**3.3 Development and Testing**

Development and Testing This chapter discuss the hardware and software used during the development and testing processes of the HydroHub: An All-in-One Solution for Sales, Inventory, and Delivery at Water Refilling Stations.

**3.3.1 Development**

During the development phase, the researchers used a laptop with a 12th Gen Intel(R) Core(TM) i5-12450H processor, 8GB RAM, NVIDIA GeForce RTX 4050 GPU, and a 64-bit operating system to build and test the system.

Windows 11 Pro 64-bit was used as the operating system, and the system was developed using the following technologies: Flutter, Node.js, PostgreSQL, Postman, and Visual Studio Code. These frameworks and tools were chosen for both frontend and backend development.

Flutter is a free, open-source UI toolkit used for building natively compiled applications for mobile and web from a single codebase. Node.js is utilized for backend operations due to its event-driven, non-blocking nature, ensuring high performance and scalability. PostgreSQL serves as the database management system (DBMS), providing structured data storage with high reliability. Postman is used for API testing to ensure seamless communication between the frontend and backend.

Visual Studio Code (VS Code), a powerful and lightweight code editor developed by Microsoft, is used as the integrated development environment (IDE). It provides essential debugging, version control, and extension support for efficient software development.

**3.3.2 Testing**

The testing phase aims to evaluate the system’s functionality, usability, and overall effectiveness in meeting user requirements. Testing is conducted with active participation from water refilling station owners, operational staff, and customers, ensuring a comprehensive assessment of the mobile application.

This study takes place in Tagbilaran City, Bohol, where participants are selected using a purposive sampling technique to ensure balanced representation from all user groups. The study involves three (3) water refilling station owners, six (6) staff members, and three (3) customers, totaling 12 participants. This selection process ensures that feedback is collected from key stakeholders directly involved in refilling station operations and service usage.

The selection criteria for participants include the following: water refilling station owners must have at least (2) years of experience in the industry, staff members must have worked in sales, inventory, or delivery roles at that specific station, and customers must be individuals who have purchased water refills but have not previously used a mobile ordering platform. If any participant withdraws during testing, a replacement is selected based on the same criteria. Participants are excluded from the study based on several criteria to maintain the accuracy and relevance of the testing process. These include water refilling station owners with less than two (2) years of experience in the industry and staff members who are not directly involved in sales, inventory, or delivery operations. Customers who have previously used any mobile or digital platforms to place water refill orders are also excluded, as their prior experience may influence the objectivity of their feedback. Additionally, individuals who are not affiliated with any water refilling station in Tagbilaran City, as well as those who are unwilling or unable to provide informed consent, are not eligible to participate. Persons with visual, motor, or cognitive impairments that significantly hinder interaction with mobile applications—unless the study specifically includes accessibility testing—are also excluded. Participants may be removed from the study if they fail to engage meaningfully with the testing process, provide incomplete responses, or do not meet the minimum participation requirements. Lastly, individuals currently involved in other usability or mobile application research studies are excluded to avoid potential bias in the results. The testing phase lasts for one (1) week, during which participants engage with the system and provide feedback. Before testing begins, participants are asked for their consent to be part of the study. Researchers explain the purpose of the study, the testing process, and how collected data will be used. Participants have the opportunity to ask questions and express any concerns. The testing session lasts between 30 minutes to 1 hour, and participation is entirely voluntary.

Participants in this study have the right to withdraw at any point during the research process without any penalty or consequence. Withdrawal may occur for any reason, including discomfort, schedule conflicts, or a change of willingness to participate. Participants may inform the researchers verbally or in writing of their intention to withdraw, and all data associated with their participation will be excluded from the final analysis if requested. Additionally, participants who show signs of distress during interviews or who fail to meet minimum participation requirements (e.g., incomplete responses or disengagement) may also be respectfully withdrawn by the researchers to maintain the integrity of the data collection process. Ensuring voluntary participation and the right to withdraw upholds the ethical standards of informed consent and respect for participant autonomy. Before using the system, they sign an informed consent form, which is available in English and Cebuano. To protect privacy, the participants’ names, signatures, and personal details are kept confidential throughout data collection, analysis, and reporting.

The testing process is conducted within water refilling stations, where owners and staff typically operate. The locations are selected to ensure a realistic testing environment, reflecting actual operational conditions. The required tools, such as mobile devices and a stable internet connection, are provided to support testing. Researchers also ensure that the testing environment remains private and secure to maintain confidentiality. No monetary transactions or business operations are conducted during the testing process.

The user functionality test is conducted by allowing participants to interact with the system and assess each feature’s performance. Testers follow predefined test cases and compare actual outcomes with expected results. A "PASS" remark signifies that a feature functions correctly, while a "FAIL" remark indicates that a functionality issue exists and requires refinement. Participants are encouraged to provide feedback and suggest improvements. The testing process does not require participants to provide signatures or names.

The user usability test evaluates the ease of use and learnability of Hydrohub’s interface for station owners, delivery personnel, and customers. The usability assessment consists of two key aspects: Software Design and User-Friendliness. Software Design testing involves assessing various interface elements crucial for user experience. The layout of the mobile application is examined to ensure intuitive navigation, while the color scheme is evaluated for visual coherence. Text clarity, including labels and instructions, is analyzed for readability. Buttons, menus, and other interactive elements are tested for accessibility and responsiveness. Additionally, multimedia components, such as images and icons, are reviewed for relevance and user engagement.

For User-Friendliness, testers evaluate how efficiently users can interact with the platform. The readability of text, including font size and style, is assessed for clarity. The navigation between different sections of the application is tested for smooth transitions. The ease of selecting options from menus and dashboards is also examined. Lastly, the application’s responsiveness across various mobile devices, including Android and iOS smartphones, is tested to ensure a consistent and user-friendly experience across platforms. Through these usability testing processes, researchers refine both Software Design and User-Friendliness, enhancing the overall user experience.

The usability test results are analyzed using a Likert scale assessment sheet. Researchers apply statistical procedures, including the weighted mean and grand mean, to interpret collected data. The weighted mean is used to determine the overall usability rating based on each criterion. The 5-point Likert scale is structured as follows:

|  |  |  |
| --- | --- | --- |
| **Value** | **Description** | **Range** |
| 5 | Excellent | 4.21 - 5.00 |
| 4 | Very Good | 3.41 - 4.20 |
| 3 | Average | 2.61 - 3.40 |
| 2 | Fair | 1.81 - 2.60 |
| 1 | Poor | 1.00 - 1.80 |

***Table 1.*** *Likert Scale*

Points Range Equivalent Descriptive Meaning 5 4.21 - 5.00 E Excellent 4 3.41 - 4.20 VG Very Good 3 2.61 - 3.40 G Good 2 1.81 - 2.60 F Fair 1 1.00 - 1.80 P Poor

The usability ratings help assess the system’s overall user satisfaction and effectiveness. The calculated weighted mean and grand mean provide insight into Hydrohub’s performance based on user feedback.

The findings of the functionality and usability tests indicate overall positive performance, with testers expressing satisfaction with the platform. Each functionality test receives a "PASS" remark, confirming that the features meet system requirements.