



İZMİR EKONOMİ ÜNİVERSİTESİ
İZMİR UNIVERSITY OF ECONOMICS

STAJ RAPORU
INTERNSHIP REPORT

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DEPARTMENT : Application Software Design Directorate
KIND OF THE INTERNSHIP : EVC HMI Software Development (Electric Vehicle Charge
Station Human Machine Interface Software Development)

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CONTENTS

<i>CONTENTS</i>	2
<i>SUMMARY</i>	3
<i>General Corporate Information</i>	4
<i>Corporate Organizational Structure</i>	5
<i>Languages During Internship</i>	6
<i>Advice for Efficiency Improvement</i>	6
<i>The Project and My Tasks</i>	7
<i>First Week</i>	7
<i>Second Week</i>	9
<i>Third Week</i>	11
<i>Fourth Week</i>	12
<i>Beneficial Courses</i>	12
<i>SE 302 - Principles of Software Engineering</i>	12
<i>CE 223 - Database Systems</i>	13
<i>CE 221 - Data Structures and Algorithms</i>	13
<i>Gains From Internship</i>	13

SUMMARY

This report presents a detailed overview of the internship completed at Vestel Mobility Sanayi ve Ticaret A.Ş., a technology company operating under Zorlu Holding. The internship took place in the Human Machine Interface (HMI) Software Department, which is responsible for the user interface and embedded communication systems of electric vehicle charging stations. The company specializes in electromobility and energy storage solutions, with operations spread across Manisa, İzmir, and Istanbul. Its main products include AC and DC electric vehicle chargers, energy storage systems, and automotive electronic components. During the internship, three main projects were carried out. The first involved designing a carbon emission interface to inform users about the environmental impact of each charging session. The second focused on redesigning the web panel used to configure and manage the charging stations, with improvements in responsiveness, design patterns, and database connections. The third project was a research-based study on integrating home-type chargers with smart home systems through the MATTER protocol, which included technical requirements and future development suggestions. The report also outlines the structure of the company, emphasizing its function-based hierarchy and collaborative approach between departments such as software, hardware, testing, and business operations. Throughout the internship, Turkish was used for internal communication, while English was the language of technical documentation, code development, and international meetings. From a technical standpoint, the internship provided hands-on experience with Linux-based systems, embedded communication protocols, REST APIs, and cloud-based data management. Key technologies included C++ with Qt for interface design, Python for backend logic, and Java for DC charging station development. Additionally, the intern participated in testing, debugging, and improving both software and hardware components of the assigned device. Academic knowledge from university courses such as Software Engineering, Database Systems, and Data Structures was applied directly during the internship, particularly in the areas of system design, concurrency handling, and algorithm optimization. In conclusion, the internship offered valuable insight into real-world software development practices, the significance of structured teamwork, and the technical complexities of electromobility systems. It served as a strong foundation for understanding how modern embedded devices operate within industrial and consumer environments.

1. General Corporate Information



Figure 1 : Corporate Logo

Vestel Mobility Sanayi ve Ticaret A.Ş. is a newly established company under the Vestel Group, which itself operates under Zorlu Holding. The company's R&D departments are located in Vestel City, Manisa, while its main production facilities are based in Gaziemir, İzmir. Its headquarters are situated in Şişli, Istanbul. Vestel Mobility offers solutions in the fields of electromobility and energy storage systems. Its primary focus is on the production of electric vehicle (EV) charging stations, which are categorized into AC and DC types. These categories are further divided into subtypes based on features and power levels. The current product line supports up to 720 kW charging capacity, with new models under development to reach 1 MW by the end of 2025. The company also manufactures and markets energy storage and battery management systems for residential, commercial, and automotive sectors. In addition, it produces automotive electronic components, such as in-vehicle displays, control units, power electronics, and communication systems. Vestel Mobility employs a significant number of professionals, including electrical, software, mechanical, and computer engineers, as well as technicians, production workers, R&D staff, administrative personnel, and sales teams. While exact numbers are not specified for the company alone, the broader Vestel Group employs around 20,000 people. In terms of charging solutions, AC chargers are designed for homes and small businesses and do not require major infrastructure changes, while DC chargers come in fast-charging versions 60 kW, 120 kW, 150 kW and ultra fast versions 180 kW to 720 kW. These devices vary in infrastructure requirements and can be configured in modular combinations. DC products are offered in High Security and Non-High Security variants; although hardware differences are minimal, the High Security versions include advanced software-level encryption from the kernel level, offering enhanced data protection at a higher price. Vestel Mobility currently operates over 250,000 charging sockets in Turkey and 30 European countries. In the field of energy storage, the company offers a variety of scalable solutions, including container based, residential, commercial, automotive, and grid level systems. It supplies components such as lithium ion battery cells, electronic parts, and power modules to both local and global markets. Vestel is one of Turkey's top exporters and aims to significantly expand its EV related production through new facilities, targeting hundreds of

thousands of units annually. With the EV market growing rapidly, Vestel is heavily investing in the expansion of charging infrastructure and battery production, aiming for a 2 GW annual battery module assembly capacity by the end of 2025. The company exports primarily to over 30 European countries, the Middle East, and North Africa, and works with major clients such as Electrip Italy, ZES, BP Pulse, E.ON, Shell, Total, Webasto, and other key players in the European market. It is also involved in joint product development with OEMs such as TOGG and plans to collaborate with Chinese automaker BYD, which is setting up a manufacturing facility in Manisa.

2. Corporate Organizational Structure

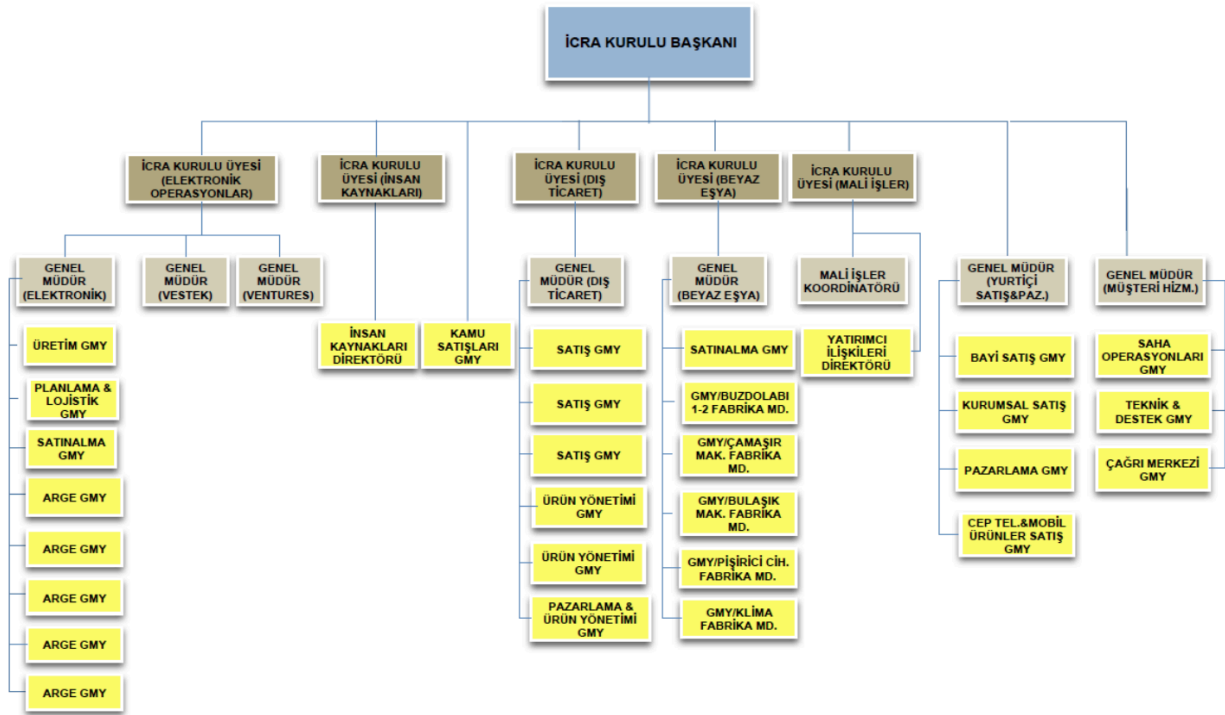


Figure 2: Corporate Organizational Structure Schema

Vestel Mobility Sanayi ve Ticaret A.Ş. has adopted a functionally based organizational structure with a clearly defined hierarchy. At the top of this structure is the Chairman of the Executive Committee, who also serves within Zorlu Holding. The Chairman oversees various departments managed by general managers and executive committee members. Vestel Group is divided into business units such as Electronics, E-Mobility, Household Appliances, Public Relations, and Customer Services, each focusing on a specific product category. Every department is led by a General Manager, supported by Deputy General Managers responsible for R&D, production, sales, and procurement. The General Manager works closely with the deputies to manage and supervise these core functions. Below them, there are more specific structures based on product types and job roles. In Vestel Mobility, areas such as R&D,

software, hardware, and testing are separated into distinct branches. Software and hardware teams often collaborate; when changes occur in hardware, the software team updates and adapts the software accordingly. The software department itself is divided into units focusing on electric vehicle charging stations, energy storage systems, automotive components, and more. The EV charging station unit is further divided due to the variety of internal circuit boards some teams focus on HMI boards while others work on ACP boards. There is also a kernel team responsible for embedded software that works closely with both software and hardware departments. In addition to product-based units, the company also has structures dedicated to business operations such as marketing, finance, and human resources, all managed through the executive committee and general managers. These departments handle brand image, advertising, and customer feedback, and aim to ensure efficient production management, coordinate sales, and control financial and resource planning.

3. Languages During Internship

During the internship, Turkish was the main language used in daily communication, as employees generally spoke Turkish among themselves and conducted internal meetings in Turkish. However, since the company operates internationally and has employees in various parts of the world, meetings with international staff were held in English. These meetings were usually conducted online, although in-person meetings also occurred occasionally. In the software department, English was used during product development. Variables, connections, database entries, and file names were created in English, and any additions were made using English as well. While tasks or error messages were initially recorded in Turkish, responses and solutions were provided in English. Comments in the code and error explanations were also written in English. Additionally, reports and documentation were prepared in English to ensure that foreign colleagues and customers could review them. In short, Turkish was used within the team for direct communication, while English was used for all other technical and formal purposes due to the company's international structure.

4. Advice for Efficiency Improvement

One important area where the company should focus on growth is the automotive sector, which is also one of the main purposes behind the establishment of Vestel Mobility. In Turkey, there are many major automotive manufacturing plants, and Vestel's electronic components can be highly beneficial for these factories. Currently, Vestel actively produces the central control unit mainboard for Togg and also manufactures batteries. Expanding further in this sector and increasing production capacity could help reverse the recent downsizing experienced by the company. These high value added products have the potential to generate

not only domestic but also international sales. If Vestel continues to grow in this direction, it could move beyond the home appliance industry and become a leading technology company. It may even produce its own vehicle in the future, which would greatly enhance its image in international trade. Vestel currently supplies the majority of electric vehicle charging stations in Turkey and sells them to companies like ZES and ToggCare. The electric vehicle market in Turkey has grown faster than expected, largely due to the success of Togg, which has increased public interest and demand for quality and cost effective solutions. Therefore, Vestel must not miss this growth opportunity; instead, it should adapt quickly and position itself as a leader in this field. If successful, it has the potential to become the top manufacturer in Turkey's electric vehicle industry. Vestel Mobility is already making progress in this direction, and in the coming years, it could become a key representative of this sector not only in Turkey but also across Europe.

5. The Project and My Tasks

During the internship, the department supervisor asked me to review the work being done and then develop a project of my own based on my observations. I began by examining the EVC04 HS model device that was assigned to me. Initially, I approached the device from the perspective of a user, identifying potential issues and errors that an active user might encounter. I aimed to develop solutions for these problems, and I also considered possible feature requests from customers, which led me to generate several project ideas. I then explored the device in more depth, analyzing both its software and hardware aspects to evaluate what I could realistically implement. Based on this technical analysis, I refined my initial ideas by adding or removing certain features. While developing these ideas, I also aimed to create solutions that would be useful for the department and could be actively implemented. After forming these concepts, I discussed them with the department supervisor, received feedback, and made further improvements. Eventually, we decided on a project to present carbon emission data to users. After completing this project, I worked on revising the web panel used to manage all Vestel electric vehicle charging stations, as it is the main interface for users. Once this was finished, I conducted research on the software and hardware requirements needed to connect Vestel's home type EV charging stations with smart home systems. I then presented my findings and recommendations to the department supervisors to guide future developments in this area.

5.1. First Week

On the first day of the internship, we visited the Human Resources department, where we were given information about the company. Following this session, we completed the

required paperwork and signed our internship contracts. On the same day, we received occupational health and safety training. On the second day, personalized access cards were distributed to us, and we were given a tour of the factory. After the tour, I was taken to the department where I would be completing my internship, the Human Machine Interface (HMI) Software Department for electric vehicle charging stations. The department supervisor explained the work they were doing and told me that they are responsible for the HMI board inside the device. This HMI board serves as a communication bridge between the user, the electrical grid, and the vehicle, ensuring that the charging process starts properly. It collects data from other boards within the device, such as the ACP board, and facilitates the proper initiation of the charging process. At the same time, it ensures communication with mobile devices via LTE, Wi-Fi, and Bluetooth modules. To store information and receive various software updates, they use a communication protocol called OCPP. While the charging data is temporarily stored locally on the device, it is transferred to the cloud when an internet connection is available, again using the OCPP protocol. The system also features an RFID card reader that allows users to start charging using pre-registered cards. Most of these functionalities can be controlled through the web panel. This web panel acts as a comprehensive control center for the device, allowing users to view detailed device information, make changes to interface design and layout, configure OCPP settings, manage internet connections via Wi-Fi, Ethernet, or LTE, and establish a Bluetooth connection for setup via mobile phone. It also allows users to manage the energy of multiple devices connected to the same grid, perform software updates or rollbacks in case of security vulnerabilities, check logs when errors occur, and contact authorized personnel. The operating system used in these electric vehicle charging stations is Linux, chosen because it is open-source and easily customizable to meet specific needs. Developers in another department customized this Linux based system from the kernel level, removing unnecessary background processes and protocols to create a faster and more efficient operating system. The department I worked in, EVC HMI, is responsible for writing the software that ensures safe and proper charging within this operating system. After the department introduction, I met the rest of the team, and they arranged a computer for me. I observed the work being done by other employees and received general information about their tasks. They introduced me to different device models and provided a basic overview of how they function. On the third day, they uploaded the source code of the EVC04 model to my computer and asked me to analyze it. I reviewed the internal file structure of the device to understand how it functions. Based on a discussion with the department supervisor, I was asked to explore the device and then develop a project of my own. While examining the software, I identified a REST API structure in the device. All communications with the database and other related functions are centralized in a component

called “agency.” This component also handles interactions with the database and connects to the cloud and other servers using the OCPP protocol. Python is the primary language used in this structure, particularly following object-oriented programming principles. For the interface side, C++ is used, specifically with help from the Qt library. All interface designs on the devices are implemented using the C++ Qt framework. The EVC04 model I reviewed is an AC-based charging station, while the DC-based EVC03 model is developed more heavily in Java. In some parts of the software, C is also used, particularly for operations that go down to the processor level to encrypt internal keys, thus ensuring a high-security system. On the fourth day, they assigned me a device specifically an EVC04 HS model. I installed the software intended for customers and began testing it as if I were an end user. I aimed to identify potential issues or areas for improvement. I performed the setup via a mobile phone, then connected the device to a computer using a micro USB cable to access and analyze the log panels. I observed how the device reacts in different situations, how the error handling system functions, and how the system recovers from problems to resume operations. I studied all of these through the log panel and took detailed notes. I discovered that the device operates in nine different states: Charging, SuspendEV, Available, Finishing, Preparing, SuspendEVSE, Faulted, Reserved, and Unavailable. Each state represents a different phase of operation and has its own unique error handling system. On the fifth day, based on my observations, I developed several ideas. I took notes on these ideas and conducted research to understand how they could be integrated into the existing system. I analyzed each one in detail and documented my findings comprehensively.

```

1  #ifndef CO2UTILS_H
2  #define CO2UTILS_H
3
4  const double CO2_PER_LITRE_GASOLINE = 2.31; // kg CO2 / litre benzin
5  const double AVERAGE_CONSUMPTION_GASOLINE = 6.4; // litre / 100 km
6  const double CO2_PER_KWH_ELECTRICITY = 0.41; // kg CO2 / kWh
7
8  const double DEFAULT_EV_CONSUMPTION_PER_100KM = 15.0;
9
10 inline double calculateCO2Savings(double energy_kWh) {
11     double evCO2 = energy_kWh * CO2_PER_KWH_ELECTRICITY;
12
13     double distanceKm = (energy_kWh / DEFAULT_EV_CONSUMPTION_PER_100KM) * 100;
14
15     double fuelLiters = (AVERAGE_CONSUMPTION_GASOLINE / 100.0) * distanceKm;
16
17     double gasCO2 = fuelLiters * CO2_PER_LITRE_GASOLINE;
18
19     return gasCO2 - evCO2;
20 }
21
22 #endif // CO2UTILS_H
23

```

The screenshot also shows an Issues panel at the bottom with the following warnings:

- In function 'int theme_callback(void*, int, char**, char**): mainwindow.cpp
- no return statement in function returning non-void [-Wreturn-type] mainwindow.cpp 225
- unused parameter: 'data' [-Wunused-parameter] mainwindow.cpp 182
- unused parameter: 'src' [-Wunused-parameter] mainwindow.cpp 182
- unused parameter: 'azColName' [-Wunused-parameter] mainwindow.cpp 182

Figure 3 : Carbon Emission Test Calculation

After completing the research, I used my remaining time to write a few test calculations for carbon emissions, as shown in the test codes in Figure 3. I also tested how I could display this using Qt. By converting the energy data received from the device into carbon emissions, I implemented and visualized the calculations based on the data I obtained through my research.

5.2. Second Week

In the second week of my internship, based on the analyses and research I had conducted, I presented my project ideas to the department supervisor. The ideas I developed primarily focused on solutions that could be implemented directly on the device, provide practical benefits to the team, and serve as functional improvements. After discussing the proposals with the supervisor, we decided to focus on three main projects. The first was a project aimed at informing users about carbon emissions. The motivation behind this project was the growing significance of carbon emissions in many European countries, where strict environmental regulations are enforced. Since many European technology companies are engaged in renewable energy initiatives, their technological products often include features that inform users about carbon emissions or other harmful gases. In line with this trend, we are working on electric vehicle charging stations, whose fundamental purpose is to reduce the carbon dioxide emissions caused by internal combustion engine vehicles. While electric vehicles do not emit carbon dioxide directly, the electricity used to charge them may still originate from thermal power plants, which contribute to carbon emissions. If the charging stations are connected to renewable energy sources such as solar panels or wind turbines, the emissions are effectively zero. However, in many cases, the electricity is still generated using fossil fuels, which means there is still some level of carbon emission albeit significantly lower than that of traditional vehicles. Taking these factors into account, I designed an interface that would display carbon emissions based on the energy source of the charging station. If the station is connected to renewable energy, the system would reflect zero emissions; if not, it would calculate the average emissions based on general energy production statistics. I planned to design this feature both for the mobile app and for the on device screen, incorporating graphical and numerical data for user clarity. The second project focused on revising the backend system of the web panel used to configure Vestel's electric vehicle charging stations. The current backend was outdated, overly complex, and not easily extendable, functioning only on desktop and specific resolutions. The user interface was also based on very old design standards. I proposed a complete redesign of the web panel using a proper design pattern and modern frontend development practices, aiming to make the system accessible across all devices and more user-friendly. My third and final idea was to develop software and hardware

integrations that would allow home-type charging station models to be compatible with smart home systems. To achieve this, I researched MATTER standards, which are widely accepted by smart home systems such as Google Home and Apple Home. Since adapting the device to MATTER would require hardware modifications, it was determined that the full implementation would not be feasible within my internship period. Therefore, I planned to focus on researching the necessary software and hardware requirements and preparing a presentation to inform the department team about how they could transition toward MATTER compliance. We agreed on these three project ideas and created a schedule that allowed each project to follow one another, along with specific delivery deadlines. For the remainder of the second week, I started working on the carbon emission interface. The device interface is developed in C++ using the Qt framework, so I used QtCreator IDE to build the new software component. I began by researching the average carbon emissions of internal combustion engine vehicles and the amount of carbon dioxide released per kilowatt of electricity generated by the power grid. I translated these values into software logic to calculate how much carbon dioxide was emitted during each vehicle charge session. I then created a system that generates statistical and graphical representations based on previous charging data. This component was designed to align with the existing user interface and to be simple and intuitive for users to understand. I completed this project during my second week, tested it directly on the device, and confirmed that it worked without errors. The software integrated smoothly with the device. During the development process, I encountered a few challenges, the most significant of which involved retrieving data from the database. Since the database was constantly being updated by the system, I faced issues when trying to access data from a different file while it was being modified. I solved this by using the "agency" component to redirect the "charging sessions" data to a separate database, which prevented conflicts. In this new structure, data could be accessed smoothly because the secondary database was not being modified at the same time. Another issue was that when the device was connected to the internet, charging session data was stored in the cloud, which meant the local database did not retain this information. To address this, I wrote a code segment that ensured the last five charging sessions would always be stored locally. As a result, I developed a complete system that calculates and displays carbon emissions based on recent charging activity, presented through both the mobile application and the device interface.

Charging Sessions Summary

Date	Duration	Energy (kWh)	CO ₂ Saved (kg)
20 Haz 13:27	2h 10m	12.50	6.18
19 Haz 23:12	2h 10m	18.00	8.89
18 Haz 08:36	2h 10m	8.00	3.95
18 Haz 23:08	2h 10m	20.00	9.88
17 Haz 01:55	2h 10m	50.00	24.70

Figure 4 : Charging Sessions Summary

As mentioned in Figure 4, the first page of my work appears as a table. This table displays previous charging sessions performed on the device and their dates, the duration of each charging session on the far left, the amount of energy consumed, and the amount of carbon emissions prevented during the process, respectively. These data are actively retrieved from the device and are displayed at the end of the charging session.

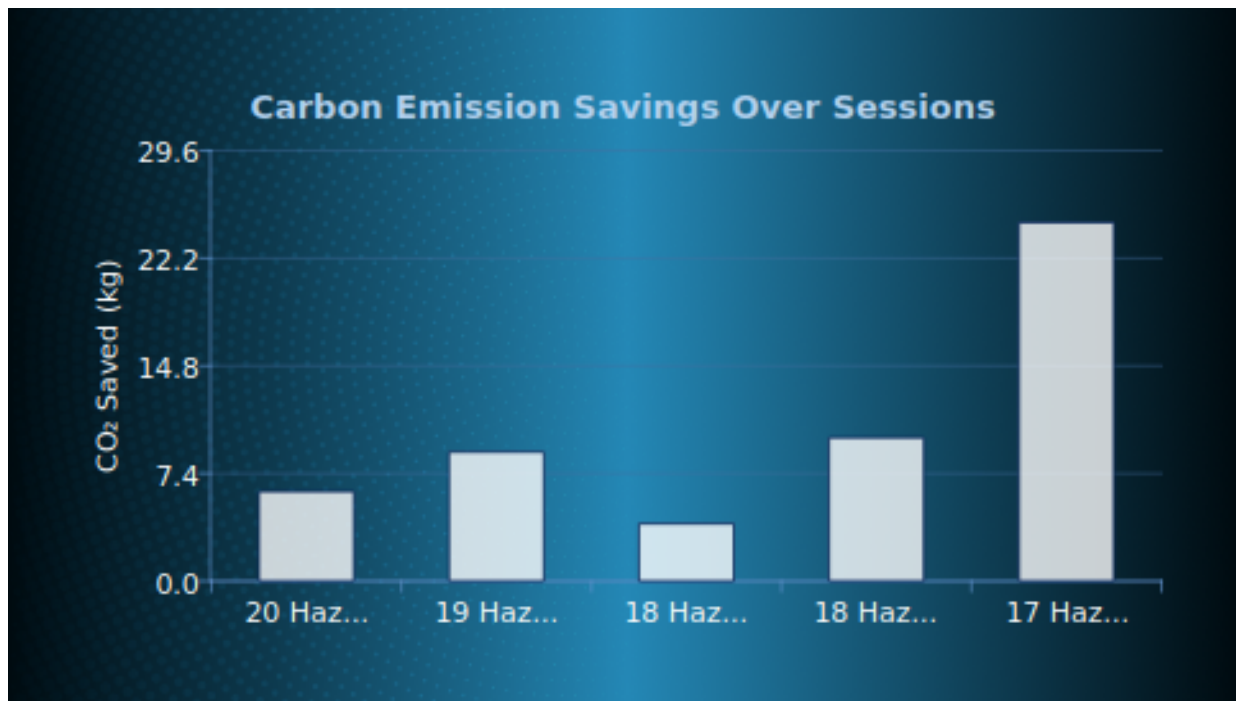


Figure 5 : Carbon Emission Savings Over Sessions

In Figure 5, the second page shows the reduction in carbon emissions based on the most recent charging sessions. In the graph, carbon dioxide emissions are displayed on the right side, while the dates and times of the last charging sessions are shown at the bottom. The screens in Figures 3 and 4 appear on the display of the EVC 04 model after the charging process is completed and alternate at specific time intervals.

5.3. Third Week

In the third week, I started working on my second planned project. In this project, I began by reviewing the source code files of the web panel. After analyzing the database connections as well as the design and management structure, I concluded that the most appropriate design pattern to use would be the Singleton pattern. I first created the general layout and implemented a responsive design. With this structure in place, the web panel became fully compatible with different screen resolutions. In desktop mode, a header at the top and a sidebar on the left allow for fast navigation between pages. When switching to mobile view, the sidebar disappears and a menu button appears in the header. Clicking this button reveals a dropdown-style navbar. Instead of using a sidebar for page transitions in mobile view, I adapted the navigation into dropdown menus within the navbar. I utilized the Bootstrap framework to implement this layout and further optimized it using custom JavaScript and CSS code, resulting in a more refined responsive design. I then proceeded to design the inner structures of the pages, making sure they were also fully responsive. Tables, images, and all other components were adapted accordingly. I added a loading screen to allow users to see whether a page was actively loading during transitions. However, this animation initially caused delays in page loading. I identified that the issue was due to a background blur effect. To fix this, I reduced the resolution of the background view and minimized the intensity of the blur, which significantly improved performance. I also developed a notification system that provides users with real-time feedback such as error messages, save confirmations, warnings, and general success/failure messages using popup components. After ensuring the frontend design worked smoothly, I proceeded to develop the backend. I established the necessary database connections. Since the panel would be used globally, I decided to implement a language selection feature. Rather than retrieving language data from the database, I chose to use text-based PHP files containing language variables, which improved performance. I linked the database content to the appropriate locations in the panel and configured them according to the selected language. I then wrote the necessary functions to handle database modifications such as UPDATE, DELETE, and INSERT operations. To enhance security and prevent unauthorized access, I developed a reliable login system. I implemented various measures to prevent SQL injection vulnerabilities when fetching data from the database. Using references from older

code, I designed a debugging system and revised it to be more functional. Since the completed project contains a wide range of features, I began testing the panel extensively. The testing phase continued until the end of the week.

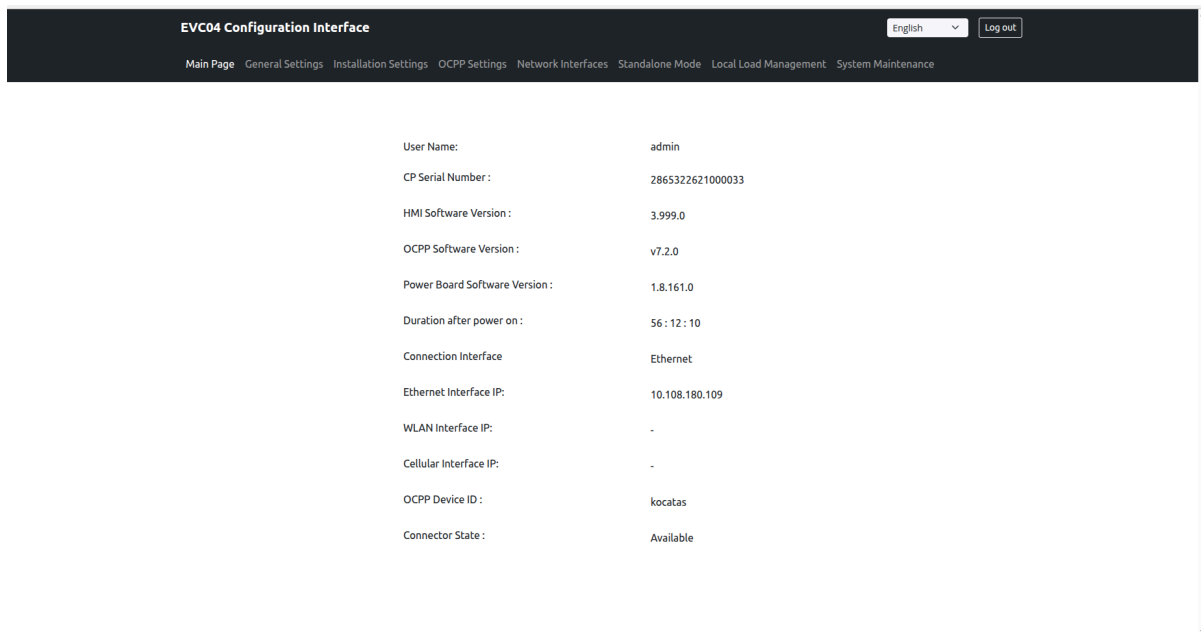


Figure 6 : Webconfig Main Page

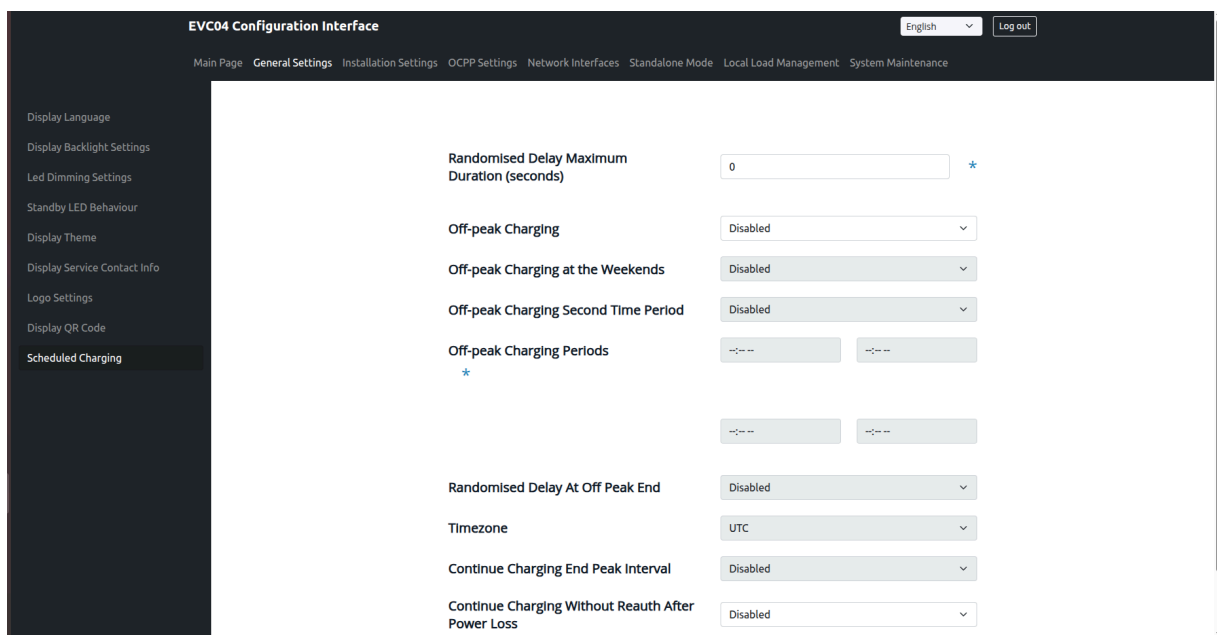


Figure 7 : Webconfig General Settings Page

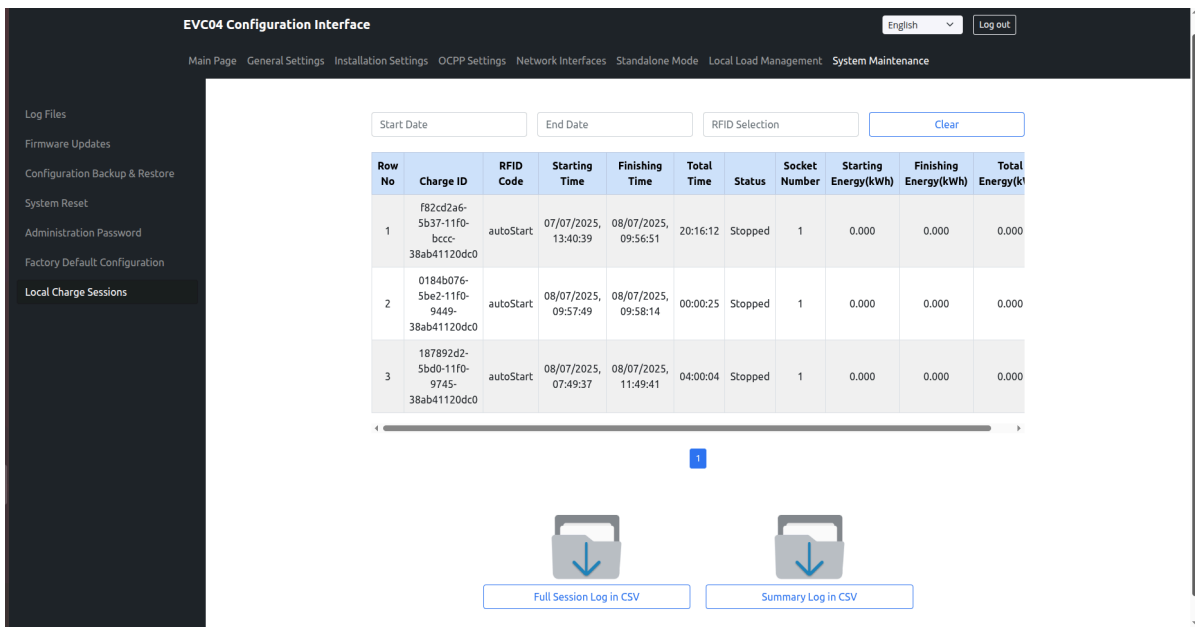


Figure 8 : Webconfig System Maintenance Charge Sessions Page

As shown in Figures 6, 7, and 8, the design of the webconfig interface used in all EVC models has been revised to be responsive. Since this revision ensures mobile compatibility, users can access the interface from a computer, tablet, or mobile device regardless of the specific device model. Additionally, the use of a more straightforward and easy-to-understand design makes the interface appear elegant and minimalistic.

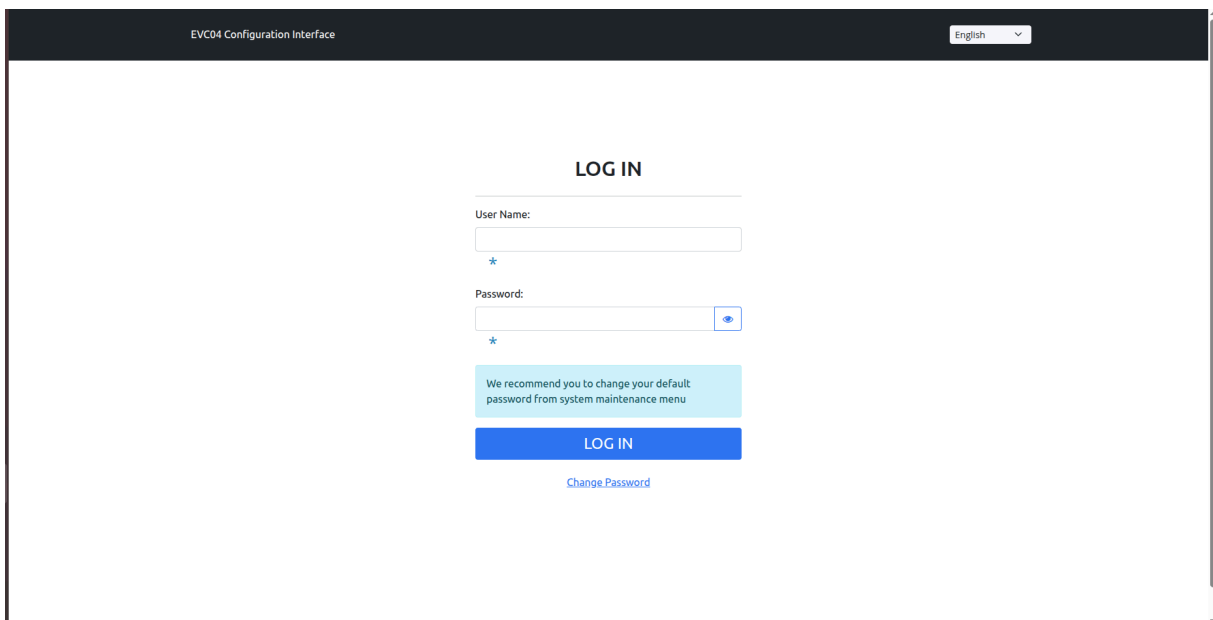


Figure 9 : Webconfig Login Page

In Figure 9, the login screen of the webconfig interface is shown. In terms of design, this login screen has been completely revised from scratch. In the conducted work, potential

data vulnerabilities, including SQL vulnerabilities, were tested in the background, and corresponding revisions were implemented accordingly.

5.4. Fourth Week

In the final week of my internship, I presented the project whose testing phase I had completed to the department supervisors. Following the presentation, the supervisors shared the project with other team members and the testing team to begin the formal testing process. During this phase, I addressed minor errors that were reported, and once all issues were resolved, the project was approved as fully functional. The team then initiated the process of integrating it into their active product systems as a new software update. With this update, the project I developed will be officially launched as part of the live product environment. Due to confidentiality agreements, I am unable to share specific images or code from the project; however, I did my best to visually represent the system where possible. In the remaining time, I conducted research on smart home systems and tried to better understand their workflow, especially how they manage tasks through a point based system. The team uses a tool built on a Git based infrastructure called Gerrit. When developers complete or update a task, they push their changes through Gerrit. I also had the opportunity to observe how they manage and track incoming tasks through Vestel's internal dashboard, as well as how they can easily view a history of changes and updates. I spent the remainder of my time completing and finalizing my internship report.

6. Beneficial Courses

The courses I had the opportunity to apply and test in the field during my internship are listed below.

SE 302 - Principles of Software Engineering

Through the Principles of Software Engineering course, I had the opportunity to experience the value of teamwork in a real-world setting. One of the key takeaways was the importance of architectural design, which we studied in class. I realized how critical it is for a software system to be understandable and easily extendable especially when it is updated by someone other than the original developer. This is one of the core requirements in the industry. I also observed firsthand how essential the testing phases we learned about are. Before software reaches the end user, it must go through various levels of testing. I saw that many bugs and errors are discovered during these stages. As mentioned, the knowledge I gained in the classroom was directly reflected in the workplace, where I had the chance to both observe and

apply it. This experience allowed me to gain a new perspective on my profession and deepened my appreciation for the foundational principles of software engineering.

CE 223 - Database Systems

The Database Systems course was the most beneficial course for me during my internship. One of the real-world challenges I encountered was related to retrieving data from the database through multiple simultaneous operations. During this process, I faced an issue where the retrieved data became inconsistent when updates occurred at the same time. I was able to solve this problem by implementing *Transactions*, a concept we had covered in the course. I also shared this solution with the personnel in the department, who were not previously familiar with this approach. As a result, they made improvements in the product's database interactions by adopting this method, allowing for more stable and accurate data retrieval. This improvement was implemented during my internship and contributed to the overall development of the system.

CE 221 - Data Structures and Algorithms

The Data Structures and Algorithms course was particularly useful when I needed to create methods capable of performing fast searches on datasets containing over one hundred thousand records. To achieve this, I applied various sorting algorithms we had learned in the course. By building upon these methods, I was able to further optimize them and adapt them to function efficiently within the system. In addition to this, the course also helped me develop a deeper understanding of fundamental programming structures by encouraging me to approach problems from different perspectives. This allowed me to analyze code more effectively and gain better insights into how to improve it.

7. Gains From Internship

One of the most valuable things I learned during my internship was the importance of teamwork. I had the opportunity to closely observe how software developers collaborate and adapt to one another in a team environment. I gained a clearer understanding of how tasks are divided among team members and how this coordination plays a key role in the success of a project. Although we also practiced task division in university projects, there was no clear hierarchy among students, which often led to a lack of structure. During my internship, I realized how crucial a hierarchical order is when developing a real world project. Another important aspect I observed was the frequent and systematic use of Git when implementing new features or fixing bugs based on user feedback. For example, a team member would be assigned a bugfix task and create a pull request accordingly. The developer then made

necessary code changes to resolve the issue. After that, other team members including supervisors and reviewers examined the code, made suggestions, and added comments. The person who opened the pull request revised the code based on this feedback and pushed the updated version. Finally, the revised code was tested by the QA team and team lead before being merged into the main codebase. Observing this structured workflow helped me fully grasp the concept of systematic development. Throughout my internship, I also gained advanced experience in using Linux, as the department heavily relied on Linux systems. This provided me with the opportunity to strengthen my skills in working with Linux-based environments. One of the most valuable technical insights I gained was understanding how devices communicate with each other. I explored various communication methods whether through internet protocols, port connections, or physical interfaces like USB. The devices we worked with included multiple boards that needed to communicate with each other in a secure and efficient manner. Analyzing and testing the protocols involved in these interactions significantly improved my understanding of embedded communication systems. Additionally, I learned a great deal about managing communication protocols involving cloud services and wireless modules. Since the devices also communicated with cloud platforms and other wireless systems, I had the chance to explore and understand various connection management strategies and network configurations.