

TQS: Product specification report

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1 Introduction

1.1 Overview of the project

This project was developed in the context of the Test and Quality Software (TQS) course, which emphasizes building robust, testable, and maintainable software systems. Throughout the project, we applied principles of agile development, user-centered design, and quality assurance.

Our product, ChargeHub, is a digital platform designed to improve the experience of electric vehicle (EV) drivers and facilitate efficient management for station operators. It aims to simplify the process of discovering, reserving, and managing EV charging sessions, while also providing essential administrative tools. Below lies a comprehensive list of our core functionalities

Station Discovery

- Search for nearby charging stations based on location.
- Filter stations by charger type, availability, and cost.

Slot Booking & Scheduling

- Reserve a charging slot in advance.
- Receive notifications and booking confirmations.

Charging Session Management

- Start/stop charging sessions using a reservation token.
- View real-time session data including time, cost, and energy used.

Payment Integration

- Review and pay for charging sessions within the app.
- Station operators can access financial reports and track payments.

User Profiles & Charging History

- Track past charging sessions and total energy consumption.

Back Office Operations for Station Operators

- Update station data such as pricing and availability.
- Report user misconduct.
- Admin features include account creation and station assignment.

ChargeHub reflects the TQS course objectives by combining well-structured software design with comprehensive feature testing and quality control measures.

1.2 Known limitations

In the **Station Discovery** module, features like the map view and real-time route tracing to charging stations were excluded from the MVP. Although visualizing stations on a map and guiding users to their destination would have significantly enhanced usability, the development effort required to integrate mapping APIs and manage location data in real time was beyond the scope of the initial release. Similarly, the ability to plan long-distance trips with intermediate charging stops was deferred due to its high complexity and limited necessity for everyday use cases.

Within **Slot Booking & Scheduling**, the system does not currently support operator-defined custom schedules or advanced notification flows. While users receive immediate booking confirmation, reminders such as those scheduled 15 minutes before a reserved slot or alerts about charger disruptions were not fully implemented. These features were deprioritized in favor of ensuring reliable booking and confirmation workflows.

In the **Charging Management** area, several enhancements were considered but ultimately left out. For instance, users are not yet able to monitor real-time metrics like battery level, cost accumulation, or energy consumption during a session. Additionally, the option to restart a recently stopped session was not included, as it involves maintaining complex session state and reconnection logic. A live dashboard for station operators to monitor charging sessions was also scoped out for future development, as it required significant backend support.

From a **sustainability and user history** standpoint, the platform does not currently track estimated CO₂ emissions saved—an optional feature designed to give users a sense of environmental impact. Similarly, administrative dashboards to analyze platform-wide trends and KPIs were planned but not pursued in this version, as the focus remained on delivering a strong user-facing experience.

Lastly, in the **account and backoffice management** domain, full administrative control over user accounts and a user-led charger feedback mechanism were not implemented. While operators can manage station data and create new accounts, broader moderation and analytics capabilities were reserved for future iterations. Additionally, the ability for users to permanently delete their accounts was not completed in time for the initial release.

In summary, the omitted features reflect a careful balancing of ambition and feasibility. While not part of the current release, they represent valuable directions for future development, ensuring that **ChargeHub** remains a scalable and feature-rich platform as it evolves beyond the scope of the TQS course.

1.3 References and resources

<document the key components (e.g.: libraries, web services) or key references (e.g.: blog post) used that were really helpful and certainly would help other students pursuing a similar work>

2 Product concept and requirements

2.1 Vision statement

<functional (black-box) description of the application: Which is the high-level/business problem being solved by your system? Which are the key features you promise to address it?>
<if needed, clarify what was planned/expected to be included but was changed to a different approach/concept >
<optional: how is your system different or similar to other well-known products?>
<optional: additional details on the process for the requirements gathering and selection (how did we developed the concept? Who helped us with the requirements? etc)>

2.2 Personas and scenarios

Personas

EV Driver



Sofia is a thirty-nine-year-old Marketing Consultant based in Lisbon, Portugal. She recently made the switch from a diesel car to an electric vehicle. Though confident in her decision, she wants to ensure it makes long-term financial sense, especially given how often she drives for work.

She frequently travels across city and suburban areas to meet clients and attend events. Despite her marketing background, navigating EV-related logistics is new to her. She often finds herself concerned about where and when she can charge her vehicle and how charging costs compare to the fuel expenses of her previous car.

Sofia is motivated to make smarter decisions about EV ownership. She would benefit from a user-friendly app that shows available charging stations along her route, provides real-time charger availability, and offers expense comparisons. This would give her peace of mind during daily commutes and work trips.

Motivation: Sofia wants to improve her EV experience and be sure her switch from diesel is both eco-friendly and economically viable.

Station Operator



Miguel is a forty-seven-year-old station manager who oversees two Galp service stations in Aveiro, Portugal. He is married and has worked in the fueling industry for more than two decades. Recently, Miguel installed electric chargers at both locations to modernize his business and meet the rising demand for EV infrastructure.

Despite this upgrade, Miguel struggles with making the most of the chargers. He needs real-time insights into charger usage, availability, and performance. His goal is to keep the stations visible and attractive to EV drivers and avoid chargers being offline or underused.

Miguel is looking for a smart management system that lets him track usage patterns, schedule maintenance, and update station status instantly. He also wants a tool to advertise his chargers' availability to drivers nearby.

Motivation: Miguel wants to maximize charger usage, attract more EV drivers, and run his stations efficiently.

Admin



José is a twenty-seven-year-old System Administrator working in Aveiro, Portugal. He is married and plays a key role in managing the user accounts and access permissions for an EV charging platform.

José's work revolves around ensuring that the right people have access to the right tools. He is responsible for creating and managing accounts for station operators, assigning stations to them as needed, and updating platform access to reflect organizational changes. He also oversees EV driver accounts and ensures that user data stays clean, current, and compliant with platform rules.

Although he doesn't deal directly with technical maintenance or infrastructure, José's work is essential for keeping operations organized and secure. He values clarity and simplicity in admin tools, and needs efficient interfaces to carry out tasks quickly and accurately.

Motivation: José wants to manage users and station assignments effectively and ensure the platform reflects the latest organizational setup at all times.

Scenarios

Sofia searches for a charger nearby

- Sofia notices her EV battery is getting critically low while driving to an important client meeting. She opens the app and is greeted by a clean interface showing nearby charging points. The app detects her current location and displays available fast chargers within reach. She quickly filters by availability and connector type, selects the nearest compatible charger, and the app provides real-time navigation to the station.

Sofia checks for chargers along her planned route

- Sofia is planning a work trip from Lisbon to Porto and wants to ensure charging won't disrupt her schedule. She opens the trip planner in the app and enters her destination. The system calculates the best route and overlays charging stations along the way. She taps on a few stations to compare details and estimated costs, helping her plan a smooth and stress-free trip.

Sofia reserves a charger in advance

- Knowing she'll arrive in a busy downtown area during peak hours, Sofia wants to avoid the risk of waiting in line. She searches the app for chargers in the area and sees that only a few are available. She selects a station, reviews the terms, and reserves a slot. Upon arrival, she checks in via the app and begins charging immediately.

José suspends an EV driver account due to policy violation

- José receives an automated alert about repeated misuse of charging sessions by an EV driver, such as overstaying after sessions end. He reviews the user's charging history and confirms multiple violations. Through the admin panel, he temporarily suspends the driver's account.

José adds a new station operator and assigns them their stations

- A new charging station operator joins the platform. José logs into the admin system and creates the operator's account. He selects the appropriate role and access permissions, then assigns the relevant stations. After final review, he activates the profile. The new operator now has access to manage pricing, monitor charger status, and view usage analytics for their assigned stations.

Miguel configures pricing and details for his assigned charging stations

- Miguel has recently been assigned a new set of EV chargers at his Galp stations. He logs into the management portal for the first time to complete the initial setup. He selects each station and inputs key details, such as the type of connectors available, maximum charging power and pricing. Once the configuration is complete, the stations become visible to EV drivers through the platform's app.

2.3 Project epics and priorities

EPIC 1: Station Discovery

User Stories:

- **As an EV Driver**, I want to search for charging stations near my location so that I can access stations within a short distance from me.
 - **Priority/Estimate:** High, 2
 - **Acceptance Criteria:**
 - Given I have opened the charging station app,
 - When I allow location access
 - Then I see a list of charging stations ordered by proximity to my current location
- **As an EV Driver**, I want to filter stations by charger type, availability, and cost so that I can find stations that match my technical needs and budget.
 - **Priority/Estimate:** Medium, 2
 - **Acceptance Criteria:**
 - Given I am viewing the list of charging stations,
 - When I apply filters for charger type, availability or cost,
 - Then only the charging stations that meet the selected criteria are displayed
- **As an EV Driver**, I want to see charging stations on a map so I can easily locate them.
 - **Priority/Estimate:** Low, 3
 - **Acceptance Criteria:**
 - Given I have granted location access,
 - When I open the map view,
 - Then I see markers for all nearby charging stations
- **As an EV Driver**, I want to trace a route to a nearby charging station so that I can visualize the path to it.
 - **Priority/Estimate:** Optional, 4
 - **Acceptance Criteria:**
 - Given I select a charging station,
 - When I select “Get Directions”,
 - Then a route from my current location to the station is shown on the map
- **As an EV Driver**, I want to see the closest charging stations when planning a trip, so that I can see where I should stop to charge my vehicle.
 - **Priority/Estimate:** Optional, 5
 - **Acceptance Criteria:**
 - Given I input my trip's start and end points,
 - When I begin trip planning,
 - Then I see a list of charging stations closest to the path between those two points,
 - And each station includes the distance from the departure and estimated time deviation from the route.

EPIC 2: Slot Booking & Scheduling

User Stories:

- **As an EV Driver**, I want to book a charging slot in advance so that I can ensure availability.
 - **Priority/Estimate:** High, 3
 - **Acceptance Criteria:**
 - Given I have selected a charging station and charger type,
 - When I choose a time slot and confirm the booking,
 - Then the system reserves that slot for me and prevents other users from booking it.
 - And I receive confirmation with the booking details, including the charger type, time and a token.
 - **As a Station Operator**, I want to set custom schedules for my charging stations, so that I can control when each station is available for use.
 - **Priority/Estimate:** Optional, 4
 - **Acceptance Criteria:**
 - Given I am logged in as a station operator,
 - When I open the schedule management interface for a station,
 - Then I can define available and unavailable time slots for each charger.
 - **As an EV Driver**, I want to receive notifications 15 minutes before my booked time starts and when it starts, so that I am reminded to arrive at the charging station on time.
 - **Priority/Estimate:** Optional, 2
 - **Acceptance Criteria:**
 - Given I have an active charging slot booking,
 - When my scheduled time is approaching,
 - Then I receive a notification 15 minutes before the booking starts.
 - And I receive another notification at the exact start time of the booking.
 - **As an EV Driver**, I want to receive a notification if a charger I booked becomes disabled before my scheduled time, so that I can make alternative arrangements in advance.
 - **Priority/Estimate:** Low, 2
 - **Acceptance Criteria:**
 - Given I have an active charging slot booking,
 - When the assigned charger becomes unavailable before my scheduled time,
 - Then I receive an immediate notification informing me of the issue,
 - And I am prompted to either rebook at another station or cancel the booking.
-

EPIC 3: Charging Management

User Stories:

- **As an EV Driver**, I want to use my reservation token in the app to unlock the charger when I arrive, so that I can start my charging session securely and only during my reserved slot.
 - **Priority/Estimate:** High, 3
 - **Acceptance Criteria:**
 - Given I have an active reservation and have arrived at the charging station,
 - When I open the app and input my reservation token,
 - Then the corresponding charger is remotely unlocked,

- And my charging session begins.

- **As an EV Driver,** I want to see real-time charging status including battery percentage, current cost, and energy consumed, so that I can monitor and manage my charging session according to my needs and budget.
 - **Priority/Estimate:** Optional, 4
 - **Acceptance Criteria:**
 - Given I have an active charging session,
 - When I open the session details in the app,
 - Then I see live updates of the battery level, cost so far, and energy (kWh) delivered.
- **As a Station Operator,** I want to monitor all active and historical charging sessions, so that I can ensure operational visibility, detect issues, and analyze usage patterns
 - **Priority/Estimate:** Optional, 4
 - **Acceptance Criteria:**
 - Given I am logged as station operator,
 - When I open the charging session panel,
 - Then I see a list of all current sessions with user info, charger status, duration, and energy consumed.
 - And I can also access a history of past sessions with filtering options.
- **As an EV Driver,** I want to stop the charging session from the app at any time, so that I can charge only the amount I need and control the cost.
 - **Priority/Estimate:** High, 2
 - **Acceptance Criteria:**
 - Given I am in an active charging session,
 - When I select “Stop Charging” in the app,
 - Then the charger stops delivering power and the session ends,
 - And I see a summary of total cost, time, and energy charged.
- **As an EV Driver,** I want to restart the charging session from the app if I stop it accidentally, so that I can continue charging without needing to make a new reservation.
 - **Priority/Estimate:** Optional, 2
 - **Acceptance Criteria:**
 - Given I have recently stopped a charging session,
 - When I select “Restart Charging” in the app,
 - Then the charger resumes delivering power using the same reservation

EPIC 4: Payment Integration

User Stories:

- **As an EV Driver**, I want to receive the payment summary in the app when my charging session ends, so that I can easily review and pay for the charging cost directly through the app.
 - **Priority/Estimate:** High, 4
 - **Acceptance Criteria:**
 - Given my charging session has ended,
 - When I open the app,
 - Then I see a payment summary with the total amount due, energy consumed, and charging duration,
 - And I can choose a payment method and complete the transaction within the app.
 - **As a Station Operator**, I want to access financial reports per charging session and verify their payment status, so that I can monitor revenue and ensure that all sessions have been correctly billed and paid.
 - **Priority/Estimate:** Medium, 4
 - **Acceptance Criteria:**
 - Given I am logged as station operator,
 - When I open the financial reporting section,
 - Then I can view individual charging sessions along with payment status, amounts charged, and payment timestamps
-

EPIC 5: User Profiles & Charging History

User Stories:

- **As an EV Driver**, I want to view my charging history and total energy consumption over time, so that I can track my usage patterns and manage my charging behavior more efficiently.
 - **Priority/Estimate:** Medium, 4
 - **Acceptance Criteria:**
 - Given I am logged into my account,
 - When I open the "Charging History" section,
 - Then I see a list of past charging sessions with dates, locations, energy consumed (kWh), duration, and cost.
- **As an EV Driver**, I want to track my estimated CO₂ savings based on my charging activity, so that I can understand the environmental impact of using electric vehicles instead of fuel-based alternatives.
 - **Priority/Estimate:** Low, 4
 - **Acceptance Criteria:**
 - Given I have completed one or more charging sessions,
 - When I visit the sustainability section in my profile,
 - Then I see an estimate of CO₂ emissions avoided (in kg or tons) based on energy charged and average EV efficiency.

- **As an Admin**, I want to view aggregated user statistics and charging behavior trends, so that I can analyze platform usage and optimize the service for users.
 - **Priority/Estimate:** Optional, 5
 - **Acceptance Criteria:**
 - Given I am logged into the admin dashboard,
 - When I open the analytics or reporting section,
 - Then I see data such as total users, active users, average energy per session, peak usage times, and CO₂ saved across the platform.

EPIC 6: Backoffice Operations

User Stories:

- **As a Station Operator**, I want to update my station's information such as availability and pricing, so that users always see accurate data when booking a charging slot.
 - **Priority/Estimate:** Medium, 3
 - **Acceptance Criteria:**
 - Given I'm logged into the operator dashboard,
 - When I access a station's details and make changes to availability, pricing, or charger info,
 - Then the updated information is saved and reflected in the user-facing app immediately.
- **As an Admin**, I want to create station operator accounts, so that new employees can manage charging stations assigned to them.
 - **Priority/Estimate:** High, 3
 - **Acceptance Criteria:**
 - Given I am logged into the admin dashboard,
 - When I fill in the required details to create a new operator account,
 - Then the operator receives credentials and can log into the platform with their permissions.
- **As an Admin**, I want to assign or remove stations from specific station operators, so that I can manage responsibilities across the network effectively.
 - **Priority/Estimate:** High, 3
 - **Acceptance Criteria:**
 - Given I am on an operator's profile in the admin dashboard,
 - When I select stations to assign or remove,
 - Then the operator's access is updated accordingly.
- **As an Admin**, I want to manage all user accounts, including EV drivers and station operators, so that I can enforce platform rules and support operations effectively.
 - **Priority/Estimate:** Low, 4
 - **Acceptance Criteria:**

- Given I am in the admin dashboard,
 - When I view the list of users (EV Drivers and Operators),
 - Then I can search, edit, deactivate, or delete any account as needed.

 - **As an Admin**, I want to view system-wide reports and statistics, so that I can monitor platform performance and usage trends.
 - **Priority/Estimate:** Optional, 4
 - **Acceptance Criteria:**
 - Given I am logged into the admin dashboard,
 - When I access the analytics section,
 - Then I see KPIs like total sessions, revenue, energy delivered, user growth, etc.

 - **As a Station Operator**, I want to report users for misconduct such as not paying or damaging equipment, so that the platform can take appropriate action.
 - **Priority/Estimate:** Medium, 3
 - **Acceptance Criteria:**
 - Given I'm on the operator dashboard and have identified a problematic session,
 - When I click "Report User" and provide a reason,
 - Then the report is submitted to the admin team for review.

 - **As an EV Driver**, I want to report chargers I use, so that other drivers can benefit from my feedback.
 - **Priority/Estimate:** Optional, 2
 - **Acceptance Criteria:**
 - Given I've completed a charging session,
 - When I visit the charger's detail page,
 - Then I can submit a report (comment)
-

EPIC 7: Authentication & Account Management

User Stories:

- **As an EV Driver**, I want to update my account information, so that my profile stays accurate and secure.
 - **Priority/Estimate:** Medium, 3
 - **Acceptance Criteria:**
 - Given I am logged into my account,
 - When I navigate to the profile settings,
 - Then I can edit and save my personal details.

- **As an EV Driver**, I want to permanently delete my account, so that I can stop using the service and remove my personal data from the platform.
 - **Priority/Estimate:** Optional, 2
 - **Acceptance Criteria:**
 - Given I am logged into my account,
 - When I choose to delete my account and confirm the action,

- Then my account and associated data are removed and I am logged out.

3 Domain model

<which information concepts will be managed in this domain? How are they related?>

<use a logical model (UML classes) to explain the concepts of the domain and their attributes, not a entity-relationship relational database model>

4 Architecture notebook

4.1 Key requirements and constraints

<Identify issues that will drive the choices for the architecture such as: Are there hardware dependencies that should be isolated from the rest of the system? Does the system need to function efficiently under unusual conditions? Are there integrations with external systems? Is the system to be offered in different user-interfacing platforms (web, mobile devices, big screens,...)? For a more systematical approach:

- Note the collection of Architectural Characteristics the software architect should be aware
- Identify architectural characteristics that are relevant for your project (will drive the key design decisions). Note the case study and the explicit characteristics related to users and extensibility. This will support later non-functional tests.

4.2 Architecture view

→ Discuss architecture planned for the software solution: what are the main building blocks? include a diagram (a logical view, such as a package or block diagram). Avoid implementation technology or deployment references, but protocols/standards can be included.

→ refer to the architecture style applied, if any

explain how the identified modules will interact. Use a sequence diagram to clarify the interactions along time, when needed

→ discuss more advanced app design issues: integration with Internet-based external services, data synchronization strategy, distributed workflows, push notifications mechanism, distribution of updates to distributed devices, etc.>

4.3 Deployment view

[Explicar a organização prevista da solução em termos configuração de produção (*deployment*). Anotar, no diagrama, as tecnologias de implementação, e.g.: colocar o simbolo do PostgreSQL na Base de dados,...]. Indicar a existência de containers (Docker), endereços IP e portos,... Esta parte será completada quando houver efetivamente deployments

5 API for developers

[Explicar genericamente a organização da API e coleções principais. Os detalhes/documentação dos métodos devem ficar numa solução *hosted* de documentação de APIs, como o [Swagger](#), Postman documentation, ou incluída no próprio desenvolvimento (e.g.: maven site)

- Be sure to use [best practices for REST Api design](#). Keep mind a REST API applies a resource-oriented design (APIs should be designed around resources, which are the key entities your application exposes, not actions)