Project Name: Parking Management System (Parko)

Team Name : Trilogy

Team Members:
22101163: Marwa Jamal
22101168 : Md. Sarjil Hossain
22101171 : Most. Mahomuda Akter

Introduction:

Parko is a Smart Parking Management System that uses IoT and cloud technology to provide real-time parking availability, reservations, and cashless payments. It reduces traffic congestion, enhances convenience, and supports sustainable urban mobility.

Motivation:

Urbanization has led to increasing traffic congestion and inefficiencies in parking management, which not only cause frustration for drivers but also contribute to environmental degradation through excessive fuel consumption and emissions. A smart and automated parking system is essential to address these challenges, offering a seamless and sustainable solution for urban mobility.

Problem Statement:

Finding a parking spot in urban areas is often time-consuming and inefficient, leading to increased traffic congestion, wasted fuel, and driver frustration. Existing parking systems lack real-time monitoring, efficient allocation, and user-friendly interfaces. There is a need for a smart parking management system that provides real-time slot availability, optimizes resource utilization, and enhances the parking experience for users.

Objectives:

The objectives of **Parko**, the Smart Parking Management System, are as follows:

1. **Enhance Parking Efficiency:**
   Provide real-time information on parking slot availability to reduce search time and optimize resource utilization.

2. **Enable Convenient Slot Reservation:**
   Allow users to reserve parking slots in advance through a user-friendly mobile application.

3. **Promote Sustainability:**
   Reduce traffic congestion and vehicle emissions by optimizing parking allocation and minimizing idle time.

4. **Integrate Advanced Technology:**
   Utilize IoT devices, cloud computing, and AI-based predictive analytics for accurate slot detection and demand forecasting.

5. **Ensure Seamless Payment Processing:**
   Support secure and cashless transactions through various payment methods like bKash, bank transfers, and credit cards.

6. **Improve User Experience:**
   Deliver a highly intuitive interface with personalized recommendations, notifications, and dynamic pricing for enhanced convenience.

7. **Facilitate Operator Efficiency:**
   Provide a centralized dashboard for parking lot operators to monitor, manage, and analyze parking operations effectively.

8. **Support Scalability and Adaptability:**
   Design a system that can adapt to increasing urban demands

and incorporate future technological advancements.

9. **Promote Compliance and Security:**
   Adhere to local regulations and ensure robust data security for user and transaction information.

10. **Encourage Smart City Integration:**
    Align with smart city initiatives by integrating with municipal traffic management systems and urban infrastructure.

Project Output

The Smart Parking Management System offers:

1. **Real-Time Parking Availability:** Displays available parking slots through IoT-enabled sensors and cameras.
2. **Slot Reservation:** Allows users to reserve parking slots in advance through a mobile app.
3. **Payment Processing:** Supports cashless payment methods, including mobile wallets and bank transactions.
4. **Sustainability:** Reduces traffic congestion and fuel consumption, contributing to a greener urban environment.
5. **Enhanced User Experience:** Provides a user-friendly interface with features like personalized recommendations, notifications, and dynamic pricing.
6. **Operational Efficiency:** Centralized dashboard for parking lot operators to manage slots and monitor data effectively.
7. **Scalability:** A system designed to accommodate growing urban demands with minimal infrastructure adjustments.

This system ensures convenience for drivers, promotes environmental sustainability, and integrates seamlessly with smart city initiatives.

Requirement Analysis

Requirement analysis defines the core needs of the **Smart Parking Management System**, identifies performance expectations, collects data, and assesses feasibility to ensure project success.

Basic Requirements:

1. **Accurate Parking Availability Data:**
   Real-time detection of parking slot availability using IoT sensors and cameras.
2. **AI-Based Slot Prediction:**
   Implementation of machine learning algorithms to predict future parking demand and optimize resource allocation.
3. **User-Friendly Interface:**
   A mobile app and web dashboard offering intuitive navigation for parking reservations and payments.
4. **Robust Data Security:**
   Ensuring secure storage and transmission of user data, including payment details, using encryption protocols.
5. **Integration with Traffic Systems:**
   Seamless integration with municipal traffic management systems for better parking coordination in urban areas.

6. **User Profiles and Personalization:**
   Personalized recommendations for preferred parking spots based on user habits and past parking history.
7. **Transparent Cost Information:**
   Clear and detailed pricing for parking slots, including hourly rates, subscription options, and additional fees.
8. **Multi-Platform Compatibility:**
   Compatibility with smartphones, tablets, and desktop platforms to cater to a wide range of users.
9. **Feedback Mechanism:**
   A feature for users to provide feedback on the parking experience and suggest system improvements.
10. **Compliance with Local Regulations:**
    Adherence to local traffic and parking laws, including permits and environmental regulations.

Functional Requirements

- User Registration and Authentication
- User Profiles
- Parking Space Availability
- Reservation System
- Payment Processing
- Admin Dashboard
- Real-Time Notifications and Alerts
- Search and Filtering
- User Reviews and Ratings
- Mobile Compatibility
- Multi-Language Support
- Dynamic Pricing
- Location-Based Services

● Waitlist Management
● Incident Reporting

Non-Functional Requirements:

● Performance
● Scalability
● Security
● Usability
● Reliability and Availability
● Maintainability
● Compatibility
● Compliance
● Data Management
● Localization

Fact-Finding Methods for Parking Management System

The fact-finding process involves collecting data and information to better understand, analyze, and solve the challenges related to parking management. Below are the methods we used for the **Parking Management System**:

1. Interviews:

We conducted over **5+ interview sessions** with stakeholders such as parking lot operators, city planners, drivers, and local authorities. These sessions provided valuable insights into challenges like overcrowding, slot management, and payment processes.

2. Prototyping:

We developed prototypes showcasing the key functionalities of the system, including real-time parking availability, slot reservation, and payment processing. Feedback from users and operators was used to refine the design and functionality before final implementation.

3. Research:

We carried out a literature review by analyzing relevant research papers, industry white papers, and case studies of existing parking management systems globally. This helped us identify the best practices and integrate innovative technologies such as IoT and AI.

4. Questionnaires:

A detailed questionnaire was shared with end-users to understand their preferences and expectations. Some of the key questions included:

a. How do you currently find parking spaces in busy areas?
b. What challenges do you face in parking management (e.g., availability, pricing, security)?
c. Would you use a system that allows you to reserve parking slots in advance?
d. How important is real-time availability of parking spaces to you?
e. Do you prefer cashless payments for parking fees?
f. Would you trust a parking management system to handle your personal and payment information securely?
g. What features would you like to see in a parking app to improve your experience?

h. Do notifications or reminders about expiring reservations help in managing your parking?
i. How do reviews and ratings of parking spaces influence your decision to park there?
j. Are you willing to provide feedback on the app for continuous improvement?

Feasibility analysis:

1. Technical Feasibility

- **Technology Requirements**:
  The project relies on IoT devices (sensors, cameras, actuators), cloud platforms (AWS, Azure, or Google Cloud), and mobile applications for real-time monitoring and data visualization.
- **Existing Infrastructure**:
  Basic infrastructure such as internet connectivity, parking facilities, and mobile devices is widely available in urban areas, making the project technically viable.
- **Implementation Complexity**:
  The integration of IoT sensors with a cloud-based system and mobile apps requires skilled professionals but can be managed using standard tools and technologies like MQTT protocols, Arduino, and Raspberry Pi.

2. Economic Feasibility

- **Cost of Implementation**:
  The major costs involve procuring IoT devices, server hosting for the cloud platform, and development of mobile applications. Estimated initial investment ranges from **10,000,00 Tk to 25,000,00** Tk depending on the scale.

- **Potential Revenue Sources**:
  The system can generate revenue through subscription models, parking slot reservations, and collaboration with municipal authorities or private parking operators.
- **Cost-Benefit Ratio**:
  Significant benefits include reduced traffic congestion, improved fuel efficiency for users, and enhanced resource utilization, making the investment justifiable.

3. Operational Feasibility

- **Ease of Use**:
  The system is user-friendly, with a mobile app providing real-time parking slot availability, directions, and payment options. For parking lot operators, a centralized dashboard simplifies management.
- **Maintenance**:
  IoT sensors and cloud-based systems require periodic updates and troubleshooting, which can be managed by a dedicated technical team.
- **User Adoption**:
  Given the growing demand for smart city solutions, user adoption is expected to be high, especially in urban areas where parking is a significant challenge.

4. Legal Feasibility

- **Compliance with Regulations**:
  The system must comply with local data privacy and security laws (e.g., GDPR or CCPA) since it involves collecting user data.
- **Permits and Approvals**:
  Implementation in public parking spaces requires collaboration with municipal authorities and obtaining necessary approvals.

5. Social and Environmental Feasibility

- **Social Impact**:
  The project enhances the convenience of drivers and reduces frustration caused by the unavailability of parking slots, improving quality of life.
- **Environmental Benefits**:
  By optimizing parking allocation, the system reduces vehicle idling and fuel consumption, contributing to lower greenhouse gas emissions.

Technical Requirements

In the **Smart Parking Management System** project, we have adopted **Agile methodology** to ensure adaptability, user-centric development, and continuous improvement. This approach allows us to deliver a parking management solution that meets user needs while remaining flexible to technological and environmental changes. The principles guiding our project are as follows:

1. **Customer Satisfaction**:
   Agile focuses on customer satisfaction by delivering a parking management system that provides users with real-time parking availability, secure payment options, and seamless user experiences.
2. **Adapting to Changing Requirements**:
   Agile ensures our system can adapt to changes in urban infrastructure, user behavior, or technological advancements, such as incorporating new IoT devices or integrating with city traffic systems.
3. **Frequent Delivery**:
   The project delivers frequent updates to the parking management app and dashboard, ensuring users have the latest

features, such as improved slot allocation algorithms or enhanced user interface designs.

4. **Regular Communication**:
   Frequent communication within the development team and with stakeholders ensures alignment with project goals, allowing us to address real-world parking challenges effectively.
5. **Supporting Team Members**:
   Encouraging collaboration among team members fosters an environment of mutual support, enhancing productivity and innovation.
6. **Face-to-Face Communication**:
   Regular face-to-face interactions with parking lot operators, city officials, and end-users provide valuable insights to refine the system and address their specific needs.
7. **Measuring Work Progress**:
   Progress tracking helps monitor the development of critical components such as IoT sensor integration, mobile app features, and predictive analytics for parking demand.
8. **Adaptable Development Process**:
   Agile's flexible approach allows us to incorporate user feedback and adjust to operational challenges, such as optimizing slot detection accuracy or streamlining payment processing.
9. **Good Design**:
   Agile emphasizes creating a user-friendly interface for the mobile app and web dashboard, ensuring an intuitive and visually appealing design for users and administrators.
10. **Continuous Progress Measurement**:
    By continuously measuring progress, we ensure that each iteration improves the system's reliability, efficiency, and value to users.
11. **Seeking Continuous Results**:
    The system is driven by the goal of reducing traffic congestion,

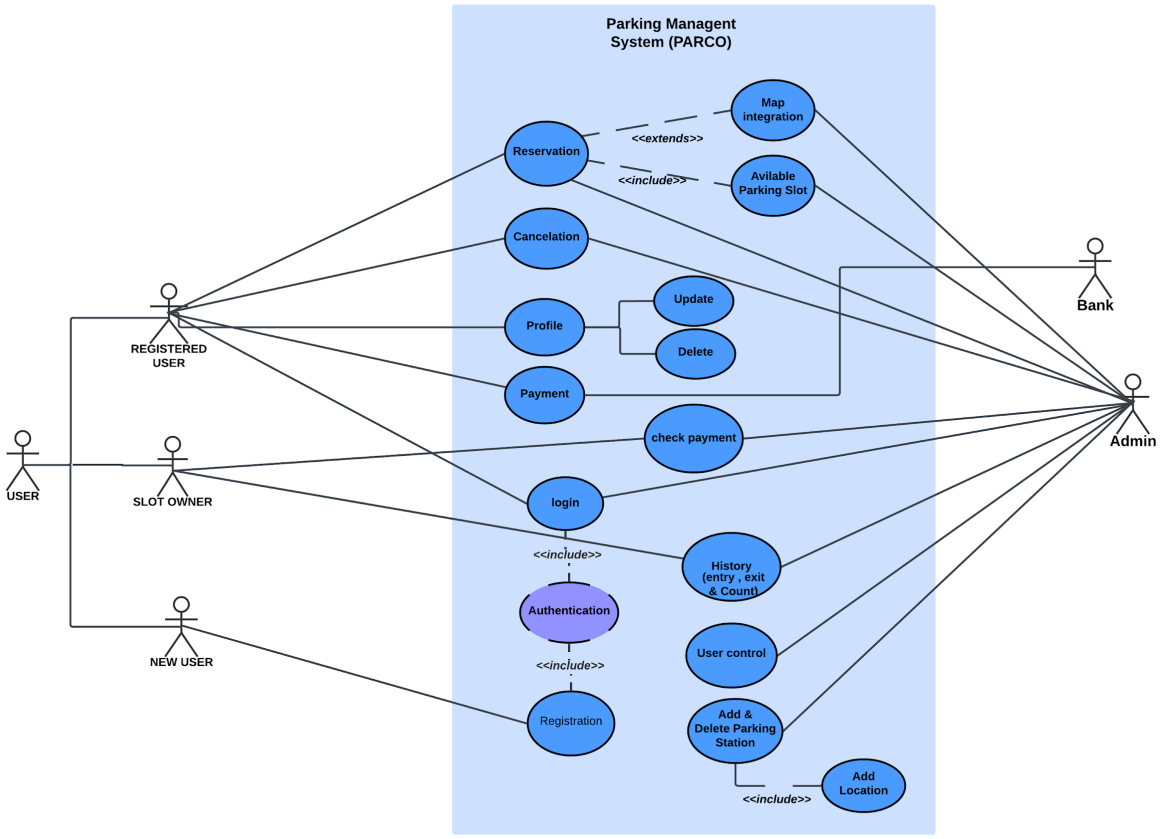
improving user convenience, and promoting sustainability, with continuous efforts to refine predictive analytics and real-time monitoring.

12. **Reflect and Adjust Regularly**:
    Regular retrospectives allow the team to reflect on processes, identify areas for improvement, and make adjustments to enhance the system's performance and user experience.

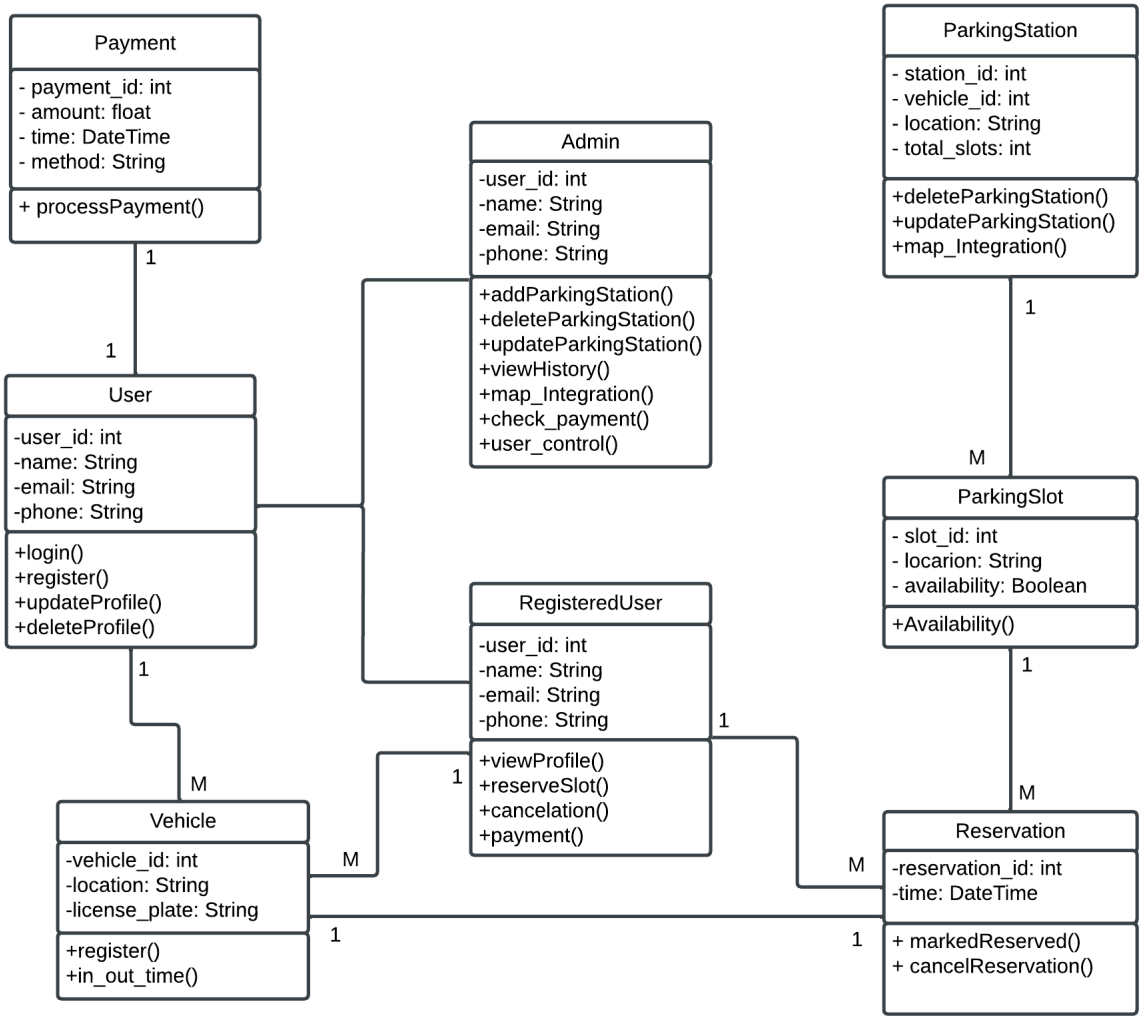
Project Designing Tools

To design this project we used certain modeling techniques like Use Case Diagram, Entity-Relationship Diagram,Gantt Chart. And activity diagram.

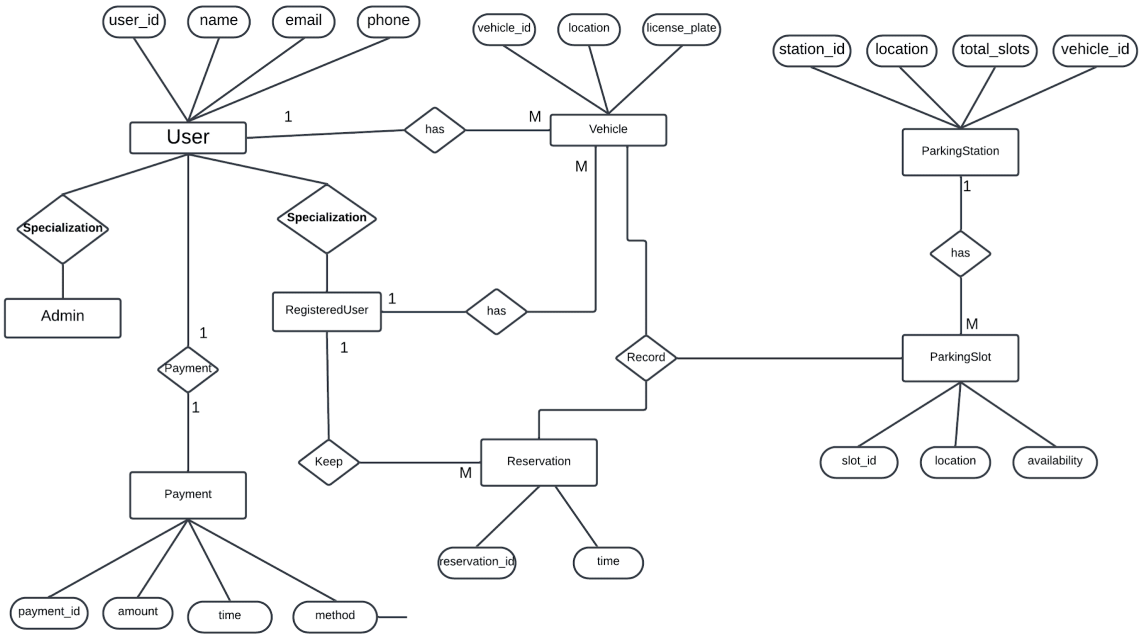
Use Case Diagram:



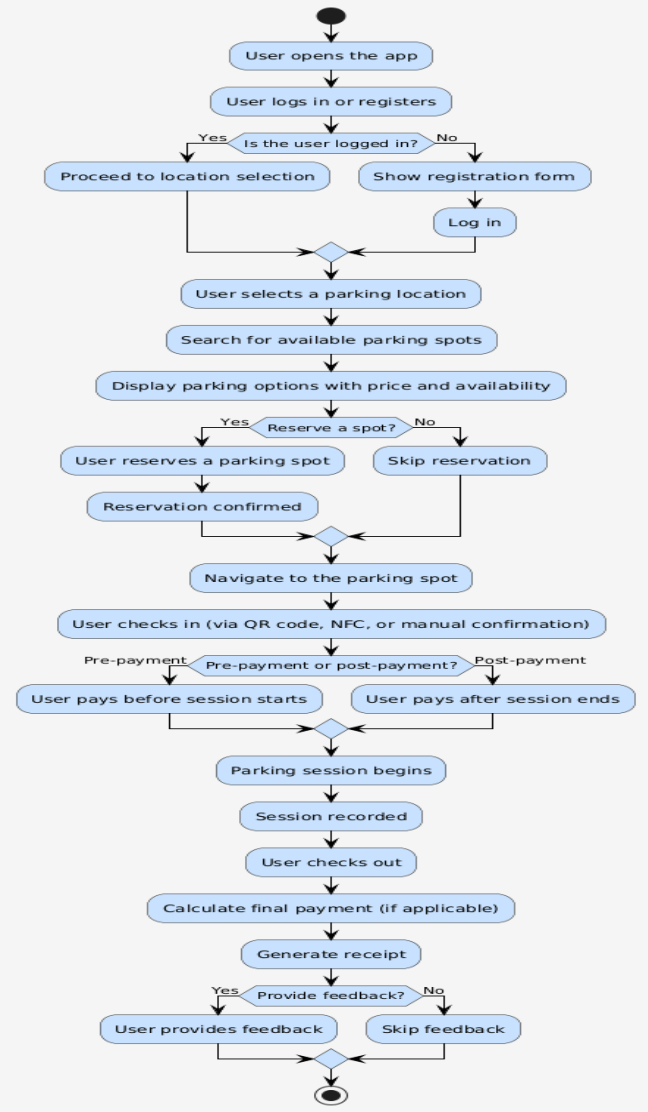
Class Diagram:



ER diagram

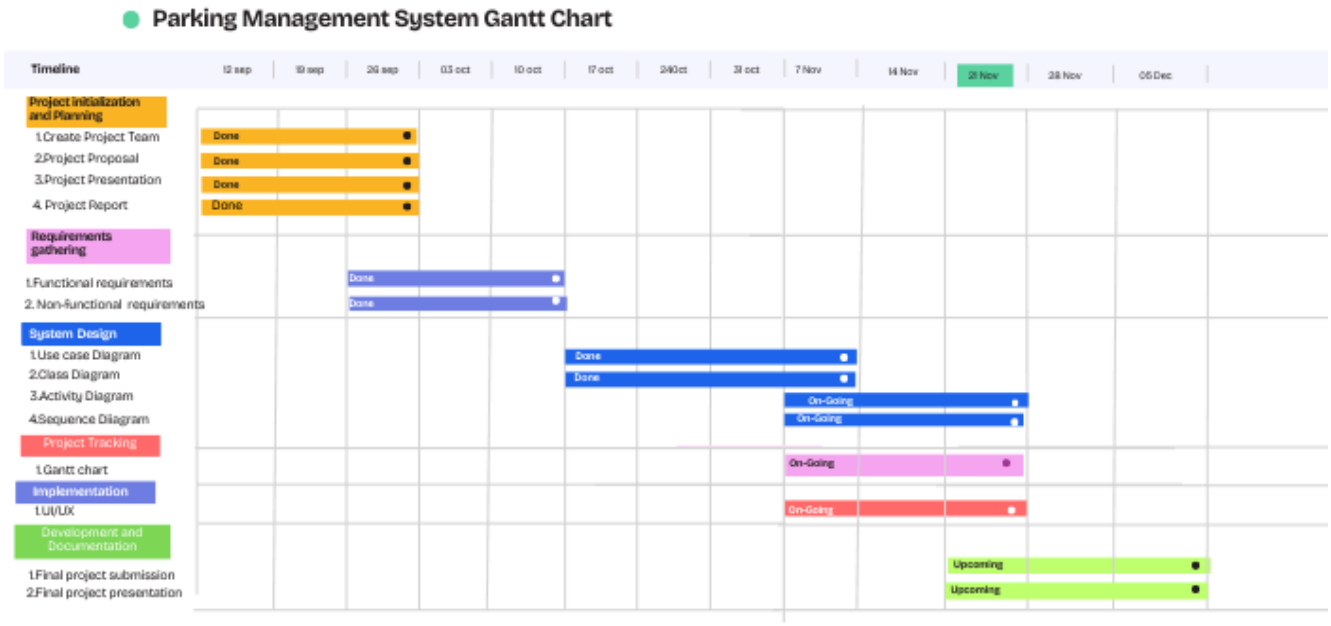

user_id
name
email
phone
User
1
has
M
Vehicle
vehicle_id
location
license_plate
station_id
location
total_slots
vehicle_id
ParkingStation
1
has
M
ParkingSlot
M
Specialization
Admin
Specialization
RegisteredUser
1
has
1
Payment
1
1
Payment
Record
Keep
M
Reservation
slot_id
location
availability
payment_id
amount
time
method
reservation_id
time

Activity Diagram:



Project Management

Gantt chart



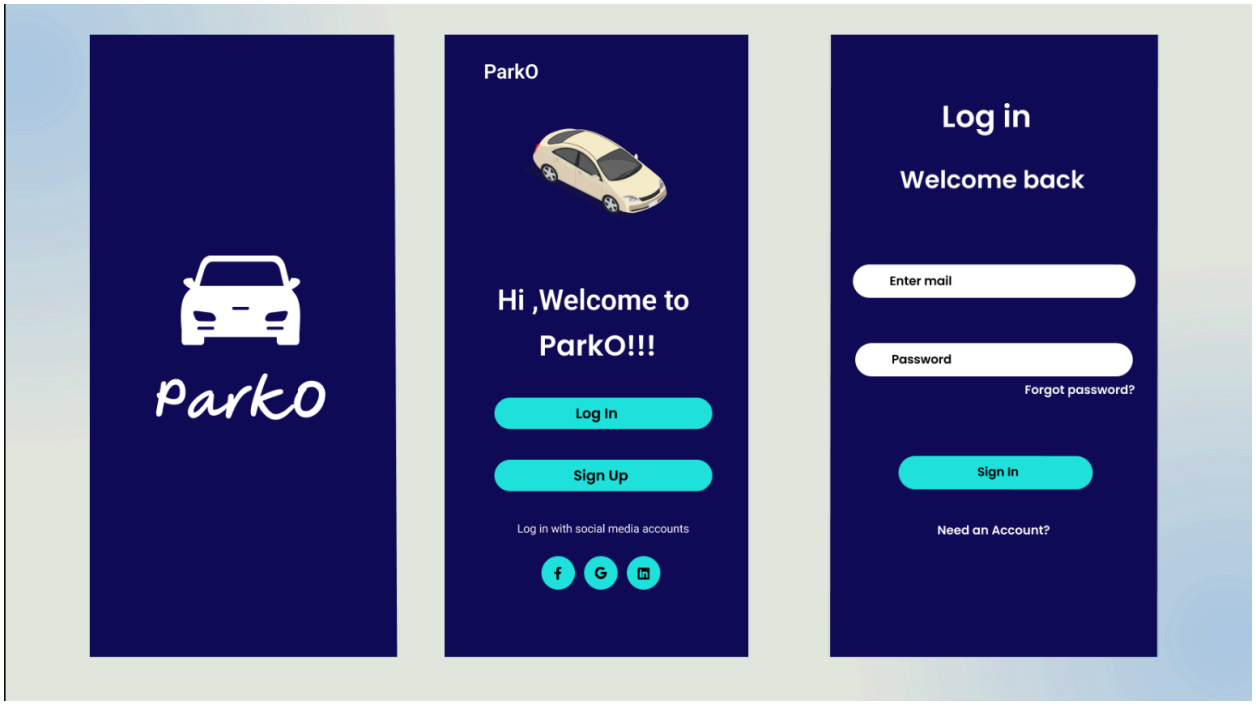
Team contributions:

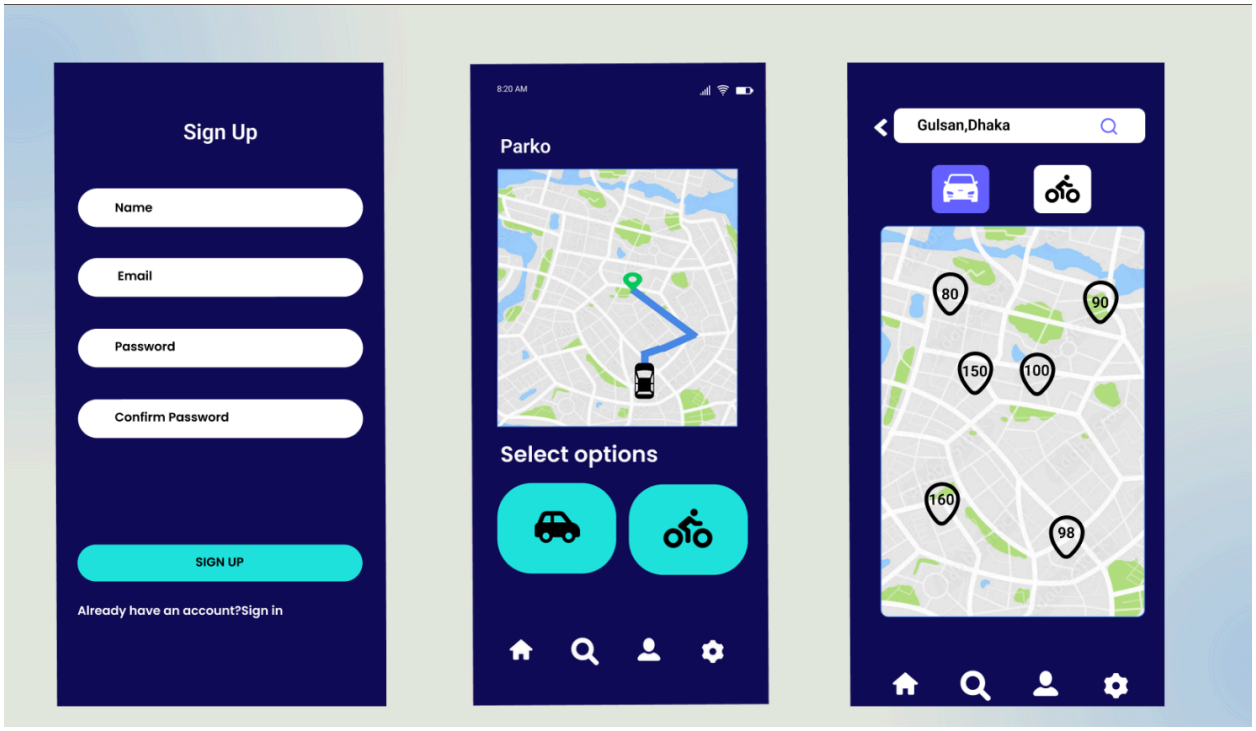
Marwa Jamal - Activity Diagram, Gantt chart, Report , Project proposal presentation report and slide, Final project presentation slide

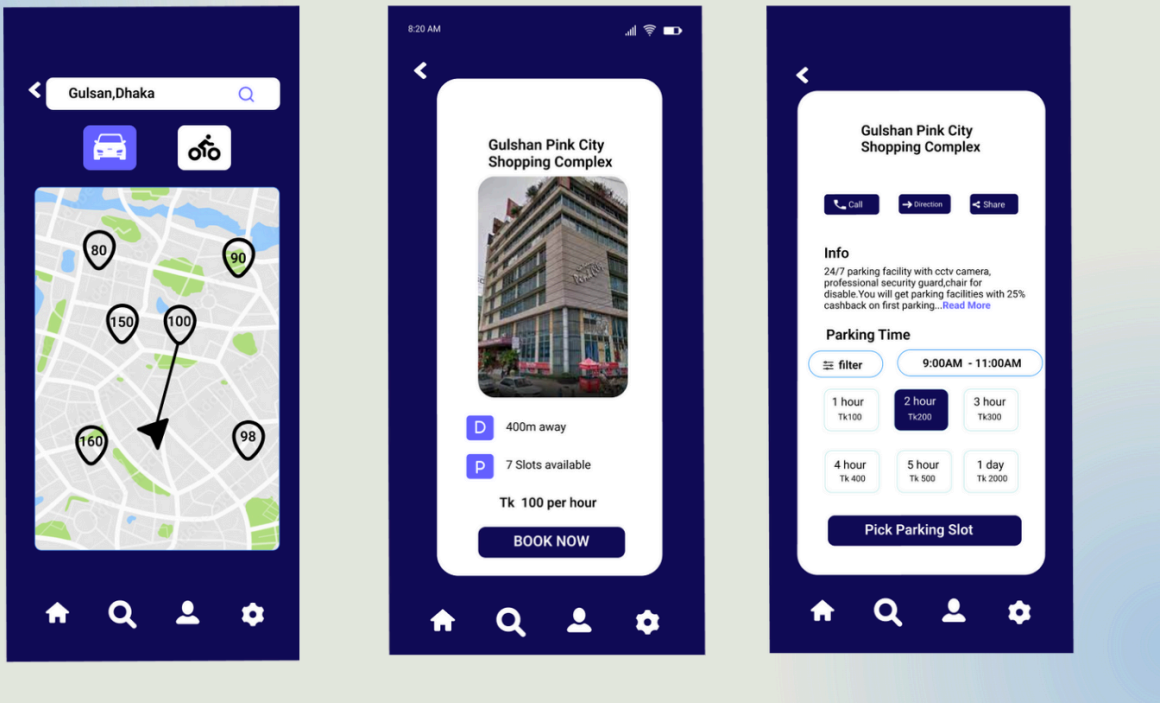
Md. Sarjil Hasan - prototype, Report, functional and non-functional requirements

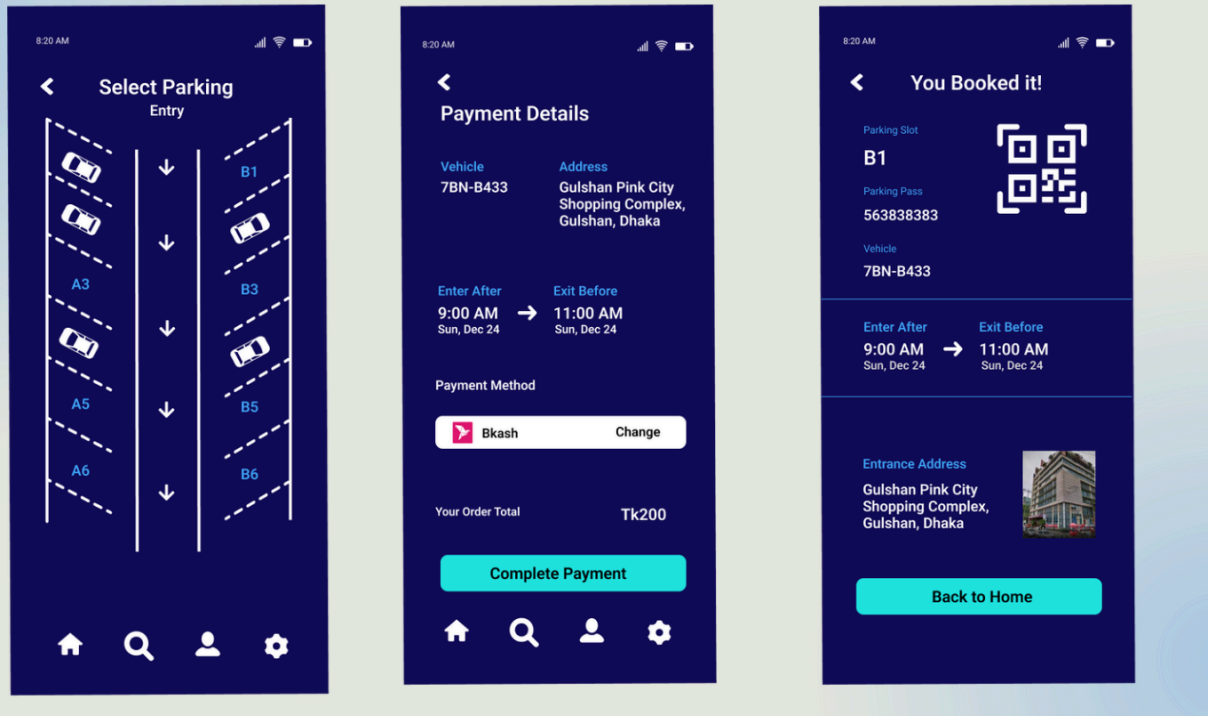
Most. Mahomuda Akter - use case diagram, er diagram, class diagram, Project proposal report

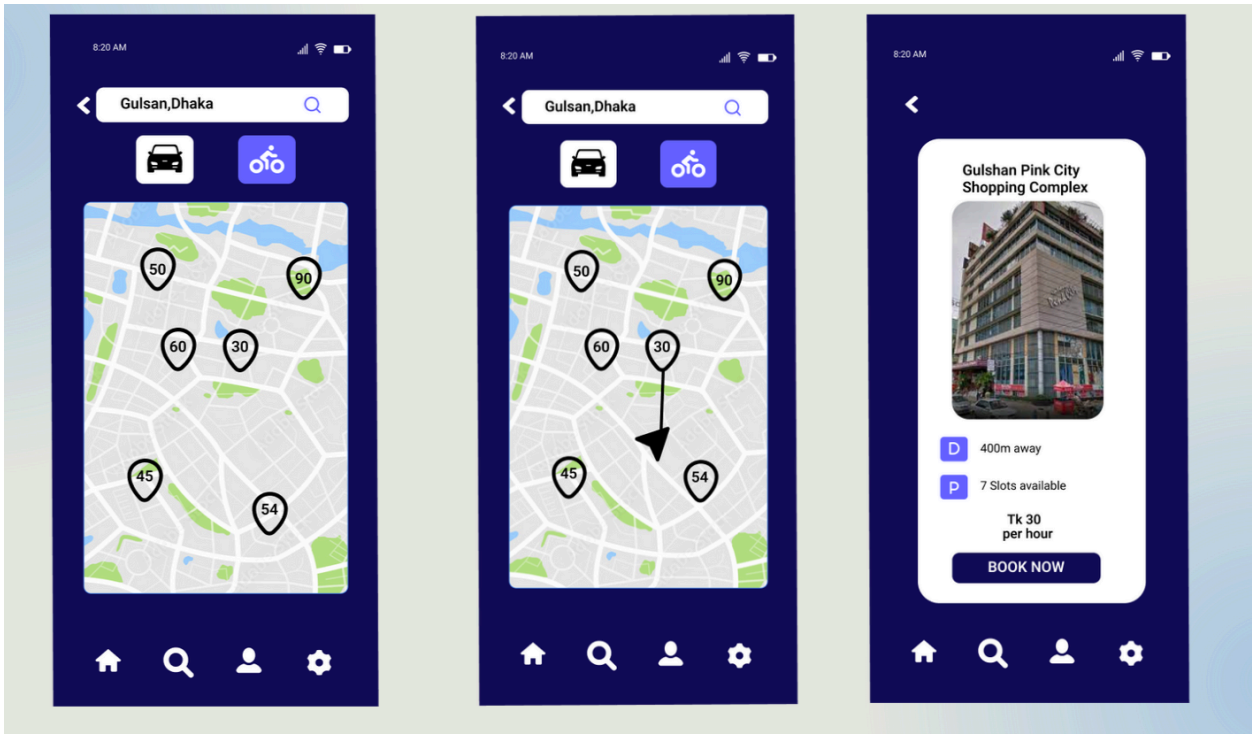
Parko UI

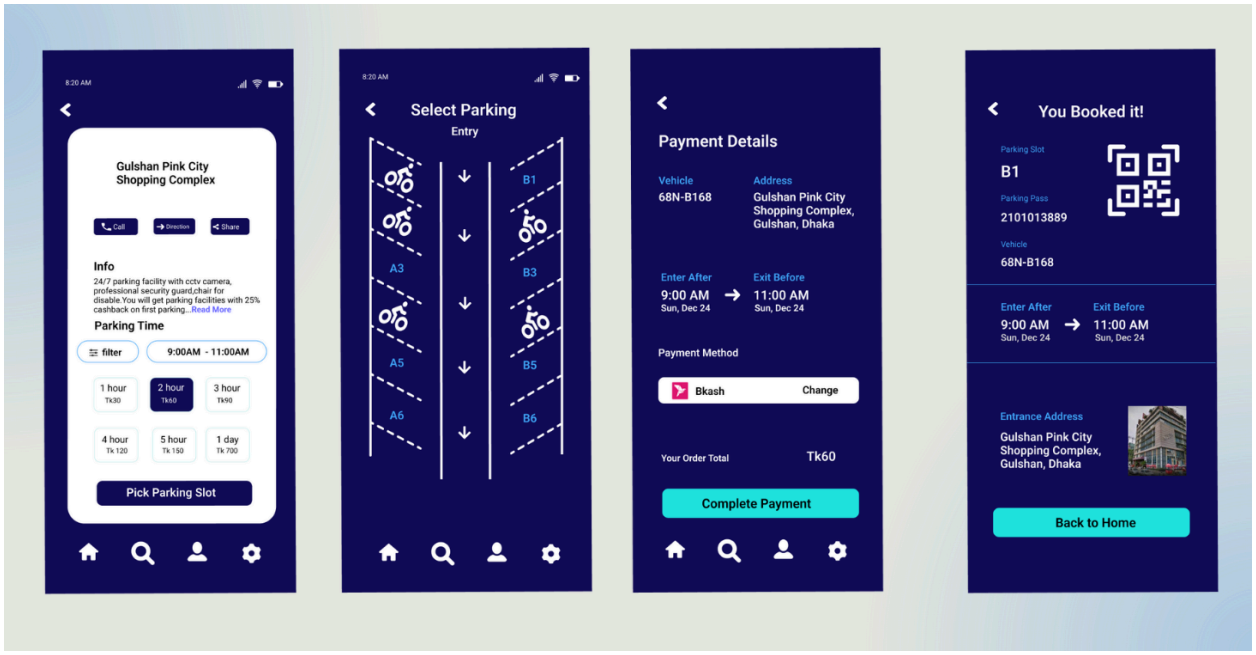

Parko
ParkO
Hi ,Welcome to ParkO!!!
Log In
Sign Up
Log in with social media accounts
Log in
Welcome back
Enter mail
Password
Forgot password?
Sign In
Need an Account?

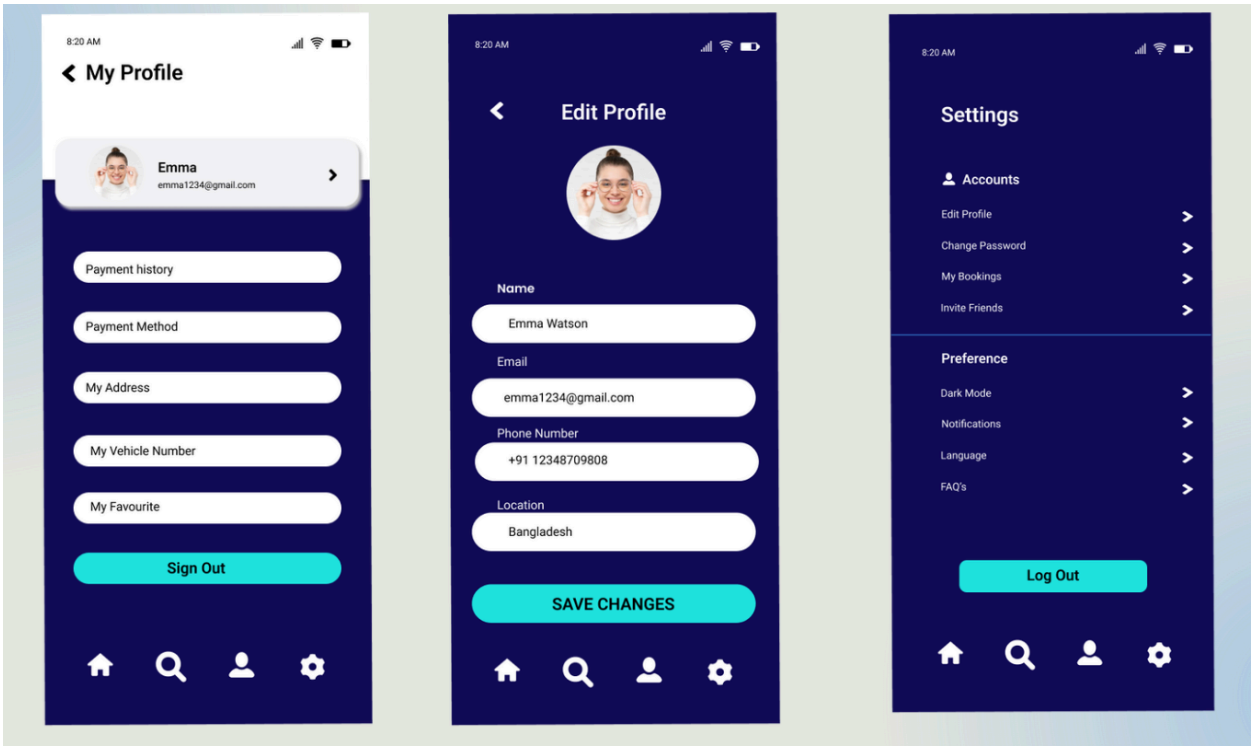

Sign Up
Name
Email
Password
Confirm Password
SIGN UP
Already have an account?Sign in
8:20 AM
Parko
Select options
Gulsan,Dhaka
80
90
150
100
160
98


Gulsan,Dhaka
80
90
150
100
160
98
8:20 AM
Gulshan Pink City
Shopping Complex
400m away
7 Slots available
Tk 100 per hour
BOOK NOW
Gulshan Pink City
Shopping Complex
Call
Direction
Share
Info
24/7 parking facility with cctv camera, professional security guard,chair for disable.You will get parking facilities with 25% cashback on first parking...Read More
Parking Time
filter
9:00AM - 11:00AM
1 hour
Tk100
2 hour
Tk200
3 hour
Tk300
4 hour
Tk 400
5 hour
Tk 500
1 day
Tk 2000
Pick Parking Slot


8:20 AM
Select Parking
Entry
B1
A3
B3
A5
B5
A6
B6
Payment Details
Vehicle
7BN-B433
Address
Gulshan Pink City Shopping Complex, Gulshan, Dhaka
Enter After
9:00 AM
Sun, Dec 24
Exit Before
11:00 AM
Sun, Dec 24
Payment Method
Bkash
Change
Your Order Total
Tk200
Complete Payment
You Booked it!
Parking Slot
B1
Parking Pass
563838383
Vehicle
7BN-B433
Enter After
9:00 AM
Sun, Dec 24
Exit Before
11:00 AM
Sun, Dec 24
Entrance Address
Gulshan Pink City Shopping Complex, Gulshan, Dhaka
Back to Home


8:20 AM
Gulsan,Dhaka
50
90
60
30
45
54
Gulshan Pink City
Shopping Complex
400m away
7 Slots available
Tk 30
per hour
BOOK NOW


Gulshan Pink City
Shopping Complex
Call
Direction
Share
Info
24/7 parking facility with cctv camera, professional security guard,chair for disable.You will get parking facilities with 25% cashback on first parking....Read More
Parking Time
filter
9:00AM - 11:00AM
1 hour Tk30
2 hour Tk60
3 hour Tk90
4 hour Tk 120
5 hour Tk 150
1 day Tk 700
Pick Parking Slot
Select Parking
Entry
A3
A5
A6
B1
B3
B5
B6
Payment Details
Vehicle
68N-B168
Address
Gulshan Pink City Shopping Complex, Gulshan, Dhaka
Enter After
9:00 AM
Sun, Dec 24
Exit Before
11:00 AM
Sun, Dec 24
Payment Method
Bkash
Change
Your Order Total
Tk60
Complete Payment
You Booked it!
Parking Slot
B1
Parking Pass
2101013889
Vehicle
68N-B168
Enter After
9:00 AM
Sun, Dec 24
Exit Before
11:00 AM
Sun, Dec 24
Entrance Address
Gulshan Pink City Shopping Complex, Gulshan, Dhaka
Back to Home



CEP Mapping

How **Knowledge Profile (K's)** are addressed through our project and mapping among **K's, CO's, PO's:**

K's	Attributes	How K's are addressed through our project	CO	PO
K4	Specialist knowledge	We require knowledge in IoT, cloud computing, and smart sensors to design an automated parking management system with real-time availability.	CO1	PO1
K5	Engineering design	We used ER diagrams, Use Case Diagrams, and Data Flow	CO3	PO3

		Diagrams to design an efficient parking slot allocation and monitoring system.		
K6	Engineering practice	We implemented the project using Arduino, Raspberry Pi, IoT platforms, and cloud services like AWS to manage parking data dynamically.	CO4	PO5
K7	Comprehension	Our system ensures effective resource utilization by reducing traffic congestion and helping drivers locate parking slots quickly.	CO5	PO7

How **Complex Engineering Problems (P's)** are addressed through our project and mapping among **P's, CO's, PO's:**

P's	Attribute	How P's are addressed through our project	CO	PO
P1	Depth of knowledge required	Requires knowledge of IoT architecture, smart sensors, real-time data handling (K4), programming for embedded systems (K6), and ethical practices (K7).	CO1,CO2	PO1,PO7
P3	Depth of analysis required	The system requires a detailed analysis of real-time parking data, developing predictive algorithms to estimate slot availability (K4, K5).	CO2,CO3	PO3,PO6
P7	Interdependence	The system's interdependent components include IoT devices, a centralized cloud database, user-friendly applications, and real-time monitoring, requiring	CO3, CO5	PO3, PO7

		seamless integration for efficiency.		

How **Complex Engineering Activities (A's)** are addressed through our project and mapping among **A's, CO's, PO's:**

A's	Attribute	How A's are addressed through our project	CO	PO
A1	Range of resources	The project utilizes diverse resources such as IoT devices (sensors and actuators), cloud platforms for data storage, mobile applications, and collaboration among users and developers.	CO1, CO4	PO1, PO7
A4	Consequences for society and the environment	Reduces traffic congestion and fuel consumption by optimizing parking usage. Promotes urban sustainability and improves user convenience through real-time slot allocation and monitoring.	CO5, CO7	PO4, PO7

Conclusion

Parko, the Smart Parking Management System, effectively tackles the challenges of urban parking through the integration of IoT, cloud computing, and real-time data analytics. With features like real-time slot availability, reservation options, and seamless payment processing, **Parko** enhances user convenience, reduces traffic congestion, and promotes efficient resource utilization.

By prioritizing sustainability, **Parko** contributes to environmental preservation by minimizing vehicle idling and reducing fuel consumption. Its user-friendly interface, secure data management, and adherence to local regulations ensure its practicality and acceptance among users and stakeholders.

As a scalable and adaptive solution, **Parko** aligns with the vision of creating smarter, sustainable cities, providing a foundation for future advancements in urban mobility and parking management systems.

References:

Prototype:
https://www.figma.com/proto/CXwKBL5H4gJX5sW0csMYxw/PARKING-MANAGEMENT-SYSTEM?node-id=4-6&starting-point-node-id=18%3A54&t=XrxzInRzsahJ5mbu-1

Gantt Chart:
https://www.canva.com/design/DAGXCQdt0sI/leyzmzwqBZvGTqOCbTAosQ/view?utm_content=DAGXCQdt0sI&utm_campaign=designshare&utm_medium=link&utm_source=editor

Er diagram:
https://docs.google.com/document/d/1u1xYdU3LQ54-6f5qj-NK7JThJEao2Qf2bvep-5ipwOs/edit?usp=sharing

Class Diagram
https://docs.google.com/document/d/1LFRC6Lo_H4vp_2p-gnGwTXKlpyazunTJANfY3NQyb-s/edit?usp=sharing

Use case diagram
https://docs.google.com/document/d/1SKsgyyD8cqgFARBNwxI0oDi1mTRaHgWYtnVhNxEELBE/edit?usp=sharing

activity diagram
https://docs.google.com/document/d/1O6Da14EcKYApBArQ-5tFnebXu-BSl2_FtTqmIFXgpZk/edit?usp=sharing