**CHAPTER 1: INTRODUCTION**

* 1. **Background**

The influx of technology and new innovations is driving the world to a new direction and this said direction has caused businesses to step out of their comfort zones. In a world where these businesses are at an infallible cut-throat competition, companies cannot afford to have their employees slacking off during work hours. To avoid incurring losses and to keep employees focused, employee monitoring applications are used by companies to assess their employees’ level of productivity at workplaces. Similar applications have been built for government employees as well. However, tracking the progress of field officers/ engineers becomes a bit of a challenge.

The specified matter under consideration is the development of a monitoring application for government field officers. Field officers often have to go out of workplace environment to inspect and generate reports. Most officers inaccurately report that they went to the specified site, even though they did not. This could greatly undermine the government’s productivity. Moreover, going off-site, carrying out inspections, coming back to site, and then submitting paper-based reports could take a lot of time, thereby compromising the government’s efficiency [1]. Therefore, using a mobile application for real-time reporting would be much more convenient and plausible. It would not only assist supervisors monitor field officers effectively but would also assist the field officers in reporting and inspection of various companies and organizations.

* 1. **Research Gap**

Currently in Pakistan, the process of investigation is still paper based. Different government sectors carry out different field activities via their enforcement officers. This includes surveys for identifying potential problems and monitoring activities in different companies and businesses. The field team visits different restaurants, hotels, banks, and companies regularly to monitor their business activities. All these investigative activities mostly involve physical labor and manual records. The reports made by enforcement officers are then submitted to their respective in-charge officers after which they are analyzed and managed by hand.

Since the medium of reporting i.e. paper is being used, the whole process brings up certain risks and issues. The papers might get lost or deteriorate owing to time factors. There might be no dedicated space allocated for storing piles of documents and reports. Moreover, this brings up certain challenges like dispatching of the report to another officer or report. The paperwork might be prone to data manipulation and manual errors by respective enforcement officers. Another issue is the lack of monitoring of these enforcement officers. Their attendance and their contribution towards their work needs to be observed. Hence, a layout for an automated solution is needed considering all the limitations above.

* 1. **Purpose**

This research serves to propose the idea of an IT-based assistant to aid field and enforcement officers in conducting investigative surveys. Not only that, it would also ensure proper management at the administration’s end. The assistant would do this by allowing field officers to enter the data collected from surveys into the forms displayed inside the assistant. Besides that, it would also provide a complete track and record of the field officer’s activities to his supervisor thereby maintaining complete transparency. This report proposes a development plan of a reporting and monitoring application for field officers.

* 1. **Research Aim**

This research aims to make the jobs of field officers easier by proposing an IT-based solution. It also analyzes the feasibility of the application if it replaces paper-based reporting. The aims are listed as follows:

* Digitize process of reporting,
* Make data tabulation easier for field and supervising officers,
* Get a user analytics overview to measure productivity levels,
* Improve levels of productivity by saving time and resources,
* Improve government accountability.
  1. **Scope**

The proposed software solution consists of an android application, a web-based dashboard application and a server with database management. The android application provides real-time reporting functionality to field enforcement officers. The reports generated are kept and managed at the back-end server. The web application provides functionality for generating and analyzing reports for decision making. Successful implementation of the application can provide a dashboard prototype system to be worked on. The benefits gained by this system are listed as follows:

* real time reporting; increased efficiency by saving time and resources,
* increased data security and reduced data manipulation; improved data transparency,
* efficient tracking of field force team: a check on exactly where the field officer is at any given moment (location of field officer),
* check whether the field officer has made the assigned visits or not, and ensure attendance management,
* check the time devoted by each field officer at a given location to keep a track of their activities,
* sent, received and custom generated reports will be useful and meaningful to concerned in-charge officers and will be further analyzed for business analytics and for decision making,
* in case of system failure, the data can be shifted on a cloud server.
  1. **Overview**

Chapter 2 presents a literature review which further justifies the purpose of study, by conducting secondary researches and by identifying the research gap present. Chapter 3 presents all modules of requirements and design. Chapter 4 explains the implementation and testing phase which includes primary data for the research and finally Chapter 5 concludes the research and lists out some recommendations and long-term goals.

**CHAPTER 2: LITERATURE REVIEW**

In a world where competition is cut-throat, every business is trying to gain an advantage over the other. In such times if employees fail to perform their tasks on time, then productivity levels could rapidly fall. For this reason, employee monitoring came into focus to track the progress of employees. The first time someone ever thought of introducing a system of check and balance on employees dates back dates to the time of Frederick Winslow who worked towards analyzing the flow of work and made use of performance monitoring to achieve goals [1]. When a worker is monitored, there are less chances of him sabotaging his work. Saval believed that when an employee is left unmonitored, he is bound to become unproductive [2]. With time, new technologies were developed thereby, creating new modes of monitoring and tracking progress of employees. Governments across the world also took it upon themselves to digitize the process of reporting and monitoring their employees. Field inspectors, especially, are among those who follow a different work regime. They often have to visit the field to perform inspections and tasks [3]. The reports they generate are often paper based and need to be submitted separately in the office which results in a wastage of time and resources. This research focuses on the development of an application that would enable field officers to report effectively and their supervisors to track and monitor their activities. Before conducting the actual investigation, we analyze what has been done in various researches in order to realize the gap present.

* 1. **Problems with Paper-Based Method**

Generating paper-based reports is a time taking procedure. It is a part of the field officers’ job to visit and inspect sites and generate reports. They go to the site, take notes, then they come back to the office and write reports manually on paper [3]. All of this takes a generous amount time which affects the employees’ efficiency a lot. Vinothi [4] believes that another issue that prevails is the difficulty in tracking time and taking updates of every single activity performed by those who go on outfield duties. It is an arduous task. Moreover, this paves way for ‘buddy punching.’ Synerion [5] describes this as a phenomenon when one person performs a task for another colleague. Government agencies incur huge sums of losses when this happens. Often employees who go on off-field duties intermingle their work with other tasks which could greatly disrupt the flow of work [6]. Another issue that field officers complain about is against-the-clock-monitoring [9]. They think that their employers focus more on the quantity of work rather than the quality of work. They are forced to work from nine to five even though the work they do in just three hours yields quality results. All these factors could greatly contribute to corruption in the government sector, thereby compromising government credibility [7].

* 1. **Advantages of Web-Based Dashboard and Android Application**

There are multiple advantages associated with a web-based dashboard and android application. With the advent of technology, many companies and likewise, governments have started digitizing their entire process of inspection. Successful implementation of such an application could lead to increased data transparency. This means employees can easily work and do their job no matter where they are located. This in turn suppresses budding corrupt behavior among the government sector. If there will be a proper system of tabulation, with a clear and visible transparency, then this could greatly contribute to improvement in the government’s accountability. Furthermore, citizens would have more confidence in government employees because once everything is digitized, there would be no room for lies on the field officer’s part [7]. This makes room for growth.

Another boon is that an application for this purpose would help yield measurable results because this would help supervisors get visibility in the officer’s activity, which does not happen in paper-based method [6]. The application and web dashboard would have certain metrics to measure employee productivity. Those metrics would include work tracking (the reports the employee is generating and the time spent on it), location tracking (whether he is present at the specified location or not), and geo – tagging (if an employee does not understand anything then he can take a picture and send it to his supervisor for assistance) [8].

The development of this application would greatly simplify work for field officers. They would not have to go through the hassle of turning in paperwork after coming back from the site. They can just collect it digitally on the application and generate an instant report. The application would also cater to network connectivity issues. If an officer does not have network, he can still feed in data which would sync once the network is restored. Often when filling out paperwork, officers miss out on important details because it gets difficult to maintain accurate and consistent information. The application makes sure that no field is left empty as the data needs to be entered instantly. This makes sure that all required information is entered correctly. Other than that, the development of the application is platform independent, that is, it can work on both iOS and Android operating systems [3].

* 1. **Issues Concerning the Reporting and Monitoring System**

Whenever a new technology or application system is introduced, it has to face some challenges. The first and foremost, issue concerning employee monitoring system is privacy. Employers face both active and passive resistance from employees [8]. They feel that an application that tracks all their activities is not fair and therefore, cannot measure the amount of work and effort they put into performing their jobs. Furthermore, employees feel that it is a matter of privacy invasion when an application tracks where they go and what they do [1]. Also, as the entire system will be pushed on an online server, the government’s data would be susceptible to hackers on the loose. This would mean that the government would have to spend a huge amount of resources for the protection of their data. Another issue is the lack of technical literacy. Most officers would face the issue of learning and adapting to the application and this illiteracy may hinder growth in the area [7]. Although the application has proven successful in many regions, it can open new means of corruption (though, this time, lesser than before) in the government.

All in all, the proposition that such an application should exist seems plausible. At this stage, there is no ideal yardstick for measuring the progress of field officers, but the development of a single platform, where field officers can report effectively and their supervisors can monitor their progress with ease, is the most desirable choice that exists.

* 1. **Research Gap**

With reference to the above literature, implementation of such an application would prove to be extremely beneficial to the community but more work needs to be done on some aspects of it. This report minimizes that gap and covers everything that has not been done yet on the matter pertaining to effective monitoring and tracking of field officers.

Privacy is one of the major concerns for any employee working in the field. No one wants a twenty-four-hour surveillance on them throughout the day. This research solves this issue by giving out separate devices to the officers solely for the purpose of doing their jobs. This way their privacy would not be compromised. Another hurdle is the risk of data theft. Government data is highly sensitive data and if that data gets disclosed, then it is a matter of alarming concern. To save the system from hackers, end-to-end data encryption will be present between the server and client. Over and above that, often when centralized systems fail, the entire workflow is impeded. Therefore, there needs to be a cloud server that would prevent this from happening. Lastly, the development and stages of such an application have not been realized. This research will work towards covering the development and requirements of an application which will eventually cater to field officers.

**CHAPTER 3: REQUIREMENTS AND DESIGN**

* 1. **Functional Requirements**

The functional requirements are as follows:

**3.1.1 Field Officer Privileges** Listed below are functional requirements for field officers:

* + User should be able to login through a proper validation process from the back-end server which leads him to his profile.
  + User should be able to update his profile including his personal information and account settings such as passwords. As the user makes the update of information, the server should be updated as well.
  + User should be able to report about registered and unregistered hotels, restaurants, companies etc.
  + User should be able to enter the name of the venue, add a geolocation, time of visit, and information regarding the owner in a customized form. It would have respective data fields to be filled.
  + User should be able to view his submitted reports.
  + User should be able to track his progress and view his statistics in the form of graphs
  + User should be able to collaborate with other fellow field officers and the in-charge officer by in-app real-time communication through messages.

**3.1.2 In-charge Officer Privileges** Listed below are functional requirements for in-charge officers:

* User should be able to login through a proper validation process from the back-end server which leads him to the dashboard of the application.
* User should be able to monitor the field officers’ team in the dashboard and get a summarized picture of their recent activities.
* User should be able to view individual reports of officer. System should be able to get the profile and information of the officer, his current status, track progress, and the reports submitted by that officer.
* User should be able to view reports of a specific location. System should be able to search from the database server and return the location requested and fetch the reports linked to that location.
* User should be able to generate daily, weekly, monthly, quarterly and annual reports. He should be able to perform certain filters and fetch reports of enforcement officers individually. The reports can be searched through many filters: through location assigned to field officer, through commissioner, through time frame.
* User should be able to generate graphs and charts by dragging and dropping the fields, filters and groupings.

## Non-Functional Requirements

## The non-functional requirements are as follows:

**3.2.1 Performance Requirements** The performance requirements describe how the application would respond in certain situations. They are listed as follows:

## Any kind of invalid input or if the system loses response must be immediately notified to the user operating it.

## The response time should be fast which depends mainly on the server and the hosting facility used.

## There must be a search option in the application. The option can be used to search a field /in-charge officer, the location for a venue, or any report. The option should be easy to understand and use, and the user interface for the results obtained should be user friendly.

## The user interface for selecting a report must be convenient and one click away from showing the desired results.

## There must be a limit to maximum number of users (e.g. 1000) logged in at a time.

* The ‘geolocation’ feature should make use of the most advanced technology available for the field officer to pin his location instantly.

**3.2.2 Security Requirements** Security is one of the most important features of an application. Its requirements are listed as follows:

### Login will be used for identification and authentication.

* User will be the only one to access authorized information, pages, features and data.
* Privacy needs to be ensured. Personal information need not be viewed. Passwords must be entered in asterisks.
* Data must be transferred in encrypted way with maximum layers of security.
* The encryption of the whole system must be layered which would prevent hackers from breaking into the database server.

**3.2.3 Software Quality Attributes** Listed below are the software quality attributes:

* The user interface must be designed in away that it supports all different operating systems and platforms (platform-independent and bootstrap integration).
* The applications must be compatible with all Android-based platforms.
* The system should always be in running state, except in the time of system failure. It must be connected to the internet and the GPS service for real-time communication and continuous data transfer.
* The system needs to be reliable in order to produce correct and desired outputs.
* The layers of the system must be designed in such a scalable way that allows room for alterations and additions without need for major changes.

## 3.3 Hardware and Software Requirements

**3.3.1 Hardware Requirements** Listed below are the hardware requirements for the application:

* + Android compatible phone with Android 7.0 (Nougat or above), at least 13MP camera, Quad-core 1.2 GHz processor.
  + 1GB RAM or above.
  + For the web and mobile app, the physical GPS is managed by the GPS application in the mobile phone and the hardware connection to the database server is managed by the underlying operating system on the mobile phone and the web server.
  + 3G/ 4G compatible phone to connect with internet.
  + Processor for laptop/ desktop system: CORE i3 or higher.
  + Keyboard and mouse as input devices.

**3.3.2 Software Requirements** Following software and libraries have been used in designing the application:

* API: Location, Camera, Voice Recorder
* Languages: NodeJS, Android, Java, HTML5, C#
* Emulator: Android Studio
* Storage: Mongo DB/ Cloud
* MIS (Management Information Systems) Tools: SAP Analytics
* Operating System (Desktop): Linux, Windows, or MacOS
* Operating System (Mobile): Android
* UI (User Interface) Design: Indigo Studio
* IDE (Integrated Development Environment): Visual Studio Code 2019, IntelliJ, Android Studio

## System Architecture

## This software solution would have a centralized web server with a database. If the system fails for any unforeseen reason, then cloud facility is also available. As the android application is going to be providing real-time reporting facilities, thus the reports generated will be kept and managed at the back-end server. The reports generated will be further analyzed for decision making.

## The next page shows an illustration of the system architecture. At the core is the centralized server. The server is connected by the web application and mobile application. Communication between the two takes place through the server. At the server’s backend, there is a database server, which performs all kinds of database management operations.

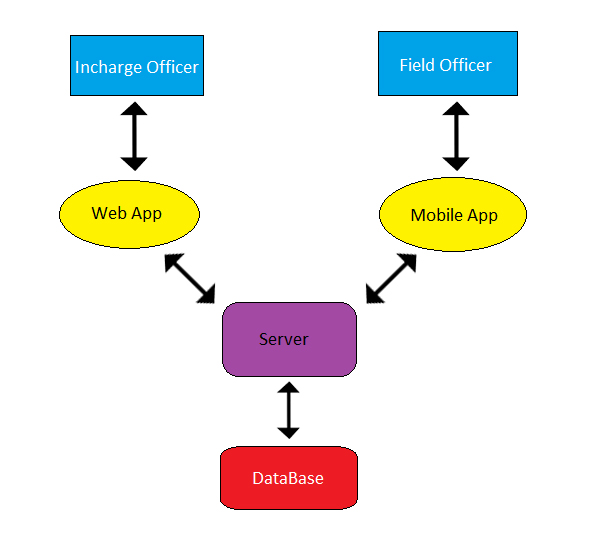


Figure 1: System Architecture of Reporting and Tracking Solution

## Architectural Strategies

**3.5.1 Use Cases** Listed below are the use case requirements which clarify system requirements.

**3.5.1.1 Use Case Tables** All the possible use case scenarios have been listed in the table below:

*\*EO is Enforcement Officer*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Login | | | |
| **Created By:** | Ahmad Moatasim | | **Last Updated By:** | Ahmad Moatasim |
| **Date Created:** | 03/04/2019 | | **Last Revision Date:** | 05/04/2019 |
| **Description:** | | EO attempts to login to the application. | | |
| **Actors:** | | EO | | |
| **Precondition(s):** | | 1. EO has connected to internet.  2. EO has opened the login page of the application. | | |
| **Post condition(s):** | | EO has successfully logged into his account. | | |
| **Flow:** | | 1. EO will provide the username and password.  2. EO will select the login option.  3. System will validate the username and password with database and redirect EO to home page. | | |
| **Alternative Flows:** | | 1A. In step 1 of the normal flow, if EO does not provide the information in the required format.  1.1A. System will ask EO to provide the information again in the correct format.  3A. In step 3 of the normal flow, if the username and password are not present in the database.  3.1A. System will display an error message and ask EO to try again. | | |
| **Exceptions:** | | 2A. In step 2 of the normal flow, if EO selects the back option  2.1A. System will redirect EO to the login page. | | |
| **Requirements:** | | 1. The username and password should be encrypted.  2. The password should not be visible. | | |

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| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Update Profile | | | |
| **Created By:** | Mehar Fatima | | **Last Updated By:** | Noor Fatima |
| **Date Created:** | 06/04/2019 | | **Last Revision Date:** | 07/04/2019 |
| **Description:** | | EO attempts to login to the application. | | |
| **Actors:** | | EO | | |
| **Preconditions:** | | 1. EO has connected to internet.  2. EO has successfully logged into his account. | | |
| **Post conditions:** | | 1. EO has successfully updated his profile. | | |
| **Flow:** | | 1. EO will select the option of update profile.  2. System will redirect EO to the update profile page.  3. EO will enter the information that needs to be updated.  4. EO will select the submit option.  5. System will prompt EO to enter previous password.  6. EO will enter the previous password.  7. System will validate the previous password, update the information, and display a success message. | | |
| **Alternative Flows:** | | 3A. In step 1 of the normal flow, if EO does not provide the information in the required format.  3.1A. System will ask EO to provide the information again in the correct format.  5A. In step 5 of the normal flow, if the previous password does not validate.  5.1A. System will display an error message and ask EO to enter password again. | | |
| **Exceptions:** | | 4A. In step 4 of the normal flow, if EO selects the back option  4.1A. System will redirect EO to the home page. | | |
| **Requirements:** | | 1. The password should be encrypted.  2. The password should not be visible. | | |

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| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Reporting of a Registered Company/ Business | | | |
| **Created By:** | Minahil Imtiaz | | **Last Updated By:** | Mehar Fatima |
| **Date Created:** | 06/04/2019 | | **Last Revision Date:** | 07/04/2019 |
| **Description:** | | EO attempts the reporting of a registered company/ business. | | |
| **Actors:** | | EO  Business Owner/ Manager: Participatory Actor | | |
| **Preconditions:** | | 1. EO has connected to the internet.  2. EO has connected to the GPS service.  3. EO has successfully logged into his account. | | |
| **Post conditions:** | | 1. EO has successfully added the report of a registered company/ business. | | |
| **Flow:** | | 1. EO will select the option of Add Report.  2. System will redirect EO to Business Type page.  3. EO will select the option of  4. System will redirect EO to status page.  5. EO will select the option of registered.  6. System will redirect EO to the monitoring form.  7. EO will enter name of business/ company.  EO will enter name of event.  EO will enter all details.  EO will enter cell number.  EO will enter name of hall representative.  8. EO will select option of Add Geolocation.  9. System will direct EO to page with map and GPS service will give exact location of EO.  10. EO will select option of Add Signature.  11. System will redirect EO to signature page.  12. Marriage hall manager will use the stylus pen to draw his signature.  13. EO will select the submit option.  14. System will look for missing fields, if no field is missing it will save the report in the database and display a success message. | | |
| **Alternative Flows:** | | 7A. In step 7 of the normal flow, if EO does not provide the information in the required format.  7.1A. System will ask EO to provide the information again in the correct format.  12A. In step 12 of the normal flow, if the signature seems incorrect to the manager, he can rewrite in again.  12.1A. System will refresh the signature page and ask marriage hall manager to sign again.  12.2A. Return to step 12.  14A. In step 14 of the normal flow, if any missing fields are present.  14.1A. System will prompt EO to fill those missing fields. | | |
| **Exceptions:** | | 3a. In step 3 of the normal flow, if EO selects the back option   1. System will redirect EO to the home page.   5a. In step 5 of the normal flow, if EO selects the back option   1. System will redirect EO to the business type page.   7a. In step 7 of the normal flow, if EO selects the back option   1. System will redirect EO to the status page.   13a. In step 13 of the normal flow, if EO selects the home option   1. System will redirect EO to the home page. | | |
| **Requirements:** | | 1. Stylus Pen will be used to get signature of Business Owner/ Manager. | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Reporting of an Unregistered Company/ Business. | | | |
| **Created By:** | Ahmad Moatasim | | **Last Updated By:** | Ahmad Moatasim |
| **Date Created:** | 09/04/2019 | | **Last Revision Date:** | 10/04/2019 |
| **Description:** | | EO attempts the reporting of an unregistered company. | | |
| **Actors:** | | EO  Manager/ Business Owner: Participatory Actor | | |
| **Preconditions:** | | 1. EO has connected to the internet.  2. EO has connected to the GPS service.  3. EO has successfully logged into his account. | | |
| **Post conditions:** | | 1. EO has successfully added the report of an unregistered company. | | |
| **Flow:** | | 1. EO will select the option of Add Report.  2. System will redirect EO to Business Type page.  3. EO will select the category of business.  4. System will redirect EO to status page.  5. EO will select the option of unregistered.  6. System will redirect EO to the monitoring form.  7. EO will enter name of company/ business.  8. EO will select option of Add Geolocation.  9. System will direct EO to page with map and GPS service will give exact location of EO.  10.EO will select the submit option.  11. System will look for missing field, if no field is missing it will save the report in the database and display a success message. | | |
| **Alternative Flows:** | | 7A. In step 7 of the normal flow, if EO does not provide the information in the required format.  7.1A. System will ask EO to provide the information again in the correct format.  11A. In step 11 of the normal flow, if any missing fields are present.  11.1A. System will prompt EO to fill the missing field. | | |
| **Exceptions:** | | 3A. In step 3 of the normal flow, if EO selects the back option.  3.1A. System will redirect EO to the home page.  5A. In step 5 of the normal flow, if EO selects the back option.  5.1A. System will redirect EO to the business type page.  7B. In step 7 of the normal flow, if EO selects the back option.  7.1B. System will redirect EO to the status page.  11B. In step 11 of the normal flow, if EO selects the home option.  11.1B. System will redirect EO to the home page. | | |
| **Requirements:** | | None. | | |

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| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Search Report by Officer | | | |
| **Created By:** | Minahil Imtiaz | | **Last Updated By:** | Noor Fatima |
| **Date Created:** | 11/04/2019 | | **Last Revision Date:** | 11/04/2019 |
| **Description:** | | Commissioner attempts to search reports of a specific officer. | | |
| **Actors:** | | Commissioner | | |
| **Preconditions:** | | 1. Commissioner has connected to internet.  2. Commissioner has successfully logged into his account. | | |
| **Post conditions:** | | 1. Commissioner has successfully found the reports of specific officer. | | |
| **Flow:** | | 1. Commissioner will select the option of search report by officer.  2. Commissioner will enter the name of the officer.  3. System will display a list of officers matching that name.  4. Commissioner will select one officer from list.  5. Commissioner will select the search option.  6. System will get officer from list of EO’s present in database and get the list of reports submitted by that EO.  7. System will display the list to the commissioner. | | |
| **Alternative Flows:** | | 2A. In step 2 of the normal flow, there is no officer with the entered name.  2.1A. System will display the message “There is no officer matching the entered name”.  5A. In step 5 of the normal flow, if the field of officer name is empty.  5.1A. System will display the message “Enter the name of the officer”. | | |
| **Exceptions:** | | 1. Commissioner may abandon the search at any time. | | |
| **Requirements:** | | 1. A list of officers matching the string will be displayed at run time. | | |

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| --- | --- | --- | --- | --- |
| **Name of Use Case:** | Search Statistics by Officer | | | |
| **Created By:** | Mehar Fatima | | **Last Updated By:** | Mehar Fatima |
| **Date Created:** | 12/04/2019 | | **Last Revision Date:** | 15/04/2019 |
| **Description:** | | Commissioner attempts to search statistics of a specific officer. | | |
| **Actors:** | | Commissioner | | |
| **Preconditions:** | | 1. Commissioner has connected to internet.  2. Commissioner has successfully logged into his account. | | |
| **Post conditions:** | | 1. Commissioner has successfully found the statistics of specific officer. | | |
| **Flow:** | | 1. Commissioner will select the option of search statistics by officer.  2. Commissioner will enter the name of the officer.  3. System will display a list of officers matching that name.  4. Commissioner will select one officer from list.  5. Commissioner will select the search option.  6. System will get officer from list of EO’s present in database and get the list of reports submitted by that EO and generate a bar graph based on submitted reports.  7. System will display the bar graph to the commissioner. | | |
| **Alternative Flows:** | | 2A. In step 2 of the normal flow, there is no officer with the entered name.  2.1A. System will display the message “There is no officer matching the entered name”.  5A. In step 5 of the normal flow, if the field of officer name is empty.  5.1A. System will display the message “Enter the name of the officer”. | | |
| **Exceptions:** | | 1. Commissioner may abandon the search at any time. | | |
| **Requirements:** | | 1. A list of officers matching the string will be displayed at run time. | | |

* + - 1. **Use Case Diagram** The illustration depicts use cases with their actors.

### **pic2**

Figure 2: Use Case Diagram of Effective Reporting and Monitoring System

* + 1. **Class Diagram** The analysis of static view of the application has been described with the help of a class diagram. The given diagram indicates the responsibilities of users and their interactions with each other.

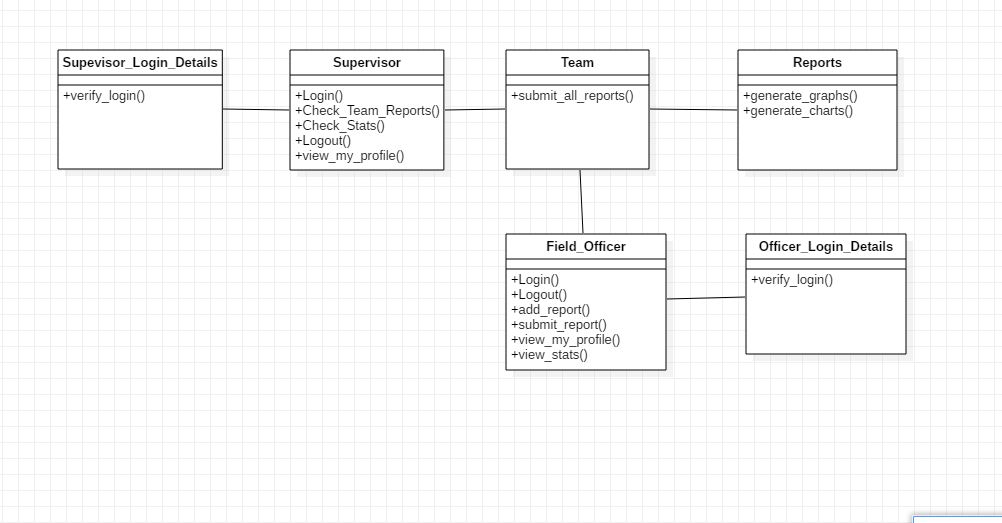


Figure 3: Class UML Diagram for Reporting and Monitoring System

* + 1. **Database Design** The database design is similar to class diagram design. It consists of some tables for team, supervisor, and field officers and it would store their data in it. The next page shows the basic implementation code and diagram for the database design of the application.

**3.5.3.1 Database Queries** The diagram depicts the database queries for creating database schema.

Figure 4: Queries for Creating Tables

A screenshot of a cell phone

Description automatically generated

A screenshot of text

Description automatically generated

Figure 5: Foreign Key Constraints in the Schema

A screenshot of a social media post

Description automatically generated

**3.5.3.2 Database ER (Entity Relationship)** The illustration below is an ERD for the database schema with foreign and primary key constraints.

Figure 6: Entity-Relationship Model

![A screenshot of a cell phone

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RD0RXhpZgAATU0AKgAAAAgABAE7AAIAAAAOAAAISodpAAQAAAABAAAIWJydAAEAAAAcAAAQ0OocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEFobWFkIE1vYXRzaW0AAAWQAwACAAAAFAAAEKaQBAACAAAAFAAAELqSkQACAAAAAzg2AACSkgACAAAAAzg2AADqHAAHAAAIDAAACJoAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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6f4UbT/fb9P8KdRQA3af77fp/hRtP99v0/wp1FADdp/vt+n+FG0/32/T/CnUUAN2n++36f4UbT/fb9P8KdRQA3af77fp/hRtP99v0/wp1FADdp/vt+n+FG0/32/T/CnUUAN2n++36f4UbT/fb9P8KdRQA3af77fp/hRtP99v0/wp1FADdp/vt+n+FG0/32/T/CnUUAN2n++36f4VzHiEbdQwP+e2m/+lldTXL+Iv8AkI/9ttN/9LKAOoooooAKKKKACiiigAooooAKKKKACiiigArl/Dv/ACEf+22pf+lldRXHwW+q2csgTS9SDpc3TJNbSWpV0lnMg4kfPTb2BoA7CiuX+067/wA+Ouf99WH/AMVR9p13/nx1z/vqw/8AiqAOoorl/tOu/wDPjrn/AH1Yf/FUfadd/wCfHXP++rD/AOKoA6iiuX+067/z465/31Yf/FUfadd/58dc/wC+rD/4qgDqKK5f7Trv/Pjrn/fVh/8AFUfadd/58dc/76sP/iqAOoorl/tOu/8APjrn/fVh/wDFUfadd/58dc/76sP/AIqgDqKK5f7Trv8Az465/wB9WH/xVH2nXf8Anx1z/vqw/wDiqAOoorl/tOu/8+Ouf99WH/xVH2nXf+fHXP8Avqw/+KoA6iiuX+067/z465/31Yf/ABVH2nXf+fHXP++rD/4qgDqKK5f7Trv/AD465/31Yf8AxVH2nXf+fHXP++rD/wCKoA6iiuX+067/AM+Ouf8AfVh/8VR9p13/AJ8dc/76sP8A4qgDqKK5f7Trv/Pjrn/fVh/8VR9p13/nx1z/AL6sP/iqAOoorl/tOu/8+Ouf99WH/wAVR9p13/nx1z/vqw/+KoA6iqWtf8gDUP8Ar1k/9BNYn2nXf+fHXP8Avqw/+Kpk76zcW8kE2n640cilHXdYjIIwR9+gDR8P/wDH9rv/AGEF/wDSaCtqsbw9DdI2pz3lpJaG6vBLHHKyM20QxJk7GYdUPetmgAooooAKKKKACiiigAooooAKKKKAMfxT/wAgWP8A6/rP/wBKYqdozFbF/kY5uZ+QP+mrU3xT/wAgWP8A6/rP/wBKYqsaJ/yDT/18T/8Ao56ALXmH/nnJ/wB80hcnHyOOR/D71PRQBV1C0tdU025sL6JpbW6iaGaP5l3IwwwyMEcHtU0eyKNY0VgqgKo2ngCpKKAG+YPRv++TR5g9G/75NOooAb5g9G/75NHmD0b/AL5NOooAb5g9G/75NHmD0b/vk06igBvmD0b/AL5NHmD0b/vk06igBvmD0b/vk0eYPRv++TTqKAG+YPRv++TR5g9G/wC+TTqKAG+YPRv++TR5g9G/75NOooAb5g9G/wC+TR5g9G/75NOooAb5g9G/75NHmD0b/vk06igBvmD0b/vk0eYPRv8Avk06igBvmD0b/vk1y/jP/kGXx7HSr3Gf92Ouqrl/G3/ILvP+wTe/+gpQB1FFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAYviD/j+0L/ALCDf+k09XdF/wCQBp//AF6x/wDoIqn4hhunbTJ7O0kuza3hlkjiZFbaYZUyN7KOrjvWbA+s29vHBDp+uLHGoRF3WJwAMAffoA6uiuX+067/AM+Ouf8AfVh/8VR9p13/AJ8dc/76sP8A4qgDqKK5f7Trv/Pjrn/fVh/8VR9p13/nx1z/AL6sP/iqAOoorl/tOu/8+Ouf99WH/wAVR9p13/nx1z/vqw/+KoA6iiuX+067/wA+Ouf99WH/AMVR9p13/nx1z/vqw/8AiqAOoorl/tOu/wDPjrn/AH1Yf/FUfadd/wCfHXP++rD/AOKoA6iiuX+067/z465/31Yf/FUfadd/58dc/wC+rD/4qgDqKK5f7Trv/Pjrn/fVh/8AFUfadd/58dc/76sP/iqAOoorl/tOu/8APjrn/fVh/wDFUfadd/58dc/76sP/AIqgDqKK5f7Trv8Az465/wB9WH/xVH2nXf8Anx1z/vqw/wDiqAOoorl/tOu/8+Ouf99WH/xVH2nXf+fHXP8Avqw/+KoA6iiuX+067/z465/31Yf/ABVH2nXf+fHXP++rD/4qgDqKK5f7Trv/AD465/31Yf8AxVH2nXf+fHXP++rD/wCKoA6iuX8Rf8hH/ttpv/pZR9p13/nx1z/vqw/+KqvPb6reSxh9L1Iu9zas81zJahUSKcSHiN89N3YmgDsKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigDH8U/8AIFj/AOv6z/8ASmKrGif8g0/9fE//AKOenazp8mqaYbaGdYJBLFKkjx7wDHIrjK5GQduOo61jv4Zv5HZ5LjRWZjlmbSGJJ9f9dQB01Fcv/wAIte/89tD/APBO3/x6j/hFr3/ntof/AIJ2/wDj1AHUUVy//CLXv/PbQ/8AwTt/8eo/4Ra9/wCe2h/+Cdv/AI9QB1FFcv8A8Ite/wDPbQ//AATt/wDHqP8AhFr3/ntof/gnb/49QB1FFcv/AMIte/8APbQ//BO3/wAeo/4Ra9/57aH/AOCdv/j1AHUUVy//AAi17/z20P8A8E7f/HqP+EWvf+e2h/8Agnb/AOPUAdRRXL/8Ite/89tD/wDBO3/x6j/hFr3/AJ7aH/4J2/8Aj1AHUUVy/wDwi17/AM9tD/8ABO3/AMeo/wCEWvf+e2h/+Cdv/j1AHUUVy/8Awi17/wA9tD/8E7f/AB6j/hFr3/ntof8A4J2/+PUAdRRXL/8ACLXv/PbQ/wDwTt/8eo/4Ra9/57aH/wCCdv8A49QB1FFcv/wi17/z20P/AME7f/HqP+EWvf8Antof/gnb/wCPUAdRRXL/APCLXv8Az20P/wAE7f8Ax6j/AIRa9/57aH/4J2/+PUAdRRXL/wDCLXv/AD20P/wTt/8AHqP+EWvf+e2h/wDgnb/49QB1Fcv42/5Bd5/2Cb3/ANBSj/hFr3/ntof/AIJ2/wDj1MuPCeoT2N1are6TAt1C8DvDpTK21hg4PnUAdXRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAH//2Q==)

**3.5.4 Design Considerations** Listed below are some factors that need to be considered when designing the application:

* + - * Most people do not feel comfortable sharing their personal information on web platforms. The solution to this problem is a privacy policy design. Assure the user that the process is easy and intuitive. Use *large icons* for major components of our policy so that our user can identify the key components. If the user wants additional information, he can also access a detailed privacy policy.
      * User can change the color of the background (black or white) according to the state of the day (daytime or night-time) for better visibility.
      * The font and size of text can also be changed according to the user’s liking.
      * Using bullet points, different fonts for different headings, and short paragraphs also helps the user go through reports easily.
      * The colors of the large icons or main menu should be different than the shorter icons, and the colors should not be overwhelming.
      * There will be a ‘*Contact for Help’* option so that enforcement officer can easily contact the in-charge officer.
      * **Use pull-down menus, radio buttons, and checkboxes.**
      * **When the boxes are clicked/ tapped, they should be highlighted.**
      * **We can use drag-and-drop option to drag and drop a report in the report section.**
      * Bar and pie graphs are used for statistical analysis.

**3.5.5 Graphical User Interface (GUI)** The mobile application will start with a ‘Login Page’ for the user to enter his credentials. After entering the verified username and password, the app leads to the ‘Home Screen’ for the user which consists of his ‘Profile Information’. The side bar menu button will consist options like ‘Home’, ‘Geolocation’, ‘Report’, ‘Track Progress’, ‘My Reports’, ‘Update Profile Information’, ‘Update Account Settings’, ‘Log Out’. In case the ‘Report’ option is selected, it will address multiple reports of different types of services. It will prompt the user to answer whether the visited venue is registered or not. The user may then proceed with submitting the desired reports. The ‘Geolocation’ section will allow the user to tag his current location while he is doing his field work.

The user interface for the web application also consists of the ‘Login Page’ for the user. Successful login will lead the user to the main ‘Dashboard’ tab to get a complete overview of his team. The ‘My Team’ tab will let the user (supervisor) locate his field officers in a certain location area. The ‘View Routes’ tab will let the user track the officers in real-time and view the routes he covered. The ‘View Reports’ tab will let the user view the submitted reports by an officer, per location, statistics and computer-generated graphs and charts. The ‘Log Out’ button will redirect back to the ‘Login Page’.

The next page shows some illustrations of how the graphical user interface would look like for mobile application and web dashboard [10].

**3.5.5.1 Mobile View** Depicted below are some mobile views of the android application.

A screenshot of a cell phone

Description automatically generated

A screenshot of a cell phone

Description automatically generated

A screenshot of a cell phone

Description automatically generated

A screenshot of a cell phone

Description automatically generated

*Figure 4: Mobile View of Application*

**3.5.5.2 Web View** The illustration below are views of the web dashboard.

A close up of text on a white background

Description automatically generated

A screenshot of a social media post

Description automatically generated

*Figure 5: Web View of Application*

**CHAPTER 4: IMPLEMENTATION AND PRIMARY RESEARCH**

**4.1 Product Functionality**

The basic functionality of the proposed idea is listed as follows:

* The system of mobile app and web app will be connected with a centralized server.
* The server will allow the authentication and verification process based upon the credentials of the respective officers stored in its database system.
* The mobile app will allow the user to view his current tracked progress, his recent activities and regular logs.
* The communication of field officers will be recorded real-time by built-in in voice recorder.
* The mobile app will allow the submitted reports to be stored in the database system of the server.
* The web-app will provide a dashboard functionality to get a convenient overview of all the activates of field officers
* The web application will be used to list reports requested by the user.
* The web app will provide statistical functionality through which the user can request different reports based on different options, for example reports regarding a certain officer, a location, a timeframe.
* The web app will provide feature to generate custom graphs and charts based on the preference of the in-charge officers.

**4.2 Implementation**

### **4.2.1 Web Drawer Application** Web Drawer helps illustrating the complex data in meaningful way in form of charts. In the first step, for designing the front of the web drawer application, Boostrap templates will be used as many of these are available online for free. In the next step, for representation of data in form of charts, ChartJS (a JavaScript chart library) will be used. Finally, the backend of the application will be designed using Express framework. The development of web application will be on Visual Studio.

**4.2.2 Mobile Application** The development of mobile application will be done in Android Studio. The backend of the application is designed using JAVA language. Several APIs will be integrated e.g. Location API, Camera API, Voice Recorder API etc. Location API will be used for tagging pinned locations and reporting to in-charge officers. Google Camera API will be used if pictures and videos need to be attached with reports. Google Voice API will be used for a real-time voice recorder. The minimum supported version will be 7.0 Nougat since that is a widely used version. For storing some information locally, SQLite database will be used. It is the mobile back-end database in Android devices.

### **4.2.3 Central Database** MongoDB is currently the most popular and responsive DBMS (Database Management System). This will be an interconnected centralized database as the mobile application will send data to this database and the web application will retrieve data from it. MongoDB is the most suitable choice because it is a non-relational document-oriented database which stores data in the form of JSON documents.

## 4.3 Methodology

The qualitative research method was used for gathering information. For gathering and analyzing the data, two interviews were conducted, and five open ended questions were asked in both interviews.

**INTERVIEW I**: An interview was conducted with Dr. Kamran Lodhi, a Software Engineer and Associate Professor at National University of Computer and Emerging Sciences. The purpose of this interview was to discuss the proposed solution and technical details related to the implementation of the application. The key points of the interview are discussed below.

### **4.3.1 User Friendly Interface and Training of Field Officers** An important factor to be considered in digitalizing the whole reporting process is the literacy rate in Pakistan. Currently the whole reporting process is paper-based, and it would be difficult to suddenly digitalize the whole process. Field officers must be provided proper training to use the application, which will require cost too. There are two possibilities in this case. The first possibility is that if the application is implemented properly, is user-friendly and meets its goal then it can play a key role in improving the record keeping of official documents. It will also improve the accountability system of government sectors. Resultantly, the risk of corruption in Pakistan will be lower and the training cost will be overcome. The other possibility is that the project suffers the same fate as other projects affected by bureaucratic and political influence.

### **4.3.2 Platform Independent Language for Development** The architecture of the proposed application is a three-module based structure including a mobile application, web application and centralized database. But to improve the system, only Android based application should not be developed. Even if the government is providing Android devices to field officers, the in-charge officer might own an iOS device. The better approach is to use platform independent languages like Unity3D and JAVA which can work on both Android and iOS platforms. This approach will help in saving the development costs and time.

### **4.3.3 Optical Character Recognition API** In order to improve efficiency, Optical Character Recognition APIs can be integrated in the application for digitalizing paper-based record keeping systems using basic Computer Vision concepts.

### **4.3.4 Centralized Database Design and Other APIs** As far as architectural strategy is concerned, the centralized database design will work properly for the application. But to improve it for later use, layered architecture can be implemented. Several APIs can be used for the implementation: Location API, Camera API and Voice Recorder API to fulfill the requirements of the application.

This interview helped us in understanding the technical details of the project and moved us closer to the implementation phase of the project.

**INTERVIEW II:** Another interview with Mr. Zaheer Abbas, Head of Development Department at Pakistan Revenue Authority, was conducted to find out about the social and economic impact of the proposed application. The main points are discussed below.

### **4.3.5 Political Influence in Government Sector** In a country like Pakistan, political influence plays a major role in development of any government project. In most cases, higher officials do not allow any initiative even if it is beneficial for the country because it can be a cause of threat to their power and position. Therefore, many times such eager beavers have to lose their jobs or position. This political resistance is a hindrance in the progress of the country because many government projects are either left incomplete or they take a long time to get completed.

### **4.3.6 Resistance by Field Officers** Initially, active resistance will be faced. An example can be taken from the E-challan system which was criticized by traffic wardens because the chances of bribery were reduced. A recent report suggests that because of this project the crime index in Lahore has decreased and has provided check and balance on traffic wardens. Similarly, in the case of project field officers, they will also resist the change at first because it will be difficult for them to move from paper-based record keeping to digital record keeping. Also, the chances of bribery will be reduced. This system can provide many long-term benefits like reducing chances of record tampering and corruption which in turn will help in restoring the credibility of government institutes.

**4.3.7 Privacy Protection** Field officers can raise questions related to privacy concerns as their location will be monitored. For this reason, separate devices should be provided to them so that they can be only monitored when they are on a round. This tracking facility can help in verifying whether the field officer actually performed his task or not. So proper guidelines must be designed to deal with this issue.

## 4.3.8 Limitations and Constraints Listed below are some limitations and problems that can occur when aiming for the proposed solution.

* System breakdown and failure will stop the whole operation process so use cloud server,
* Data manipulation reduced but not eradicated completely,
* Less human resource leading to burdened responsibilities on senior management,
* Technical literacy rate of the field officers,
* Political influence in government departments,
* Many government institutes do not have their own software development divisions, so they need third party assistance.

## 4.3.9 Cost Listed below are the costs involved in launching the operation:

* IT training to be provided to field officers and in-charge officers to enable them to run the system.
* The ongoing costs e.g. maintenance of the systems needs to be ensured for it to be on running and stable state.
* The initial set up will be time consuming and will require many employees to deviate from their everyday tasks
* Outsourcing third party tools and software will be costly.
* Upgrade costs: The system needs to be completely updated with latest hardware and software with the passage of time.
* Cost of Android devices provided to field officers.

## 4.4 Results

The interview conducted with Mr. Lodhi helped us in understanding the technical details of the project and moved us closer to the implementation phase of the project. The interview session with Mr. Abbas prepared us for the upcoming social challenges and pressure by highlighting the issues of government departments. This application can help in revolutionizing the record keeping system by digitizing everything which would result in easy access to documents. No need to search hundreds of files for a single issue; it would be just a key away through this application. Furthermore, documents can be transferred easily from one place to another. The would be no hassle of getting the document photocopied before sending it to someone; sending is just a click away. All of this would help in improving accountability of government institutions and curtail chances of corruption by monitoring the performance and location of field officers. Thus, this will improve the performance of field officers, performance of government institutes and save time and resources.

**CHAPTER 5: CONCLUSION AND RECOMMENDATIONS**

**5.1 Conclusion**

The idea this research proposes digitizes the process of reporting as there is no check and balance in the conventional method and a lot of time and resources are wasted as well. If reporting is digitized then field officers can work on more reports, hence increasing the productivity of the department. Moreover, the risk of losing a report or deteriorating of paper is slim to none. The application also allows the in-charge officer to monitor activities of the field officer. This functionality of the application will urge the field officers to do their work properly and diligently.

Technology is progressing day by day but according to past researches there is not much work in the field of monitoring government sectors, usually because of bureaucratic grip. Successful implementation of web-based dashboard and android application could lead to increased data transparency. This proposed application will have a very strong privacy policy. Only the user will be able to access authorized information, features and data. The whole system is encrypted which means a third person will not be able to see something he/she is not authorized to see. This would prevent hackers from breaking into the system. Moreover, android devices will be provided to field officers which will ensure the safety of data and personal information. These said devices would track their location only when they are at work. A cloud server is used which means when centralized systems fail, the cloud server will prevent workflow from impeding.

The literacy rate of Pakistan shows that if we are to implement this application, we will need to train the field officers. Thus, keeping the interface as user friendly as possible should be one of the key considerations. To save time and cost, platform independent language like JAVA is used at the backend to develop this application. Optical Character Recognition API should also be embedded to convert already existing paper-based documents into bitmap images.

**5.2 Recommendations**

Listed below are some recommendations and long-term goals:

* The application is platform independent so that it can also be modelled on iOS in the future.
* The architecture for web dashboard should be MVC (Model, View, Controller) with a REST-full API so that the same model can be easily mapped in other frameworks.
* This application can be generalized to other sectors of the government as well such as hospitals (for doctors taking surveys), police stations (for police officers investigating a case) etc.
* The application can be integrated with social media platforms in the future to enhance the level of employee tracking.
* Shifting the data on cloud can greatly enhance the department’s productivity, and it can be widely adopted by different sectors of the government.
* Adoption of optical character recognition can totally eradicate the need for paper-based documents.

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**APPENDIX**

**Questions for Interview for Mr. Kamran Lodhi**

Q1.

**Questions for Interview for Mr. Zeeshan Abbas**

Q1.