chat.
- WhatsApp: WhatsApp is a powerful and versatile instant messaging application that is used by billions of people worldwide for personal and business communication. One of most important features is group chat that allow users to create and participate in groups.

#### 3- for document sharing:

- Microsoft Word: Microsoft Word is a word processing application developed by Microsoft. Documents such as reports are created, edited, and formatted using it. Spell check, grammar check, and the ability to insert images and tables into documents are all included in Word. It will assist us in writing our seminar reports.

## **5. Quality Assurance Plan**

Quality assurance (QA) is any systematic process of determining whether a product or service meets specified requirements.[5]

Quality assurance plan is important in any project because it helps a company to create products and services that meet the needs and the expectations of the user about the products.

### **5.1 Inspection**

Inspection are a formal type of review that includes checking and reviewing the documents before meeting and is carried out mostly by the team members.

The team members will divide themselves into different roles. The roles of inspections are reader, moderator, authors and inspector. A meeting is then held to review the code and the design.

To view the performed Inspection until now see [Appendix 1].

### **5.2 Walkthrough**

Walkthrough in software testing is used to review documents with peers, managers, and fellow team members who are guided by the author of the document to gather feedback and reach a consensus.[6]

To view the performed walkthrough until now see [Appendix 2].

### **5.3 Templates**

This is a standardized document that provides guidelines and instructions to ensure a high-quality

project. Our team used the template provided by the Graduation Project Committee (GPC) to ensure the quality of the report and project and to save time and effort.

To view the templates here <https://bit.ly/2qZuBlr>.

### **5.4 Checklists**

After the team finish the document of the project, they will review it by checklist provided by the Software Engineering Department Graduation Committee (SWE GPC), to ensure the team cover all of deliverables requirements.

To view the Checklists here <https://bit.ly/2DuHhZ0>

### **5.5 Testing**

Software testing is the process of verifying a system with the purpose of identifying any errors, gaps or missing requirement versus the actual requirement. Software testing is broadly categorised into two types - functional testing and non-functional testing.[7] Our team will do the following testing strategies:

#### **5.5.1 Unit Testing**

Our team will test every individual unit/component of the project. to make sure that it performs as expected.

### **5.5.2 Integration Testing**

Integration Testing is defined as a type of testing where software modules are integrated logically and tested as a group. [8]

### **5.5.3 Functional Testing**

Our team will use the black box testing to test all the functionalities of the system.

### **5.6 Project Management**

Project management is the application of processes, methods, skills, knowledge and experience to achieve specific project objectives according to the project acceptance criteria within agreed parameters. Project management has final deliverables that are constrained to a finite timescale and budget.[9]

## **6- Requirements**

The requirement gathering phase of our project, Kashef, which aims to detect potholes. As with any project, this phase is crucial in ensuring that we obtain accurate and relevant requirements that will guide the development process. To achieve this, we have used two techniques, including questionnaires, to gather information from different stakeholders. We recognize that the success of our project depends on the effectiveness of our requirement gathering process. Therefore, and We have been reading about the problem thorough research literature to gain a deeper understanding of the issue and identify potential solutions, which involves working closely with people from different backgrounds to ensure that we gather requirements that are comprehensive and meet the needs of all stakeholders. Through this approach, we hope to obtain useful information that will guide the development of a reliable pothole detection system.

### **Survey**

To make good understanding of our project problem we use a survey to gather requirements on a manageable sample size, municipal employees, and user and it was an effective way to understand their needs and preferences. Our survey was designed with clear and concise questions, and an assurance of anonymity and confidentiality. Once the data is collected, it should be analyzed to identify trends and patterns. The findings from the survey should be used to inform decision-making, make improvements, and address any concerns or issues that were raised. Communicating the results and any action taken back to the participants can show that their input was valued and acted upon. Overall, [Appendix 3] present an overview and summary of the survey results.

### **6.1 - Functional Requirements**

#### **6.1.1- User**

- 6.1.1.1 The user should be able to log in to the system using their email address and password.
- 6.1.1.2 The user should be able to log out of the system.
- 6.1.1.3 - The user should be able to register for an account by providing their name, email address, phone number, and password.
- 6.1.1.4 - The user should be able to reset their password by entering their email address and

following the instructions in the password reset email.

6.1.1.5 - The user should be able to view their own profile, which includes their name, email address, phone number, and password.

6.1.1.6 - The user should be able to edit their own profile information (name, email address, phone number and password).

6.1.1.7 The user shall be able to view all reports history sorted by status.

6.1.1.8 The user shall be able to view report details.

6.1.1.9 The user shall be able to rate the report service.

6.1.1.10 The user shall be able to receive notification about report status.

6.1.1.11 The user shall be able to view the comment associated with the rejected report from the municipal employee.

6.1.1.12 The user shall be able to view the status of his report (Accepted / Rejected / Pending / In progress / Completed).

6.1.1.13 The user shall be able to view the detected potholes.

    6.1.1.13.1 the system shall identify pothole using dashcam video.

    6.1.1.13.2 the system shall record video.

    6.1.1.13.3 the system shall send video with its coordinates(x,y) to server.

    6.1.1.13.4 the system shall be able to create report.

## **6.1.2- municipal Employee**

6.1.2.1 - The municipal employee should be able to log in to the system using their email address and password.

6.1.2.2 - The municipal employee should be able to log out of the system.

6.1.2.3 - The municipal employee should be able to reset their password by entering their email address and following the instructions in the password reset email.

6.1.2.4 - The municipal employee should be able to view their own profile, which includes their name, email address phone number and password.

6.1.2.5 - The municipal employee should be able to edit their own profile information (name, email address, phone number and password).

6.1.2.6- The municipal employee should be able to delete report from the list.

6.1.2.7- municipal employee shall be able to view statistics of the system.

6.1.2.8 The municipal employee shall be able to view report list sorted by regions.

6.1.2.9 The municipal employee shall be able to change report status to one of these cases (accepted / rejected / pending / In progress / Completed)

6.1.2.10 The municipal employee shall be able to add a comment to a rejected report in order to provide an explanation for the rejection.

6.1.2.11 The municipal employee shall be able to view heat map.

6.1.2.12 The municipal employee shall be able to accept reports submitted by users.

6.1.2.13 The municipal employee shall be able to reject reports submitted by users.

6.1.2.14 The municipal employee shall be able to view report details.

## **6.1.3 Admin**

6.1.3.1-The admin should be able to log in to the system using their email address and

password.

-6.1.3.2 The admin should be able to log out of the system.

6.1.3.3 - The admin should be able to reset their password by entering their email address

6.1.3.4 - The admin should be able to create new municipal employee account by providing its name, phone number, email address, and password.

6.1.3.5- The admin should be able to view their own profile, which includes their name, email address, phone number and password.

6.1.3.6- The admin should be able to edit their own profile information (name, email address, phone number and password).

6.1.3.7- The admin should be able to edit the profiles information (name, email address, phone number) of municipal employees.

6.1.3.8- The admin should be able to edit the profiles information (name, email address, phone number) of users.

6.1.3.9- The admin should be able to delete accounts of municipal employees.

6.1.3.10- The admin should be able to delete accounts of users.

6.1.3.11- The admin should be able to view the profiles information (name, email address, phone number) of municipal employees.

6.1.3.12- The admin should be able to view the profiles information (name, email address, phone number) of users.

## **6.2 - non-Functional Requirements**

### **6.2.1. Performance:**

6.2.1.1- Average system response time should be less than 10 seconds.

### **6.2.2-Security:**

6.2.2.1- Password shall be required to access Municipal Employee and user screens.

### **6.2.3- Usability:**

6.2.3.1- The new user shall be able to learn all system functionality in less than 20 minutes.

### **6.2.4-Availability:**

6.2.4.1-The system should be available 24/7, with minimal downtime for maintenance and updates, to ensure that users can report potholes and track their status at any time.

## **7-ALGORITHMS**

Our system relies on artificial intelligence and machine learning technology, specifically YOLO technology, to accurately identify objects in images and videos in real-time. A dash camera is used to provide visual data to the system.

A Jetson Nano computer is installed on top of the dash camera to provide the necessary computing power to run the YOLO technology, which is an advanced algorithm that uses deep learning to analyze images and identify areas that contain potholes on the streets. The YOLO model is trained using a large dataset of images that contain potholes, allowing the system to accurately detect and classify potholes in images and videos in real-time."

How does yolo algorithms work?

YOLO divides the input image or video frame into a grid of cells and predicts a set of bounding boxes for each cell. Each bounding box represents a candidate object.

Object classification: YOLO then predicts the probability that each candidate object belongs to a certain class (such as "pothole").

This is done using a softmax function that assigns a probability score to each class based on the features of the candidate object.

Output: Finally, the detected and classified potholes

## 8- USE CASE

### 8.1 Use Case 1:

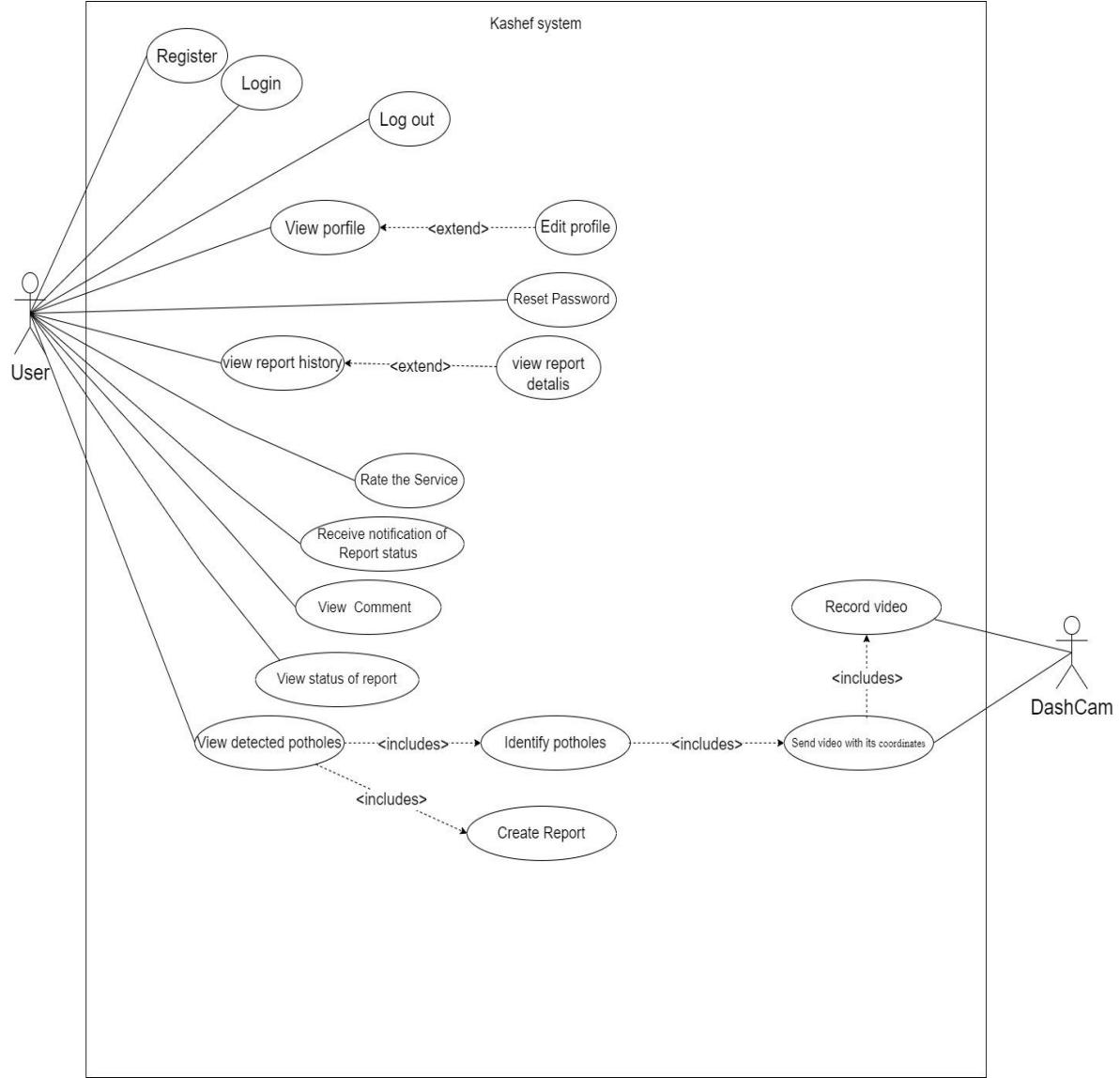


Figure 5: Use Case I

### 8.2 Use Case 2:

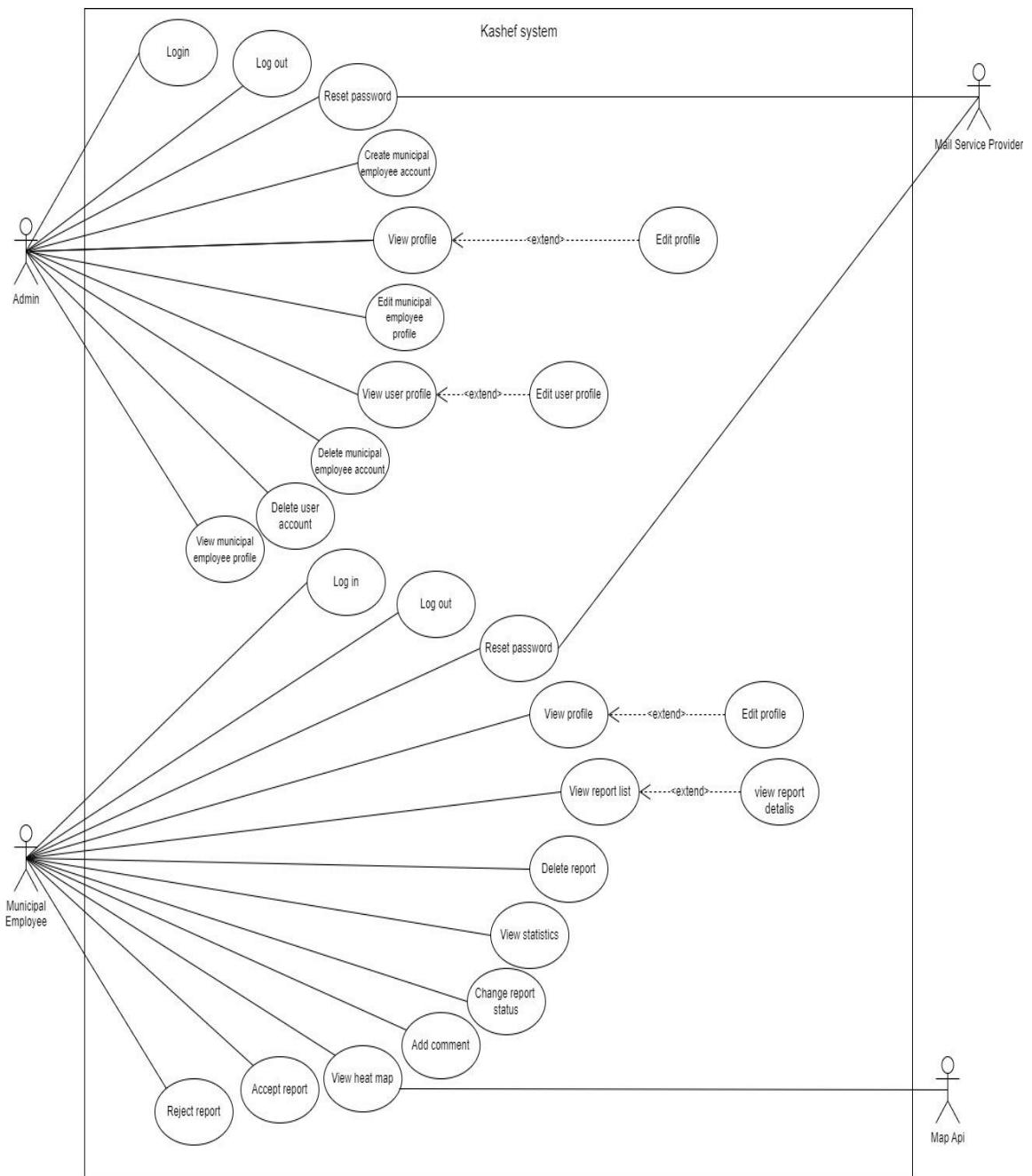


Figure 6: Use Case 2

## 9- Class Diagram:

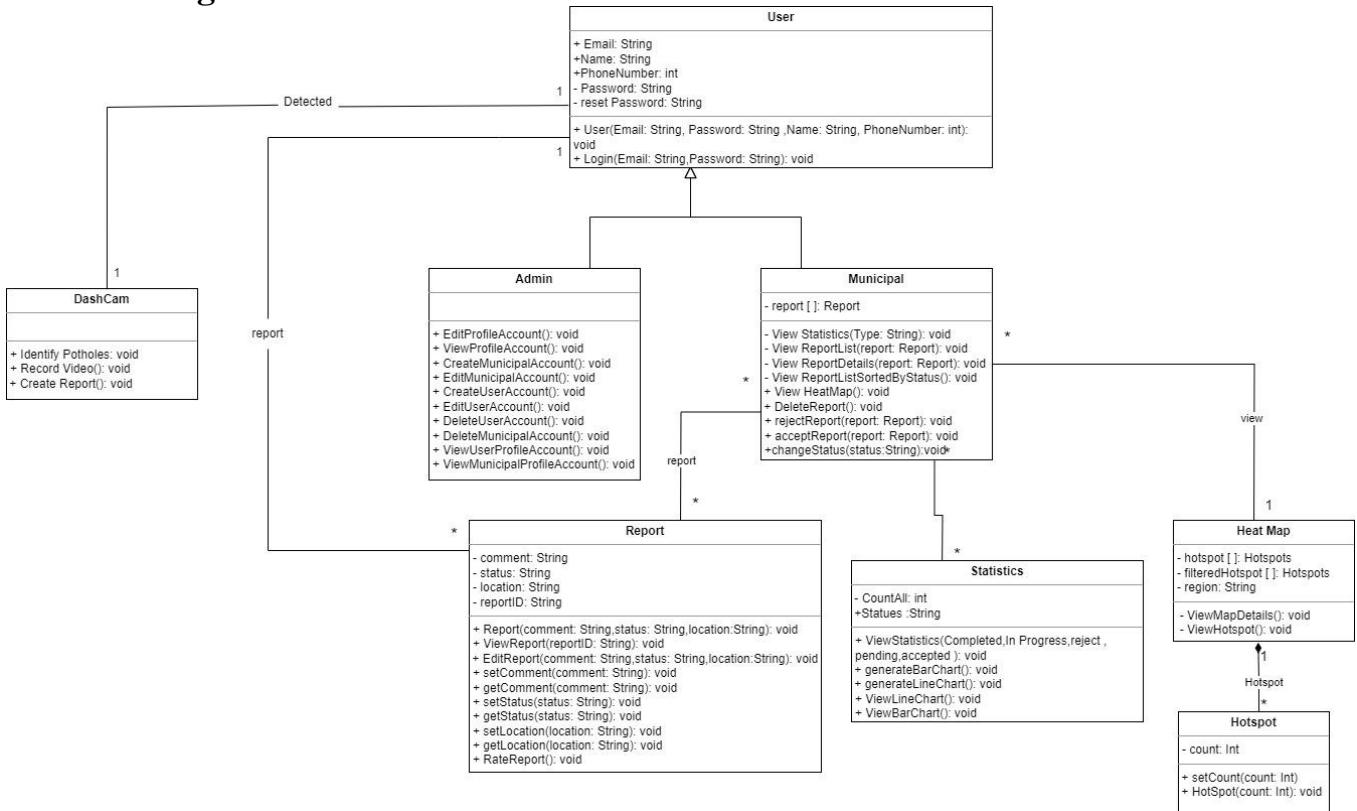


Figure 7: Class Diagram

## Use case Description

**View Statistics:**

<b>Use Case Description</b>	
	<b>System:</b> Kashef
<b>Use Case name:</b> View statistics	
<b>Secondary actor:</b> none	<b>Primary actor:</b> The Municipal Employee
<b>Description:</b> This use case allows the Municipal Employee to view the total number of reports based on statues	
<b>Relationships</b> <ul style="list-style-type: none"> <li>· <b>Includes:</b> None</li> <li>· <b>Extends:</b> None</li> </ul>	
<b>Pre-conditions:</b> The Municipal Employee is logged in to his/her account successfully The Municipal Employee is in the homepage	
<b>System</b>	<b>Primary Actor</b>
2. System counts the number of report (based on status) 3. System displays the following statistics a. number of rejected reports b. number of in progress reports c. number of in completed reports d. number of pending reports e. number of accepted reports f. number of total reports	1- The Municipal Employee selects ‘statistics’ tab.
<b>Alternative and exceptional flows:</b> None	

**Post-conditions:**

- **Successful condition:** The Municipal Employee can view statistics of reports statuses successfully .

**Failure condition:** The Municipal Employee cannot view statistics of reports statuses.

**View report details:**

Use Case Description	
	<b>System:</b> Kashef
<b>Use Case name:</b> View report details.	
<b>Secondary actor:</b> None	<b>Primary actor:</b> Municipal Employee
<b>Description:</b> This use case will allow the user to view the details of report from list of reports showing picture of pothole, status, location and date.	
<b>Relationships</b> <ul style="list-style-type: none"><li>• <b>Includes:</b> None</li><li>• <b>Extends:</b> view report list</li></ul>	
<b>Pre-conditions:</b> The Municipal Employee is logged in to his/her account successfully. The Municipal Employee in homepage.	
System	
System	Primary Actor
3- System shows the details of the selected report.	1- The user selects ‘Report’ tab.  2- User selects the required report.
<b>Alternative and exceptional flows:</b> If in any step the user cancels, return to step 1	

**Post-conditions:**

- **Successful condition:** The user successfully views the details of a specific report.
- **Failure condition:** The user cannot view the details of a specific report.

**view status of report:**

Use Case Description	
	<b>System:</b> Kashef
<b>Use Case name:</b> view statuses of reports	
<b>Secondary actor:</b> none	<b>Primary actor:</b> User
<b>Description:</b> This use case allows the user to view the statuses of a reports.	
<b>Relationships</b> <ul style="list-style-type: none"><li>• <b>Includes:</b> None</li><li>• <b>Extends:</b> None</li></ul>	
<b>Pre-conditions:</b> The user is logged in to his/her account successfully The user in homepage.	
System Primary Actor	
System	Primary Actor

<p>2. system displays a list of all reports submitted by the user and their corresponding status.</p> <ul style="list-style-type: none"> <li>a. accepted reports</li> <li>b. rejected reports</li> <li>c. pending reports</li> <li>d. in progress reports</li> <li>e. completed reports</li> </ul>	<p>1- The user selects ‘Report’ tab.</p>
<p><b>Alternative and exceptional flows:</b> No Reports: If the user has not previously submitted any reports, the system displays a message indicating this.</p>	
<p><b>Post-conditions:</b></p> <ul style="list-style-type: none"> <li>• <b>Successful condition:</b> The user can view statuses of reports successfully •</li> <li>• <b>Failure condition:</b> The user cannot view statuses of reports.</li> </ul>	

### Rate the Service:

Use Case Description	
	<b>System:</b> Kashef
<b>Use Case name:</b> Rate the Service.	
<b>Secondary actor:</b> None	<b>Primary actor:</b> User
<b>Description:</b> The user wants to rate the service they received from the Kashef system.	

<b>Relationships</b>	<ul style="list-style-type: none"> <li>• <b>Includes:</b> None</li> <li>• <b>Extends:</b> None</li> </ul>
<p><b>Pre-conditions:</b> The user is logged in to his/her account successfully.  The user in homepage.  The user successfully submits a report from dash cam.</p>	
<b>System</b>	<b>Primary Actor</b>
4- The system prompts the user to rate the service.  6- The system saves the rating and displays a success message.	1-The user selects 'Report' tab. 2- User selects the required report.  3- The user clicks on the "Rate Service" button.  5- The user selects a star rating from 1 to 5 and submits the rating.
<p><b>Alternative and exceptional flows:</b> If in any step the user cancels, return to step 1</p>	
<b>Post-conditions:</b>	<ul style="list-style-type: none"> <li>• <b>Successful condition:</b> The user successfully rating is saved in the system.</li> <li>• <b>Failure condition:</b> The user cannot the service</li> </ul>

### Change report status:

Use Case Description	
	<b>System: Kashef</b>
<b>Use Case name:</b> Change report status	

<b>Secondary actor:</b> none	<b>Primary actor:</b> Municipal Employee
<p><b>Description:</b> This use case allows the Municipal Employee to change the status of a report received from user</p> <p>.</p>	
<p><b>Relationships</b></p> <ul style="list-style-type: none"> <li>• <b>Includes:</b> None</li> <li>• <b>Extends:</b> None</li> </ul>	
<p><b>Pre-conditions:</b> The Municipal Employee is logged in to his/her account successfully.</p> <p>The Municipal Employee successfully viewed the report received from user.</p>	
System	Primary Actor
1.1- The system displays a list of options for the Municipal employee to choose from (accepted, rejected, pending, in progress, completed)	1- Municipal Employee selects update status.  2- Municipal Employee chooses the new status 3- Municipal Employee press submit option.  4- Municipal Employee confirms the message.
3.1- The system displays a confirmation	
4.1- The System updates the status of the report in the system.  4.2- The System notifies the Municipal employee that the report status has been updated.	
<p><b>Alternative and exceptional flows:</b> If in any step, the Municipal employee cancels, return to step 1.</p>	

**Post-conditions:**

- **Successful condition:** The report status is updated, and the Municipal employee is notified.
- **Failure condition:** The report status is not updated.

**View heat map:**

Use Case Description	
	<b>System:</b> Kashef
<b>Use Case name:</b> View heat map	
<b>Secondary actor:</b> Map Api	<b>Primary actor:</b> Municipal Employee
<b>Description:</b> This use case allows the Municipal Employee to view the map.	
<b>Relationships:</b> <ul style="list-style-type: none"><li>· <b>Includes:</b> None</li><li>· <b>Extends:</b> None</li></ul>	
<b>Pre-conditions:</b> The Municipal Employee is logged in to his/her account successfully. The Municipal Employee in homepage.	

Map Api	System	Primary Actor
3.1 map Api display the map	2.1 System redirects Municipal Employee to the map Api	1- The Municipal Employee selects 'map' tab.  4.1 The Municipal Employee view the map
<b>Alternative and exceptional flows:</b> None		
<b>Post-conditions:</b> <ul style="list-style-type: none"> <li>• <b>Successful condition:</b> The Municipal Employee can view heat map successfully .</li> <li>• <b>Failure condition:</b> The Municipal Employee cannot view heat map .</li> </ul>		

### View Report History:

Use Case Description	
<b>System:</b> Kashef	
<b>Use Case name:</b> View Report History	
<b>Primary actor:</b> User	<b>Secondary actor:</b> none
<b>Description:</b> This use case allows the user to view his report history.	
<b>Relationships</b> <ul style="list-style-type: none"> <li>• <b>Includes:</b> None</li> <li>• <b>Extends:</b> View Report Details</li> </ul>	

**Pre-conditions:** The User is registered/logged in to his/her account successfully.  
**The User is in the homepage.**

Primary Actor	System
1. The user selects 'Report' tab.	2. System displays list of all reports with their statuses
<b>Alternative and exceptional flows:</b> if any step before step 2 the user selects the cancel option 1.1 The use case ends with failure condition.	

**Post-conditions:**

- **Successful condition:** The User can view his report history successfully.
- **Failure condition:** The User can't view history of his reports.

#### View Detected Potholes:

Use Case Description	
<b>System:</b> Kashef	
<b>Use Case name:</b> View Detected Potholes	
<b>Primary actor:</b> User	<b>Secondary actor:</b>
<b>Description:</b> This use case allows the user to view detected potholes.	

**Relationships**

- **Includes:** Create Report
- **Extends:** None

**Pre-conditions:**

1. The system access to the user dashcam enabled successfully.
2. The technique (yolo) placed on dashcam successfully.
3. The pothole placed in front of dashcam.

Primary Actor	System
	<ol style="list-style-type: none"><li>1. This use case begins when the system starts detecting the pothole.</li><li>2. The dashcam starts capturing the pothole</li><li>3. return captured pothole.</li></ol> <ol style="list-style-type: none"><li>4. The system identifies pothole and create a report contain the information:<ol style="list-style-type: none"><li>a. picture of the pothole</li><li>b. status</li><li>c. location</li><li>d.date</li></ol></li></ol>
<b>Alternative and exceptional flows:</b> if in step 1 the user failed to detect pothole 1.1 The use case ends with failure condition.	
<b>Post-conditions:</b> <b>Successful condition:</b> The system detect pothole successfully. <b>Failure condition:</b> No detected pothole performed by the system.	

## 10- Interaction diagram:

### View report details:

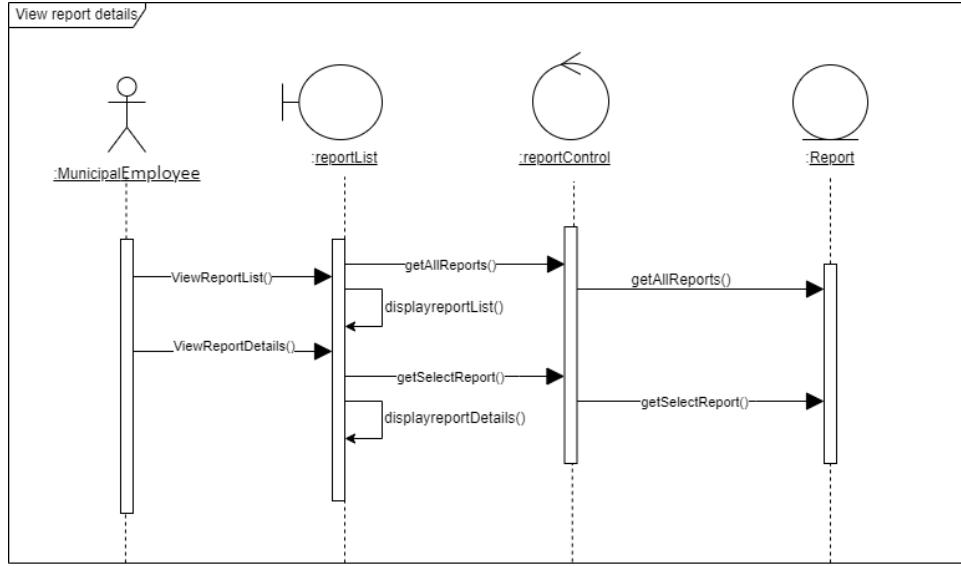


Figure 8: View report details sequence diagram

### View Statistics:

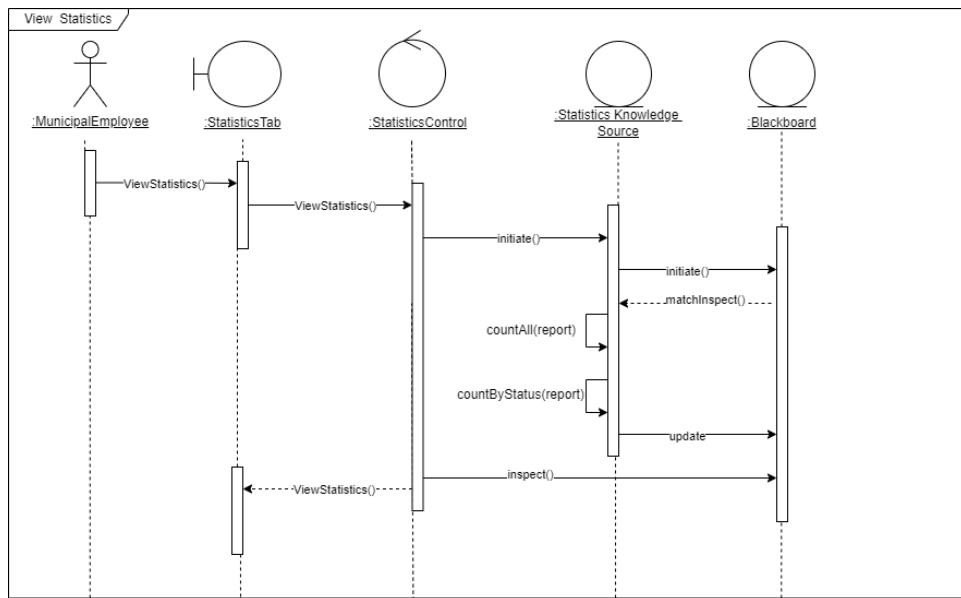


Figure 9: View statistics sequence diagram

### **View Status of Report:**

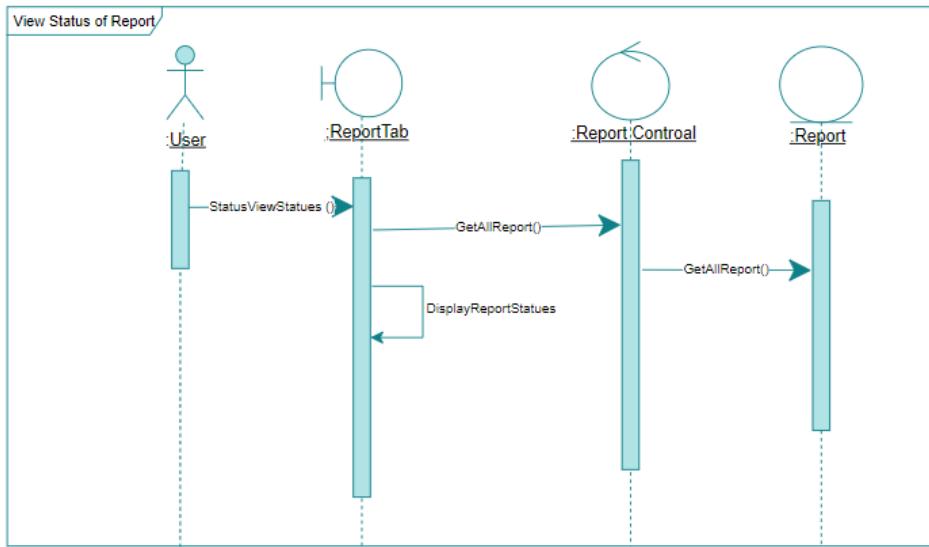


Figure 10: Sequence View Status of Report

### **View Report History:**

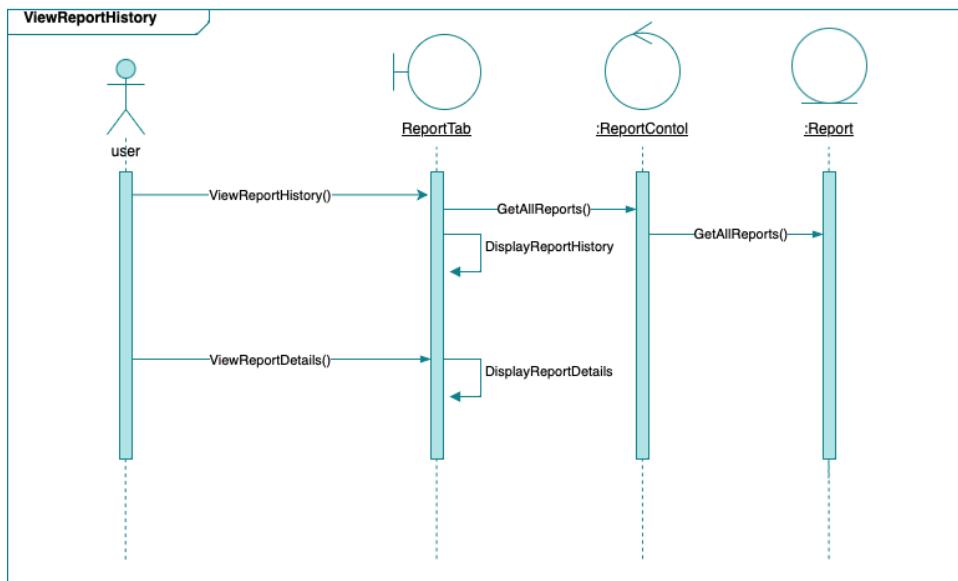


Figure 11: Sequence View Report History

## Change Status of Report

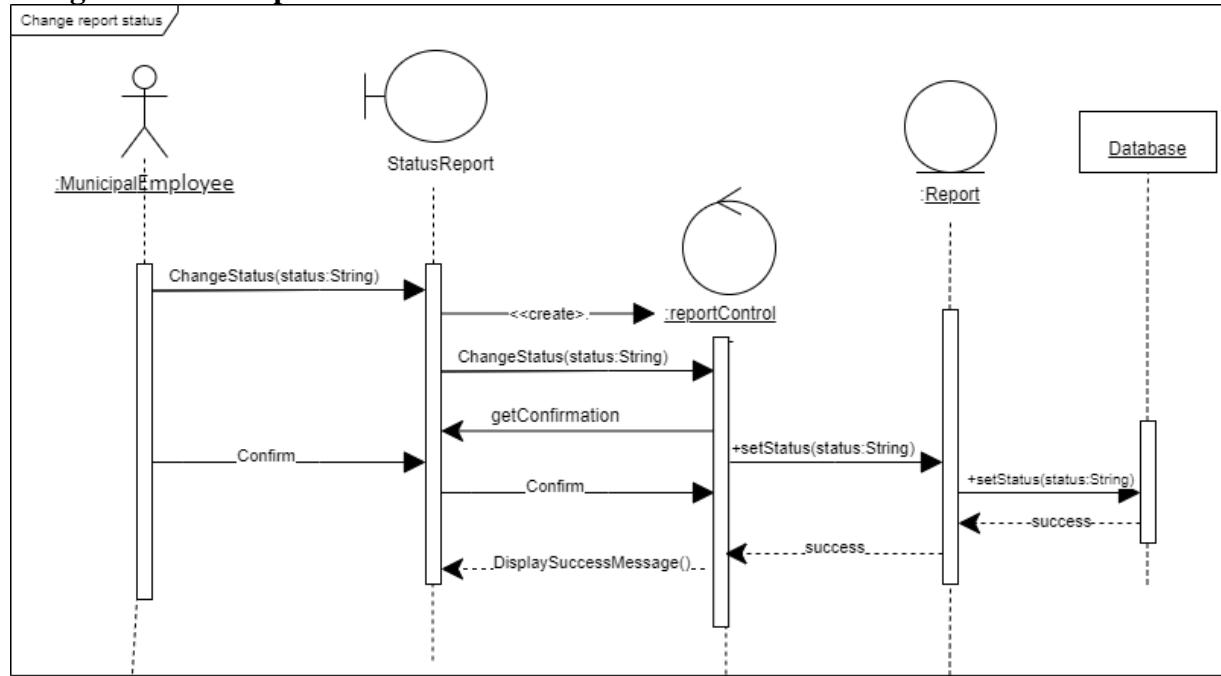


Figure 12: Change Status Of Report

## ANALYSIS CLASS

### 1. VOPC Diagram

View Statistics:

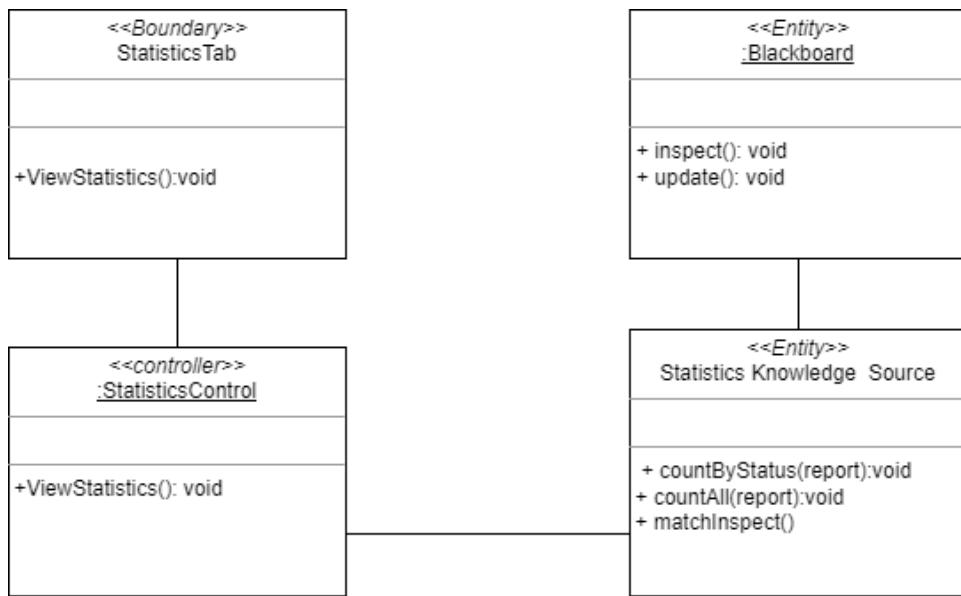


Figure 18: View report Statistics VOC

### View report details:

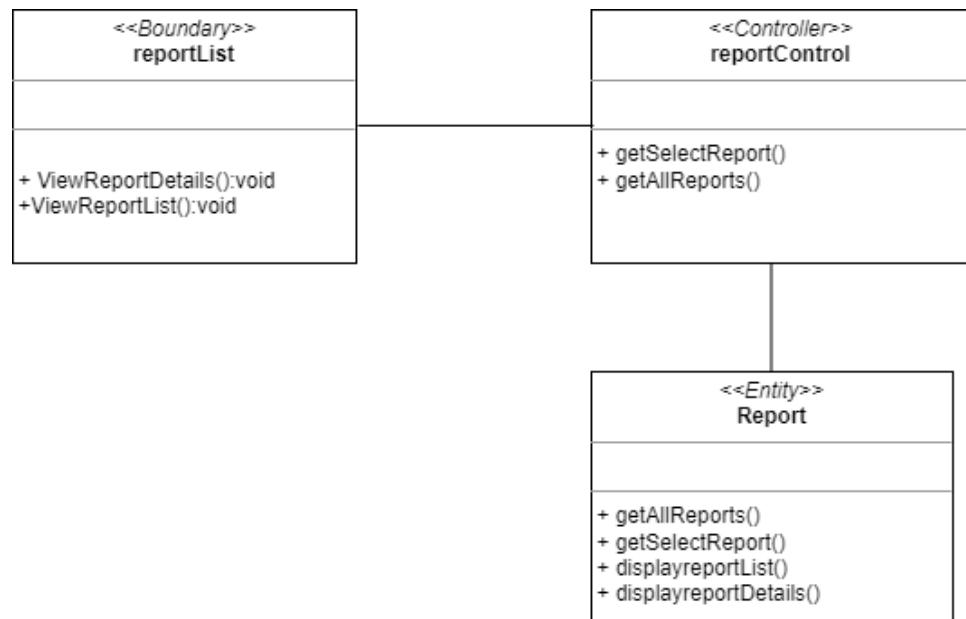
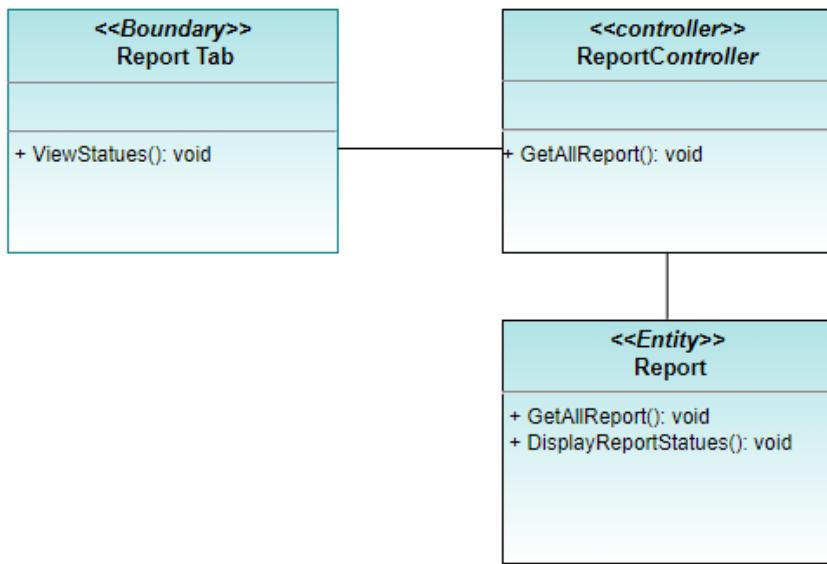


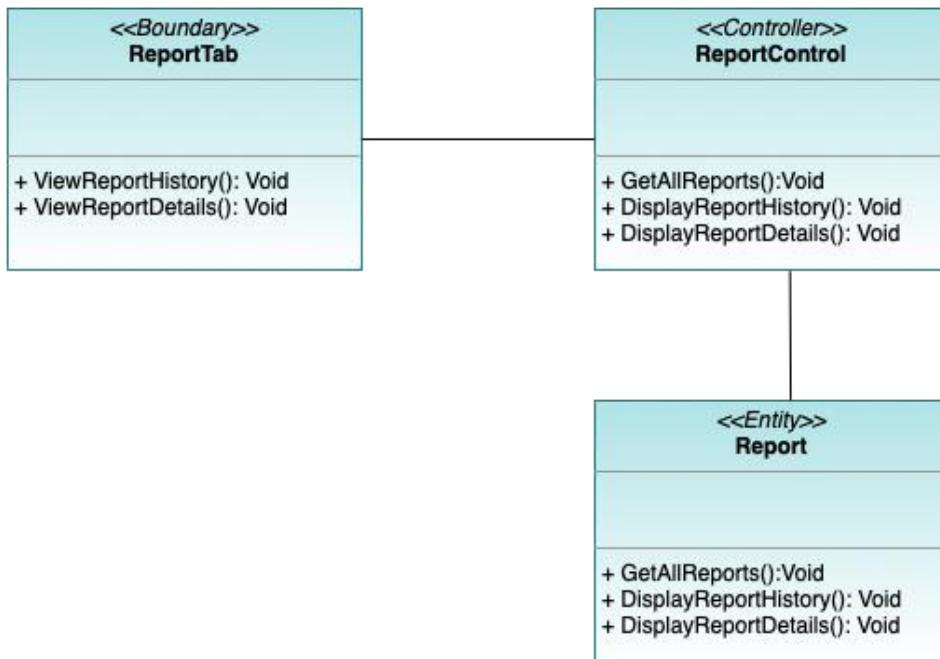
Figure 19: View report details VOC

### View Status of Report:



*Figure 20: View Status of Report (voc)*

### View Report History:



*Figure 21: View Report History (voc)*

## 12- System Architecture

The process of architectural design involves identifying the various sub-systems that make up a system and establishing a framework for controlling and communicating between these sub-systems. This involves hiding the implementation details of the

system, while putting in place mechanisms for coordination and communication between the different components. The architectural style is determined by a set of predefined design considerations and constraints, which are aimed at achieving specific qualities in the system. The primary objective of the process is to identify requirements that impact the structure of the system, and to come up with a structured approach that addresses the technical and operational needs of the system. Additionally, the design must adhere to the quality attributes required by the Kashef system, such as performance and efficiency, to ensure that it meets the necessary standards.

In the Kashef system, our proposal is to use artificial intelligence for detecting potholes through a dashcam. After careful consideration, we have determined that the 3-Tiers architecture would be the most efficient and effective architectural style for our system. This is because it provides a clear separation of functionality both logically and physically. Furthermore, it will enable us to develop the website at a faster pace.

The 3-Tiers software architecture is a commonly used design that divides an application into three distinct layers: presentation, application logic, and data storage. The presentation layer is responsible for displaying data to the user through a user interface, such as a mobile app or web page. The application logic layer is responsible for carrying out the business logic of the application, processing data, and implementing business rules. The data storage layer is responsible for storing and managing data in a database or other storage system.

This architecture offers numerous benefits, including scalability, maintainability, and security. By separating the user interface, business logic, and data storage, it becomes easier to modify and scale the application. Additionally, the application can be developed and maintained by different teams, with each team responsible for a specific layer.

Overall, the 3-Tiers architecture is an adaptable and modular architecture that can be used for a variety of applications. It provides a clear separation of concerns between the different layers, enabling the development of complex applications that are scalable, maintainable, and secure.

Therefore, in addition to the 3-Tier architecture, our system will be developed using a Blackboard architecture, creating a heterogeneous architecture. With the Blackboard architecture, we have three main components: the blackboard, the knowledge sources and the control component. Knowledge sources are independent modules that work together to solve the problem. Each knowledge source has a specific area of expertise and can read and write information to the blackboard. The control component is responsible for coordinating the activities of the knowledge sources and ensuring problem solution.

Following this approach, the blackboard architecture will be implemented on the server side. For the first tier, we have the system users, including municipal employees and users. For the second tier, we have the application server which will perform most business logic such as handling reports of potholes, accounts, and data. The third tier

will be where the most critical part of our system resides. It will include the blackboard component with its knowledge sources.

We have chosen a blackboard architecture that provides several benefits that make it suitable for developing our intelligent system. Some of these benefits are:

Highly scalable. As the problem size increases, more knowledge sources can be added to the system to solve it.

It also allows collaboration between different knowledge sources. Each knowledge source can contribute to the problem solution independently.

Hence, it is suitable for problems requiring a variety of expertise.

Our team chose the 3-tier architecture with blackboard architecture because it has proven to be beneficial for designing and managing AI systems, for the following reasons:

- Separation of concerns: The 3-tier architecture style separates the system into three distinct layers, which is beneficial for AI systems with many components and data sources. By separating the presentation layer, application layer, and data storage layer, it becomes easier to manage the different components of the AI system and to ensure that each component is responsible for a specific task.
- Modularity: Blackboard architecture allows modular knowledge sources. A knowledge source can be developed independently and reused in other similar systems.
- Scalability and Flexibility: The 3-tier architecture style is also highly scalable and flexible, which can benefit AI systems that require large amounts of data processing and storage. As AI systems often require large amounts of computational power and storage, the ability to scale up or down quickly and easily is critical.
- Real-Time Response: The blackboard architecture can respond to problems. As new information is added to the blackboard, AI components can update their solutions and provide new solutions in real-time. This makes it suitable for websites that require fast and accurate responses, such as chatbots or customer service systems.
- Security: The 3-tier architecture style can also help AI systems stay secure by separating the user interface from application logic and data storage. This helps prevent unauthorized access to sensitive data and reduces security breaches risk.
- Integration with Other Systems: AI systems often need to integrate with other systems and technologies, such as databases, web services, and APIs. The 3-tier architecture style can make it easier to integrate AI systems with other technologies by separating the different layers and providing clear interfaces between them.

KASHEF is a web-based application, and the use of a 3-tier architecture with blackboard architecture can enhance maintenance and reuse of web applications by municipal employees and users.

## **13-Problem complexity**

In the following section of the report, the system's main problems regarding its technological interdependence and management difficulties will be discussed

### **1-Technical complexity**

Since the team has only a limited understanding of the technologies involved, the team expects that several difficulties may arise during the implementation process.

Pothole detection, integration of real time data processing with a dash-cam.

In order to ensure high accuracy levels in decisions, it is important to handle the integration of different models carefully in order to avoid conflicts that can arise.

### **2- Security**

Kashef needs to have a high level of security and be able to handle sensitive information. Dash cam footage may contain sensitive information, such as license plates and people's movements, which has to be protected from unauthorized access. The website also needs to handle user authentication and access controls to ensure privacy.

### **3-Management complexity**

Kashef aims to possess and handle large volumes of data in real-time. This requires a robust and scalable architecture that can accommodate high traffic volumes and process large amounts of data in real-time. The website needs to be able to handle data processing requirements and display heat maps accurately to users

### **4- Integration with existing infrastructure**

The Kashef system would need to integrate with existing infrastructure, such as road maintenance departments or city management systems. The team would need to ensure that the system is compatible with these existing systems and that data can be easily shared between them.

### **5- User adoption**

The success of the Kashef system would depend on user adoption and engagement. The team would need to ensure that the system is easy to use and that users understand the benefits of reporting potholes.

### **6- Environmental factors**

The detection of potholes using dashcam and AI may be affected by environmental factors such as weather conditions, lighting, and road surface conditions. The team would need to ensure that the system is robust enough to handle these variations and that accuracy is not compromised.

## 14-Database schema

NoSQL is a type of database that does not employ a traditional relational database's table-based structure. Instead, a more adaptable schema-less design is used. This implies that data can be stored in any format and that the data's structure does not need to be predefined. When scalability is crucial, large data applications frequently use NoSQL databases. They can also be applied to real-time online applications when rapid data access is necessary.

A brief description of each collection used in attribute is provided in the figures below.

Collection	Document fields
Users	Uid :String Name: String Email: String PhoneNumber :number Password: String
Municipal employee	Mid: String Name: String Email: String PhoneNumber :number Password: String
Reports	Date: date Location: Array Picture: String Status: String Uid :String Comment: String Rid: String
Admin	Name: String Email: String PhoneNumber :number Password: String Aid: String

## 15-Prototypes

### 17-TEST SENARIO

#### Login Test Scenarios

##### Login With Valid Inputs:

TC1	TC id
Login With Valid Inputs	Title
Admin give authorization to username: Moneraheng	Precondition
This test case aims to test how the system behave when the user tries to login with valid username and password	Description
1- User open Kashef website 2- User enters their username 3- User enters their password 4- User selects on “login” button	Test steps
Username: Moneraheng Password: a1369a\$	Test data
The system directs the user to the dashboard screen	Expected result

##### Login With Empty Username:

TC2	TC id
Verify Login with Empty Username	Title
Admin give authorization to username:Moneraheng	Precondition
This test case aims to test how the system behave when the user tries to login with empty username field	Description
1- User open Kashef website 3- User enters their password 4- User click on “login” button	Test steps
Password: a1369a\$	Test data
The system displays an uninformative error message.	Expected result

##### Login With Empty Password:

TC3	TC id
Verify Login with Empty Password	Title
Admin give authorization to username: Monerahfeng	Precondition

This test case aims to test how the system behave when the user tries to login with empty password field	Description
1- User open Kashef website 3- User enters their username 4- User click on “login” button	Test steps
Username: Moneraheng	Test data
The system displays an uninformative error message.	Expected result

### **Login With Wrong Username:**

TC4	TC id
Verify Login with Wrong Username	Title
Admin give authorization to username: Moneraheng	Precondition
This test case aims to test how the system behave when the admin tries to login with wrong username	Description
1- User open Kashef website 2- User enters wrong username 3- User enters their password 4- User click on “login” button	Test steps
Username: Moneraheng Password: a1369a\$	Test data
The system displays an uninformative error message.	Expected result

### **Login With Wrong Password:**

TC5	TC id
Verify Login with Wrong Password	Title
Admin give authorization to username: Moneraheng	Precondition
This test case aims to test how the system behave when the user tries to login with wrong password	Description
1- User open Kashef website 2- User enters their username 3- User enters wrong password 4- User click on “login” button	Test steps
Username: Moneraheng Password: a1369a\$	Test data
The system displays an uninformative error message.	Expected result

### **Reset Password with Valid Email:**

TC6	TC id
Reset Password with Valid Email	Title
Admin give authorization to username: Sara_6	Precondition
This test case aims to test how the system behave when the user tries to reset password with valid email	Description
1- User open Kashef website 2- User enters valid Email 3- User click on “Reset Password” button	Test steps
Email:sarakhalidabd@gmail.com	Test data
The system will display message “reset password link send to your email successfully”	Expected result

### **Reset Password with Invalid Email:**

TC7	TC id
Reset Password with Invalid Email	Title
Admin give authorization to username: Sara_6	Precondition
This test case aims to test how the system behave when the user tries to reset password with invalid email	Description
1- User open Kashef website 2- User enters invalid Email 3- User click on “Reset Password” button	Test steps
Email:sarakhalidabd@gmail	Test data
The system displays an uninformative error message.	Expected result

### **Reset Password with Empty Email:**

TC8	TC id
Reset Password with Empty Email	Title
Admin give authorization to username: Sara_6	Precondition
This test case aims to test how the system behave when the user tries to reset password with empty email field	Description

1- User open Kashef website	Test steps
2- User click on “Reset Password” button	
Email:	Test data
The system displays an uninformative error message.	Expected result

#### **View Report Details:**

TC9	TC id
View Report Details	Title
1- Municipal Employee is successfully logged in . 2- The Municipal Employee in reports page. 3- Report has been submitted before.	Precondition
This test case aims to test how the system behave when the Municipal Employee tries to view Report Details	Description
1- Municipal Employee select specific Report from Report page. 2- Municipal Employee select “Report Details” button	Test steps
Selected Report: Report20	Test data
The system presents the report with the following information: Date,Location,Picture of pothole,Status	Expected result

TC10	TC id
View Statistics	Title
1- Municipal Employee is successfully logged in. 2- Report has been submitted before.	Precondition
This test case aims to test how the system behave when the Municipal Employee tries to View Statistics	Description
1- Municipal Employee select View Statistics from homepage.	Test steps
Select tab: View Statistics	Test data
The system shows statistics in the form of a line chart and a bar chart with the following information:  1. number of rejected reports 2. number of in progress reports 3. number of in completed reports	Expected result

4. number of pending reports 5. number of accepted reports 6. number of total reports	
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## Edit Profile Test Sceaniros

### Edit profile with valid username:

TC11	TC id
edit profile with valid Username	Title
Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with valid Username	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: Jourialanazi2 password: Ji12345\$	Test data
The system update user profile information successfully, and the system will display a message indicates that the user profile information is updated successfully.	Expected result

### Edit profile with valid password:

TC12	TC id
edit profile with valid Password	Title
Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with valid Password	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: Jouri_21 password: Jo246810#	Test data
The system update user profile information successfully, and the system will display a message indicates that the user profile information is updated successfully.	Expected result

### Edit profile with invalid username:

TC13	TC id
edit profile with invalid Username	Title

Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with invalid Username	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: -, password: Ji12345\$	Test data
The system displays an uninformative error message.	Expected result

#### Edit profile with invalid password:

TC14	TC id
edit profile with invalid Password	Title
Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with invalid Password	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: Jouri_21 password: j1234	Test data
The system displays an uninformative error message.	Expected result

#### Edit profile with empty password:

TC15	TC id
edit profile with empty Password	Title
Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with empty Password	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: Jouri_21 password:	Test data
The system displays an uninformative error message.	Expected result

#### Edit profile with empty username:

TC16	TC id
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edit profile with empty Username	Title
Admin give authorization to username: Jouri_21	Precondition
This test case aims to test how the system behave when the user updates his profile with empty Username	Description
1- User open Kashef website 2- user must log-in to his account 3- User click on “View Profile” button 4- User click on “Update” button	Test steps
Username: password: Ji12345\$	Test data
The system displays an uninformative error message.	Expected result

TC17	TC id
View Statuses of Reports	Title
1- User is successfully logged in. 2- Reportes has been submitted before.	Precondition
This test case aims to test how the system behave when the user tries to View Status of reports	Description
1- user select report tab from homepage.	Test steps
Select tab: report	Test data
The system shows statuses of reports with the following information:  a) accepted reports b) rejected reports c) pending reports d) in progress reports e) completed reports	Expected result

	TC id
	Title
	Precondition
	Description
	Test steps
	Test data
	Expected result

## 19- CONCLUSION

## **6. Reference**

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## 7. APPENDIX

### Appendix 1

Phase 1 (Proposal) inspection table.

Table 3: Phase 1 (Proposal) inspection table

Task	Author	Inspector	Inspector comments
Introduction	Renad	Jouri, Monerah, Sara, Fai	Unify some words
Domain Analysis	Jouri	Renad, Monerah, Sara, Fai	Rephrase some sentences.

Risk/Constraints	Monerah	Jouri, Reand, Sara, Fai	Delete some sentences.
Project Plan	Sara	Jouri, Monerah, Renad, Fai	Rephrase some sentences.
Quality Assurance plan	Fai	Jouri, Monerah, Sara, Renad	Rephrase some sentences.

## Appendix 2

Phase 1 (Proposal) walkthrough table.

Table 4: Phase 1 (Proposal) walkthrough table

Task	Done by	Examined by	comments
Introduction	Renad	Jouri	-
Domain Analysis	Jouri	Renad	Rephrase some sentences.
Risk/Constraints	Monerah	Sara	Delete some sentences.
Project Plan	Sara	Fai	-
Quality Assurance plan	Fai	Monerah	Rephrase some sentences.

## Appendix 3

### Survey Summary and Charts

١- هل أنت موظف في أمانة منطقة الرياض؟

26 ردًا

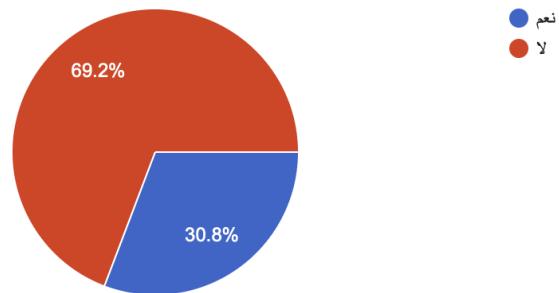


Figure 28: Surveys Question #1 Answers

٢- هل أنت؟

26 ردًا

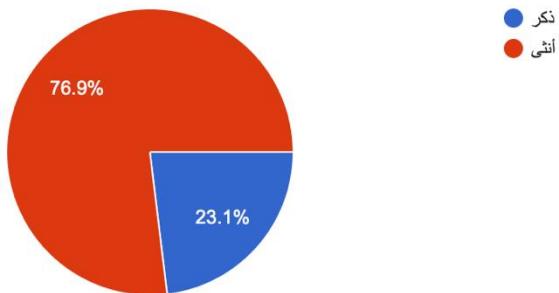


Figure 29: Surveys Question #2 Answers

٣- هل تملك داش كام؟

(الداش كام : هي عبارة عن كاميرا تسجل باستمرار تثبت على الزجاج الأمامي لسيارتك الخاصة وأحياناً في النوافذ الخلفية أو النوافذ الأخرى)

26 ردًا

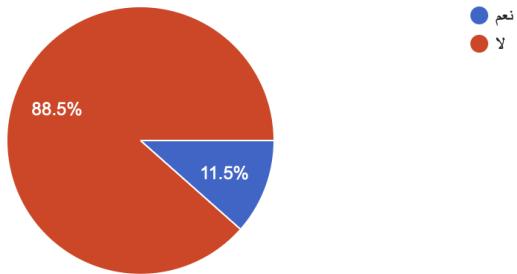


Figure 30: Surveys Question #3 Answers

٤- هل سبق لك وان قدمت بلاغ عن حفرة بالطرق العامة؟

رداً 26

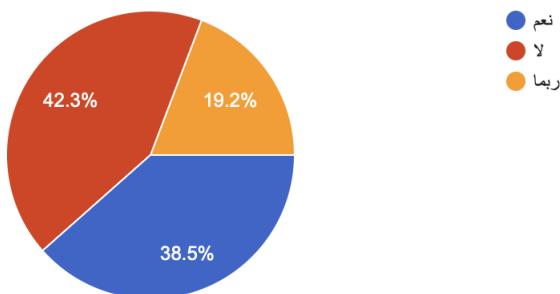


Figure 31: Surveys Question #4 Answers

٥- كيف كانت تجربة تقديم البلاغ؟

(التقييم من ١ - ٥ حيث :

١- غير راضي/ة

٢- راضي/ة

٣- جيد/ة

٤- جيد جدا/ة

٥- ممتاز/ة )

رداً 26

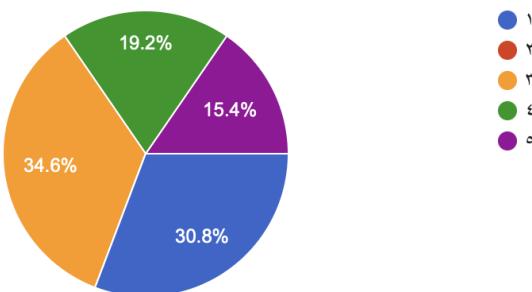


Figure 32: Surveys Question #5 Answers

نسخ

٦- ماهي الاسباب التي تمنعك من تقديم البلاغ؟

(اختر جميع ما ينطبق)

رداً 26

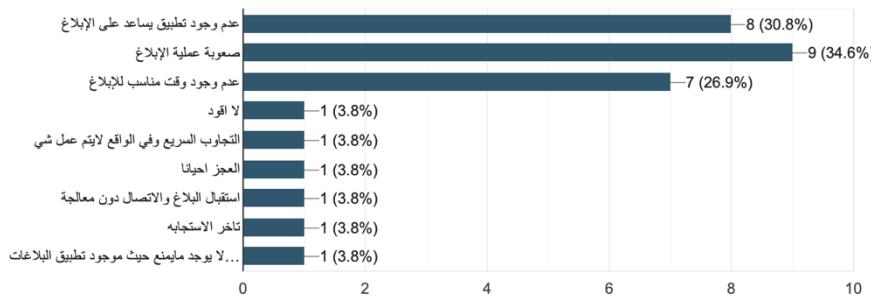


Figure 33: Surveys Question #6 Answers

٧- ما مدى احتمالية استخدامك لتطبيق يسهل الإبلاغ عن الحفرة المؤذنة بالطريق العام باستخدام الذكاء الاصطناعي عن طريق الداش كام بالإستغناء عن العنصر البشري؟

رداً 26

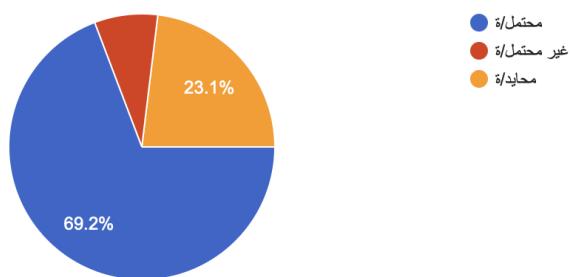


Figure 34: Surveys Question #7 Answers

نسخ

٨- إذا كانت الإجابة متحمل، فما هي المميزات التي ستجدها مفيدة في التطبيق؟  
(اختر كل ما ينطبق)

رداً 24

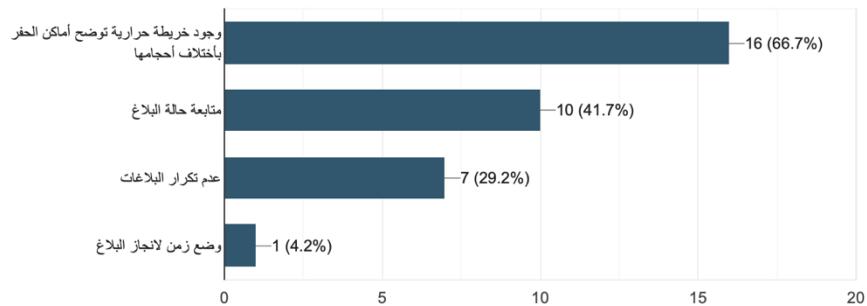


Figure 35: Surveys Question #8 Answers

نسخ

٩- إذا كانت الإجابة غير متحمل ، فما هي أسباب عدم رغبتك في استخدام التطبيق؟  
(اختر كل ما ينطبق)

رداً 18

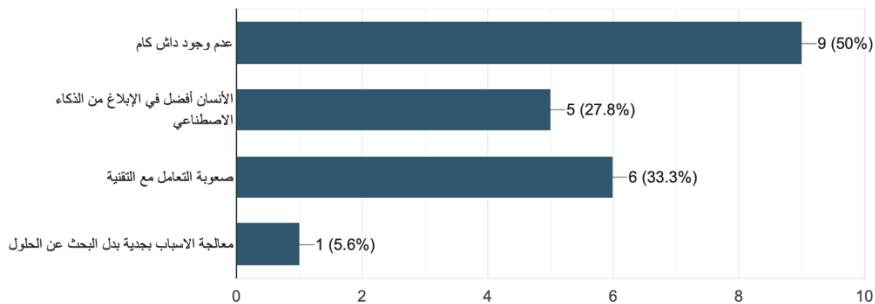


Figure 36: Surveys Question #9 Answers

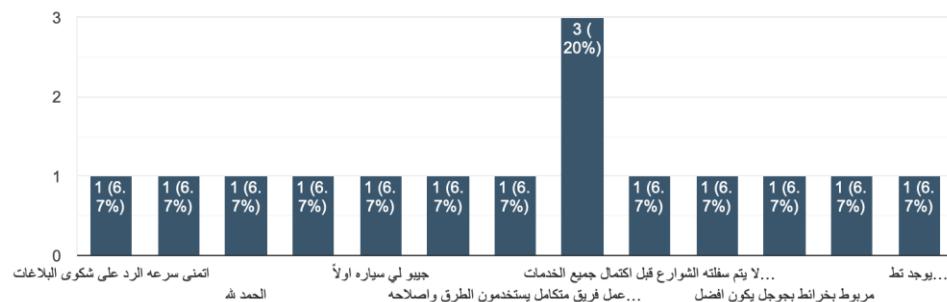


Figure 37: Surveys Question #10 Answers