eBillH2o: Web-Based Billing and Support System for Streamlined Water Management

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A B S T R A C T

Bongabong Waterworks and Sanitation Association (BOWASA) currently uses a traditional method of water billing that involves taking meter readings, calculating water usage per household, and issuing billing statements. A web-based system that automatically calculates water usage and generates billing statements was proposed and developed. SMS notifications were integrated to notify consumers' bills, due dates, and disconnection notices, and consumers were able to pay bills using online payment technology. The spiral model was used as a software development method, and the system was tested and evaluated by BOWASA management, consumers, and IT experts using ISO 25010 software quality standards. The system was found to be user-friendly, interactive, and functional, achieving its expected functions in terms of functional suitability, performance efficiency, usability, compatibility, and security. It can greatly improve BOWASA management by streamlining transactions and services and providing consumers with accurate and timely information about their water consumption and bills. It also enhances convenience for consumers by enabling online payment and SMS notifications. Overall, the web-based system can increase efficiency, accuracy, and convenience for BOWASA and its consumers.

R E S U M O

A Associação de Sistemas de Água e Saneamento de Bongabong (BOWASA) utiliza atualmente um método tradicional de cobrança de água que envolve fazer leituras de medidores, calcular o uso de água por domicílio e emitir extratos de cobrança. Foi proposto e desenvolvido um sistema baseado na web que calcula automaticamente o uso de água e gera extratos de cobrança. Notificações por SMS foram integradas para notificar contas dos consumidores, datas de vencimento e avisos de desconexão, e os consumidores puderam pagar contas usando tecnologia de pagamento online. O modelo espiral foi usado como método de desenvolvimento de software, e o sistema foi testado e avaliado pela administração da BOWASA, consumidores e especialistas em TI usando os padrões de qualidade de software ISO 25010. O sistema foi considerado fácil de usar, interativo e funcional, alcançando as funções esperadas em termos de adequação funcional, eficiência de desempenho, usabilidade, compatibilidade e segurança. Pode melhorar significativamente a gestão do BOWASA, simplificando as transações e serviços e fornecendo aos consumidores informações precisas e oportunas sobre o seu consumo e faturas de água. Também aumenta a conveniência para os consumidores, permitindo pagamentos online e notificações por SMS. No geral, o sistema baseado na web pode aumentar a eficiência, a precisão e a conveniência para a BOWASA e seus consumidores.

Introduction

Water is necessary for life. It is essential for the survival of humans, animals, and plants. It has a significant impact on our daily lives in a variety of ways. We rely on water for food, health, livelihood, fun, and recreation. Many of our daily household activities, such as dishwashing, washing clothes, bathing, cleaning the house or vehicles, cooking, and so on, require the use of water (Velayutham, 2019).

In Manila, the Metropolitan Waterworks and Sewerage System (MWSS) and two private consortia, the Maynilad Water Services Inc. (MWSI) for the West Zone and the Manila Water Company, Inc. (MWCI) for the East Zone, provide water to Metro Manila and its vicinities. Some households in the Municipality of Bongabong, Province of Oriental Mindoro, receive water from free plowing, but there are also individual households and business establishments that use the Bongabong Waterworks System (BOWASA). BOWASA provides water services to the barangays of Bagong Bayan 1 and 2, Aplaya, Ipil, and Poblacion. The BOWASA staff oversees managing its services, primarily the waterworks service, which provides water to their customers or households.

During the needs assessment conducted by the researchers, it became evident that BOWASA's management heavily relies on a traditional billing system. However, this traditional approach proves to be time-consuming and prone to errors, particularly when dealing with a large number of customers. The existing process involves six (6) meter readers who manually record the readings of over 900 consumers using pen and paper. Additionally, there is only one (1) encoder responsible for generating the billing statements. Subsequently, the meter readers have to return to each household to issue receipts individually. Compounding the problem, many members or consumers have busy schedules due to work and other commitments, which increases the likelihood of forgetting payment due dates. Furthermore, BOWASA lacks an efficient means of providing customer assistance, such as addressing concerns, answering questions, or handling complaints promptly. To address these challenges, the researchers proposed a web-based water billing and support system to BOWASA.

This system aims to enhance the efficiency of their waterworks services by leveraging modern technology and digital solutions. By adopting a web-based billing system, BOWASA can streamline their processes and reduce the time and effort required for manual data recording. Meter readers can use mobile devices or tablets to directly input readings, eliminating the need for pen and paper. The system can automatically generate accurate billing statements, reducing the likelihood of errors. Moreover, with a centralized database, BOWASA can manage customer information more effectively. The proposed system also addresses the issue of payment reminders. By implementing automated notifications via SMS, customers will receive timely reminders about upcoming due dates, reducing the risk of missed payments. This feature caters to the busy schedules of customers and enhances their overall payment experience. Furthermore, the web-based system incorporates a customer support module, allowing consumers to easily reach out to BOWASA with their concerns, questions, or complaints. By providing a quick and convenient means of communication, BOWASA can improve customer satisfaction and enhance their overall service quality.

In Asia, the Philippines stands out as the country with the highest dependency on mobile phones (Lacsamana, 2022). As of 2021, a staggering 82.3 million Filipinos were already using mobile phones, showcasing the widespread adoption of this technology. Furthermore, projections indicate that the number of mobile phone users in the country will continue to grow, reaching nearly 90 million by 2025 (Statistica Research Department, 2023). The prevalence of mobile phones in the Philippines underscores their importance as an essential tool in modern society. Recognizing this, researchers have capitalized on this trend by

integrating SMS notifications into various services, such as billing notifications, due dates, and disconnection notices. This integration allows service providers to leverage the ubiquity of mobile phones to effectively communicate with customers and households.

Overall, in a country like the Philippines where mobile phone usage is extensive, the integration of SMS notifications for various services presents an opportunity to leverage this technological reliance. By harnessing the power of mobile phones, service providers can optimize their communication strategies, increase customer satisfaction, and ensure a more efficient and streamlined service experience for all. Mobile phones have proven to be a necessity nowadays, and customers or households with phones provide an opportunity to materialize the idea. The researchers integrated SMS notifications for new bills, due dates, and disconnection notices.

Despite advancements in billing systems, certain water stations, like BOWASA, still encounter difficulties in effectively managing water bills because they are currently using the traditional method. Recognizing this need, the researchers were inspired to propose the development of a web-based water billing and support system. This study specifically aimed to: (1) design and develop a web-based water billing and support system capable of: (a) keeping consumers informed about BOWASA's announcements and events; (b) sending an SMS with information about water consumption, bills payment, due date, and disconnection schedules; (c) viewing, monitoring, and generating real-time water consumption, billing statement, and payment reports; and (d) using the real-time chat (RTC) feature to provide direct consumer assistance with their questions, concerns, and complaints. (2) Evaluate the system's functionality suitability, performance efficiency, usability, compatibility and security using ISO 25010 software quality standards.

Related Work

Several prior studies have explored topics related to the proposed web-based water billing and support system. For instance, Pelandiana & Ado (2018) conducted research on a Web-Based Billing and Collection System specifically designed for a Municipal Water and Services Unit. This study likely shares similarities with the proposed system, as it addresses the challenges associated with managing water bills and collections. Another relevant study by Dhumale et al. (2018) focuses on an Automatic Water Billing System based on an Android Application. The water billing system is equipped with a feature that can automate the computation of the consumer's monthly bill and the payment needed to be paid making it easier to track consumption, payment status. In any water billing system, it is important that the customer have permission to access their bill consumptions anywhere and at any time (Kumar et al., 2018).

The study by Li, Yang and Sitzenfrei (2020) cited that the application of the smart water network is the unavailability of a systematic framework to guide real-world design and deployment that aims to facilitate more extensive adoption of the smart water system, to increase effectiveness and efficiency in real-world water system contexts. By using hand-held devices, the system is cost-effective and gives automated water meter reading with high accuracy (Bhoyar et al., 2018). Furthermore, other related studies, as shown in Table 1, explore various existing electronic water billing systems designed to streamline water consumption monitoring and billing processes, summarizing each system's key features and descriptions.

Table 1.

Summary of Related System

Title of Existing System	Description	Key Features
Electronic Water Billing System (Shoukry et.al, 2017)	Develops an automatic electronic water billing system for apartments in Egypt using smart meters and GSM modules.	Smart meters Wireless data transmission via GSM email invoicing SMS notifications before/after readings
Automated Household Water Supply Monitoring & Billing (Rahman et.al, 2018)	Utilizes Arduino Mega 2560, water level sensors, and water flow sensors for monitoring and billing household water supply.	Arduino Mega 2560 Automation of water motor Display of water usage Billing based on usage
Pattern Recognition based Smart Billing System (Alagarsamy et.al, 2022)	Implements pattern recognition for calculating water bills based on usage, with immediate notifications and online payment options.	Pattern recognition Immediate notifications Online payment SMS updates
Smart Water Billing System for Apartments (Dheepanchakkravarthy et.al, 2021)	Develops a smart water billing system for apartment residents, measuring consumption and providing extra usage alerts.	Water flow sensor Extra consumption alerts Shared/separate water tanks
Automated Water Billing System (Jagtap et.al, 2019)	Implements smart water meters for electronic billing, sending readings to users via SMS and saving data automatically in the institution database.	Smart water meters SMS notifications Automatic data storage

Materials and Methods

This study employed a combination of developmental and descriptive research methods to achieve its objectives. The system design and development employed a developmental approach, and the testing and evaluation of the system followed a descriptive approach.

Software Materials

eBillH20 can be operated using a desktop computer, laptop, and mobile phones. The following software applications are used in the development of the system. (a) Sublime Text Editor. It is a shareware text and source code editor used to manage and edit the system codes. (b) MySQL Workbench. It is used to manage and edit the database design of the system. (c) Xampp Server. It is used to test the system that is on a local host server as well as it can also be used to create and manipulate databases like MySQL. (d) Semaphore. It is used as the SMS gateway of the system. (e) TawkTo. It is a free live chat software, and it is used for the Real-Time-Chat support of the system (f) Hostinger. It is a website optimization software that is used to host the system online making it accessible on the internet. (g) Web Browser. It is used to render codes that is used to design web pages. It is used to show the output of a certain code or the interface of a web system.

Development Method

The developmental approach utilized in the design and development of the system followed the spiral development model. This model was chosen because it allows for iterative and cyclical enhancements of the system during the development process. Throughout the creation of each version of the program, multiple stages were completed concurrently, as depicted in Figure 1. These stages represent essential steps in the development process,

ensuring a synchronized and efficient approach to system refinement. The spiral development approach employed in this study enabled the researcher to iterate and refine the system based on feedback and evolving requirements. This iterative nature ensured that the system evolved effectively and met the needs of users and stakeholders.

Figure 1.
Spiral Model
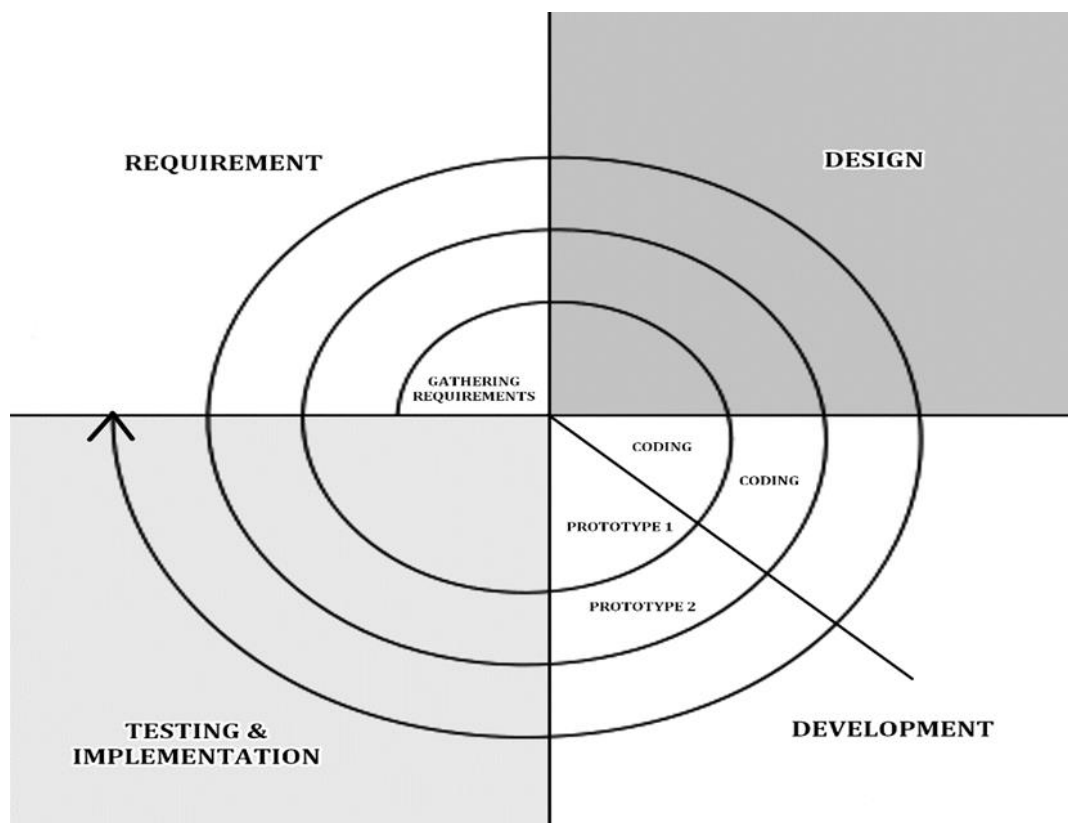
Gathering Requirements

In the initial phase, the focus lies on planning, identification, and collection of essential information. This phase plays a critical role in establishing the system's logic and design. During this stage, key details, such as water bill computation, geographic location of consumers, and other relevant services offered by the Public Utility Unit in relation to the waterworks services, are gathered. These crucial data points are acquired through interviews conducted with the responsible Public Utility Unit overseeing the management of the Bongabong Waterworks System.

Design

The Design phase involves translating the gathered requirements from initial phase into the software interface of the system. In this process, the researchers plot the specific location for each component of the system. The initial design of the system is created using Moqups, a tool for creating mock-up designs. Subsequently, the design and functionality are finalized by utilizing HTML, CSS, and Bootstrap, ensuring a visually appealing and responsive user interface.

Development (Coding and Prototyping)

The development phase encompasses the actual development of the system, involving tasks such as hard coding and prototyping. Throughout this process, the codes are refined and finalized to achieve the desired output. Additionally, this phase involves uploading the system online, making it accessible to users.

Testing and Implementation

The testing and implementation phase are crucial as it entails reviewing the prototype and gathering feedback on the system's performance. The received feedback is invaluable in iteratively improving the system and creating a more refined version. This iterative cycle of the spiral model persists until the system achieves its full functionality, ensuring that it meets the required standards and user expectations.

Descriptive Method

The descriptive method of research was also employed in the system evaluation process. Purposive sampling was used in selecting the respondents. A total of one hundred ten (110) who answered the evaluation survey. The respondents consisted of 100 consumers or households, three (3) meter readers, one (1) encoder, one (1) collector and five (5) IT experts. Additionally, a questionnaire was used to evaluate the system functionality and performance. The evaluation questionnaire used was adapted from ISO 25010 software quality standards (ISO/IEC, 2011). These criteria evaluated were functional suitability, usability, reliability, compatibility, security, and portability. The proponents devised the indicators for each criterion, which was validated by the Research Coordinator and other IT faculty researchers of Mindoro State University-Bongabong Campus.

The system undergoes rigorous testing to ensure compliance with ISO 25010 standards and to verify the proper functioning of its components. This testing phase aims to minimize errors and ensure smooth operation of the system. The evaluation primarily focuses on performance, usability, and reliability aspects. Performance efficiency evaluates how well the system performs relative to the resources it consumes under specific conditions. It aims to optimize the system's performance while utilizing the minimum required resources. Usability refers to the extent to which the system can be effectively and efficiently used by specified users to accomplish predefined goals. It also considers user satisfaction within a specific context of use. Reliability measures the system's ability to consistently perform the intended functions under specified conditions for a designated period. It ensures that the system remains dependable throughout its operation.

Survey instruments serve as valuable tools for gathering data. Examples of survey instruments include questionnaires, interviews, and observations. In this study, survey questionnaire and interviews were employed as the data gathering tool to assess the usefulness and performance of the system during its implementation at LEE/PU Bongabong.

Table 2 presents the list of questions that have been carefully curated to evaluate the overall performance of eBillH20. These questions serve as a vital survey instrument, designed to gather valuable feedback and insights from various stakeholders. The survey will be distributed to selected respondents residing in Aplaya, Poblacion, and Bagong Bayan, Bongabong, who are within the defined scope of the study. In addition, employees of LEE/PU, who are responsible for handling waterworks management transactions and IT experts, will also participate in the survey. By including these specific groups, our study aims to collect input from both end-users and individuals with expertise in the system.

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Table 2.
System Evaluation Instrument

Criteria	Indicators
Functional Suitability	1. The system allows the users to register and reset forgotten password. 2. The system allows Confirmation/Verification of Registered Consumers. 3. The system allows to add meter readings and bill statement or receipts. 4. The system allows the user to send disconnection notice and due date via SMS notifications to the consumers' mobile number. 5. The system allows users to view the consumers' bill history and generate reports. 6. The system allows the admin to post important announcements and the other users (consumers & meter reader) to comment on the post. 7. The system allows users to view & reply to complaints. 8. The system allows the user to exchange messages using the system's RTC (Real-Time Chat).
Performance Efficiency	1. The system ensures that all button functions work. 2. The system guarantees efficient and prompt loading of pages. 3. The system provides a responsive design. 4. The system should be able to process many requests at the same time.
Usability	1. The system is user-friendly and easy to learn and understand. 2. The system is easy to operate (navigate, control). 3. The system's user interface exhibits an aesthetically pleasing design. 4. The system is responsive to the user's command.
Compatibility	1. The system is cross-platform on any mobile devices/computers with an internet connection. 2. The system is cross-browser. It appears fully functional on a different browser.
Reliability	1. The system works properly. 2. The system provides an accurate result. 3. The system provides Real-Time SMS.
Maintainability	1. The system maintains the information update. 2. The system allows users to update their profiles. 3. The system admin updates the billing information, schedule of disconnection notices, and announcement.
Security	1. The system can be accessed only by authorized users. 2. The system required the users to provide a unique "Username" and "Password" to be authenticated in the system. 3. In order to reset a forgotten password, the system required a user to provide his/her E-mail Address. 4. The system provides its unique account to each end user.

The proponents used five-point Likert scale with the mean range interpretation of (1) 1 to 1.49: poor, (2) 1.50 to 2.49: fair, (3) 2.50 to 3.49: good, (4) 3.50 to 4.49: very good and (5) 4.50 to 5.00: excellent as shown in Table 3 below.

Table 3.

Likert Scale for System Evaluation

Rating	Mean	Verbal Interpretation
5	4.21-5.00	Excellent
4	3.41-4.20	Very Good
3	2.61-3.40	Good
2	1.81-2.60	Fair
1	1.00-1.80	Poor

Proposed System

The proponents conducted an ocular visit and informal survey at the BOWASA office, as well as interviews with one-meter reader, encoder, and consumers living nearby. The analyses indicated that consumers were eager to adopt the proposed technology. The suggestions of BOWASA staff and customers were taken into consideration and aided the proponents in creating the system architecture. (See Figure 2).

Figure 2.
System Architecture
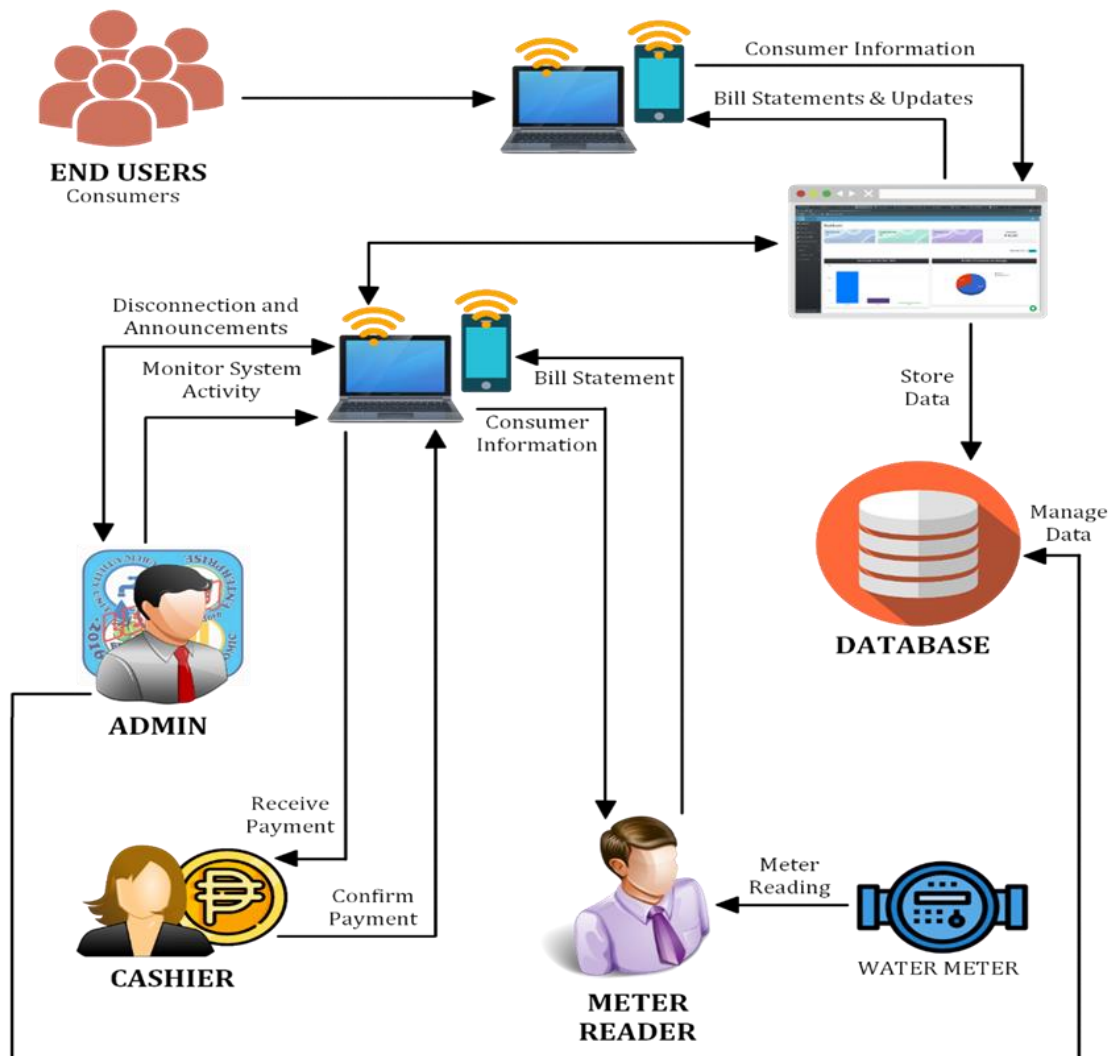
Figure 2 shows the system architecture. To explain further, the users, which are the consumers, the meter reading clerk, the cashier, and the admin (BOWASA), will need to have their own accounts in the system. In the consumer account, the consumers can see their water bill reading for their monthly consumption, view the announcement stream, view their bill history, add complaints and messages, and view their monthly and yearly water consumption. The admin account managed by the IT Staff of the Public Utility Unit can view their customers' consumption reports. They can also view their customers' bill history, keep track of their customers' current bills, send cut off notices and post updates on the announcement stream for their customers to see. The admin is the only one authorized to create other admin accounts including the meter reader accounts. Consumers can register and create their own account on the system. The cashier account is responsible for managing the payments received by the system. The cashier is able to view the consumers billing history, confirm payments and view sales report generated by the system. Lastly, the meter reading clerk or the meter reader account is also a separate account for the person in charge of reading meter numbers and sending the electronic bill to the system which the management and the consumers can view.

Figure 3.
Use Case Diagram
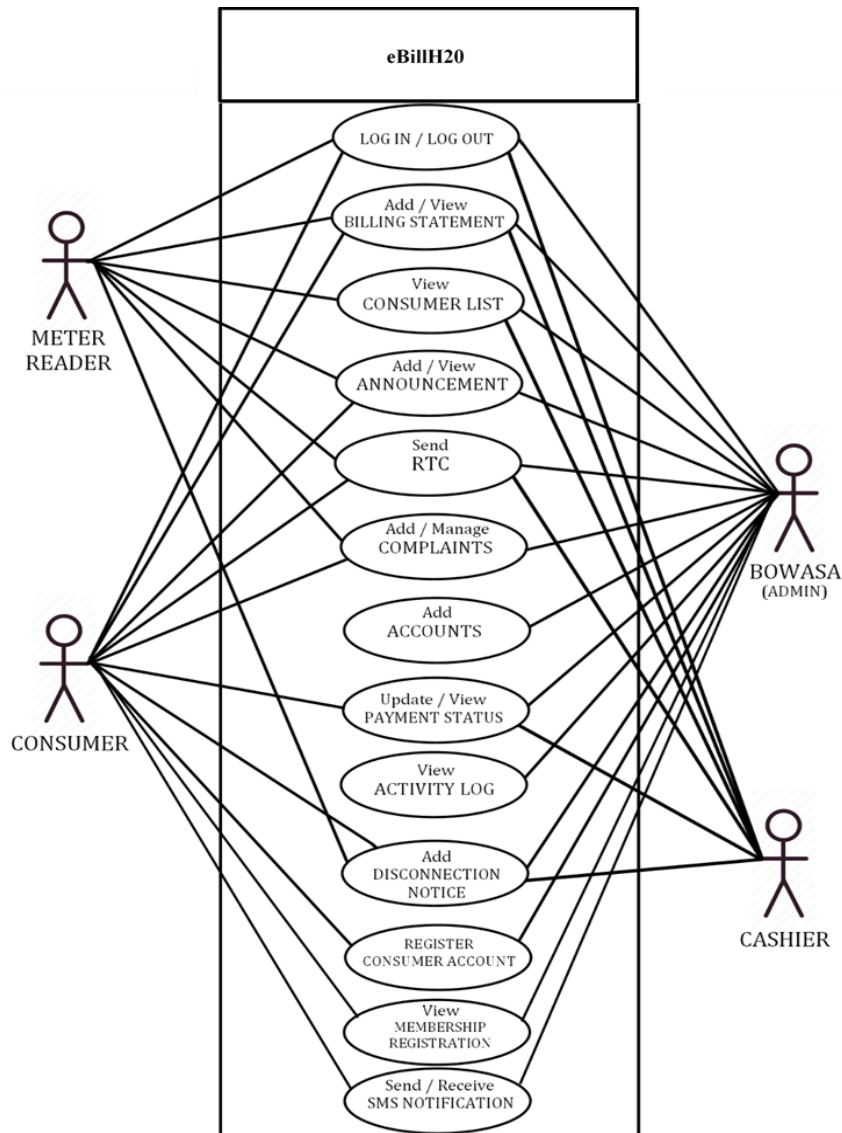
As shown in Figure 3. the proposed system can provide the following features, such as log in and log out for all account types, the admin can manage, view, and add billing statements, announcements, disconnection notices and add other admin accounts such as meter reader accounts to the system and they can also manage consumer lists (both verified and unverified), monitor user activity on the system, and access the RTC (Real-Time Chat). the meter reader can also view the consumer list, consumer billing history, disconnection notice, RTC, and complaints, consumers can view their billing history, receive an announcement, receive SMS regarding due date payment and disconnection notice and register a consumer account.

Results and Discussion
1. *Design and Development of eBillH2O System Interface Design*

Figure 4 displays the secure admin login page, which serves as a protected interface allowing administrators to access their accounts by inputting their individual username and password credentials. Each user, whether they are an admin, meter reader, cashier, or consumer, is required to log in using a login form before gaining access to the system. This login form serves as a gateway for users to authenticate their identities and access their respective functionalities within the system.

Figure 4.
Admin Login

Figure 5 displays the consumer login page. It is a secure interface, enabling consumers to effortlessly access their accounts. By registering their information, users can establish a personalized login. Additionally, the page features a convenient "forgot password" functionality, allowing users to easily recover their account access in case of a forgotten password.

Figure 5.
Consumer Login
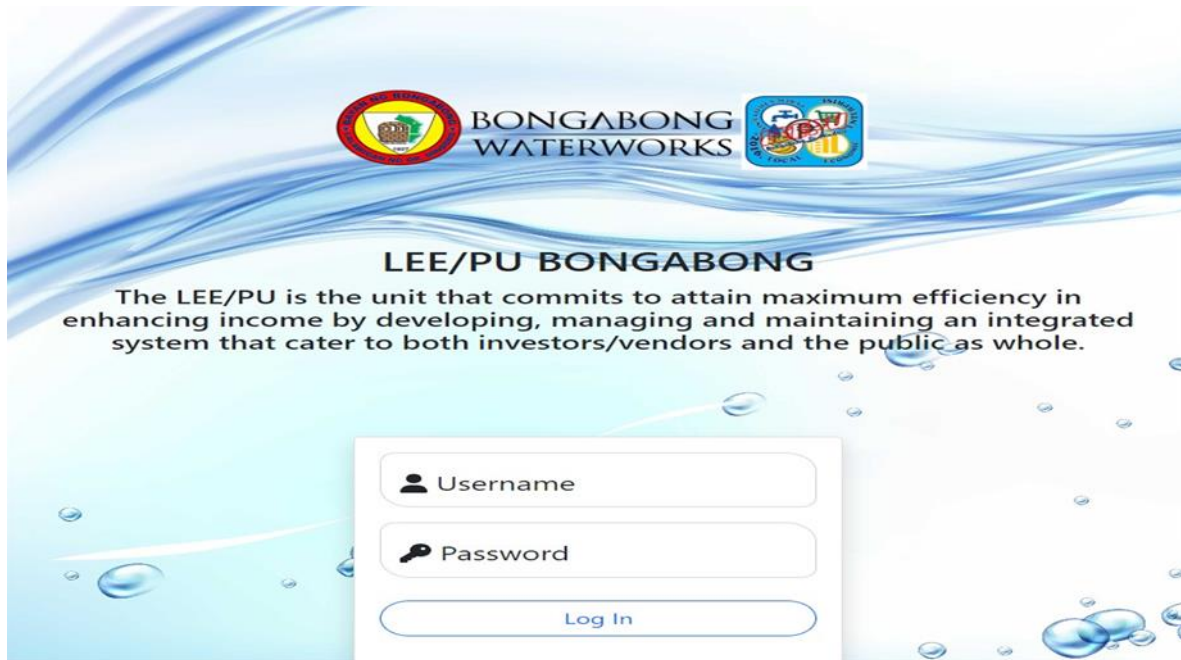
Figure 6
Admin Dashboard
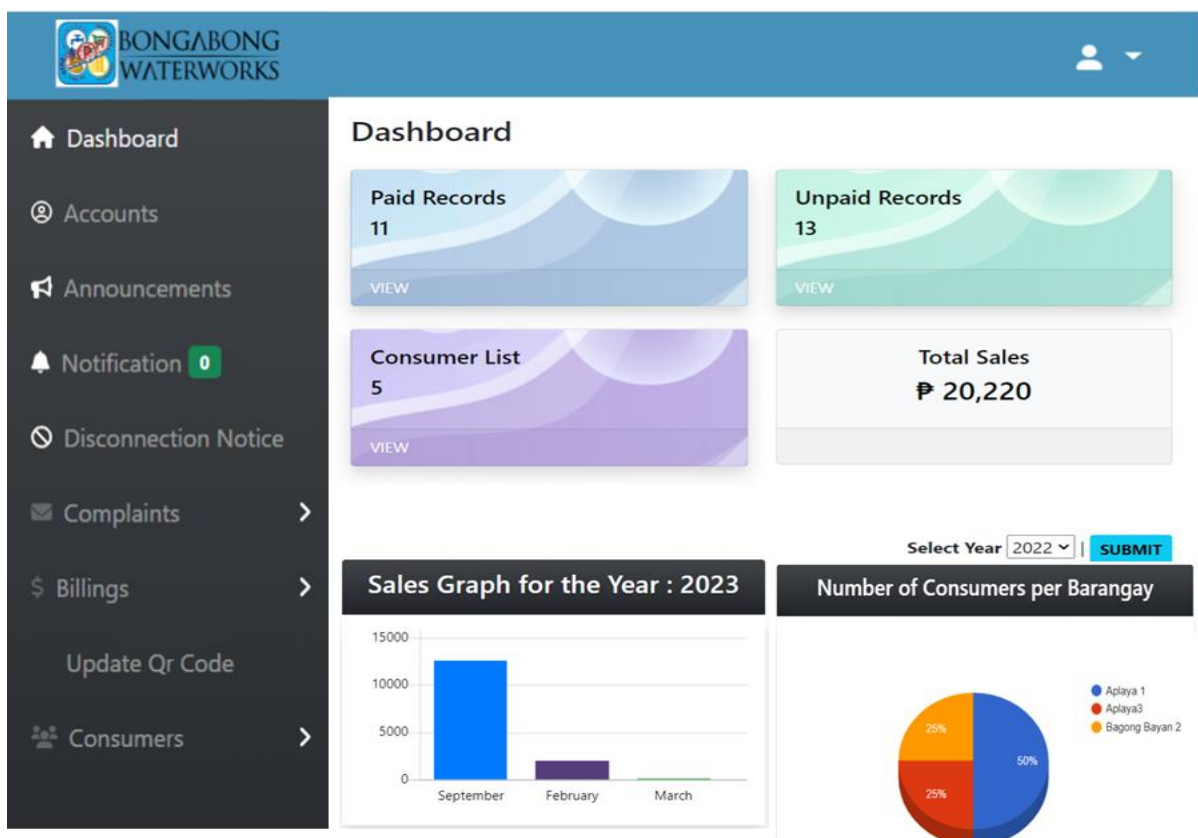
Figure 6 displays the admin dashboard which provides a comprehensive overview of the system, featuring easy navigation to key sections such as Admin account, Announcements, Notifications, Disconnection Notices, Complaints, and Billings. It incorporates an updating QR Code feature, allowing seamless updates to be shared. Furthermore, it showcases vital information about the system's consumers, enabling efficient management and monitoring.

Figure 7.
Meter Reader Dashboard
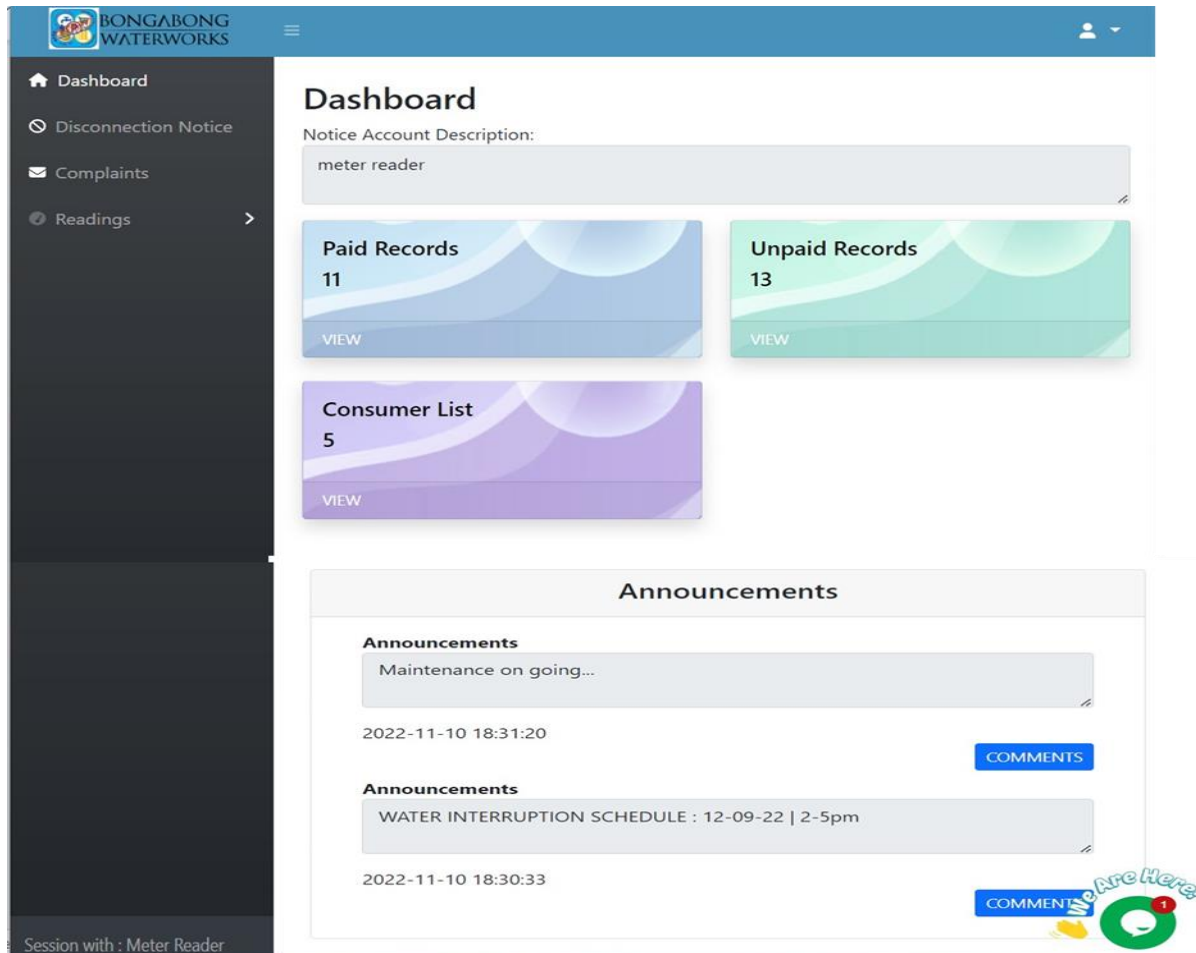
In Figure 7, the meter reader dashboard provides a comprehensive navigation system, enabling easy access to various functionalities within the system. It offers convenient access to key sections, including Admin, Announcement, Disconnection Notice, Complaints, Billings, and Consumers.

In Figure 8, the cashier dashboard conveniently displays system navigation options, including total sales, paid and unpaid records, consumer list, notifications, billing information, and disconnection notices. Also, it has data visualization of sales graph per year and the number of consumers per barangay.

Figure 8.
Cashier Dashboard
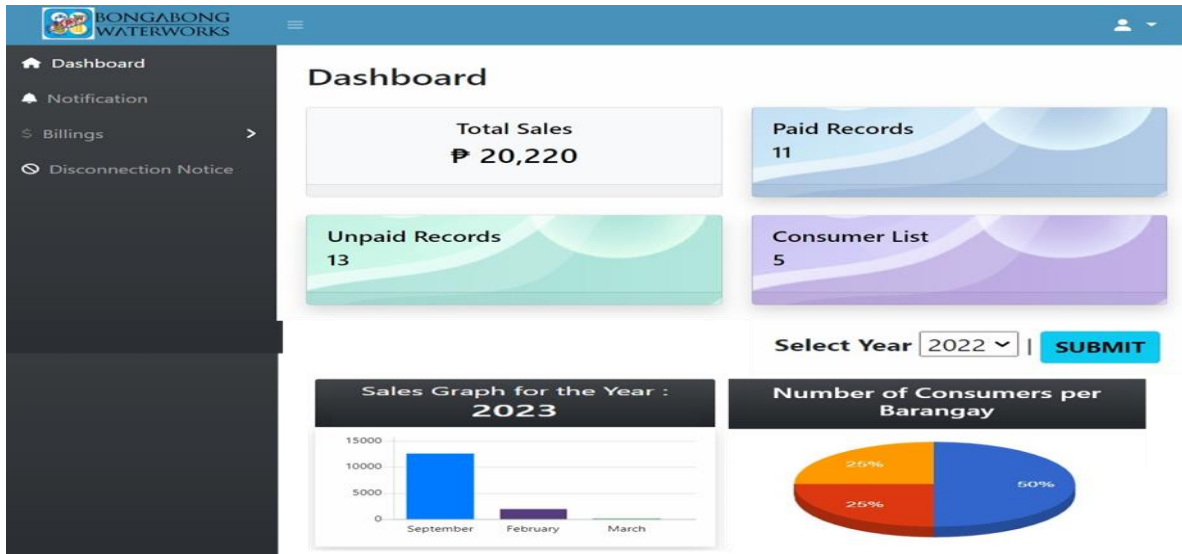
In Figure 9, the consumer dashboard provides consumers with various features, including viewing announcements, managing comments, filing complaint reports, and accessing billing history.

Figure 9.

Consumer Dashboard
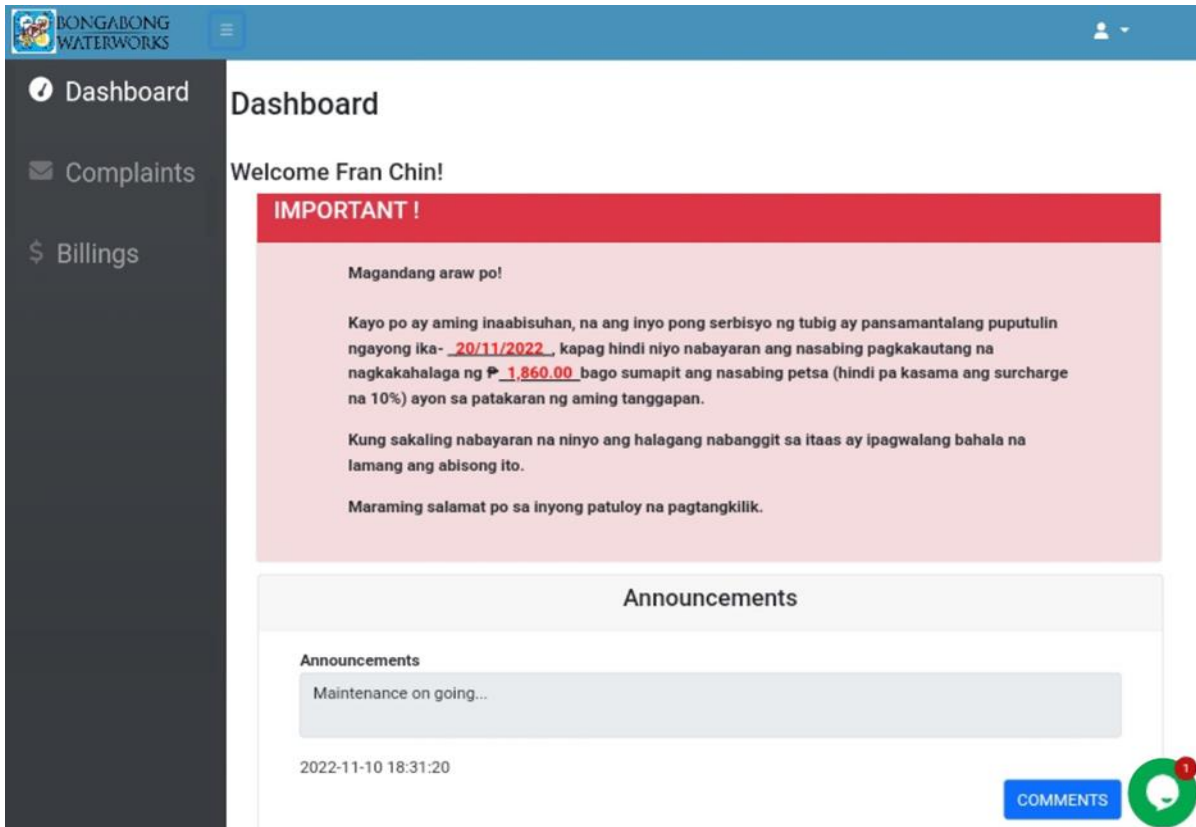
A web-based water billing and support system capable of:

(a) Keeping consumers informed about BOWASA's announcement and event.

Figure 10.
Add Announcement
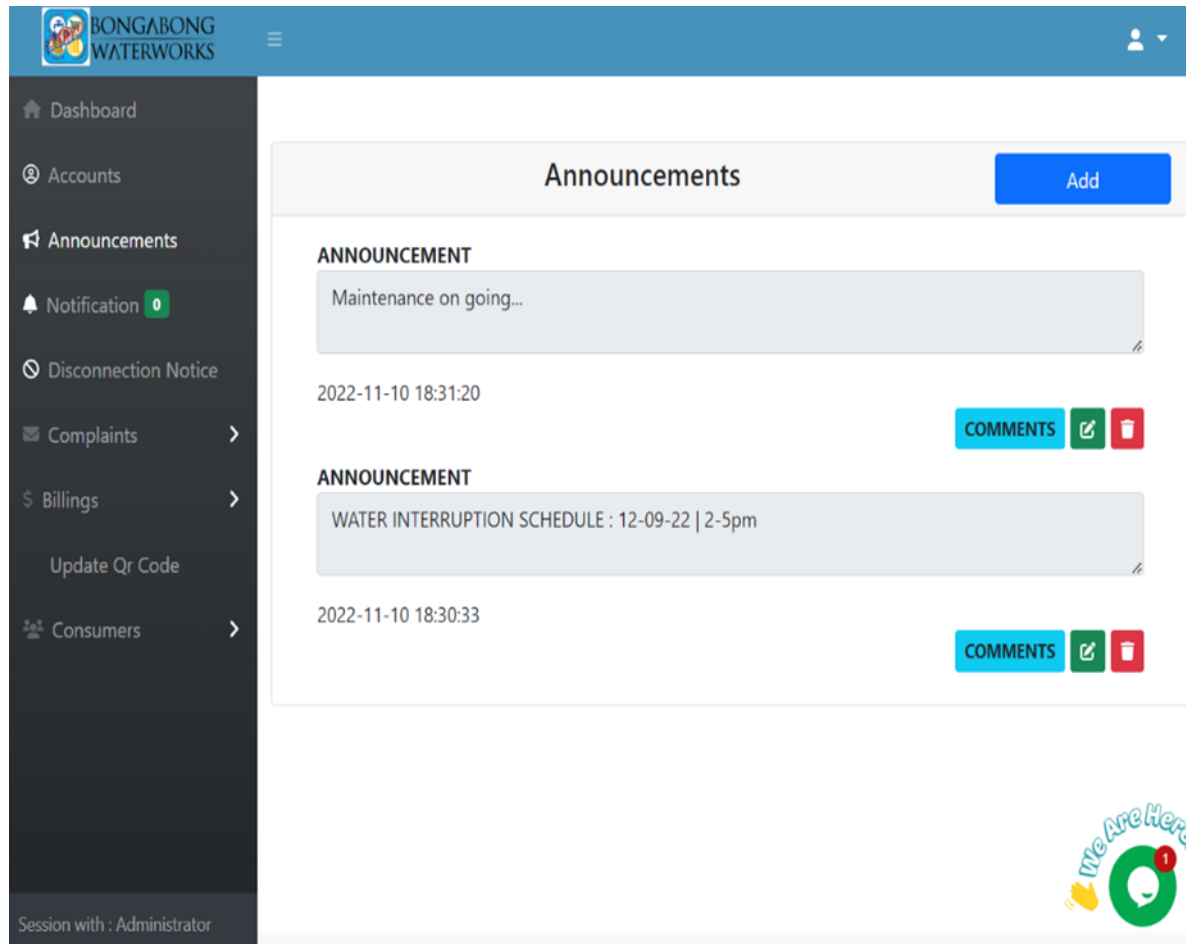
Figure 10 shows the admin announcements section, offering administrators a seamless way to add, remove, and make changes to announcements as required. The meter readers also have the capability to add, edit, and delete announcements within the system. In addition to their primary role of reading meters, they are granted the necessary permissions to manage announcements effectively. This allows them to contribute to the announcement management process alongside other user roles, such as administrators.

As depicted in Figure 11, consumers are given the ability to view the announcements that have been posted by both the administrators and meter readers. Although they do not have the permissions to add, edit, or delete announcements themselves, they can easily access and read the announcements shared by the admin and meter readers within the system. This allows them to stay informed about important updates, events, or any relevant information shared by the admin or meter readers within the system.

Figure 11.
View Announcement
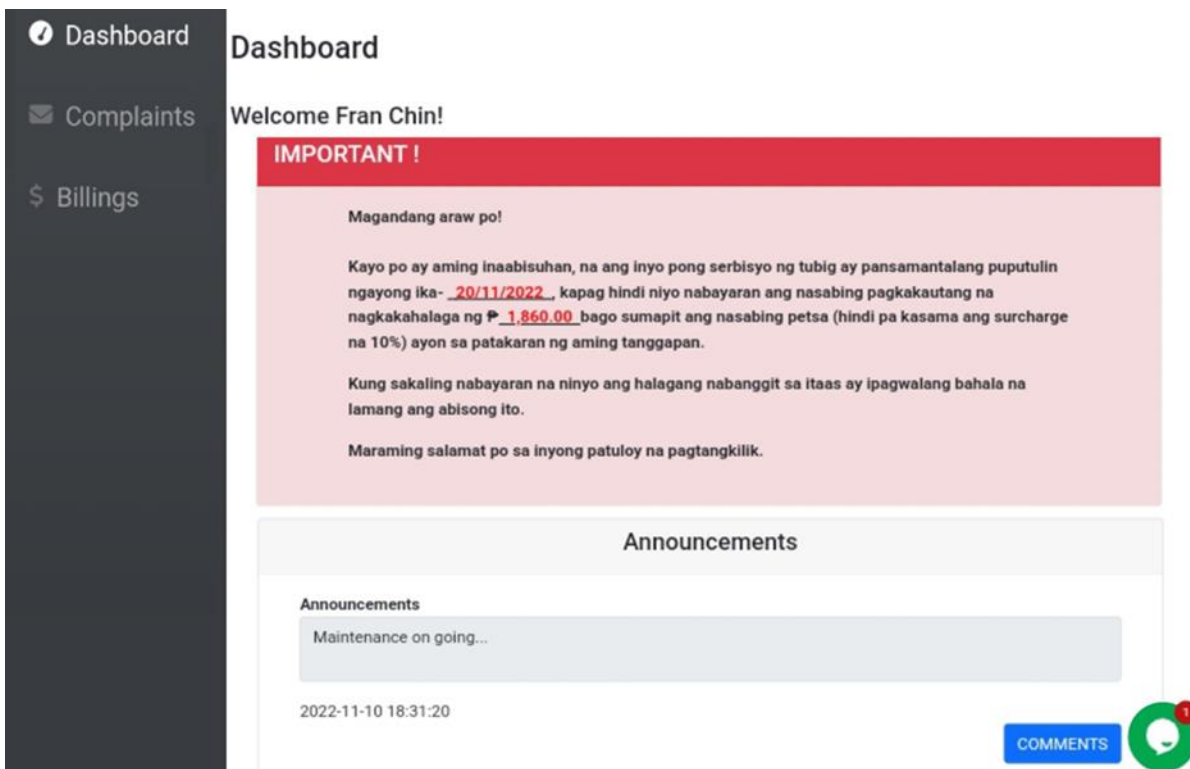
(b) Sending an SMS with information about water consumption, bills payment, due date, and disconnection schedules.

Figure 12.
SMS Text Notification for New Bill and Due Date
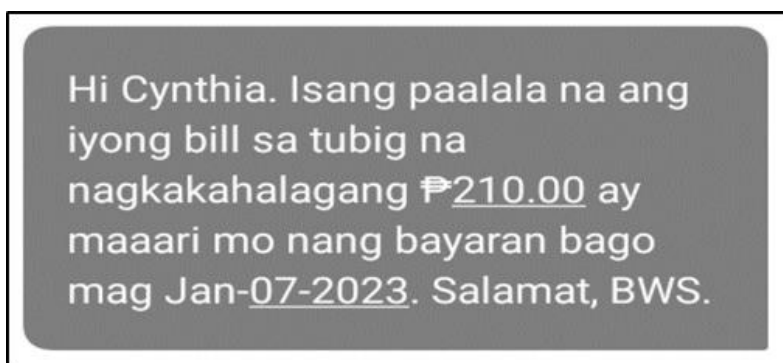
The information provided through Figure 12 illustrates the SMS text notification that consumers receive on their mobile devices. This notification contains essential details about their latest bill and the impending due date, ensuring that consumers stay informed about their financial obligations in a convenient and timely manner. The BOWASA admin ensures that consumers receive timely updates about their billing status.

Figure 13.
SMS Text Notification for Disconnection Notice
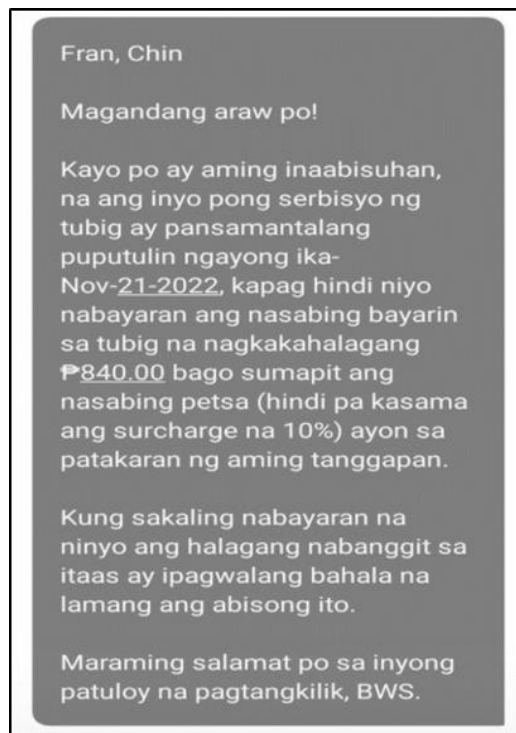
Figure 13 shows the SMS text notification sent to consumers on their mobile numbers. This notification serves to inform consumers about a disconnection notice issued by the admin. It is designed to provide consumers with timely information regarding any potential service disconnection and serves as a reminder to take necessary actions to prevent the disconnection from occurring.

Figure 14.
Manage Disconnection Notice

Figure 14 displays the Disconnection Notice which provides administrators with a range of options to efficiently manage notices. It allows administrators to easily add, edit, print, resend, and delete notices as needed.

(c) Viewing, monitoring, and generating real-time water consumption, billing statement, and payment reports.

Figure 15.
Add Billing
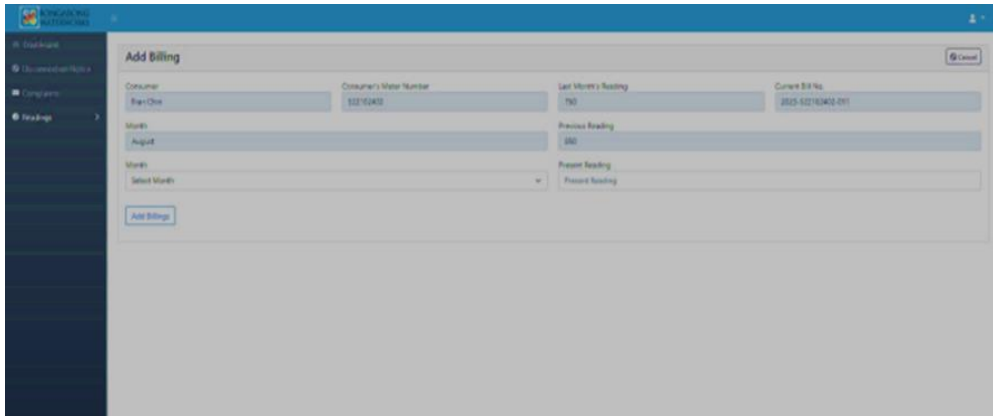
Figure 15 presents an add billing and generate water consumption that includes relevant information for each consumer. Add billing typically includes the consumer's name and consumer's meter number along with details such as the previous month reading, current bill no. previous reading and present reading.

Figure 16.
Consumer's Billing History
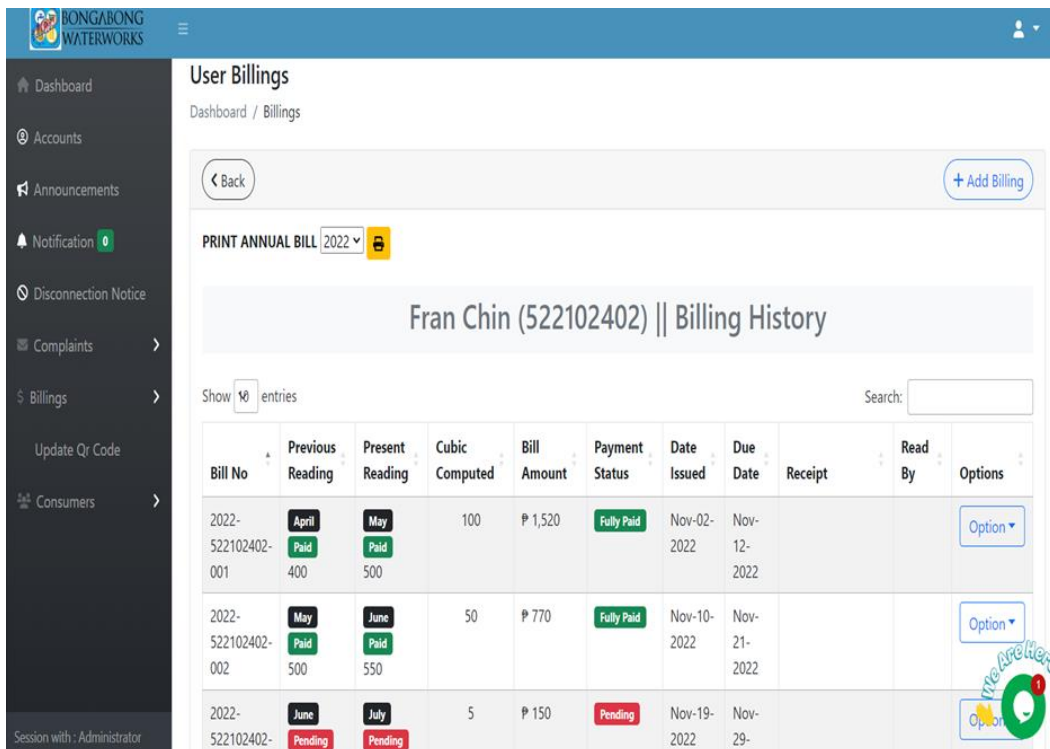
Figure 16 shows the Consumer's Billing History, which serves as a comprehensive and detailed record containing the water billing information for individual consumers. This record includes essential data such as billing numbers and dates, consumption details (cubic computed), previous and present readings, payment status, bill amount, and due dates. It enables administrators and consumers to easily access and review the complete billing history for each individual consumer, facilitating accurate record-keeping and transparent financial management.

Figure 17.
Consumer's Billing Statement

Figure 17 presents the bill receipts issued to individual consumers, serving as important documents for verifying and recording their water usage and associated charges. These receipts serve as both a receipt of payment and proof of transaction. They contain detailed information about the billing period, water consumption, rates applied, any additional fees or adjustments, and the total amount paid. By providing a tangible record of payment, these bill receipts offer consumers peace of mind and a reliable reference for their water billing transactions.

Figure 18 displays the Consumer Payment Report, which provides a comprehensive overview of all payment transactions made by consumers. This report consolidates and presents data on the various payment activities, such as bill no. previous and present readings, cubic meter computed, date issued, payment status, and transaction or bill amounts. It offers a clear and detailed record of consumer payments, enabling easy tracking and recording of financial transactions. By visualizing the Consumer Payment Report, administrators and consumers gain valuable insights into payment history, facilitating accurate financial management and ensuring transparency in the payment process.

Figure 18.
Consumer Payment Report

(d) using the real-time chat (RTC) feature to provide direct consumer assistance with their questions, concerns, and complaints.

Figure 19.
TawkTo to User Interface of eBillH2O
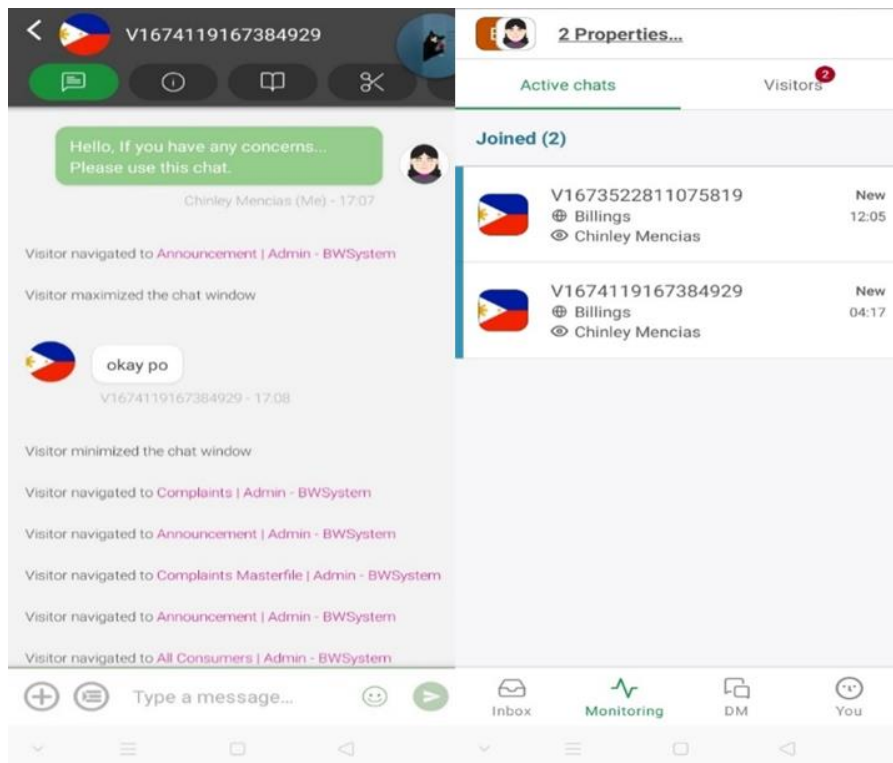
Figure 20.
Manage Complaints

Figure 19 shows the integration of TawkTo as the real-time chat (RTC) system within the eBillH2O system. TawkTo is a live chat software specifically designed to facilitate effective communication between businesses and their clients or website visitors, enabling efficient customer support services. In this integration, TawkTo is embedded eBillH2O using a JavaScript API. This integration allows users of the eBillH2O system to engage in real-time conversations with customer support representatives or system administrators. Users can seek assistance, ask questions, or address any concerns or complaints they may have directly through the TawkTo chat interface. Moreover, TawkTo not only enables real-time communication but also provides the capability to monitor user activity within the eBillH2O system. This monitoring feature allows administrators to track user interactions, identify usage patterns, and gather insights that can contribute to system enhancements and improvements.

In Figure 20, the Manage Complaints page is designed to provide a comprehensive overview of consumer details and their associated complaints. This page shows the lists of all the complaints filed by the consumers and the status of each complaint.

2. *Evaluate the system's functionality suitability, performance efficiency, usability, compatibility and security using ISO 25010 software quality standards.*

After the development and implementation of eBillH2O, the proponents conducted an evaluation using ISO 25010 as a guide. The evaluation involved a total of 110 respondents. The results of this evaluation are presented in Table 4.

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Table 4.
Summary of System Evaluation Results

Criteria	Mean	Verbal Description	Rank
Functional Suitability	4.93	Excellent	1
Performance Efficiency	4.86	Excellent	2
Usability	4.83	Excellent	3
Compatibility	4.80	Excellent	5
Security	4.82	Excellent	4
Overall Weighted Mean	**4.85**	**Excellent**	

The functional suitability of the developed system, with an impressive average mean rating of 4.93, indicates that the system's functions work exceptionally well, meeting the needs and requirements effectively. This excellent rating signifies that the developed system is suitable and performs as intended. In terms of performance efficiency, the system received an average mean rating of 4.86, further demonstrating its excellence. This indicates that the system operates efficiently, delivering quick response times and optimal performance, contributing to a smooth user experience. The usability of the system achieved an average mean rating of 4.83, reflecting its user-friendly design and intuitive interface. This high rating suggests that users find the system easy to navigate, understand, and interact with, promoting a positive user experience. In terms of compatibility, the system received a commendable average mean rating of 4.80, indicating excellent compatibility with various platforms, devices, and software environments. This ensures smooth integration and interoperability with existing systems. With a security rating of 4.82, also interpreted as excellent, the developed system demonstrates its robust security measures. This rating highlights the system's ability to protect sensitive data, prevent unauthorized access, and maintain the confidentiality and integrity of user information.

Overall, the developed system received an overall rating of 4.85, indicating excellence across all evaluated aspects. This rating underscores the system's overall quality, functionality, and effectiveness, reflecting its ability to meet user requirements and provide an exceptional user experience.

Comments and Suggestions During the Implementation

Table 5. shows the comments and suggestions of the beneficiary of the system and IT experts. It also shows the actions taken by the proponents to resolve or comply with the demands and user requirements of the target beneficiary. The table consists of two columns. Comments/Suggestions and Action Taken by the proponents. These improvements and actions prove the proponents' responsiveness to the comments and suggestions received from both beneficiaries and IT experts and panelists. The table provides a clear overview of the feedback and the corresponding actions taken, showcasing the continuous efforts to enhance the system based on user needs and preferences.

Table 5.

Comments and Suggestions During the Implementation

Comments / Suggestions	Action Taken
Instead of immediate SMS notification, the client requests that there is a 3-day delay on SMS notification for new bills.	Codded and applied onto the system.
Add another visual statistic or graph on the user dashboard aside from income forecast.	The proponents added geographical pie chart of users using the system and is part of the consumers of BOWASA.
Add payment notification page on both admin and cashier accounts as well as security measure upon changing the QR code in the system for online payment.	Codded and applied onto the system.
Allow users to print bill records annually and by barangay.	Codded and applied onto the system.
Change the design of the log in page.	The design is revised, checked, and approved by the RDE Representative, IT experts and panelist.
Allow consumers to register their own account on the system.	Registration page is added on the consumer side upon log in.

Conclusions

The design and development of a web-based water billing and support system for BOWASA offers a range of benefits and functionalities. This system enhances consumer experience and communication by keeping them informed about BOWASA's announcements and events. The integration of SMS notifications ensures that consumers receive timely updates regarding their water consumption, bills payment, due dates, and disconnection schedules. The system also provides consumers with convenient access to real-time information, allowing them to view, monitor, and generate reports related to water consumption, billing statements, and payment records. Additionally, the inclusion of a real-time chat (RTC) feature facilitates direct consumer assistance, enabling prompt resolution of their questions, concerns, and complaints. By incorporating these features, the web-based water billing and support system enhances efficiency, transparency, and convenience for both BOWASA and its consumers. It streamlines communication, improves access to information, and promotes effective consumer engagement. Overall, this system strengthens BOWASA's service delivery and consumer satisfaction, fostering a more efficient and customer-support water management experience.

The design of the system was evaluated successfully in terms of functionality suitability, performance efficiency, usability, compatibility, and security. The evaluation results proved that the system is reliable, consistent, and suitable for sending bills statement, paying bills with GCash, tracking consumer payment history, managing consumer concerns, sending disconnection notices, and keeping them up to date on all BOWASA's important announcements.

The system evaluation survey followed ISO 25010 guidelines and included the following criteria: functionality suitability, performance efficiency, usability, security, and compatibility. The developed system received an overall rating of 4.84, indicating an "excellent" rating. The compatibility test revealed that the system can run on any computing platform using various

web browser applications. Although the system could be improved further, it is fully operational, usable, and reliable enough to be used in any waterworks establishment.

Recommendations

Based on the findings and conclusions presented, the following recommendations are suggested: (1). Expand system functionality with a user-friendly mobile application for convenient access to real-time water consumption, billing statements, and payment reports, improving water billing processes. (2). Strengthen communication channels by integrating email notifications alongside SMS to inform consumers about important announcements, ensuring effective communication and updates through preferred channels. (3.) Implement automated reminders for bill payments through SMS or email, promoting timely payments and reducing disconnections due to missed deadlines. (4.) Improve real-time chat (RTC) feature with AI-powered chatbots for personalized assistance, enhancing customer satisfaction and reducing the need for human intervention. (5.) Continuously monitor system adherence to ISO 25010 software quality standards through regular security audits to maintain high data security standards and protect consumers' personal and financial information.

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