A PRELIMINARY MINI PROJECT REPORT ON

"Development of a System for Employee Productivity Monitoring and Analysis"

SUBMITTED TOWARDS THE PARTIAL FULFILLMENT OF THE REQUIREMENTS OF

BACHELOR OF ENGINEERING (Final Year B. Tech.)

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CERTIFICATE

This is to certify that, the project entitled

"Development of a System for Employee Productivity Monitoring and Analysis"

is successfully carried out as a mini project and successfully submitted by following students of "PCET's Pimpri Chinchwad College of Engineering, Nigdi, Pune-44**".**

Under the guidance of Prof. Sushma Vispute

In the partial fulfillment of the requirements for the

Final Year B. Tech. (Computer Engineering)

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Abstract and Keywords

In today's evolving workplace, tracking employee productivity is crucial for organizations to ensure operational efficiency. This project, Employee Productivity Tracking System, addresses the need for an automated, data-driven approach to monitor various aspects of employee activity during working hours. The system uses computer vision techniques to track employee presence and mobile phone usage, combined with detailed logs of work hours, meetings, breaks, and lunch periods. By integrating face recognition and object detection, the system automatically monitors whether an employee is present at their workstation, calculates the time spent away, and tracks mobile phone usage as a possible indicator of distractions. The Employee Productivity Tracking System stores this information in a structured database and generates real-time insights on an employee's daily productivity, highlighting periods of high efficiency, breaks, and meeting times. The data is captured and analyzed through a backend server and stored in a PostgreSQL database hosted on Amazon RDS. Power BI is used to visualize these metrics, allowing the organization’s administrators to track trends, compare departments, and make informed decisions based on real-time data. This project aims to streamline workforce management by leveraging machine learning and analytics, reducing the need for manual monitoring, and providing a transparent and accurate view of employee productivity. This system is particularly useful for large organizations where manual supervision is inefficient, and data-driven decisions are critical for performance management.

Keywords: Employee Productivity, Face Recognition, Computer Vision, Mobile Phone Detection, Power BI Analytics

1. INTRODUCTION

a. Problem Statement

Managing and evaluating employee productivity in real-time is a significant challenge for organizations, especially in remote or hybrid work settings. Manual monitoring methods are inefficient, prone to errors, and lack transparency. A solution is needed to automatically track employee presence, work hours, and distractions (e.g., mobile phone usage), providing data-driven insights into workforce performance.

b. Project Idea

The Employee Productivity Tracking System is a comprehensive solution designed to automate the monitoring of employee activity using advanced computer vision and machine learning techniques. The system captures real-time data on employee presence, work hours, meeting times, breaks, and mobile phone usage.

Key features include:

- Face Recognition: Using a live camera feed, the system verifies employee presence at regular intervals and flags absenteeism when detected.
- Mobile Phone Detection: Integrated object detection tracks mobile phone usage during work hours to monitor potential distractions.
- Meeting and Break Logs: The system logs meetings and break times, giving a clear view of non-working intervals during the day.
- Data Analytics: The data is stored in a PostgreSQL database and visualized in Power BI dashboards, providing insights into employee performance, trends, and overall productivity.
- Admin Controls: Administrators can review employee data in real-time and use it to inform performance reviews, workload distribution, and workforce optimization.

This automated system aims to provide accurate, real-time data that helps organizations track productivity, identify bottlenecks, and improve workforce management.

c. Motivation

The motivation behind this project stems from the increasing need for efficient, scalable, and transparent methods of tracking employee performance. Traditional manual supervision is not only inefficient but also insufficient in providing real-time insights into an employee's work behavior. As remote and hybrid work models grow, organizations require automated systems to maintain accountability and productivity. The use of data-driven decision-making can help managers improve operational efficiency and employee engagement.

d. Scope

The Employee Productivity Tracking System has wide applications across industries where monitoring employee activity is vital.

It can be deployed in:

- Remote/Hybrid Work Environments: To ensure employees are adhering to work hours and minimizing distractions.
- Corporate Offices: To track both in-office attendance and productivity metrics like meeting and break times.
- Industrial Settings: For tracking employee efficiency on the shop floor or in production environments.
- Human Resource Management: As a tool for performance reviews, identifying trends in productivity, and making data-driven decisions on employee management.
- The system is flexible and scalable, allowing for integration with other tools and future expansion to incorporate new metrics and performance indicators.

e. Literature Survey

In recent years, employee productivity monitoring has become a crucial aspect of workforce management, particularly in remote and hybrid work environments. The traditional methods of tracking employee performance through manual observation and time logs are increasingly proving inadequate. These manual methods often result in inconsistencies and human errors, leading to a lack of accurate data on employee engagement and productivity. Research by Nguyen et al. (2020) highlights that organizations are adopting technological solutions such as automated tracking systems to improve transparency and accuracy in employee monitoring [1]. The advent of computer vision, artificial intelligence, and machine learning has enabled the development of advanced systems capable of monitoring employees with minimal human intervention.

Several studies have explored the application of face recognition technology in workplace monitoring. Face recognition systems, like those discussed by Zhang et al. (2019), can detect and verify employee presence using live video feeds, thus reducing the need for manual attendance systems [2]. This technology is not only more accurate but also provides real-time updates, ensuring that supervisors can be informed immediately about employee absenteeism. In environments where remote work has become the norm, face recognition serves as an essential tool to ensure that employees remain engaged during designated work hours. By implementing such systems, companies have reported a 15-20% increase in productivity [3]. However, ethical concerns, particularly around privacy, have led to debates on how this data is used and stored.

In addition to face recognition, object detection plays a significant role in enhancing employee productivity monitoring systems. One of the primary sources of distraction during work is mobile phone usage, and automated systems can now detect and log instances of mobile phone use. A study by Gupta and Kumar (2021) delves into the effectiveness of using YOLO (You Only Look Once) object detection algorithms for identifying mobile phones in employee workspaces [4]. Their findings reveal that the integration of such detection systems into productivity tracking software provides real-time insights into employee focus and distractions. The tracking of mobile phone usage helps employers to address time theft and ensure that employees remain focused during working hours.

Another area of significant research is the monitoring of employee break times and meetings. Companies are increasingly interested in understanding how non-working periods, such as breaks and meetings, affect overall productivity. Research by Kaur et al. (2022) demonstrated that while short breaks can enhance employee performance by reducing burnout, extended or frequent breaks often negatively impact overall productivity [5]. Similarly, meeting times have also been identified as a critical component of productivity. Effective tracking of meetings can help management optimize time spent on productive tasks versus time spent in meetings, and ensure that meetings contribute meaningfully to the employee's work. By logging and analyzing break and meeting durations, the system can provide insights into whether employees are overusing these periods.

Finally, the integration of data analytics and visualization tools such as Power BI into productivity tracking systems has revolutionized how organizations analyze employee data. As discussed in a study by Patel and Shah (2023), combining employee data with visualization platforms allows managers to monitor trends and performance metrics with ease [6]. Dashboards provide clear visual representations of employee activities, from presence and break times to mobile usage and meeting hours. This integration empowers decision-makers to make data-driven decisions regarding employee management, workload distribution, and performance reviews. By implementing such systems, organizations have reported improved operational efficiency and increased accountability among employees.

2. Project Design

a. Hardware Requirements

For the development and deployment of an employee productivity tracking system, specific hardware components are essential to ensure the efficient functioning of both the application and the monitoring system.

- Server Hardware: A robust server is required to host the backend system, store employee data, and manage video feeds for face recognition. The server should have a multi-core processor, at least 4GB of RAM, and sufficient storage capacity to handle the large volumes of data generated by real-time tracking systems and video logs.
- Cameras: For face recognition and mobile usage detection, high-resolution cameras with a minimum of 1080p resolution and at least 30 frames per second (FPS) are needed. These cameras should be placed strategically in workspaces to capture clear, unobstructed views of employees during working hours.
- Client-Side Hardware: Employees will require standard desktop or laptop computers with a minimum of 4GB of RAM, a modern dual-core processor, and webcams for video-based monitoring. If mobile access is required, employees can use smartphones with similar specifications, along with access to the front-facing camera.

b. Software Requirements

The software requirements span various components including the operating system, database, development frameworks, and specialized libraries.

- Operating System: The system will operate on a Linux-based OS (e.g., Ubuntu) for servers due to its stability, security, and compatibility with most software packages. On the client side, Windows or macOS can be used for employee machines.
- Backend Development: The backend is built using Flask, a lightweight Python-based web framework, which integrates with SQLAlchemy for database management. Flask is ideal for developing REST APIs and handling real-time data communication between client devices and the server.
- Face Recognition & Object Detection Libraries: For employee verification and mobile detection, the system uses the face_recognition library for facial identification and YOLO (You Only Look Once) for object detection. Both are compatible with Python and are efficient in real-time video analysis.
- Frontend Development: The frontend is developed using HTML, CSS, JavaScript, and frameworks like Bootstrap for responsive design. It allows employees to log in, start/stop recording, and view their productivity metrics through interactive dashboards.
- Data Visualization Tools: Power BI is used to generate insightful, interactive dashboards that present data on employee productivity, working hours, breaks, and mobile usage. Power BI offers seamless integration with PostgreSQL and allows the management to visualize data trends and patterns.

c. Resources

- Development Team: A team consisting of a developer, a data analyst is required. The developers will design and build the system, while the data analyst will create Power BI reports and dashboards. The DevOps engineer will manage the server, database, and deployment processes.
- Cloud Services: Hosting and storage services such as Amazon Web Services (AWS), specifically EC2 for server hosting and S3 for storing user profile pictures and logs, are

crucial to the project's infrastructure. AWS RDS will manage the database, ensuring high availability and scalability.

- Security Resources: The system requires SSL certificates for secure data transmission and tools such as firewalls and Intrusion Detection Systems (IDS) to protect the infrastructure from cyber threats.

d. Requirements

- Login System: A secure authentication system that supports both face recognition and password-based login is essential.
- Real-time Monitoring: The system must be able to record and analyze real-time video feeds for employee presence and mobile usage.
- Data Storage & Analysis: A scalable database solution capable of handling large volumes of employee data, including video logs, is required.
- Dashboards: Intuitive dashboards to provide managers with real-time insights into employee productivity metrics. These dashboards should be customizable to reflect different departments, positions, and individual employee performance.

e. Dataset Design

1. Employee (User) Table

- **Description**: This table stores the basic details of the employees including their unique ID, name, email, role, department, position, and profile picture for facial recognition purposes.

- **Fields**:
  - employee_id (Primary Key)
  - user_name
  - email (Unique)
  - password
  - role
  - department
  - position
  - profile_picture

2. LoginLog Table

- **Description**: Records the login and logout timestamps of each employee with the total working hours for that day and status indicating whether they are logged in or logged out.

- **Fields**:
  - log_id (Primary Key)
  - employee_id (Foreign Key referencing User)
  - login_time
  - logout_time
  - total_working_hours
  - status

3. EmployeeTracking Table

- **Description**: Captures detailed activity data such as total work hours, recording time, breaks, mobile usage, meetings, and an overall productivity score for each employee.

- **Fields**:
    - tracking_id (Primary Key)
    - employee_id (Foreign Key referencing User)
    - name
    - department
    - position
    - login_time
    - logout_time
    - total_working_hours
    - total_recording_time
    - total_break_time
    - no_of_breaks
    - total_mobile_usage_time
    - no_of_mobile_used
    - total_meeting_time
    - no_of_meetings
    - lunch_duration
    - total_present_time
    - productivity_score

4. RecordingLog Table

- **Description**: Logs when recording starts and ends, capturing total time recorded and whether the recording is currently active.

- **Fields**:
    - recording_id (Primary Key)
    - employee_id (Foreign Key referencing User)
    - start_recording_time
    - end_recording_time
    - total_capture_time
    - is_active

5. MeetingLog Table

- **Description**: Tracks employee meetings, including start and end times, meeting details, duration, and whether the meeting is active.

- **Fields**:
    - meeting_id (Primary Key)
    - employee_id (Foreign Key referencing User)
    - meeting_start_time
    - meeting_end_time
    - meeting_with
    - meeting_desc
    - per_meeting_hours
    - is_active

6. BreakLog Table

- **Description**: Stores information on employee breaks, including the start and end times, break duration, and the category of the break (e.g., coffee, personal).

- **Fields**:

- break_id (Primary Key)
- employee_id (Foreign Key referencing User)
- start_time
- end_time
- break_time
- break_category

7. LunchBreakLog Table

- **Description**: Specifically records lunch breaks, tracking the start and end times, total duration, and whether the employee is currently on lunch.

- **Fields**:
  - lunch_id (Primary Key)
  - employee_id (Foreign Key referencing User)
  - start_time
  - end_time
  - lunch_duration
  - is_active

8. MobileLog Table

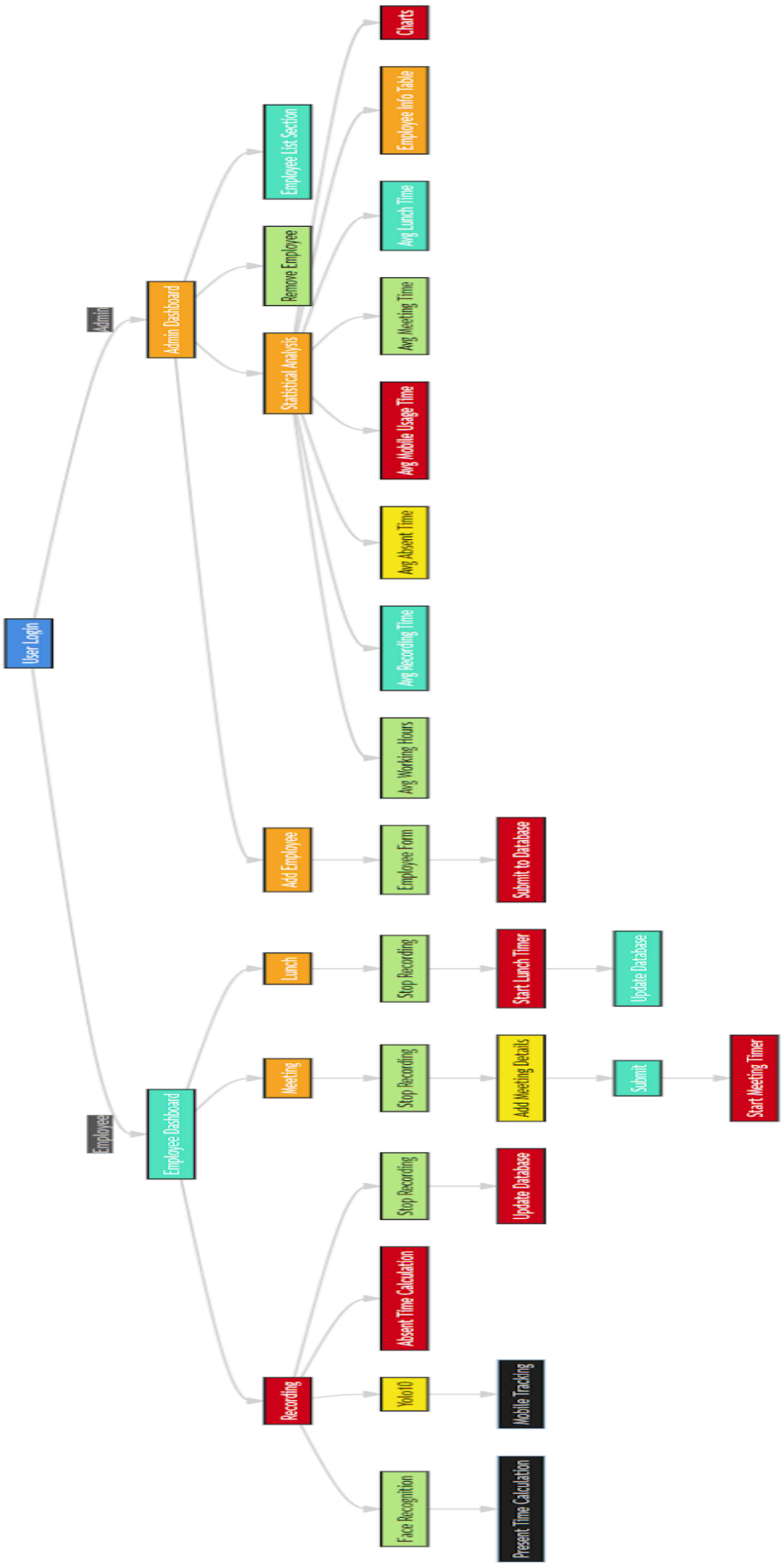
- **Description**: Tracks when an employee uses a mobile device during work hours, including the start and end times of usage, total usage time, and the type of mobile usage (e.g., calls, browsing).

- **Fields**:
  - mobile_log_id (Primary Key)
  - employee_id (Foreign Key referencing User)
  - start_time
  - end_time
  - mobile_usage_time
  - mobile_usage_category

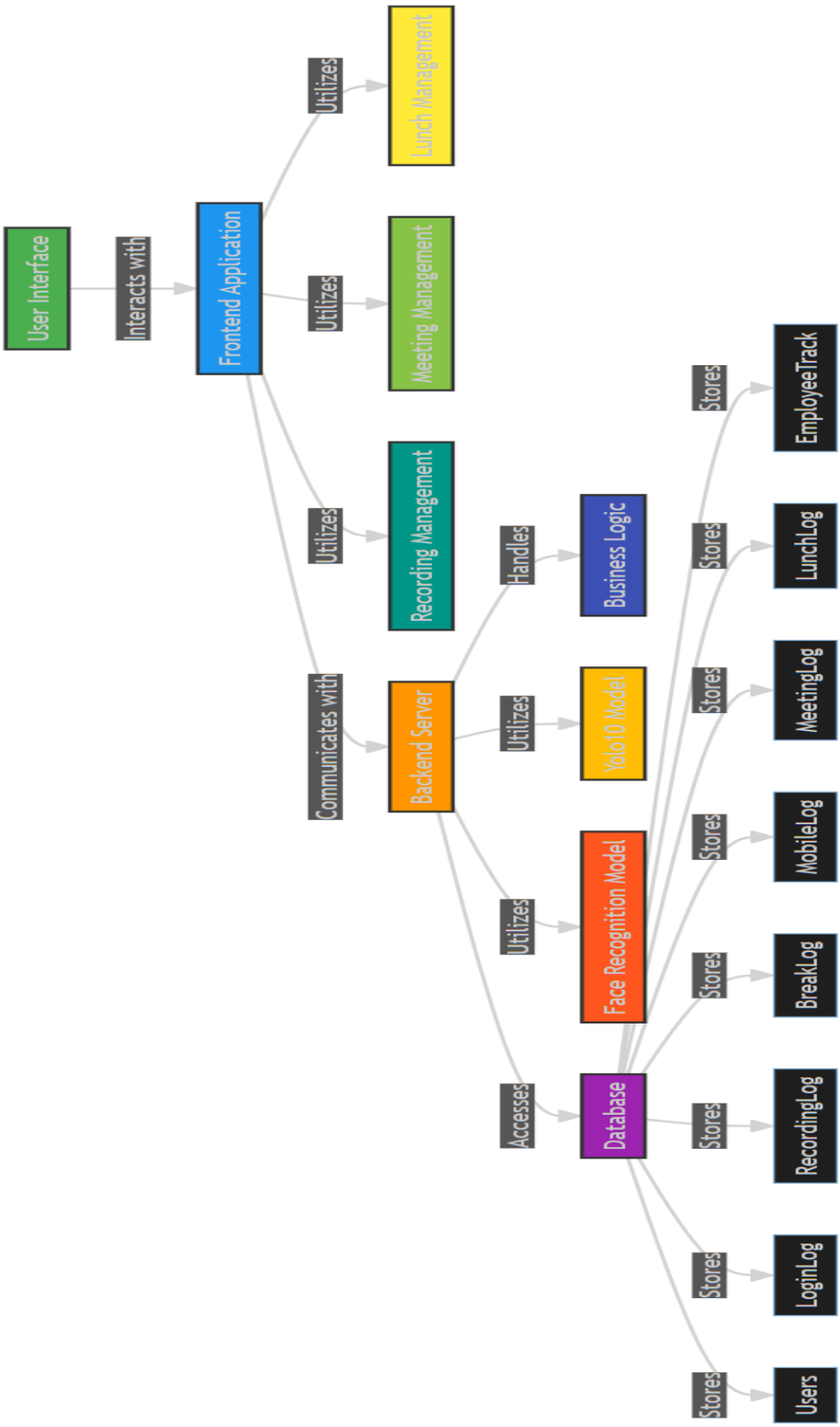
These 8 tables collectively form a comprehensive system to track the productivity and behavior of employees by capturing their login times, activities, breaks, meetings, mobile usage, and overall performance. The relationships between tables ensure a holistic view of employee productivity within the workplace.

3. Module Description

Block diagram

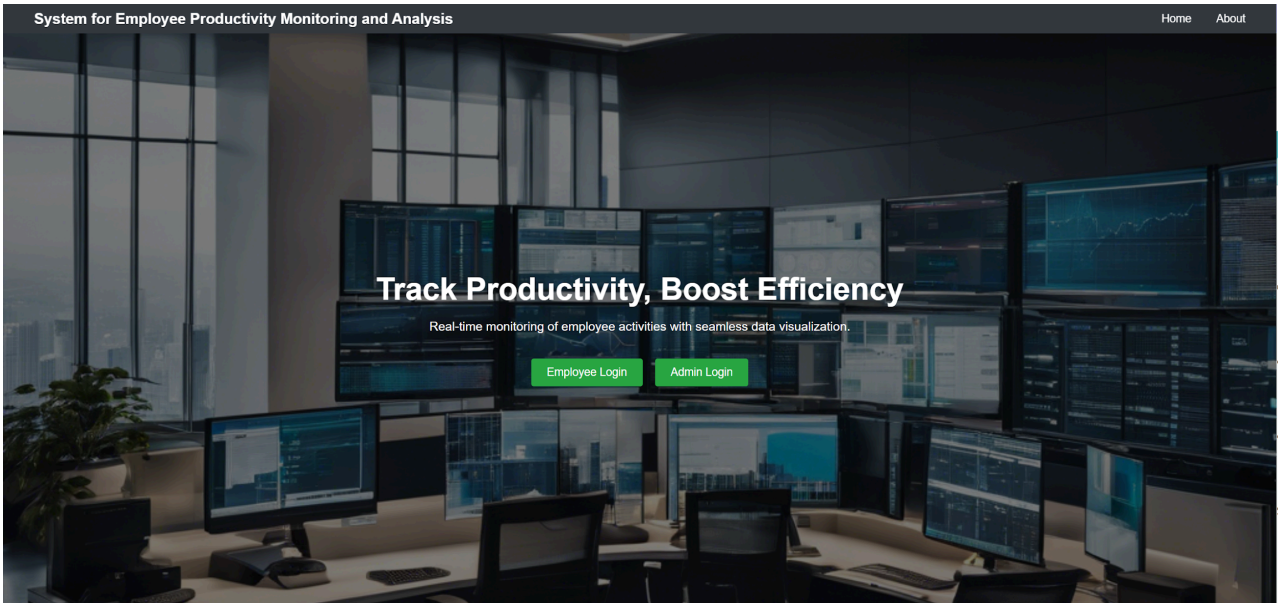


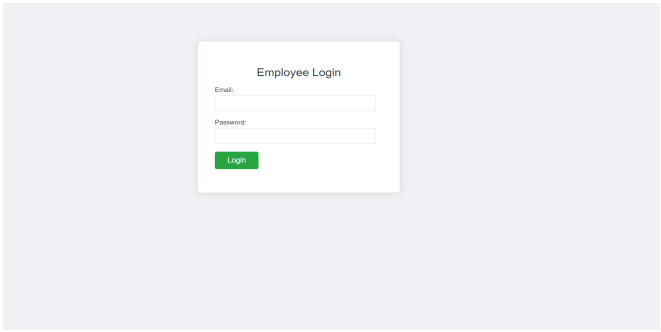
Architecture Diagram

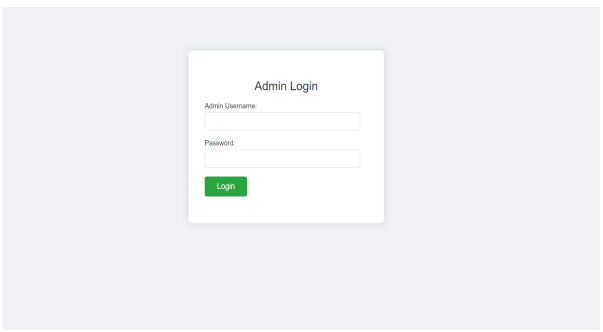


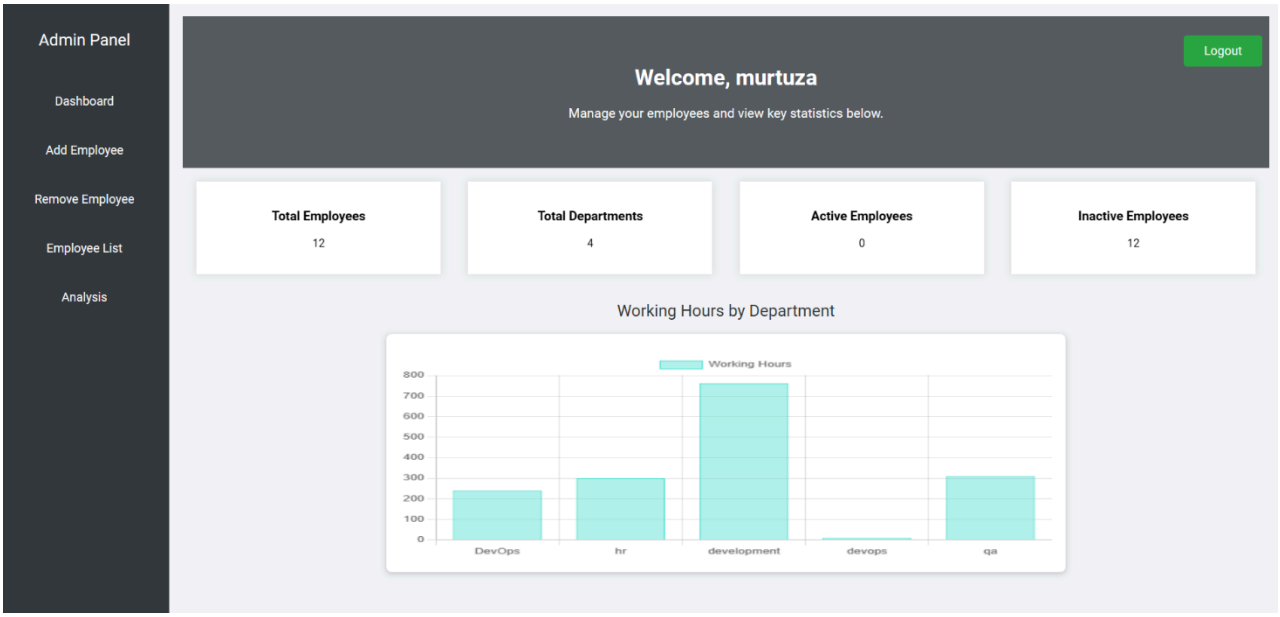
4. Results and Discussion

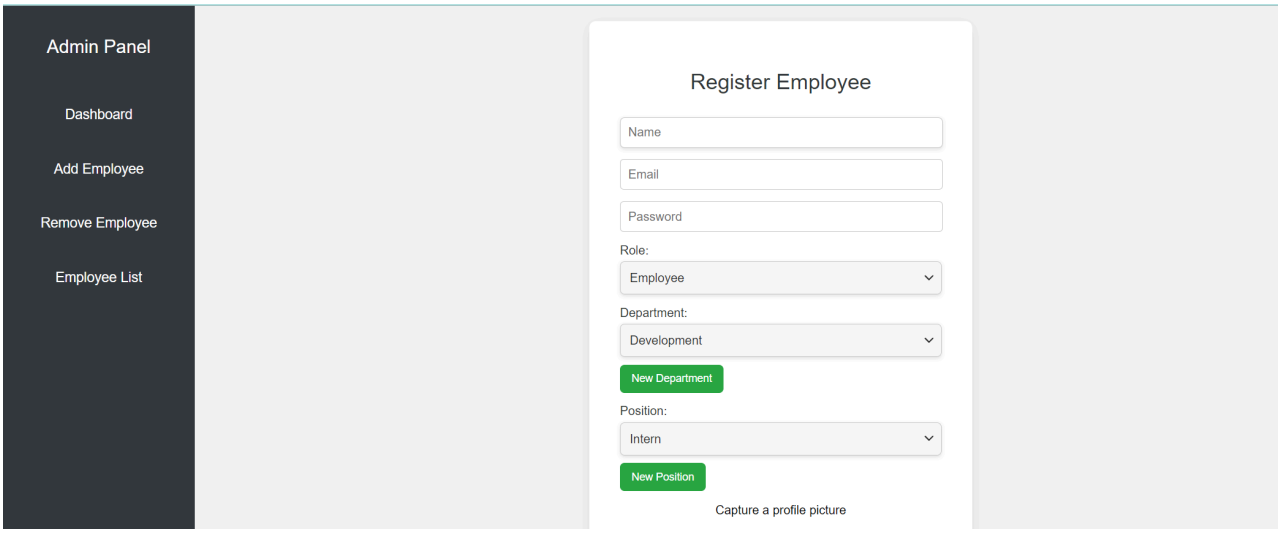
a. GUI

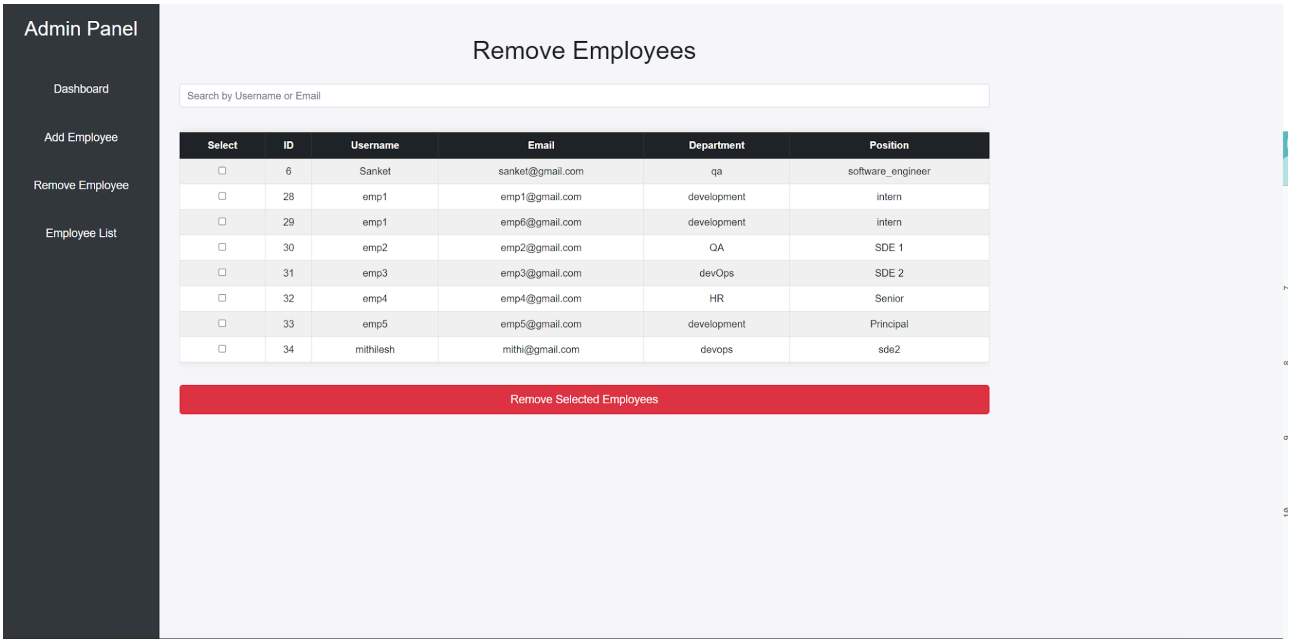


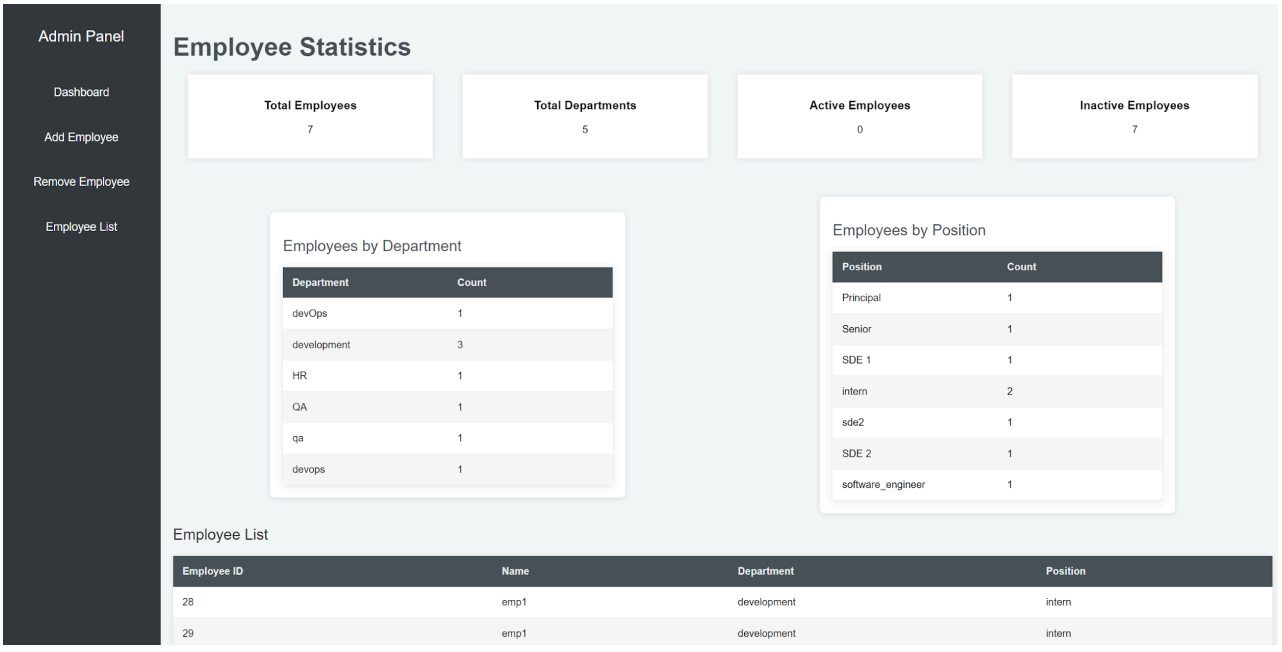







Admin Panel
Dashboard
Add Employee
Remove Employee
Employee List
Register Employee
Name
Email
Password
Role:
Employee
Department:
Development
New Department
Position:
Intern
New Position
Capture a profile picture


Admin Panel
Dashboard
Add Employee
Remove Employee
Employee List
Remove Employees
Search by Username or Email
Select
ID
Username
Email
Department
Position
6 Sanket sanket@gmail.com qa software_engineer
28 emp1 emp1@gmail.com development intern
29 emp1 emp6@gmail.com development intern
30 emp2 emp2@gmail.com QA SDE 1
31 emp3 emp3@gmail.com devOps SDE 2
32 emp4 emp4@gmail.com HR Senior
33 emp5 emp5@gmail.com development Principal
34 mithilesh mithi@gmail.com devops sde2
Remove Selected Employees


Admin Panel
Dashboard
Add Employee
Remove Employee
Employee List
Employee Statistics
Total Employees
7
Total Departments
5
Active Employees
0
Inactive Employees
7
Employees by Department
Department
Count
devOps 1
development 3
HR 1
QA 1
qa 1
devops 1
Employees by Position
Position
Count
Principal 1
Senior 1
SDE 1 1
intern 2
sde2 1
SDE 2 1
software_engineer 1
Employee List
Employee ID
Name
Department
Position
28 emp1 development intern
29 emp1 development intern


Employee Productivity Analysis
Working Hours by Department
Working Hours
800
700
600
500
400
300
200
100
0
DevOps
hr
development
devops
qa
Recording Time by Department
Recording Time
1,600
1,400
1,200
1,000
800
600
400
200
0
DevOps
hr
development
devops
qa
Mobile Usage Time by Department
Mobile Usage Time
180
160
140
120
100
80
60
40
20
0
DevOps
hr
development
devops
qa

Mobile Usage Time by Department
Mobile Usage Time
180
160
140
120
100
80
60
40
20
0
DevOps
hr
development
devops
qa
Meeting Time by Department
Meeting Time
120
100
80
60
40
20
0
DevOps
hr
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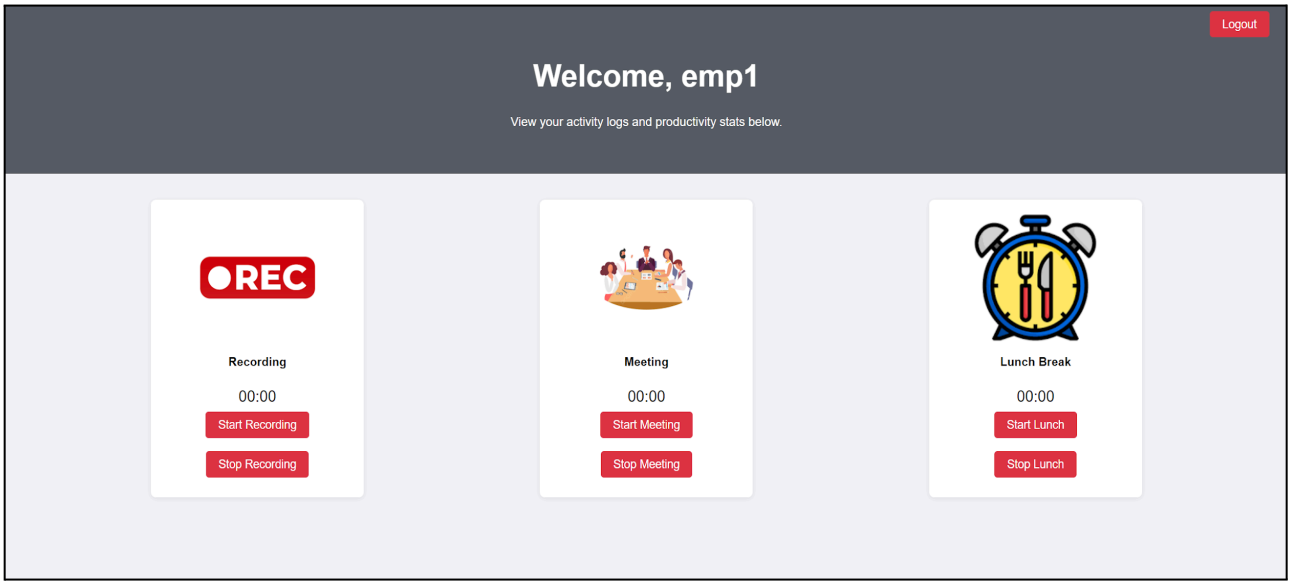
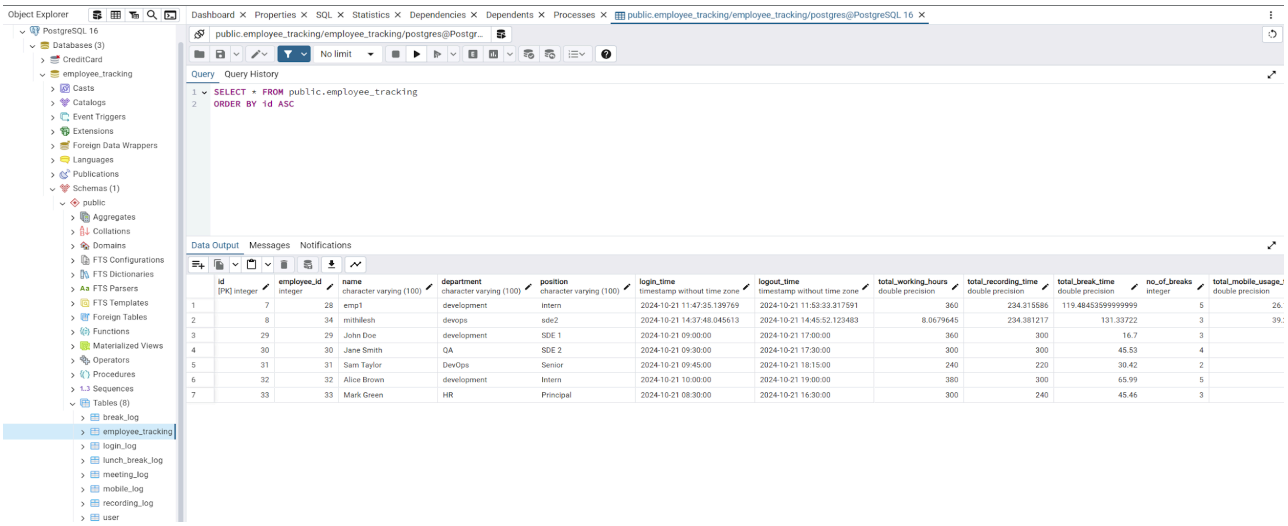
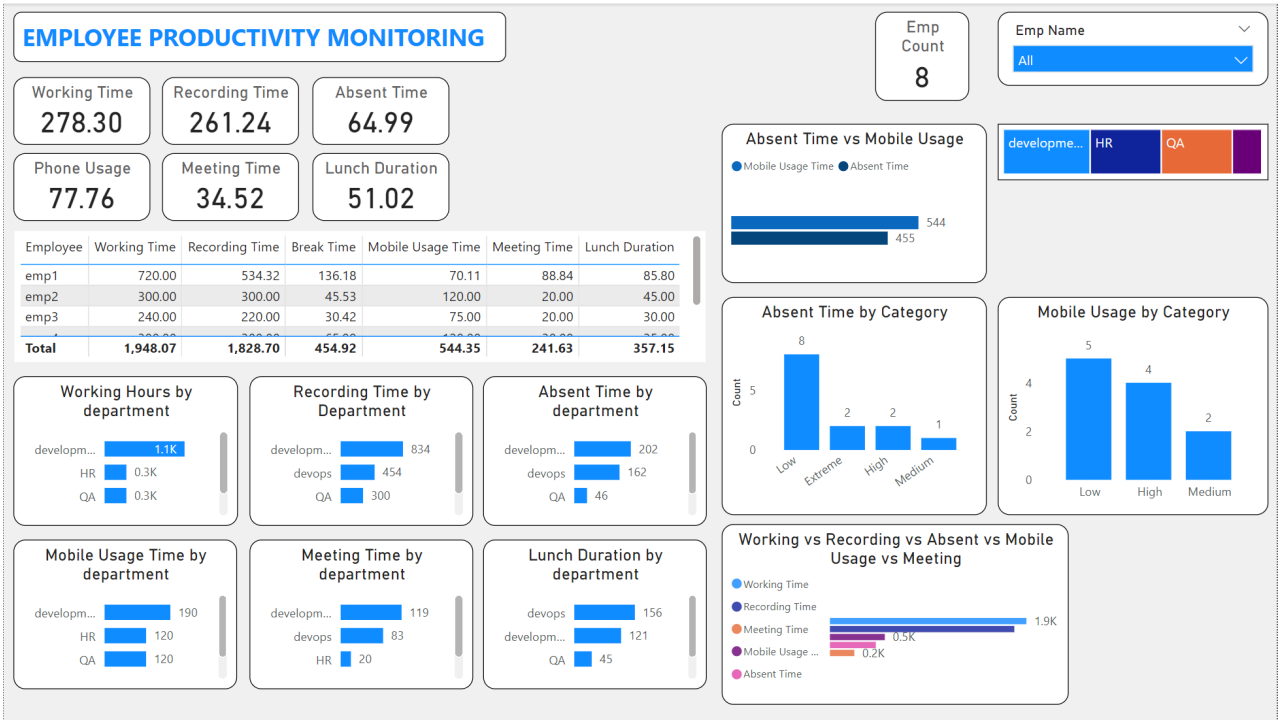
300
250
200
150
100
50
0
DevOps
hr
development
devops
qa


Logout
Welcome, emp1
View your activity logs and productivity stats below.
REC
Recording
00:00
Start Recording
Stop Recording
Meeting
00:00
Start Meeting
Stop Meeting
Lunch Break
00:00
Start Lunch
Stop Lunch



id [PK] integer	employee_id integer	name character varying (100)	department character varying (100)	position character varying (100)	login_time timestamp without time zone	logout_time timestamp without time zone	total_working_hours double precision	total_recording_time double precision	total_break_time double precision	no_of_breaks integer	total_mobile_usage_ double precision
7	28	emp1	development	intern	2024-10-21 11:47:35.139769	2024-10-21 11:53:33.317591	360	234.315586	119.48453999999999	5	26.
8	34	mithilesh	devops	sde2	2024-10-21 14:37:48.045613	2024-10-21 14:45:52.123483	8.0679645	234.381217	131.33722	3	39.
29	29	John Doe	development	SDE 1	2024-10-21 09:00:00	2024-10-21 17:00:00	360	300	16.7	3	
30	30	Jane Smith	QA	SDE 2	2024-10-21 09:30:00	2024-10-21 17:30:00	300	300	45.53	4	
31	31	Sam Taylor	DevOps	Senior	2024-10-21 09:45:00	2024-10-21 18:15:00	240	220	30.42	2	
32	32	Alice Brown	development	Intern	2024-10-21 10:00:00	2024-10-21 19:00:00	380	300	65.99	5	
33	33	Mark Green	HR	Principal	2024-10-21 08:30:00	2024-10-21 16:30:00	300	240	45.46	3	

Power BI Dashboard:



Test Cases

Test Case ID	Test Description	Input	Expected Output	Actual Output	Pass/Fail
TC01	Test user login	User ID, Password	Successful login and redirection to dashboard	Successful login	Pass
TC02	Test login log entry creation	Login time, Logout time	Entry created in LoginLog with correct working hours	Entry created	Pass
TC03	Test employee tracking log	Employee ID, Activity details	Data inserted into EmployeeTracking with accurate time tracking	Data logged	Pass
TC04	Test break log	Employee ID, Break start/end time	Break log created with correct duration in BreakLog	Break log created	Pass
TC05	Test meeting log	Employee ID, Meeting start/end time	Meeting log created with correct duration in MeetingLog	Meeting log created	Pass
TC06	Test mobile usage tracking	Employee ID, Mobile usage time	Mobile usage tracked and logged in MobileLog	Mobile log created	Pass
TC07	Test face recognition for employee	Employee ID, Profile picture	Face recognized and employee marked as present	Face recognized	Pass
TC08	Test recording stop event	Stop recording button clicked	Recording stopped, data sent to backend, RecordingLog updated	Recording stopped	Pass
TC09	Test data retrieval from PostgreSQL	Employee ID	Correct employee data fetched from database	Data retrieved	Pass
TC10	Test Power BI dashboard integration	Tracking data	Accurate display of employee performance metrics	Dashboard data correct	Pass

5. Conclusion

The employee productivity tracking system effectively monitors and analyzes various aspects of employee activities, such as working hours, breaks, mobile usage, and meetings. By utilizing machine learning models, such as Random Forest, to predict productivity, the system provides valuable insights into employee performance. The project demonstrates the potential to enhance productivity assessment by capturing and analyzing key behavioral metrics. Further improvements, such as refining prediction models and expanding the dataset, can enhance the system's accuracy and usability in real-world scenarios.

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