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"Campus Connect"

BY

Srushti Kadam (ADT23SOCB1156)
Sahil Dubas (ADT23SOCB0921)
Saksham Kumar (ADT23SOCB0934)
Gargi Srivastava (ADT23SOCB1381)

Under the guidance of

Prof. Vishal Patil
Department of Computer Science and Engineering

MIT School of Computing
MIT Art, Design and Technology University, Pune
MAEER's Rajbaug Campus, Loni-Kalbhor, Pune

Chapter 1 INTRODUCTION

1.Introduction

Daily commuting poses a significant challenge for college students, especially those traveling from distant locations. Rising fuel costs, limited public transport availability, and concerns about safety and time efficiency make the need for a reliable solution more urgent. While commercial ride-sharing services exist, they often lack the trust and affordability required by students.

To address these issues, this paper introduces a dedicated carpooling mobile application designed exclusively for college students. The app enables students to connect with peers traveling along similar routes, offering or requesting rides in a secure and cost-effective manner. Verified user authentication using college email IDs ensures a safe and trusted environment. The application also integrates features such as real-time ride tracking, cost splitting, and in-app messaging to streamline the commuting experience. This system not only enhances convenience but also promotes eco- friendly transportation and community engagement within academic institutions.

In the modern world, where urbanization and technological advancements are rapidly transforming lifestyles, the demand for intelligent and efficient transportation systems is higher than ever. Traditional transportation services often fail to meet the dynamic needs of commuters, especially in densely populated or institutionally enclosed environments like college campuses, urban centres, or industrial zones. The lack of real-time data, poor resource optimization, and inefficient routing contribute to increased travel time, higher costs, and environmental degradation. In response to these challenges, this project introduces a **Campus Connect** — a technology-driven platform designed to revolutionize the way individuals commute by leveraging automation, real- time tracking, intelligent scheduling, and user-centric design.

The Smart Transportation App aims to provide a reliable, secure, and efficient medium of transport through seamless ride-booking services, intelligent route optimization, and integrated tracking features. Unlike generic ride-hailing applications, this app is tailored to meet the specific needs of a target community (e.g., university campuses or corporate parks) by focusing on accessibility, low operational costs, and safety features. The platform harnesses the power of GPS, cloud-based infrastructure, data analytics, and mobile connectivity to create a holistic commuting solution that is both scalable and sustainable.

1.1 Digitalization in Labor Market:

The global labour market is undergoing a major transformation driven by digital technologies. Among the most impactful developments is the digitalization of the transportation industry through smart applications that connect drivers, passengers, and administrators in real time. A **Campus Connect** is not just a convenience tool— it is a powerful example of how digital platforms are reshaping work models, creating new employment types, and enhancing workforce efficiency.

As traditional transportation jobs evolve, digital tools redefine roles, responsibilities, and required skillsets. Ride-hailing, real-time logistics, data analytics, and customer management are now central to modern transportation labour dynamics. In this context, the smart transportation app serves as a microcosm of broader labour market digitalization.

Platform-Based Employment The app introduces a new category of work: digital platform-based driving. Drivers no longer rely on traditional taxi stands or dispatch offices—they are now

connected to passengers through automated booking systems.

Digitally Skilled Work Force Transport workers now need digital literacy— understanding maps, navigation apps, ride management dashboards, and customer feedback tools. Even basic transport jobs now require familiarity with smartphones, internet services, and digital wallets.

New Administrative and Support Roles The app ecosystem creates jobs beyond driving—such as app managers, customer support executives, data analysts, marketing staff, and cybersecurity specialists. These roles support the backend and user experience, expanding the labour market in tech-aligned roles.

2.Existing Work

Several ride-sharing and carpooling platforms have been developed over the years to address urban transportation challenges. Applications like Uber Pool, Lyft Line, and BlaBlaCar have demonstrated the benefits of shared mobility by reducing traffic congestion, lowering transportation costs, and minimizing environmental impact. However, these platforms are primarily designed for the general public and do not specifically cater to the needs of student communities.

Uber Pool and Lyft Line allow strangers to share rides based on route matching, but often raise concerns around safety and trust, particularly among college students. BlaBlaCar, a long-distance carpooling service, offers features like user ratings and reviews but lacks integration with academic calendars and student verification systems.

In contrast, a few university-specific solutions such as Zimride (by Enterprise) have attempted to bridge this gap by creating closed networks for campuses. While these services offer secure ride- sharing within college communities, they are often limited to specific institutions and require institutional-level partnerships, which restrict broader adoption.

Moreover, many existing systems lack features like:

- Real-time ride tracking for safety,
- In-app cost-sharing mechanisms,
- Gender or department-based ride preferences,

- Automated ride suggestions based on class schedules.

These limitations highlight the need for a more localized and accessible solution. The proposed carpooling app addresses these gaps by focusing exclusively on college students, enabling secure, efficient, and community- based commuting.

3.Motivation

The motivation behind developing a dedicated carpooling application for college students stems from the growing need for affordable, safe, and eco-friendly transportation solutions within academic communities. Many students face challenges such as high fuel expenses, limited access to reliable public transport, and long daily commutes. Additionally, existing ride-sharing platforms often lack student-specific safety measures, leading to trust concerns when traveling with strangers.

Observing unused car capacities, especially during peak college hours, highlighted an opportunity to connect students traveling on similar routes. By leveraging technology to facilitate organized and secure carpooling, students can reduce their commuting costs, save time, and contribute to lower traffic congestion and pollution levels.

This project is driven by the vision of building a community-based mobility platform that not only makes travel more efficient for students but also fosters collaboration, environmental consciousness, and mutual support among peers.

A key motivation for developing this smart transportation app is that students frequently miss buses, leading to delays in attending classes and disruptions to their academic routine. Traditional transport systems often lack real-time tracking and schedule updates, leaving students uncertain about bus arrivals and routes.

By integrating real-time bus tracking, alerts, and route suggestions, the app ensures students can plan their travel accurately and reach classes on time. It enhances punctuality, reduces stress, and supports a more efficient and student-friendly campus transport experience.

4.Objectives

To provide a platform to freelancers or working professionals. The primary objective of this project is to develop a secure and user-friendly carpooling mobile application exclusively for college students, enabling them to travel efficiently between home and campus. The specific goals include:

- Reduce Commute Costs: Allow students to share travel expenses by connecting with others going in the same direction.
- Promote Sustainable Transportation: Minimize the number of individual vehicles on the road, thereby reducing traffic congestion and carbon emissions.
- Ensure Safety and Trust: Implement college email-based verification and real-time tracking features to create a secure platform for student ride-sharing.
- Simplify Ride Coordination: Offer a seamless user experience through features like ride scheduling, route matching, in-app chat, and notifications.
- Build a Community-Driven Platform: Encourage students to collaborate and support each other through peer-rated profiles and shared responsibilities.

These objectives guide the design and development of a solution tailored to the unique needs and habits of college students, ensuring both practicality and impact.

5. Scope

The scope of this project is limited to the design, development, and deployment of a mobile- based carpooling application intended specifically for college students. The system facilitates ride-sharing between students commuting from their homes to college and vice versa, within a defined geographic range.

Key elements within the scope include:

- User Group: Only students from a verified college or institution will be allowed to register and use the app, ensuring a secure and trusted environment.
- Platform: The application will be developed for both Android and iOS platforms using Flutter for cross-platform support.
- Core Features: The app will include user authentication, ride offering and requesting, cost sharing, real-time tracking, in-app messaging, and user ratings.
- Security: Email verification, GPS tracking, and trip sharing with trusted contacts are included to enhance user safety.
- Geographical Limits: Initially, the app will serve a single college and its surrounding areas but can be expanded to other institutions in future phases.

Chapter 2 CONCEPTS AND METHODS

The app was conceived as a mobile-based platform that connects students commuting along similar routes to facilitate safe, economical, and eco-friendly ride- sharing. The development followed an Agile methodology, allowing for continuous feedback and iterative improvements. The major stages of the development cycle included:

1. Requirement Gathering: Data was collected through student surveys, peer interviews, and competitor app analysis to identify key user needs.
2. Design and Prototyping: Wireframes and UI prototypes were created using Figma, ensuring a user-friendly interface optimized for quick navigation and accessibility.
3. Technology Stack:
    - Frontend: Flutter (for Android & iOS)
    - Backend: Node.js with Express.js
    - Database: MongoDB Atlas (cloud-hosted)
    - Authentication: Firebase (college email ID verification)
    - Geolocation & Maps: Google Maps API for route matching and live tracking
4. Core Modules Developed:
    - Ride offering/requesting interface
    - Schedule-based matching system
    - Live GPS tracking & map integration
    - Cost-sharing calculator
    - In-app chat and notification system
5. Testing:

Unit testing and usability testing were performed on real users to fine-tune functionality and interface behavior.

Datasets

The dataset used in the initial testing phase was generated from:

- Student survey results from [Your College Name], involving 200+ participants who provided information on commuting routes, travel timings, and carpool preferences.
- Synthetic ride data was created to simulate ride requests, user profiles, and route patterns, allowing for algorithm testing without real-time dependency.

The dataset attributes included:

- User ID, name, email (college verified)
- Home and college location (latitude & longitude)
- Ride role (driver/rider), available seats, travel time
- Gender preference (optional), ride history, rating

2.1 Basic Definitions

To ensure clarity and a common understanding of the key concepts used throughout this project, the following basic definitions are provided:

- Carpooling: A transportation arrangement in which a group of people share a ride in one vehicle to reach a common or nearby destination, reducing individual travel costs and environmental impact.
- Ride Matching: The process of pairing drivers and passengers based on similar routes, departure times, and preferences, typically handled by a matching algorithm in the app.
- Verified Users: App users who have authenticated themselves using a valid institutional (college) email ID, ensuring the platform is limited to genuine students from the same institution.
- Cost Sharing: The fair division of fuel and travel expenses among passengers and drivers participating in a shared ride.
- Real-time Tracking: The continuous monitoring and display of a vehicle's live location on a map during an active ride using GPS technology.
- In-App Chat: A secure messaging feature within the app that allows ride participants to communicate and coordinate trip details without sharing personal contact information.
- Sustainable Transportation: Methods of transport that reduce negative environmental impacts, promote energy efficiency, and minimize traffic congestion — such as carpooling.

2.2 Algorithm

The core functionality of the carpooling app relies on a ride matching algorithm that pairs students offering rides with those requesting them, based on route similarity, timing, and preferences.

Ride Matching Algorithm Input:

- Driver's location and destination
- Passenger's location and destination
- Preferred departure time

Steps:

1. Filter Verified Users:
   Ensure both driver and passenger are verified students from the same college.

2. Location Proximity Check:
   - Use Haversine formula to calculate the distance between pickup/drop points.
   - Accept matches within a defined radius (e.g., 2 km for pickup, 5 km for drop)

3. Time Window Matching:
   - Allow ±15 minutes from the requested departure time.
   - Prioritize users with exact or near-exact time matches.

3. Preference Matching:
   - Apply filters such as gender preference or department-based grouping if enabled by users.

4. Score-Based Ranking:
   - Assign a score to each potential match based on:
     - Distance closeness
     - Timing accuracy
     - Number of empty seats
     - User ratings

5. Return Top Matches:
   Display the best-matched drivers or passengers to the user, ranked by score.

Output:

A list of available rides sorted by relevance, shown to the user for confirmation and booking.
Technologies Used:

- Google Maps API: For geolocation, distance calculation, and route plotting
- MongoDB Queries: For filtering ride requests in real-time
- Firebase: For storing verified user data and enabling notifications

Chapter 3: LITERATURE SURVEY

The concept of carpooling and ride-sharing has been widely explored in both academic research and industry applications. Existing literature highlights several platforms and studies that attempt to optimize shared commuting, each with unique approaches and challenges.

A study by Furuhata et al. (2013) provides a comprehensive classification of ride- sharing systems, outlining static vs. dynamic matching techniques and emphasizing the importance of trust, privacy, and convenience in successful implementations. Platforms like Uber Pool and Lyft Line have demonstrated the practical application of ride-sharing at scale, but they cater to the general public and often lack features tailored to specific communities such as college students.

University-focused solutions like Zimride (now part of Enterprise) were among the first to build ride- sharing networks around campus communities, offering students a platform to share rides securely. However, these systems typically require institutional partnerships and lack real-time mobile-based interaction.

Recent academic efforts have explored smart ride-matching algorithms that consider multi-criteria decision making (MCDM), machine learning for route prediction, and social matching for increased user comfort (e.g., pairing users based on department, gender, or schedule). However, many of these studies remain in prototype phase or face limitations in deployment due to infrastructure and adoption barriers. In conclusion, while significant work has been done in the domain of ride-sharing, there is a clear gap in customized, student-centric applications that ensure safety, simplicity, and community engagement. The proposed carpooling app aims to address this gap by combining verified user access, route-based ride matching, and seamless mobile user experience.

Chapter 4 PROJECT PLAN

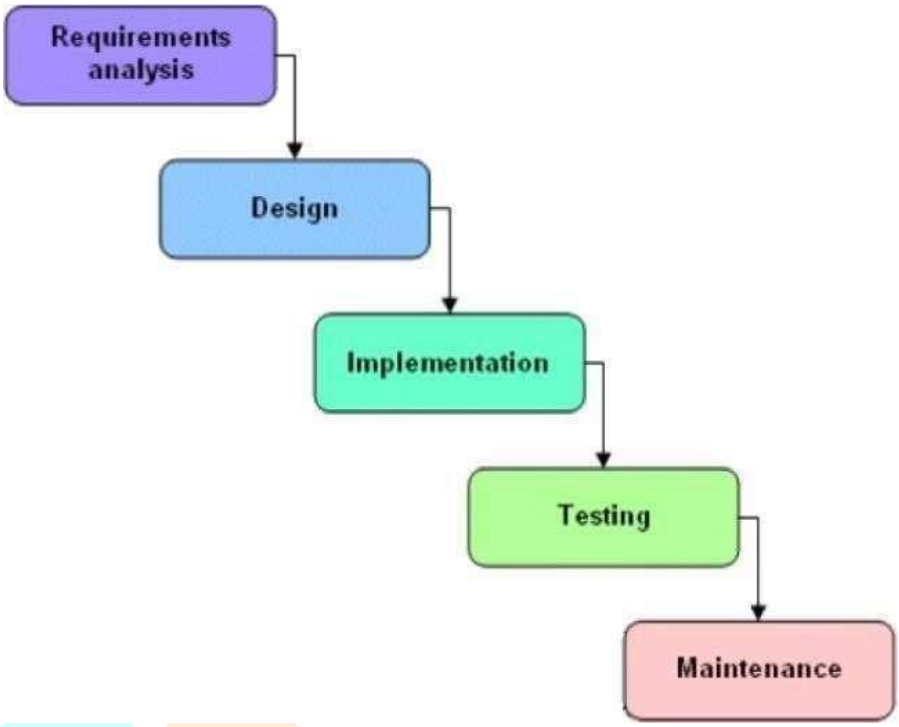

Figure 4.1: Project Plan

We approached the system development using the "Meet Route" in the Based on this model, the required estimates have been stated in Annexure. In order to map our estimates with the steps in model, we considered each phase separately and then stated the required estimates.

Risk Analysis:

The risks for the Project can be analyzed within the constraints of time and Quality

Probability	Value	Description
High	Probability of occurrence is	$> 75\%$
Medium	Probability of occurrence is	$26 - 75\%$
Low	Probability of occurrence is	$< 25\%$

Table 4.2 : Risk probability definitions

Chapter 5: SOFTWARE REQUIREMENT SPECIFICATION

5.1 Project scope

The **Campus Connect** is a mobile and web-based application designed to offer a seamless, secure, and efficient ride-booking experience within localized environments such as college campuses, corporate parks, residential societies, or institutional zones. The project aims to create an intelligent transport system that connects passengers (students, staff, or authorized users) with available drivers (shuttle services, registered private vehicles, or campus drivers) in real -time.

This system addresses the limitations of traditional transport methods and commercial ride-hailing platforms by offering a customized, community-based, and cost-effective solution. It integrates digital features such as real-time vehicle tracking, ride scheduling, route optimization, user authentication, and feedback collection.

5.2 User Classes & Characteristics Coder

- User registration and authentication (with campus ID or admin approval)
- Ride booking and scheduling
- Driver interface for trip management
- Live vehicle tracking using GPS
- In-app notifications and alerts
- Admin dashboard for monitoring, analytics, and management

Chapter 6 RESULTS

Here are the detailed results your smart transportation app is expected to deliver:

1. Reduced Missed Shuttles: By offering real-time shuttle tracking, estimated arrival times, and custom notifications, the app ensures that students and faculty are informed and prepared in advance. This minimizes the frequency of missed buses due to uncertain or mismatched timings.

2. Improved Punctuality: The alignment of shuttle schedules with class and work timings helps users reach their destinations on time. This reduces late arrivals to lectures, labs, or meetings, contributing to a more disciplined and productive academic environment.

3. Decreased Walking Distance and Physical Strain: The app reduces the need for long walks between buildings or stops by guiding users to the nearest shuttle points based on their real-time location, making daily commutes more comfortable, especially in bad weather or for those with mobility issues.

4. Increased Shuttle Utilization: With better awareness and accessibility, more students and faculty are encouraged to use shuttle services, improving occupancy rates. This makes the transport system more efficient and justifies operational costs.

5. Enhanced User Satisfaction: The convenience, time savings, and reliability provided by the app lead to positive user feedback. The sense of control and predictability reduces commute-related stress and boosts overall campus satisfaction.

6. Data-Driven Decision-Making: Admins can use app-generated data (e.g., peak usage times, high- demand stops, route efficiency) to fine-tune shuttle routes, schedules, and frequency. This results in continuous improvement of the transport system.

7. Lower Environmental Impact: Encouraging shuttle use over personal vehicles contributes to fewer cars, reducing emissions, and the demand for parking space.

Together, these results highlight how your app can transform campus mobility, improve user experience, and support smarter, greener transportation management.

Chapter 7 SOFTWARE TESTING

Type of Testing Used:

Unit Testing

Each individual module—such as user authentication, ride matching, cost calculation, and chat functionality—was tested independently to verify that they operate correctly in isolation. Testing tools like Jest (for Node.js) and Flutter's built-in test framework were used for backend and frontend components, respectively.

Integration Testing

Modules were combined and tested as a complete system to ensure smooth data flow between frontend (Flutter UI) and backend services (Node.js and MongoDB). Scenarios such as offering a ride, matching a passenger, and confirming a booking were executed to validate end-to-end behavior.

System Testing

The complete application was tested under real-world usage conditions, including simultaneous logins, concurrent ride requests, and GPS tracking. This phase verified that all components work together as expected on both Android and iOS devices.

Usability Testing

Selected students participated in hands-on testing sessions to evaluate the user interface and experience. Feedback was collected to improve button placement, reduce navigation steps, and ensure a clean and intuitive design.

Security Testing

Authentication and data access were tested to prevent unauthorized access and data breaches. Firebase's authentication system and role-based access control (RBAC) helped enforce user-level security.
Additionally, form validation and database query restrictions were tested to prevent injection attacks and misuse.

Bug Tracking and Reporting

Issues identified during testing were logged using a bug tracking system (e.g., Trello or GitHub Issues), categorized based on severity, and addressed in subsequent development iterations. This project presents a student-focused carpooling application designed to improve commuting efficiency, affordability, and sustainability for college students. By integrating features such as college email verification, real- time GPS tracking, cost-sharing, and in-app communication, the app offers a secure and user-friendly environment tailored to the specific needs of academic communities.

The development process included user requirement analysis, design, implementation using modern technologies (Flutter, Firebase, Node.js, MongoDB), and rigorous software testing. User feedback and surveys confirmed the app's relevance, usability, and potential for real-world adoption.

Chapter 8 CONCLUSION AND FUTURE WORK

This project presents a student-focused carpooling application designed to improve commuting efficiency, affordability, and sustainability for college students. By integrating features such as college email verification, real- time GPS tracking, cost- sharing, and in-app communication, the app offers a secure and user-friendly environment tailored to the specific needs of academic communities.

The development process included user requirement analysis, design, implementation using modern technologies (Flutter, Firebase, Node.js, MongoDB), and rigorous software testing. User feedback and surveys confirmed the app's relevance, usability, and potential for real-world adoption. The successful prototype demonstrates how technology can address local transportation challenges while fostering a sense of community and environmental responsibility.

FUTURE WORK:

- Integration of a secure digital payment gateway to automate fare splitting.
- AI-based ride matching for more accurate and efficient pairing of users.
- Advanced scheduling and recurring ride options for students with fixed class timetables.
- SOS and emergency contact alerts for enhanced safety.
- Expansion of the app to serve multiple colleges and universities with a centralized admin dashboard.
- Carbon savings tracker to encourage eco-friendly usage through gamification and rewards.

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