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Development of a Multi-platform Online Reservation System for Car Services

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Abstract - *Recent years have seen a rise in the number of cars in the Philippines. This translates to an increasing demand for service appointments which poses a challenge for service centers in terms of handling the increased demand for car service. As a consequence, the overall satisfaction of the customer after-sales-service is compromised. To address this, several appointment systems have been developed to allow customers to communicate and book an appointment with their service providers at any given time. However, these systems are not multi-platform. Such systems also do not offer full flexibility in terms of booking and access to an appointment and service requests. In a conducted study of comScore, more mobile subscribers used mobile apps than browsed the web on their devices: 51.1% vs. 49.8%, respectively. To cater to both users' services and to address the limitations of the existing car services appointment system, this study proposed the development of a multi-platform online reservation system. Using the modified waterfall model, the system's functional and non-functional requirements have been identified. This project used hybrid and web application technology. The testing results show that the system is stable, and the user experience shows a positive reaction.*

Keywords: multi-platform online reservation system, hybrid application, web application, car services

1. INTRODUCTION

In recent years, the Philippines automotive market has grown significantly. It is among the fastest-growing in the ASEAN. As stated in the latest ASEAN Automotive Federation data, the Philippines rank as the second-fastest growth in motor vehicle sales among seven Southeast Asia countries. The Philippines posted a 17.4% growth in the first two months, helping the country improve its position from third to second in ASEAN rankings (W. Tan, 2017). In the 2017 annual vehicle registration report of the Land Transportation Office (LTO), a total of 10,410,814 vehicles registered in the agency, 2,608,389 were either bought brand-new or imported as used units and, remarkably, 2,006,954 were new motorcycles. The National Capital Region (NCR) is the first place with a total of 2, 617 537 registered vehicles. While Region 1 is in fifth place, with 593 933 registered vehicles (V. Sarne, 2018).

For the past five years, Toyota, Mitsubishi, and Hyundai are the top three players in the Philippines' car industry based on the recent sales reports. Japan's largest car manufacturer tops the market selling 182,657 in 2017. With a difference of 115,656 units sold in 2017, Mitsubishi was the industry's second market leader. Surprisingly, Hyundai takes the third seat with a margin of 1055 units against his great contender Ford (Autodeal 2018). These data show that new cars are being purchased each year. This also means that there is a growing demand for car services.

Car services are under after-sales services. Car services are a series of maintenance activities performed on a car at designated schedules, time intervals, or after it has reached a certain distance. Based on observation and common customer experience, a customer can usually secure a reservation to avail of car services through phone

calls, through SMS, or they can go directly to the business store as walk-in customers. Service centers use a manual process to handle the reservation. Part of the processes may involve the use of logbooks, manual checking of schedules, and other paperwork. Through a semi-structured interview conducted among service centers, several problems were identified. These include concerns on report generation, duplication of reservation, queuing problems, and human error. Manual reservation usually takes time to process and is usually prone to human errors (e.g., mistakes in noting customer's reservation and miscommunication). At certain times, an error occurs due to the inability of employees to multitask especially during periods of a heavy influx of customers. This can also happen when there is a lack of overview of the on-going business reports (Oloyede et al., 2014). The manual operation gives full responsibility to the workforce, which leads to a higher possibility of human error. Transferring and sorting of records can cause wrong data input, and retrieving of records also takes time when done manually (Oribiana et. Al., 2015). Gurumoorthy (2016) stated some of the disadvantages of manual systems. These include the difficulty of retrieving or keeping the old records, the process is time-consuming, the results are less accurate, the process is less efficient, and there is too much paperwork. It is also difficult for the business to analyze data to see trends and plan future improvements (Bemile et al., 2014).

One of the service centers' aspects is the quality of the process to provide services to the customer. (Marakova I. et al., 2019). In the latest Philippine Customer Satisfaction Service Index of J.D. Power, the results show an overall dissatisfaction with after-sales service at authorized centers. The results show a decline in the average of 793 points in 2017 in contrast to the previous year which 822. This indicates a significant 29-point drop, placing satisfaction rating at its lowest since the study started way back in 2001. The major factor for the huge drop is the rapidly increasing service volumes, according to the Senior Manager of J.D. Power. Service centers are not expanding as fast as market demand, creating challenges for service centers to handle the growing number. In the said survey, service appointments increased from 40% in 2016 to 47% in 2017, and securing an appointment now takes longer as well. Seventy two percent (72%) of customers responded that it took them more than two days to set one (D. Laurel, 2017).

With all these problems encountered, Kongoli (2012) proposed automation as a solution. Automation lessens human work with the creation and application of technology. Wong (2000) stated that automation would provide essential business data faster by automating certain manual processes in the business transaction. Yongjun et al. (2017) stated that automation has great benefits for businesses. It reduces production costs, improved quality of service, and increase profits.

Moreover, Uson et al. (2012) stated that "Through automation, organizations can improve the quality of service and enhance its operations to better serve the customers." With the onset of information technology, reservations have gradually shifted to automated or online systems such as web application to facilitate better interaction with clients (Wickman, 2011).

Chavan, Adhav, Gujar, Jadhav, and Limbore (2013) developed a mobile application called Automobile Service Center Management System that runs on Android phones and tablets. This application enables a user to search and communicate with any car service center in the vicinity. The user gets its location and selects any of the services. The user also can book an appointment for service. The service center owner processes the request and responds to the user through push messages. The use of this application resulted in time-savings.

Sale H. B. et al. (2018) developed an Online Management System for Automobile Services, a web application that helps a vehicle user search and communicate with any mechanic in the vicinity. This website uses innovative technology that connects you with a mechanic with a tap of a

button. This literature also uses MEAN stack, which means MongoDB, AngularJS, and NodeJS. MEAN Stack is a free and open-source powerful JavaScript framework which simplifies and accelerates full-stack web application development.

Xu-Yin Yang et al. (2017) presented an online car service platform for mobile internet. The online car service platform (OCSP) adopts the iOS system and some online functions like vehicle query, vehicle information management, display, shopping cart, order management, and user management. The developed OCSP has a home page for the enterprise to promote their shops and reveal its stores and after-sales service team.

Hua Yi Lin et al. (2014) on the other hand, presented a web vehicle management system on the cloud computing platform that includes vehicle tracking, information services, history records, and monitoring mechanisms.
The preceding literature motivated the researcher in the development of the proposed project. An evaluation of the systems shows that these systems do not multi-platform environment. It also shows that full flexibility in booking and access to an appointment and services is not supported. In a conducted study of comScore in May 2012, the report of the previous quarter shows that more mobile subscribers used mobile apps than browsed the web on their devices: 51.1% vs. 49.8%, respectively (S. Perez, 2012).

Mobile apps can download from an app store such as the Google Play or iOS App Store. Native and hybrid are two types of mobile apps. A native app or native application is a software application build in a specific programming language of the devices, either iOS or Android. For example, Swift or Objective-C is used to develop native iOS apps. At the same time, Java is used to create a native android app. Hybrid apps are like a native app, you install it like a native app, but it is a web app on the inside.

The web apps on the other hand are particular to hybrid apps that are built with JavaScript, HMTL, and CSS and run in something called WebView, a simplified browser within your app. It is placed into a native container that runs the application code and packages it into an app. Therefore, it provides various mobile application development platforms that can generate native apps from a single original codebase, installed across multiple platforms (Khandeparkar et al., 2015).

To cater to both users, the development of a multi-platform online reservation system is proposed. This study presents a hybrid and a web application or web apps that will run on mobile devices and any browser in any mobile, tablet, or computer, using web technologies such as HTML5, CSS, and JavaScript.

With this automation project, the problem of the increase in the volume of cars and the subsequent increase in the number of car services is addressed. The main objective of the project was to develop a multi-platform online reservation system that enable customers to secure their appointment and flexibility in booking. The objectives of the study were as follows:

- to determine the functional and non-functional requirements
- to determine the feature and modules
- to determine how the system will be designed
- to develop and test the proposed project

2 METHODOLOGY

The modified waterfall model was used in this study. This proposed model attempts to resolve the problems and criticisms with the pure waterfall model. A link back to the previous stages is included (as indicated by extra lines) to accommodate future expected upgrades and requests for modifications based on user feedback. The proposed project is a generic online reservation system for car services.

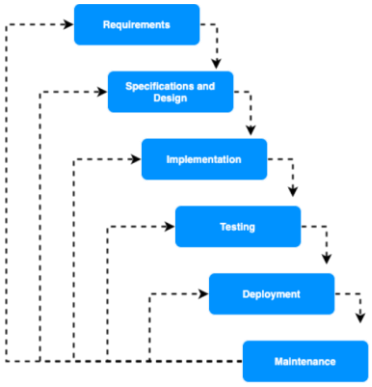

Figure 2.1 Modified Waterfall Model

2.1 Identifying functional and non-functional requirements

To determine the functional and non-functional requirements, different data gathering techniques such as interviews, and observations have been conducted. Semi-structured interviews were also conducted from the various service centers to identify the functional requirements. The observation was also helpful in gathering information about the business processes like car service reservation/appointment, from the customer's arrival, queuing method up to the actual service. The review of related literature also assisted in the determination of functional and non-functional requirements.

2.2 Identifying the features and modules

The modules and features of the system were identified by analyzing the requirements. A review of the different online reservation systems available today showed features and modules necessary for such systems. The semi-structured interviews with the different service centers' employees also result to determination of the features, modules, and functions of this system.

2.3 Identifying how the system will be designed

With the gathered information at hand, the data and information being handled by the service centers and used in the business process were identified. This information was the basis for the creation of the database and schema for the project. An Entity Relationship Diagram illustrates the logical structure of databases and the relational scheme used to describe the relations between the data models. In selecting technologies, a review of existing technologies, frameworks, IDEs, libraries, and tools. Popularity, community size, sustainability, support, documentation license, speed, and reliability were the basis for selecting technologies served as the determination of criteria in the selection of the most appropriate technologies.

2.4 Development and testing of the system

A mockup after acquiring the gathered requirements from previous sections was developed. The mockups were shown to potential clients for feedback, comments, and suggestions. The researcher developed the system based on System Architecture Diagram, Use Case, Process Flow Diagrams, Entity-Relationship Diagram, and by using various web technologies in making the web applications

The system was subjected to usability testing to ensure the correctness and completeness of the system. Black box testing and usability testing was conducted. The test cases were used in black-box testing and were done per module. For usability testing, the interface for web and mobile were different. The System Usability Scale (SUS) by John Brooked was utilized in the web interface. For the mobile interface, the researcher used a Questionnaire for User Interaction (QUIS) by Chin, J. P., et. Al., 1988 to assess user satisfaction with specific system aspects. Feedbacks from the testing phase were utilized to improve the system further.

3 RESULTS AND DISCUSSION

3.1 Functional and Non-functional requirements

The functional requirements describe the different functionalities, behaviors, and features of the system. Through direct observation, experience, interviews, and review of various literature and studies, the researcher was able to identify the functional requirements. The functional requirements is divided into three different modules these are admin, employee and customer module. The non-functional requirements includes the performance, usability, reliability, supportability, availability, security, portability and interoperability.

3.2 Features and Modules

Identification of the different modules in the system was facilitated with the complete requirements and relevant information that have been gathered. These are the administrator, employee, and customer module.

The administrator module is a crucial module as roles and availability of functions are determined in this module. The manager of the service center will use the administrator module. One of the common features of each module is the ability to log in and log out of the system. The dashboard is the first page of the administrator upon logging in successfully. The dashboard provides the administrator with quick access and summarized information on user registrations, bookings, and services.

The employees of the service center will use the employee module. One of the common features of each module is the ability to log in and log out of the system. The dashboard is the first page of the employee module upon logging in successfully. The dashboard provides the employee with quick access and summarized information on user registrations and bookings.

The customer module is designed for the customers of the service center. One of the common features of each module is the ability to log in and log out of the system. Online Registration allows the customers to register for a new account using a mobile device or any browser with an active internet connection. Name and valid email are required fields to create an account. The dashboard is the first page of the customer module upon logging in successfully. The dashboard provides quick access and summarized information on bookings.

3.3 System Design

This section presents the design tools that were used in the development of the system. Use case diagram, entity relationship diagram and system architecture helped in the overall design of the project.

Figure 3.1 Use Case Diagram for Administrator

Figure 3.2 Use Case Diagram for Employee

Figure 3.3 Use Case Diagram for Customer

3.3.1 System Architecture

Figure 3.4 shows the System Architecture diagram of the system. It shows how the system will operate on an architectural level from the users' perspectives to the browser to the web application and the servers. The users will see and interact with the web application's front-end side using a browser with an internet connection. The front-end is made possible with different web technologies like CSS, HTML, JavaScript, Bootstraps, and other libraries. While in the backend, a PHP framework called Laravel was used to make the web application. The application was deployed on a Nginx Web Server. At the same time, the data is fetched and stored in the MySQL database.

Figure 3.4 System Architecture

3.4 System Development and Testing

3.4.1 System Development

Mockups and prototypes were created using Balsamiq to provide the researcher with a visualization of what the system would look like and the flow between pages. The prototype was used to get feedback from potential clients, and changes are made to conform to initial test results and feedback collected. This section provides actual screenshots of the system per module and its functions.

3.4.2 System Testing

The researcher conducted several testing to ensure the correctness, quality, and completeness of the system. The researcher also conducted validation to make sure that the developed system conforms to the requirements. Black-box testing was also done to ensure that each function is working correctly. Test cases or scenarios are

made for black-box testing. In assessing the usability of the system the System Usability Scale (SUS) was adopted. SUS was used to evaluate the user's view and acceptance of the web interface. The questionnaires are personally handed to the various service centers. The System Usability Scale (SUS) is a Likert scale that has ten survey questionnaires. The respondents will answer the ten questionnaires from 1 to 5 based on how much they agree. Five (5) are the highest, which means they agree, and one (1) means they disagree vehemently. To calculate the usability score, the researcher adopted the current method used in finding the SUS score. For every odd number question, the researcher subtracts one from the score. For every even number question, the researcher removes the value from 5. Add up to the total score, then multiply the total by 2.5. Mean scores were calculated for each user, and a mean for all users was calculated as the overall satisfaction score. The scores were high in Manager and Customer, while in the employee, it is above average due to some resistance in using the proposed system. Overall, based on the SUS summary score, a score of 75.57 points has higher perceived usability.

The questionnaire contains four groups, and each group has specific questions. Respondents were asked to rate the system on a 10-point scale, with '0' being the least favorable and '9' the most favorable. Answering to questionnaire takes about 5 minutes. Descriptive statistics were adopted to evaluate the Questionnaire for User Interaction Satisfaction (QUIS). The respondents' responses to the questions were first averaged within each interface category. Furthermore, respondents' ratings in all interface categories to determine their overall rating of the system. The lower satisfaction scores were noted in the system capabilities and the overall reactions to the software due to a hybrid application's capabilities compared to a native application. Overall, based on the overall summary score, 6.99 indicates that the proposed system is usable. the overall summary score, a 6.99 indicates that the proposed system is usable.

Comments, suggestions, and recommendations were noted and conformed to satisfy the user. These suggestions include the following: First, the inability of the customer module to select multiple services was mentioned. The current drop-down menu was then replaced with a checkbox to allow multiple service selections and applied them to all system modules. Second, one of the respondents also suggested that the administrator module's capability to add service. This was likewise incorporated. Lastly, the display name of the users and customers under the administrator and employee module was modified.

4 CONCLUSION

The multi-platform online reservation system for car services was developed to achieve the functional and non-functional requirements aggregated and analyzed through observation, semi-structured interviews, and related literature review. These requirements have established the characteristics, functionalities, features, and modules of the system. The following are the functional requirements based on the system's functionality: User Management, Booking Management, and Data Management. Non-functional requirements are usability, reliability, performance, supportability, availability, security, portability, and interoperability.

The administrator module is a crucial module as roles and availability of functions are determined in this module. The administrator module has access to user accounts, bookings, services, statistics, and reports. The employee module is designed for the service center employees and has access to the customer's account, bookings, statistics, and reports. The customer module is designed for the customers of the service center. The customer module allows the customer to book online reservations via a web browser or mobile application.

The system was designed by specifying the entity-relationship diagram, use case diagram, system architecture, and new process flow

diagrams. The technologies used in the development were carefully selected to allow robust and efficient development. The system adopted hybrid and web applications technology. The system runs on mobile and any browser in any table, mobile, or browser, using the core web technologies, Laravel for the back end and VueJS, and Bootstrap for the front end. Adobe PhoneGap was used in the development framework of the hybrid application. Testing the system's functionalities and behavior was done to ensure the correctness and quality of the system. Black-box testing was done by creating test cases for the web and mobile. SUS and QUIS were utilized to test the usability of the system. SUS was used to evaluate and test the web interface's acceptance, while QUIS was used on the mobile interface.

With the developed system, testing was done which resulted in a positive usability result, it can be concluded that the methods and final project are functional and ready for deployment.

For future improvement, the researcher recommends integrating SMS technology for the reservation of the customer. It will also help the customer to add extra features like setting the alarm or reminder notification system for the next service. It will also be beneficial for the service center to have an inventory system of the products, parts, and accessories needed for car services. A native application for android and iOS can also be developed to improve performance, user interface, and user experience.

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