**Design of a Touch Interface for an Electric Vehicle (EV)**

**Public Charging Point**

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**1.Introduction**

This report represents the designing,developing and evaluating of a touch interface for an electric vehicle public charging point . The goal of this is to create a user friendly, efficient and secured interface for a charging point comprised for electric vehicles . The current document include the problem research, description of the design , task analysis diagram drawing using a drawing tool called

As the adoption of electric vehicles (EVs) is increasing worldwide, the demand for high-performance and user-friendly public charging stations is becoming increasingly important convenient EV charging stations and availability play an important role in encouraging more users to switch from traditional internal combustion vehicles and . Many of the existing systems suffer from complex user interfaces, vague instructions and inefficient processes, which can lead to user frustration and adoption of EVs overall use has decreased

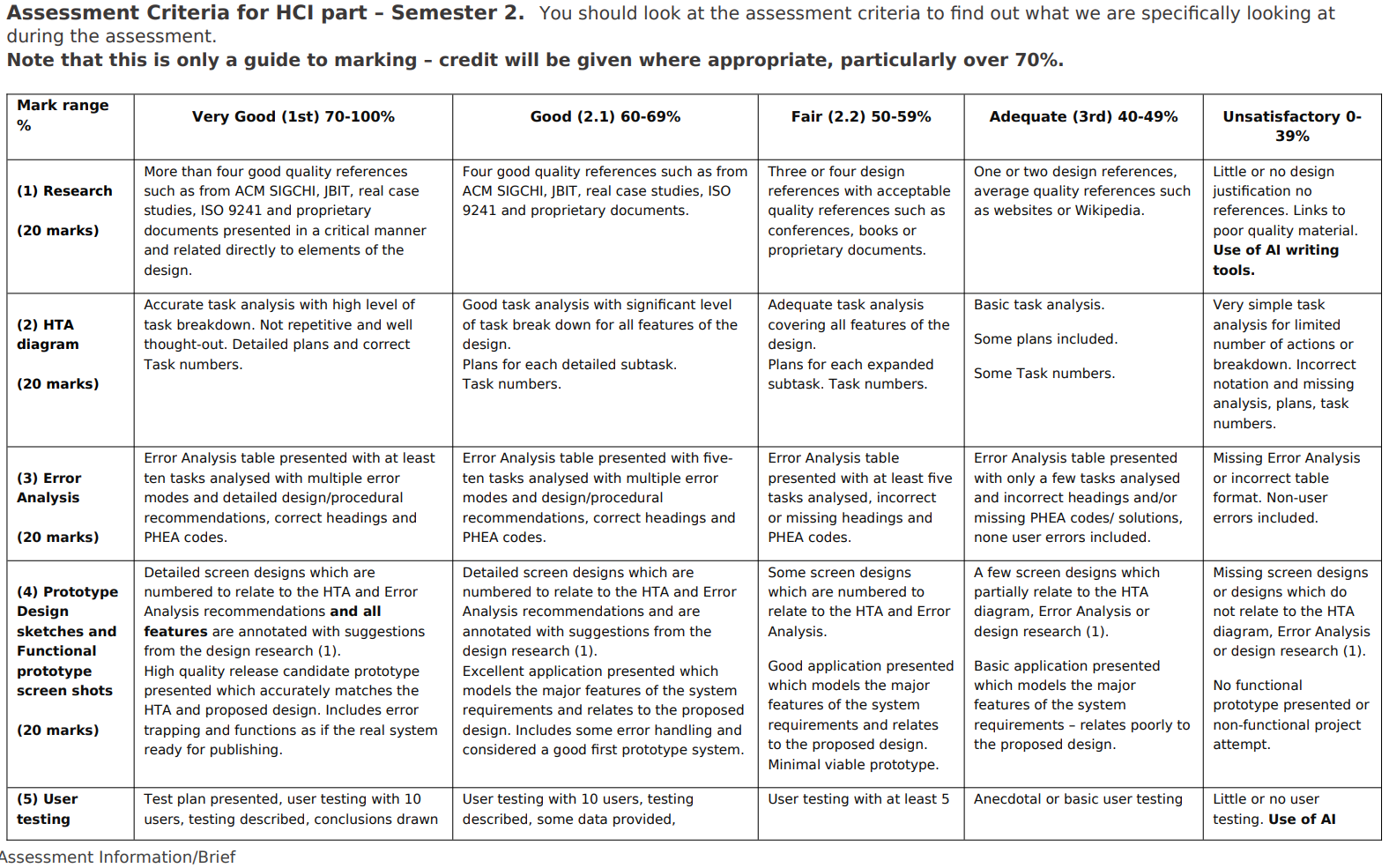
The focus of this project is to design and evaluate a touch interface for an electric vehicle (EV) public charging point that addresses these application challenges The objective is to create a simple, efficient and safe interface, which will allow users to all users have had a good experience , knowing or not of their technology or EV charging systems. This project draws on principles and standards from well-known sources such as ACM SIGCHI, JBIT, real-world case studies, and ISO 9241, which provide guidelines and best practices for human-computer interaction and management

At the beginning of this project, an extensive problem study was conducted to understand the current state of EV charging stations and the most common problems faced by users This study proposed the design of a new touch interface with and prioritizes user needs and simplifies the charging process. The design phase includes developing a task analysis diagram (HTA) to map user interfaces and identify potential failure points

Error analysis was performed to anticipate and reduce common user errors, ensuring that the interface can handle these issues gracefully. After configuration and bug analysis, the interface was prototyped and user tested. Participants from a variety of backgrounds and EV experiences were invited to use the model, providing valuable feedback on its usefulness and functionality

The results of the project test were analyzed to identify strengths in the mediation program and areas for improvement. Based on this feedback, several improvements were recommended to further optimize the user experience. This report documents the entire process from initial research and design through testing implementation and final recommendations, providing a comprehensive overview of the project and its results

Utilizing standards of resource management that focus on user-centered design principles, this project aims to contribute to the development of flexible EV charging solutions and effective, ultimately helping to increase the adoption of electric vehicles and promote sustainable transportation

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**2.Problem Research and Design Description**

**2.1. Problem Research**

Electric vehicle charging stations are becoming increasingly essential as the adoption of electric vehicles rises. A user interface is the critical component which is must to be intuitive and efficient to ensure a friendly user experience. We have gone through different real resources and references for completing this task. Some of the major references which are also provided in the academic instructions are also specified.

References:

ACM SIGCHI (Special Interest Group on Computer-Human Interaction) provides extensive research on user interface design and usability principles. This research is crucial in understanding how to create interfaces that are accessible and user-friendly.

JBIT (Journal of Business and Information Technology) includes case studies and articles on the latest trends and challenges in interface design for various applications, including EV charging stations.

ISO 9241-11:2018 outlines the principles of usability, emphasizing effectiveness, efficiency, and satisfaction in use, which are directly applicable to the design of EV charging interfaces.

The Real case studies:

A study on the usability of public EV charging stations in urban areas highlighted common issues such as complex authentication processes and unclear instructions (Smith, J., & Brown, L., 2020).

Another case study by Anderson, R., and Lee, K. (2019) on EV charging behavior revealed that users prefer interfaces that provide real-time feedback and simple navigation.

**2.2 Design Description**

The design made should follow classical approach that focuses on simplicity and usablility, providing a clear and straight forward process for electronic users for charging their vehicles.

The main functions specified in the design are :

1.Autheticate:

User can authenticate using their account number or a QR code , since this is a touch screen design , users should have the access of virtual keyboard on screen. A QR scanner code for an account card of the user is enabled in the authentication page of the interface. After recognition of their identity , user needed to enter their pin number which is about 6 numbers which was directed from either account number screening or QR code scanning.

2.Charging details

After authentication of the user , he/she is directed to a new interface called charging details where user can navigate seamlessly to all the features present in the interface. Some of the majorly used charging details are choosing the vehicle type, choosing the charging bay, choosing the charging duration. This could be done on each of the interface options selected by the user initially, user needed to select the vehicle type, other options like charging bay, charge duration is specified respectively in their own interfaces.

3. Payment details

After selecting their specified options for their electric vehicle in the charging details by the user, the user is directed to a payment page. It has multiple payment options , including contactless payments.

4.Start charging

A new interface is obtained after payment, where user can able to see all the appropriate information of their charging. The information that use could be seen in the screen are

Date

Charging station name

Time of charging

Cost of charging

Power using

Remaining Time for charging

Current charging status

Cancel charging button

5.Cancle charging

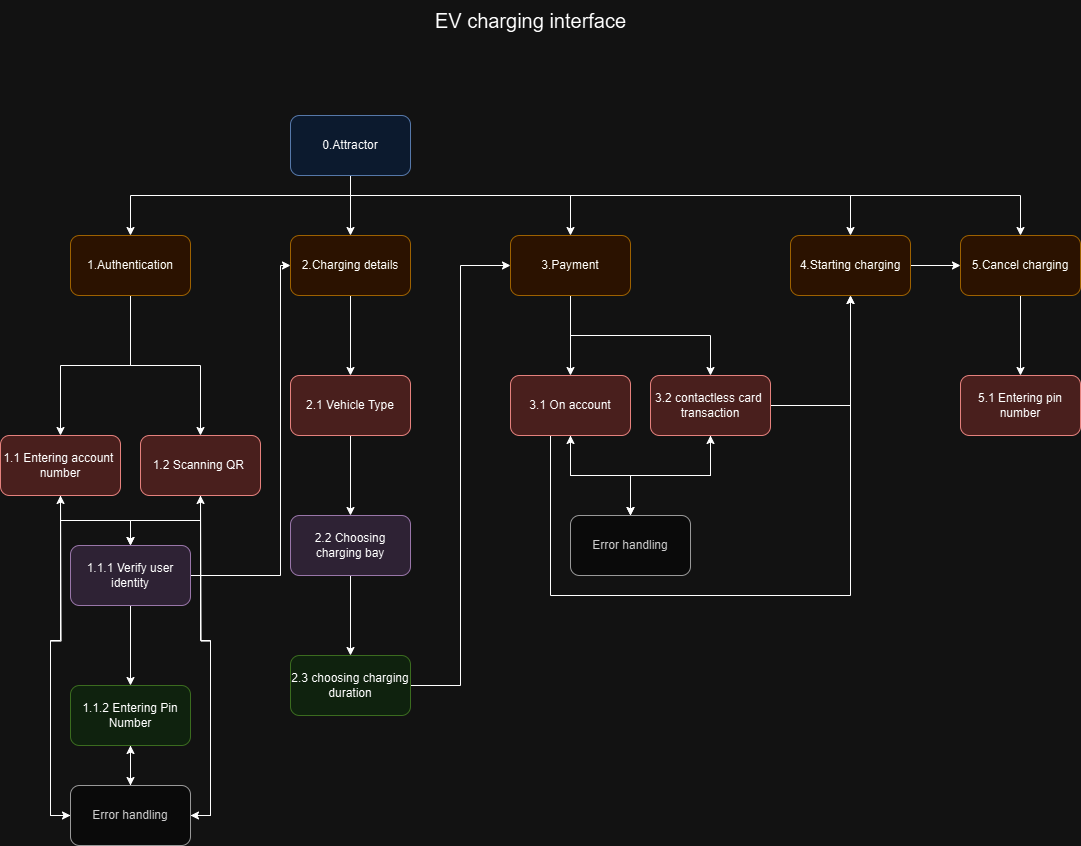
A button specified in the screen to ensure if we want to cancel the charging. This is authenticated using the users pin number which was specified during authentication. PIN authentication is not same as the PIN authentication of the first authentication page.

4.Error handling:

A clear error messages with guidance on resolving the issues made by the user. This will help the user to correct their mistakes done while authentication or in payment.

**3.Hierarchical Task Analysis Diagram (HTA)**

**“**Hierarchical Task Analysis (HTA) is a method for analysing tasks using a hierarchical structure. You start with a goal for what the task is trying to accomplish overall, break this down into top level sub-goals, and keep decomposing these sub-goals into more detail to create a tree-like structure. Hierarchical Task Analysis is a fundamental technique for understanding tasks and processes in Human Factors.”

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**4.Error Analysis**

**Error Analysis table**

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| --- | --- | --- | --- |
| **Task** | **Potential Error** | **PHEA Code** | **Migration strategy** |
| 1. Authentication | QR code not recognised | AE | Providing Manual entry option |
| 1. Authentication | No back navigation in QR code interface | OM | Providing a back navigation button |
| 1. Authentication | “submit” button not working | AE | Providing correct navigation to submit button |
| 1. Pin Authentication | Submit button not working | AE | Navigation to error handling page |
| 1. Charging bay | Identification of charging bays | OE | RED: Under use  GREEN: Can be used  BLACK: Not working |
| 1. Charging bay | Selection of charging bay | AE | Tick mark is show for making it as selected charging bay |
| 1. Charging bay | Open click option for “continue” with out selecting the charging bay | AE | Handling error with “Please select the charging bay” |
| 1. Payment details | Open click option for “continue” button without selecting the payment method | AE | Navigated to error handling interface to review the payment method |
| 1. Contactless card transaction | Dead end in contactless card screen, cannot navigate back | OM | Inserted “back” navigation button. And also when clicked “on account” , used for navigating back |
| 1. Cancel charging | User want to charge again?  No mention of continue charging option for the action | AE | A continue charging button is  Inserted to recharge the process for the vehicle. |
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**5. Prototype design**

The prototype design for EV public charging point has different screens for managing and showing a seamless transition between the screens and make it user friendly. The below are the screens used in this prototype for creating an interface. The interface is designed using a tool called figma, which is used for creating high fidelity and seamless transitions. Figma is a UI/UX designing tool used here to create a EV public charging point interface according to the given instructions. As per the previous response, I have mentioned the different screens used in my design for creating this project.

The screens used in the design:

Attractor screen – Initial page or a greeting page

Authentication screen – It includes both the account authentication and QR code authentication.

QR scanner screen – screen consisting a QR code for scanning, so that user can proceed.

QR not recognized screen – screen consists error message about “not” recognizing the QR

PIN screen – PIN screen is designed for managing the flow between the next screen from the authentication screen

Charging details screen – screen consisting of the type of vehicle choose by the user.

Charging bay screens – selection of available charging bays in the station

Charging bay error screen – screen which helps user to select the working / available bay.

Charge duration screen – A default screen where user selects time for charging the vehicle.

Payment details screen – consists of total amount to be paid , and also include their payment methods like account transaction and contactless transaction.

Payment error screen – screen helps user to select the payment method before transacation

Account transaction screen – Navigated from payment details screen in to this for completing the payment process.

Contactless screen – consisting of contactless transaction methodologies where user just places their card for making the payment

Payment success screen – a screen gives info to user about payment success.

Payment Failed screen – screen represents the failure of the payment.

Start charging screen – screen consisting of details of charging and also its analysis.

Cancel charging screen – screen consists the final charging percentage and other options like continue charging or close .

PIN 2 screen – another PIN authentication screen for closing or cancelling the charging.

From the Error analysis table, the changes which emphasized the user interface during testing of the interfaces are represented below.

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| HTA Task 1.2 | |
| Errors 1 | |
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| The design represents a digital wireframes , that represents the unauthorized or unsuccessfull authentication process using QR code.  A manual entry is needed for that , so we added a navigation button “back” for navigating to the authentication page for entering the account number manually.   * Back navigation – directed to authentication screen | |
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| HTA Task 1.2 | |
| Errors 2 | |
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| This design represents real world QR scanner authentication methodology, user puts his card that has a QR code on it. User places his card on the scanning screen to authenticate the account of the user and navigate to further process for charging  Error 2 represents a navigation error where a there is no backward flow from the screen  For it we have represented a back navigation button and it helped in solving all the back navigation problems in the design   * Back navigation – represents navigation to previous page (authentication page) | |
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| HTA Task 1.1 | |
| Errors 3 | |
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| This design is called as Authentication screen, authentication of the user is a crutial step in any of the governmental policies. The user will be able to enter his 10 digit account number in the value or lable present on the screen, he does have another option like QR code scanner option, where it is a quick authentication process.  The Error 3 represents the dead end of authenticaton screen,   * Submit button – used here to navigate to PIN screen to solve this dead end issue. | |
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| HTA Task 1.1.2 | |
| Errors 4 | |
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| This design represent final call of authentication process, user needs to enter his 6 digit PIN number , so that user then navigate into actual interface of EV. The submit button used there has a dead end similar to the error 3, as same as the authenticaton screen   * Submit button – used here to navigate to charging details screen   User can experience seamless transition between naviagtions. | |
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| HTA Task 2.2 | |
| Errors 5 | |
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| The design represent a digital framework for manitaing the charging bays, using colors , we could able to recognize the current stauts of the charging bay. Numbering are made to easy recognition of the charging bays inside the station to the user,  Color representation:  Red – Under charging  Green – Can use it for charging  Grey – not working  The above coloring technique could be very helpful for all ages of the users. This could represent a clear notation of the status of the charging bay in the screen. | |
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| HTA Task 2.2 | |
| Errors 6 | |
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| This design is a representation for selected charging bay by the user, The user will have different choice of selecting the working charging point. To represent the notation to the user, a tick mark is assigned to the selected charging bay so that user could able to remember its charging bay number  -tick mark – representation of the selected charging bay  Then user can continue for further process for charging , charging details is the next screen. | |
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| HTA Task 2.2 | |
| Errors 7 | |
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| What if user try to select under used / not working charging bay?  User will receive a recommendation interface that has a message says “please select a working charging bay” so that user can understand the type of charging bay to be selected  -back navigation – represented for navigating to the charging bay screen for repeating the selection process of the charging bay.  The user when clicked on correct, yellow colored tick mark is mentioned above the clicked charging bay. So that user understands that the charging bay is selected and then needed to click “continue” to navigate to the charge duration screen. | |
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| HTA Task 3.1 | | |
| Errors 8 | | |
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| The design represents a error handling interface occurred when clicking on continue option before selecting the payment method in the payment details page. The user frequently faces this error due to seamless flow of the design from the charging bay to the payment details.  To handle this issue , a Error handling method or a normalize interface is made to look back the payment method to be choosen.   * Back navigation – This will navigate again to the payment details page where user can able to select the payment method. | | |
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| HTA Task 3.2 | |
| Errors 9 | |
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| The design is an interface of contactless card transaction scree, user will have chance to use this payment method as this is a fastest way of completing the payment. User places card on the screen represented at the center. This will help the user to complete his transaction quickly.  What if user changes his decision or want to check the total again? A back navigation and ontap navigation is inserted for seamless interface. User could be able to view “payment details” by clicking the above navigation options. | |
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| HTA Task 4 | |
| Error 10 | |
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| What if user want to charge his vehicle again after cancelling?  This design represents the final charging status and cancelling statement of the charging. A button “continue charging” is placed , so that user can able to charge his vehicle is the cost and time is still remained.  -continue charging button – accessible for charging the vehicle after it got cancelled in middle. | |
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| HTA Task 0 | |
| Attractor screen | |
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| The design is an initial greeting interface for the task, by clicking on “get started” navigation button , we could be able to navigate to the authentication page.  But for very attractive user interface, we need to add these kind of greeting screens , so that user could able to access the tools in the software , This intital page represents the kind of text , font sizes and other button of forms used inside the design . we can easily able to understand and analyse the inside notations by looking at the attractor screen. | |
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| HTA Task 1 | |
| Authentication screen | |
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| This design represents the different ways of authentication of user, User can have choice of entering account number manually or choosing to scan the QR code.  Account Number – value space for entering 10 digit account number  Scan QR button – button for navigating to QR code scanner screen.  This design helps users to choose multiple and efficient way of authenticating their identity for charging. | |
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| HTA Task 2.1 | |
| Charging details screen | |
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| This design represents different options of EVs present in the society, user can click on those buttons as per their vehicle, we cannot able to charge different vehicles with the same power output.  As per the instruction given, power is mentioned in the “start charging” page. These buttons would navigate to another screen called “charging bay” where user could be able to select the charging bay for their vehicle. | |
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| HTA Task 2.3 | |
| Charge duration screen | |
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| Different vehicles have different max charge durations, for each and every option of “choosing vehicle” has their own maximum charge duration. We could be able to scroll the bar for selecting the charge duration with in the specified range.  This design is representing the meaning of the above description. The scroll bar, which is used for selecting the time range for keeping the vehicle to get charge, Then clicking on the continue button to navigate the payment details. | |
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| HTA Task 3.1 | |
| On Account Payment method | |
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| This design signifies the “account” payment method. User will be able to look subtotal and the total amount for the payment , after choosing the payment method , user need to click on the “pay now” button to direct the successful payment of if any issue, will lead in unsuccesfull payment. | |
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| HTA Task 4 | |
| Start charging screen | |
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| After successful transaction, The charging will start automatically in the background, By clicking on the info present in the payment successful page, That will navigate into this page called “start charging scree” or “Analysis” page. The screen consists of all the information about the charging and payment.  Date  Charging station name  Time of charging  Cost of charging  Power using  Remaining Time for charging  Current charging status  Cancel charging button | |
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| HTA Task 5.1 | |
| PIN 2 (cancelling charging) | |
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| What if user wants to cancel his charging for the vehicle, When he clicks on cancel charging , for authenticating the user benefits , he has to enter the PIN number (6 digit pin number). So that he can be able to cancel his charging for the vehicle  PIN holder space- entering the 6 digit pin number  Submit – option when clicked navigated to cancel charging screen. | |
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**6.User testing**

**6.1 Testing plan**

**Participants:**

Ten Participants were selected for this task, to represent a range of experience levels with electric vehicle (EVs) and charging stations. The Participants are :

Participants A,B: Experienced EV owner.

Participants C,D: New EV owner.

Participants E,F: Occasional EV user.

Participants G,H: Tech-savvy individual without EV experience.

Participants I,J: Non-tech-savvy individual without EV experience.

The Tasks:

The Participants were asked to complete the following tasks using the touch interface of the EV public charging point.

Authenticate (scanning QR code).

Select a charging option.

Monitor charging progress.

Make a payment.

End the charging session.

Metrics:

Task Completion Time: Time taken to complete each task.

Error Rate: Number of errors encountered during each task.

User Satisfaction: Assessed via a post-test questionnaire rating their experience on a scale of 1 to 5.

**6.2 Testing results**

Task completion time:

Participants A,B and C,D completed tasks quickly, averaging 1-2 minutes per task.

Participants E,F took slightly longer, averaging 2-3 minutes per task.

Participants G,H and I,J took the longest, averaging 3-5 minutes per task.

Error rate:

Authentication: 2 errors (Participants E struggled with QR code recognition).

Selecting Charging Option: 1 error (Participants D initially selected the wrong option).

Monitoring Charging: No errors.

Payment: 3 errors (Participants C and E had difficulties with payment method selection).

Ending Session: 1 error (Participants B did not confirm the end of the session)

User satisfaction:

Participants A,B: 10/10 - Found the interface intuitive and user-friendly.

Participants C,D: 6/10 - Appreciated the clear instructions but suggested larger buttons.

Participants E,F: 6/10 - Satisfied but found some options confusing.

Participants G,H: 8/10 - Found the interface easy to navigate despite initial confusion.

Participants I,J: 4/10- Struggled with several tasks and suggested additional guidance.

Evidence of Testing

Screenshots of Testing:

Authentication : Screenshot showing successful QR code scan.

Selecting Charging Option : Screenshot showing the charging options screen.

Monitoring Charging : Screenshot of the charging progress screen.

Payment : Screenshot of the payment options screen.

Ending Session : Screenshot of the session summary and receipt screen.

Observations:

Participants A: Completed all tasks efficiently, providing feedback on the smoothness of the process.

Participants B,D: Found the interface clear but noted that larger buttons could improve accessibility.

Participants F,H: Encountered minor confusion with the payment process but managed to complete all tasks.

Participants I,C: Initially confused by the charging options but quickly adapted.

Participants J,G: Required additional assistance, indicating a need for more intuitive guidance.

**6.3 Testing Analysis**

Overall Findings:

Task Completion: All Participants successfully completed all tasks, although the time and ease varied based on their experience and tech-savviness.

Errors: Most errors were minor and related to the authentication and payment processes. These can be mitigated by improving the error handling and guidance.

User Satisfaction: Satisfaction score was 7.2/10, indicating general satisfaction with the interface, with room for improvement in some certain fields..

**7.Conclusions and Recommendations**

Conclusions:

User testing has shown general effectiveness and user-friendly charactersists, there are many areas where improvements can enhcance the overall user experience.The primary area for improving includes the authentication process,payment method selection and also providing clear navigations for each and every screen to make the user understand it well.

Recommendations:

Enhancing Authentication:Provide clearer instructions and ensure the QR code scanner is highly responsive. Include a manual entry option for backup.

Improving Payment Process: Simplify payment options and ensure the payment method selection process is intuitive. Provide clear feedback when a payment method is selected.

Size of buttons and text needed to be improved: For accessibility, especially for users who are less tech-savvy or have visual impairments.

Error Handling: Ensure all potential errors have clear and helpful messages guiding the user on how to proceed.

User Training and Support: Provide a quick tutorial or help option on the interface for first-time users.

By implementation of these recommendations , the EV charging interface can be more efficient , and user friendly. So that ensuring a positive expeience from the users.

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