Bilkent University
CS 491 - Senior Design Project

PROJECT SPECIFICATION DOCUMENT
for
DriveMe

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1. Introduction

People often face situations when they cannot drive a car because of health problems, consumption of alcohol, temporary physical constraints, or legal limitations like a suspended driving license, and so on. In such cases, many people have a need to travel in their own car. DriveMe is designed to allow users to request verified drivers who can operate the user's personal vehicle and transport them to a desired destination. The platform shall make transport safer and offer a new flexible option of mobility to the users who cannot, or would not wish to, drive for a certain period of time.

To utilize the application, passengers will create a trip request by entering the pickup and destination locations. It then matches them with an available driver according to their selected criteria. Once a match is confirmed, the driver goes to the passenger's location and operates the passenger's vehicle for the trip. At the end of the ride, payment is completed directly, and both parties may rate each other to support long-term service quality. These interactions form the core workflow of the platform and allow for a seamless user experience.

This report represents an overview of the project description, constraints, and ethical considerations, design requirements, and feasibility discussions.

1.1 Description

The proposed mobile application connects users who cannot operate their own vehicles with available drivers who are willing to drive on their behalf. The platform is built around two primary user roles: **Drivers** and **Passengers**, each supported by tailored onboarding processes, decision-making filters, and safety-oriented features.

1.1.1 Driver Registration and Availability

Drivers create an account by entering their personal information and driver's license details. As part of the registration process, drivers sign a digital agreement confirming the following:

- They acknowledge responsibility for any speed-related fines incurred during the trip.
- They waive the right to initiate material or moral compensation claims against the vehicle owner in the event of an accident.
- They commit to safe and lawful driving behaviour.

Once registered, drivers can set themselves as **available** and enter key preferences, such as:

- Maximum distance for the pickup location (e.g. 10 km from their initial location).
- Maximum distance for the drop-off destination. (e.g. 30 km from their initial location).
- Whether they accept trips involving pets.

The application then uses these parameters to match drivers with passengers. The driver travels to the passenger's location using any preferred method (public transportation, bicycle, drop-off by a friend, etc.), which is excluded from system constraints to maintain flexibility.

1.1.2 Passenger Registration and Trip Creation

The passengers are registered by giving personal information and the type of transmission of their cars, whether manual or automatic. When requesting a journey, a passenger specifies their pickup location, destination location, and state whether they will be travelling with a pet or not. The system then generates a dynamic, AI-supported price range taking into consideration:

- The distance the driver must travel to reach the passenger.
- The distance the driver must travel to reach the passenger.
- The total distance traveled in the passenger's vehicle,
- Local transportation cost standard.

Through this range, passengers submit a price offer, which, if accepted by the driver, confirms the match.

1.1.3 Journey Execution and Rating System

Once the driver arrives at the passenger's location, the journey starts and when arrived to the destination, it ends. The passenger pays in cash or bank transfer once they arrive at the destination. Ratings can then be left by both users afterwards. In order to keep the integrity of the system, two penalty mechanisms have been introduced:

- **Speed Penalty:** This is automatically applied if the system detects that a driver has exceeded expected travel times based on navigation speed limits.
- **Cancellation Penalty:** Applied to whichever party cancels the trip after a match is confirmed.

These mechanisms promote fair use, accountability, and ensure a high-quality user experience.

1.2 High Level System Architecture & Components of Proposed Solution

The DriveMe system is designed as a modular, scalable, and secure platform combining a Flutter-based mobile client with a **Spring Boot–based microservices backend**. The architecture is structured into layers to separate user interaction, core business logic, communication protocols, and data management, ensuring maintainability and future extensibility.

1.2.1 Client Layer

The client layer consists of a Flutter mobile application used by both drivers and passengers. It supports onboarding, document uploads, trip requests, offer handling, real-time location tracking, messaging, and rating. All interactions with the backend occur through secure API calls, and drivers receive additional capabilities such as availability settings and navigation assistance.

1.2.2 Backend Layer (Spring Boot Microservices)

Spring Boot is used to develop the backend , that is structured as independent microservices that communicate through REST APIs and event streams. Each service encapsulates a specific domain:

- **Auth & Gateway Service:** Handles authentication and authorization using OAuth2/JWT and acts as the entry point by routing external requests to the correct microservices.
- **User Service:** Manages vehicle owner profiles, registered vehicles, vehicle documentation, and user-related settings.
- **Driver Service:** Handles driver accounts, verification of submitted documents (ID, licence, criminal records), availability management, and rating aggregation.
- **Matching Service:** Performs geo-based and rule-based matching using driver proximity, driver-selected radius, vehicle compatibility, and price offers.
- **Trip Tracking Service:** Manages trip initialization (QR validation), real-time updates, destination verification within the GPS tolerance radius, and finalization.
- **Payments/Offer Service:** It is calculated that dynamic minimum and maximum price ranges using driver travel distance, trip distance, and local transportation metrics. Stores accepted offers and payment confirmations.
- **Notifications Service:** Delivers email/push notifications, reminding users of trip status changes, document expiry alerts, and driver-user communications.

All Spring Boot services follow a consistent structure with controllers, services, repositories, and DTOs, ensuring maintainability and uniform behavior across the system.

1.2.3 Communication Layer

This layer mediates all data exchange within the system:

- **RESTful APIs** for registration, document upload, offer submission, and trip management.
- **WebSocket channels** for real-time driver location updates and trip progress.

- **Third-party integrations** (maps, geocoding, email services, and insurance verification) accessed through secure API clients.

The strict separation between synchronous (REST) and asynchronous (WebSocket/Kafka) communication ensures balanced performance and responsiveness.

1.2.4 Data, Logging & Storage Layer

The storage and logging layer provides persistent data handling, distributed logging, and event-streaming functionality:

- **PostgreSQL:** Stores structured relational data (users, vehicles, drivers, trip records, offers, ratings).
- **Redis:** Caches frequently accessed data, especially active driver locations, to support fast near-real-time matching.
- **Apache Kafka:** Kafka is used as the centralized event pipeline for system logs, trip events, driver availability changes, matching events, and error logs. This architecture enables:
    - Reliable and scalable log ingestion,
    - Real-time monitoring and analytics,
    - Audit trails for safety and compliance,
    - Future integration with ML-based risk scoring or fraud detection.
- **Monitoring & Observability Tools:**
  Services are planned to generate structured logs and metrics that feed into Kafka consumers and visualization tools, enabling error detection, anomaly tracking, and performance insights.

1.3 Constraints

1.3.1 Implementation Constraints

DriveMe's implementation is setted be limited by the chosen technology stack and infrastructure. The mobile application must be developed using **Flutter**, which restricts UI components and plugin availability to what the framework supports. The backend must run as **Spring Boot microservices** behind an API Gateway using OAuth2/JWT authentication. **Docker must be used to** containerize services, requiring consistent configuration and resource allocation.

Real-time GPS tracking and trip monitoring require persistent communication technologies, WebSocket, which introduce constraints on latency, battery usage, and server capacity. Document verification (ID, licence, criminal record) also requires secure file handling and object storage (e.g., MinIO). Additionally, essential system features depend on **third-party APIs** for maps, geocoding, SMS/email, and notifications, all of which apply rate limits and quota restrictions.

1.3.2 Economic Constraints

DriveMe relies on external services, like geolocation APIs, SMS/email verification, and cloud hosting that incurring costs once free-tier limits are exceeded. During development, the team must operate within student-friendly or free-tier plans, which may restrict storage, request volume, and uptime.

Background verification of drivers may require paid thirdparty systems or partnerships with government-insurance services, which are not feasible at scale within the project scope. Long-term scalability (real-time tracking, high user load) also introduces operational costs that cannot be fully supported during the prototype stage.

1.3.3 Ethical Constraints

Because DriveMe processes sensitive data that including identity documents, driving licences, criminal records, and real time location streams that has strict privacy and ethical principles must be followed. Personal data must be encrypted, stored securely, and used only for its intended purpose.

Location track is especialy sensitive, requiring minimal retention, limited access, and clear user consent in line with data-protection principles. The system must also enforce fair and non discriminat matching that avoiding any bias in driver passenger pairing or rating mechanisms.

1.3.4 Legal Constraints

DriveMe must operate within legal requirements related to insurance, liability, and safe vehicle usage. When a driver operates someone else's vehicle, many jurisdictions assign primary legal responsibility (traffic fines, damages, violations) to the vehicle owner, even if another person is driving. Therefore, both parties must digitally acknowledge this responsibility before a trip begins. Insurance regulations also pose constraints. Some insurance policies do not cover third-party drivers unless explicitly permitted. The system must warn users and require confirmation that their insurance allows another individual to operate the vehicle, especially in case of accidents or property damage.

Additionally, the platform must ensure that drivers agree to legal obligations such as not driving under the influence of alcohol, complying with traffic rules, and accepting consequences for unsafe behaviour. If an accident or misconduct occurs, the predefined digital agreement determines liability.

1.4 Professional and Ethical Issues

DriveMe operates in a domain where user safety, privacy, and trust form the core of the platform. Since the system allows a verified driver to temporarily take control of a user's personal vehicle, the ethical and professional responsibilities of the development team are much higher compared to a standard mobile application. The platform handles sensitive and legally protected data such as government-issued identification, driving licences, criminal record documents, and continuous GPS location data.

- To begin with, the documents collected during the identity verification process must be handled according to strong data protection principles. Driver's licence photos, ID cards, and other legal documents should be used only to verify the driver's identity, must not be shared with unauthorized individuals, and should be stored only for the minimum time required.
- DriveMe also collects real-time GPS coordinates for creating trips, matching drivers and users, navigation, and safety monitoring. Ethical operation requires keeping this data only as long as necessary, anonymizing past records when appropriate, and restricting access using least-privilege rules. Continuous user consent similar to GDPR or KVKK standards is essential when processing sensitive location information.
- Other personal data such as login credentials or payment information will be encrypted using widely accepted industry methods to prevent unauthorized access and to reduce the impact of any potential data breach.

1.5 Standards

- DriveMe follows general software development principles based on the **ACM/IEEE Software Engineering Code of Ethics**, which highlights the responsibility of developers to prioritize public safety, clarity, and reliability [1]. Studies on transportation technologies also show that applying these ethical principles helps reduce risks in systems involving real-world mobility [2].
- The mobile app interface follows **Google's Material Design Guidelines** (Android). Research on usability indicates that following these design rules improves accessibility, reduces user mistakes, and creates a more reliable experience especially in situations like navigation or live communication where safety matters [3].
- Regarding data privacy, DriveMe is built in line with the key rules of GDPR and the Turkish **KVKK**. These regulations underline important concepts such as informed consent, data minimization, purpose limitation, and the user's right to access or delete their data. Such principles are crucial for applications that work with sensitive information like real-time location data or identity documents [4, 5].
- Additionally, all system diagrams and modeling activities follow the **UML 2.5.1** standard, which is widely used for designing complex software systems [6]. Project documentation uses IEEE citation and formatting rules to keep the reporting consistent and easy to track.

2. Design Requirements

2.1. Functional Requirements

2.1.1. Driver Profile Management

- The drivers shall be able to register with their e-mails and/or telephone numbers.
- Drivers shall share their driver's license, criminal background and insurance records for background checks.
- The system shall flag missing or expired documents and prevent activation until resolved.
- The system shall notify drivers when any uploaded document is expiring within 30 days.
- Drivers shall be able to view and edit their profile photo, contact information, user name.
- The system shall place all new driver accounts in a *PENDING* state until they are approved.

2.1.2. Passenger Profile Management

- Each user shall be able to register one or more vehicles.
- Passengers shall upload vehicle registration and insurance policy documents.
- Passengers shall be able to view and edit their profile photo, contact information, user name.
- Passengers shall be able to update or delete their registered vehicles.
- System shall re-apply the documentation checks after an edit/update.
- The system shall place all new vehicles in a *PENDING* state.

2.1.3. Requests, Offers & Matching Users

- Passengers shall be able to place a driver request for a specified time and one of their registered vehicles.
- Passengers shall be able to create a request that is at most dated a year later than the current date.
- Drivers shall be able to view requests whose arrival or departure points are in a radius of driver-chosen distance.
- Drivers shall be able to view only the requests that contain a vehicle that they are licensed to drive.
- The system shall designate minimum and maximum prices for each request depending on the distance, neighborhood and type of vehicle.
- Drivers shall be able to offer prices between the designated minimum and maximum amounts for driver requests.
- Passengers shall be able to view offers that drivers have submitted and choose one of the drivers to match.
- Passengers shall be able to see the profile of the driver who has offered a price.
- The system shall automatically flag the driver request as *MATCHED* if any of the offers are accepted.
- Passengers shall be able to cancel their requests.
- In case of cancellation, the system shall assign a penalty to the passenger.

2.1.4 The Trip

- Users shall recognize each other by scanning QR codes that are provided by our mobile application.
- Once the QR is scanned, the system should log an event for the start of the trip.
- During the trip, vehicle owner shall be able to follow their vehicle’s location (i. e. the driver’s location)
- When the driver arrives at the destination point, they shall approve their arrival from the application.
- The system shall check if the driver’s current location matches with the destination point. (Fluctuations from GPS shall be covered by a radius of 30 meters.)
- Upon arrival, the driver shall leave the vehicle keys in an agreed spot.
- The arrival time and destination shall be logged by the system.

2.1.5 Ratings

- If and only if a trip is finalized, the vehicle owner shall be able to rate their experience.
- The average of all ratings for a driver shall be seen on their profile.

2.1.6 Payments

- The payment procedure shall take place only after a trip is finalized.
- The vehicle owner shall transfer the agreed amount to the driver's registered bank account in the following 30 minutes of arrival.
- Failure to transfer the price shall result in a temporary or permanent ban.
- The driver shall approve that they have received the payment.
- After the driver's approval, the system should log this event and flag the trip as *FINISHED*.

2.2. Non-Functional Requirements

2.2.1. Usability

- The UI should be user-friendly and intuitive.
- The UI shall support accessibility features such as font scaling for elderly.
- The application shall be available in the Android operating system.

2.2.2. Reliability

- Uploaded personal documents shall be stored securely and in accordance with KVKK.
- The system shall be able to restore event logs if needed.
- If a service request fails, the system shall queue it and retry in 5 seconds.
- The system shall prevent duplicate database entries for vehicles, drivers and vehicle owners.
- Event driven design for logging the critical events will ensure that data losses for these events shall be recoverable.

2.2.3. Performance

- The system shall support real-time location tracking with updates that are more frequent than once in a 3 seconds.
- Application shall provide feedback notifications for recordings, updates and search results in 3 to 5 seconds.

2.2.4. Supportability

- Application shall employ a microservice architecture, making it possible to update components individually.
- The system shall provide clear and specific error messages to ensure maintenance and accurate troubleshooting.

2.2.5. Scalability

- User and vehicle databases shall scale dynamically to support the amount of data if needed.
- The system shall allow onboarding of new cities with minimal effort.

3. Feasibility Discussions

3.1. Market & Competitive Analysis

3.1.1 Market Needs

In many countries, including Turkey, alcohol consumption, fatigue, medication use, and temporary health conditions contribute to traffic accidents. According to a study conducted in Turkey, drunk drivers are responsible for 5-6% of all traffic accidents [7]. At the same time, penalties and legal regulations for drunk drivers are becoming increasingly stricter, and even the introduction of new regulations such as alcohol lock is being discussed [8].

This high risk and high penalty situation creates a market for those who provide transportation services to those who want to return home safely using their own vehicles. Traditional taxi and shared transportation applications do not solve the problems of those who want their vehicles in front of their homes the next day.

3.1.2 Existing Solutions

Internationally, this need is already addressed by several platforms:

- **Dryver / Jeevz (US)**: Driving service for individuals that works in many U.S. cities. Customers can hire a driver by the hour to drive their own car, or they can ask for a "pickup service" where a team comes and takes the customer and their car home. The app lets you make reservations, track the driver and vehicle with GPS, and get help from customer service inside the app. [9].

- **Get Driven (Europe)**: Lets users book a professional driver “in less than a minute” to drive them in their own car for nights out, events or business trips, emphasizing vetted drivers and safety [10].

- **iDriveYourCar, Jeevz, DriveU, AutoPilot, etc.**: Similar chauffeur-style platforms that provide background-verified drivers on demand, often priced per hour or per trip, and mostly targeted at business travellers and high-income users [11].

- **RYDD (South Africa)**: An on-demand designated driver app that specifically markets itself as getting “you AND your car home safely after a night out [12].”

Within Türkiye, comparable services are emerging, but remain fragmented and mostly concentrated in large cities:

- **Motovale**: It calls itself a "designated driver" service for Turkey. A driver comes (with a folding motorcycle at first), puts it in the customer's trunk, and then drives the customer's car to the destination. Their app lets you call a driver with just one tap, track your GPS location, pay with a card, and rate your trip afterward.[13].

- **BiŞoför**: A mobile app that lets users request an “ayık şoför” (sober driver), “özel şoför” (hourly private driver) or “seyahat şoförü” (long-distance driver). Users enter the address, see an estimated price, track the driver on a map, pay by card or cash, and rate the driver afterward [14].

- **FunBreak Vale**: A newly launched app focusing on scenarios such as nights out, long trips, business meetings, and post-surgery hospital visits. Users call a vale driver, see transparent pricing based on distance and waiting time, and track the driver with live GPS [15].

These competitors demonstrate that this business model is feasible and that users are willing to pay to be driven using their own vehicles. It also demonstrates that the market is still developing.

3.1.3 Position of DriveMe

Compared with the above, **DriveMe** positions itself as a **safe and compatibility-oriented mobility platform** rather than only a nightlife or valet service:

- **Broader use cases:** DriveMe is not just for situations involving alcohol; it's also for tiredness, medication effects, temporary physical limitations, suspended licenses, and older or less experienced drivers who still own a car. This makes the possible user base bigger than just people who go out on the weekends..

- **Structured matching and pricing:** DriveMe employs a dynamic price range based on pickup distance, trip distance, and local cost benchmarks in place of a strictly fixed tariff, within which drivers and passengers can bargain. This seeks to improve perceived fairness and pricing transparency and is more akin to ride-hailing services than traditional chauffeur services.[9].

- **Verified drivers and vehicles:** DriveMe’s design includes digital onboarding with document uploads (driver’s license, criminal record, vehicle insurance and registration), automated checks, and a *PENDING/APPROVED* state machine before accounts become active and reachable. Many existing Turkish services highlight that drivers are “professional” but do not clearly expose a structured, auditable verification flow to end users [13].

- **Safety and trust mechanisms:** Features like live trip tracking, thorough rating histories, speed-based penalties, and cancellation penalties directly address research showing that perceived safety and trust are important adoption factors in ride-hailing.[16].

The market for designated drivers and private drivers is real and expanding, as evidenced by the existence of both domestic and international players. However, a platform that combines strict verification, transparent dynamic pricing, and explicit safety-oriented features customized to the Turkish legal and cultural context is still needed.

3.2. Academic Analysis

3.2.1 Traffic Safety and Alcohol-Related Crashes

Alcohol is a major risk factor for serious crashes and fatalities, according to traffic safety literature. According to one review, 5–6% of traffic accidents in Turkey are caused by drunk driving, with young drivers being disproportionately affected [17]. In official statistics, "drunk driving" is also identified as a separate causal factor category by more recent analyses of accident records [18].

Numerous empirical studies conducted worldwide have looked at whether on-demand transportation services like Uber and Lyft lessen the negative effects of alcohol. Greenwood and Wattal found that the introduction of ride-sharing services is associated with significant decreases in alcohol-related motor vehicle fatalities using data from U.S. cities and a difference-in-differences design [19]. According to a subsequent NBER analysis, having access to Uber is associated with a 4% decrease in overall fatalities in the US and a 6% decrease in alcohol-related traffic deaths [20]. While some reviews point to conflicting or context-dependent effects, other clinical and regional studies also indicate that ride-sharing availability is associated with fewer alcohol-related emergency visits and convictions [21].

DriveMe tackles the same fundamental behavioral issue where people choose to drive when they shouldn't; even though it isn't a traditional ride-sharing service (the passenger owns the vehicle). This information supports the theory that increasing the availability of a safe, on-demand alternative can help lower the number of traffic accidents and injuries.

3.2.2 Trust, Safety and Platform Governance

The development of trust in ride-hailing is the subject of another line of inquiry. According to Najjar et al. [16], customers' trust in ride-hailing services is greatly impacted by their perception of the legitimacy of the platform and the transparency of its processes, including clear guidelines, visible ratings, and complaint resolution procedures. Similarly, Shao et al. demonstrate that institution-based trust mechanisms such as guarantees, legal compliance signals, and platform-controlled safety features significantly increase users' willingness to rely on ride-sharing platforms [22].

More recent studies propose dynamic models for how platform-based institutional structures (identity verification, sanctions, reputation systems) impact trust and long-term use in ride-sharing contexts [23].

These scholarly recommendations are directly in line with DriveMe's planned features, which include driver document verification, trip-lifecycle logging, speed and cancellation penalties, and two-sided ratings. The project makes use of established knowledge about how to reduce perceived risk and promote adoption by integrating formal trust and safety mechanisms into the platform architecture.

3.2.3 Research Gaps and DriveMe’s Contribution

Ride-hailing, where the platform owns or manages the fleet of vehicles, is the primary focus of current research and commercial systems. Particularly in the Turkish context, designated-driver services that drive the user's own vehicle have received relatively little research. Additionally, the majority of academic research treats privacy and safety independently, but real-world platforms need to work together to optimize:

- Road-safety outcomes (reducing impaired driving and fatigue-related crashes),
- User trust and perceived security (through verification, tracking, and ratings),
- Data protection and regulatory compliance (KVKK, location-data minimization).

DriveMe offers an environment for investigating the practical interactions between these dimensions by integrating designated-driver functionality with microservice-based real-time tracking, document-driven verification, and platform-level sanctions. Therefore, the project can be positioned as both a commercial prototype and an applied case study that links research on privacy-preserving mobility platforms, trust mechanisms, and ride-hailing safety to a fresh, unexplored service model.

5. Glossary

UI: User Interface

KVKK: Data protection law in Turkey. It is focused on the security and privacy of personal data.

GPS: Global Positioning System. A satellite based navigation system.

QR Code: Quick Response Code. A barcode that is in square shape which is used to store data.

DTO: Data Transfer Object.

GDPR: General Data Protection Regulation

NBER: National Bureau of Economic Research (A U.S.-based nonprofit research organization)

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