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Implementation of sashimi waterfall model: Development of online ordering system

OPELLA, Joe Marlou[1]

(1) 0000-0000-0000-0000; Cavite State University. City of Carmona, Cavite, Philippines. joemarlou.opella@cvsu.edu.ph.

A B S T R A C T

The Online Ordering System is a website that can be utilized on both traditional desktop computers and mobile devices, such as smartphones. With the use of internet technology, customers are able to enter their orders into the system using any device, including personal computers and smart phones. The website contains predictive modelling that will allow the administrator (end user) to examine orders in advance (on a daily basis), which will allow the administrator to manage the required amount of work force in advance. The system was able to graphically depict the volume of orders in each of the important delivery locations, such as barangay, due to the use of computer analytics. Throughout the entirety of the system's design and development, Peter DeGrace's Sashimi Waterfall model served as a foundational reference point. The framework of the system was built with Hypertext Preprocessor (PHP), a popular open-source general-purpose scripting language that excels at web development and can be included into HTM. PHP is a general-purpose scripting language with a wide range of applications. During the testing of the system, an evaluation instrument that was adapted from ISO 9126 was applied, and it earned a mean rating of 4.15 along with an adjectival rating of Very Good. According to the findings of the tests, the system has successfully passed the software quality evaluation and possesses the qualities that are characteristic of good software.

R E S U M O

O Sistema de Pedidos Online é um site que pode ser utilizado tanto em computadores desktop tradicionais quanto em dispositivos móveis, como smartphones. Com o uso da tecnologia da internet, os clientes podem inserir seus pedidos no sistema usando qualquer dispositivo, incluindo computadores pessoais e smartphones. O site contém modelagem preditiva que permitirá ao administrador (usuário final) examinar os pedidos com antecedência (diariamente), o que permitirá ao administrador gerenciar a quantidade de mão de obra necessária com antecedência. O sistema foi capaz de representar graficamente o volume de pedidos em cada um dos locais de entrega importantes, como o barangay, devido ao uso de análise computacional. Ao longo de todo o projeto e desenvolvimento do sistema, o modelo Cascata de Sashimi de Peter DeGrace serviu como ponto de referência fundamental. A estrutura do sistema foi construída com o Hypertext Preprocessor (PHP), uma popular linguagem de script de código aberto e de uso geral que se destaca no desenvolvimento web e pode ser incluída em HTML. PHP é uma linguagem de script de uso geral com uma ampla gama de aplicações. Durante os testes do sistema, foi aplicado um instrumento de avaliação adaptado da norma ISO 9126, que obteve uma classificação média de 4,15, além de uma classificação adjetiva de Muito Bom. De acordo com os resultados dos testes, o sistema passou com sucesso na avaliação de qualidade de software e possui as qualidades características de um bom software.

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Introduction

The rapid spread of new technologies has had a profound impact on people's daily routines and interactions. Since computers and other electronic devices have become fundamental to the modern way of life, they have become increasingly affordable to the general public. Internet connectivity has had a significant effect on people's ability to go about their daily lives and earn a living as technology has progressed. The internet has many uses, and more people are starting to realize the benefits it can bring to areas beyond just communication and shopping. As of 2022, approximately 49.8% of Asians were online, per Internet World Stats and according to Statista around 40% of Australian will use online delivery using different online apps (Nelson, 2022; Patel, 2015). With these high figures, going online with your company is a significant technological breakthrough and opportunity to cater more customers, to give a better, satisfactory and services beyond expectations.

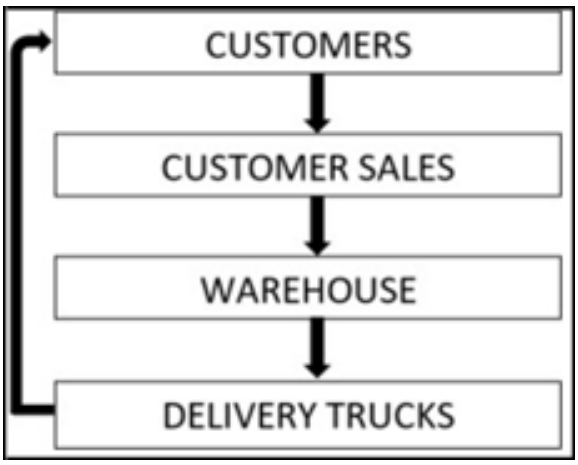
Numerous papers describe that an online ordering system is a website designed primarily for use in the delivery industry that will allow the company to increase scope of business and allow users easily navigate graphical interface for efficient processing (Patel, 2015; Bhargave, Joshi, Jadhav, Oke, & Lahane, 2013; Varsha Chavan, 2015; Akshaya, Rakshitha, Srilaxmi, & Trupthi, 2019). This kind of software application can help business owners and managers maximize the range of their business with less labor force since there is no need of sending sales personnel to different locations to take the order of the customers.

Despite this advancement of technology innovations on most of the business establishments there are some areas who were left behind. An example to these are various Enterprises and distributors of San Miguel Corporation products within municipality of General Mariano Alvarez, Cavite was still using the old and traditional business strategy. There will be a daily schedule of delivery per location regardless of if there were orders or none from wholesalers or small retailers. These traditional way of doing their daily business routines give them hard time on securing enough stocks in their warehouse. In addition, there were no prior taking of orders before delivery that leads to shortage or overstock of product in every truck loads. Figure 1 illustrates the workflow of the existing manual system for product delivery, highlighting its process flow and operational steps.

The Online Ordering System is a web-based platform designed to enable customers to conveniently place orders using their mobile phones or personal computers via an internet connection. To optimize daily delivery truck distribution, the system provides a graphical representation of order volumes across major locations. Additionally, it generates order forecasts for the following day, allowing businesses to efficiently prepare products, allocate labor, and manage delivery vehicles.

Figure 1.

Process Flow of the Current Manual System



This study focuses solely on the online ordering process. Customers are required to register before placing orders. To assist the business in managing daily delivery schedules, the system provides a graphical representation of order volumes and generates a printable daily order list, serving as an itinerary for delivery personnel. Additionally, it offers a forecast of the next day's deliveries to enhance planning and resource allocation. However, the system does not support online payments or inventory management.

Literature

The proliferation of new technologies opens the door to the eventual mechanization of all business processes. Businesses are constantly on the lookout for ways to differentiate themselves from the competition, and one way to do this is by providing superior customer service. Customers' ability to spend time waiting in line and traveling to physical storefronts will be hampered if the company is located online.

Delivery of meals bought online is referred to as "online food ordering" (Akshaya, Rakshitha, Srilaxmi, & Trupthi, 2019; Cheema, Rizwan, Rizwan, Durrani, & Sohail, 2013). This deal is only one of many made feasible by the proliferation of online resources and services that have simplified the business world. A lot of individuals prefer to avoid waiting in line at the customer service counter and instead just pick up their online orders when they get to the store. Similarly, with the use of Location Analytics integrated into the online ordering system, consumers can place orders from the comfort of their own homes and have them shipped directly to them.

The Internet is frequently used for online shopping (Zhou, Dai, & Zhang, 2007). According to (Cheema, Rizwan, Rizwan, Durrani, & Sohail, 2013), more than 85% of world's online population used internet for shopping. There are three important factors of a website that affects the online shopping: perceive usefulness is the perception of an individual that using the system can help gain work performance; perceive ease of use is the perception of individual that using the system will not cost much effort; perceive enjoyment is individual perception for pleasure upon adoption of the new technology. In an online ordering system the

most important factor is the "perceive ease of use" because no one can assist the customer upon ordering online. It is a must that the system itself can somehow teach the customer how to use it.

According to Olap.com the term Business Intelligence (BI) refers to technologies, applications and practices for the collection, integration, analysis, and presentation of business information. The purpose of Business Intelligence is to support better business decision making. Essentially, Business Intelligence systems are data-driven Decision Support Systems (DSS). Business Intelligence is sometimes used interchangeably with briefing books, report and query tools and executive information systems (Mcleod, 2021). In such a manner the developed website can forecast future orders in a weekly basis. A moving average method was used in forecasting the next weekly orders (Sahu, & Kumar, 2014). It involves calculating the average of observations and then employing that average as the predictor for the next period. The moving average method is highly dependent on n, the number of terms selected for constructing the average. The equation is as follows:

$$F_{t+1} = (Y_t + Y_{t-1} + Y_{t-2} + \ldots\ldots + Y_{t-n+1})/n$$

Where:

F_{t+1} = the forecast value for the next period

Y_t = the actual value at period t

n = the number of terms in the moving average

Evaluation is an essential procedure done prior to the implementation of any developed software. With this regard, the researcher make used of an evaluation instrument adapted from ISO 9126 that composed of six quality characteristics. Functionality is defined as an essential purpose of the study. The reliability characteristic defines the capability of the system to maintain its service provision under defined conditions for defined periods of time. Usability refers to the ease of use for a given function. Efficiency is the focus on the resource being used when providing the required functionality. Maintainability is ability of the system to identify and fix a fault within a software component. Portability refers to how well the software can adopt to changes in its environment or with its requirements. The evaluation instrument used five-point Likert

The scale in which the highest rating is 5 and 1 is the lowest (Pierce, 2019). The total of 40 respondents evaluated the system using 15 indicators and rated numerically using scoring system in Table 1. The respondents were chosen using purposive random sampling (Nedrich, 2021). This is a combination of two methods purposive and random sampling. Purposive sampling is a method choosing a respondents based on the characteristics of a population and the objective of the study (Pierce, 2019; Vagias, 2006, Crossman, 2017). Random sampling is a technique of choosing a sample in which the respondents of an accessible population has an equal opportunity to be chosen (Vagias, 2006, Crossman, 2017 ; Teddlie, & Yu, 2007).

Table 1.

Five Point Likert Scale

Numerical Rating	Descriptive Rating
5	Excellent
4	Very Good
3	Good
2	Fair
1	Poor

The researcher uses Central Limit Theorem (CLT) in getting the sample size. According to Investopedia Central Limit Theorem is a statistical theory that states that given a sufficiently large sample size from a population with a finite level of variance, the mean of all samples from the same population will be approximately equal to the mean of the population. Most sources state that for most application N=30 is sufficient as sample size (Nedrich , 2021; Matkovic, & Tumbas, 2010).

The result of the software evaluation from the respondents was counted and the mean was computed using the formula:

Mean = Σwx/Σw where:

Σ is the sum of,

w is the weights, and x is the value (Taylor, 2020).

The result of the computation was interpreted based on the distribution as shown in Table 2.

Table 2.

Mean Interpretation Table

Weighted Mean	Adjectival Rating
4.21 - 5.00	Excellent
3.41 - 4.20	Very Good
2.61 - 3.40	Good
1.81 - 2.60	Fair
1.00 - 1.80	Poor

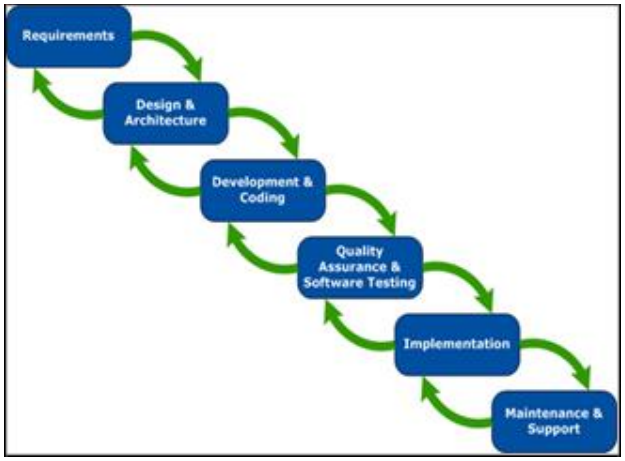
Methodology

A variation on the traditional waterfall approach, the Sashimi model was developed by Peter DeGrace (Kemper, Stringfield, & Teddlie, 2003; Matković & Tumbas, 2010). This is a modification of the traditional Waterfall software development methodology Fig. 2. It is name after a Japanese delicacy “sashimi” which features overlapping slices of fish, same with the model that emphasizes six overlapping phases in the development process namely:

requirements, design and architecture, developing and coding, quality assurance and software testing, implementation, maintenance and support (Frankenfield, 2021; Bolotaolo et.al, 2021). This model is very useful and adaptable to changes and even suited to projects with huge complexity and critical in nature because mistakes can be found and fixed early in the development process. The model also reduces the amount of documentation significantly because it treats it as a single document.

Figure 2.

Sashimi Waterfall

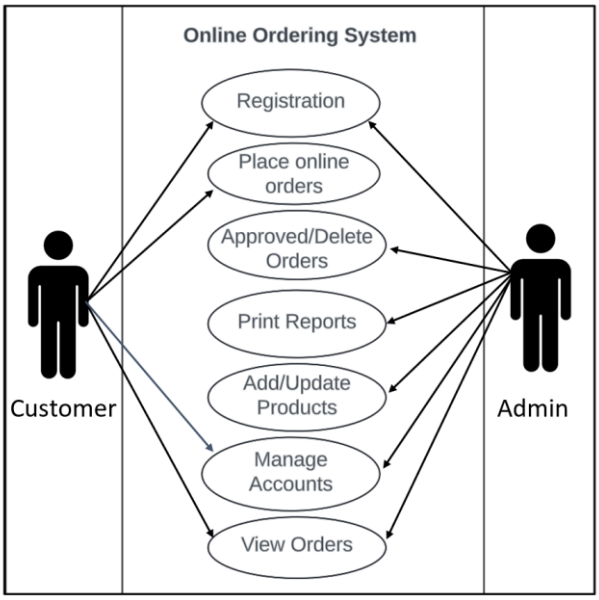


Requirements. The researcher gathered data through interviews of various owner and employees of an Enterprises or distributors San Miguel Products to know how they do their daily manual transactions.

Design & Architecture. The features of the system were created on this phase. Different modules were designed to satisfy the requirements of the client as shown in fig. 3.

Figure 3.

Use Case Diagram of the System



Development and Coding. The designed served as a basis in the project development. Every units of code was tested and debugged immediately in order to comply with the requirements of the system.

Quality Assurance and Software Testing. Before implementation of every developed software, a series of testing should be administered. This is to ensure that the software complies all the requirements and follows the standard of a good quality software.

*Unit testing i*s done to verify the internal logic of code if it satisfies the known functions of the website.

System testing the second state of testing process where the users were allowed to navigate the software and test the system functionality, reliability, usability, efficiency, maintainability and portability.

Acceptance the third and last stage of testing process where the client is allowed to navigate the system and test if it satisfies the specified requirements as approved in the memorandum of agreement.

Implementation. In this phase the software was deployed to the client and a user's manual was also provided for the users to further understand the program work through.

Maintenance and Support. After the software is deployed to the client, the development team have agreed that a six-month maintenance will be provided pertaining to problems encounter but not limited to the scope stated in the memorandum of agreement.

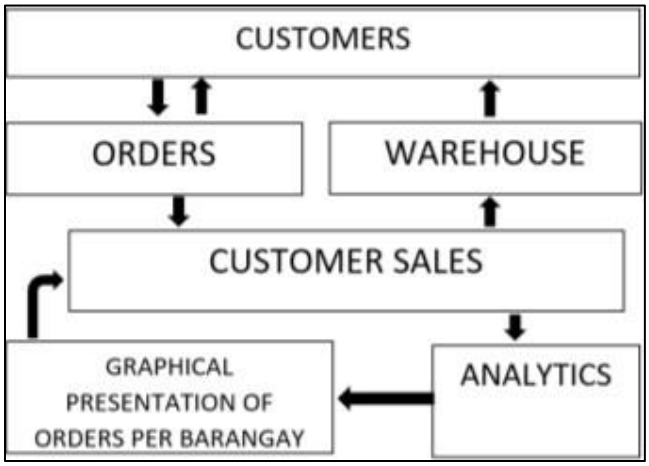
The study made used of PHP as the main language for development, MySQL for the database, JavaScript as scripting language, and different plug in available in the internet for design and most functions.

The user account module is a module where the administrator can add or edit user accounts. Viewing of orders, generating order slip, viewing of volume of orders graphically, and forecasting of delivery volume can be found in the order and delivery module. The third module, setting modules is where the administrator can add news and events, add products, and edit prices, product descriptions, and content management of the website. Lastly, the report module consists of order slip, summary of delivery per location and per products, and summary of delivery daily, weekly and monthly basis.

Fig. 4 graphically presents the order of activities done inside and outside the system. The first process is placing an order into the system. Once the order is on the database, the customer sales or Administrator will confirm the orders. There would be processes inside the system like putting analytics and forecasting. The administrator or customer sales print delivery receipts and itinerary of delivery per barangay. Once the products are delivered the delivery personnel will then liquidate. After liquidation is done, the customer sales can now generate purchase order and sale invoice.

Figure 4.

Process Flow of the Online Ordering System with Location Analytics



Results and Discussions

The Sashimi software development model has played a crucial role in shaping the Online Ordering System, enabling customers to place orders seamlessly via computer or mobile devices over the internet. The system features a home page with distinct login options for customers and administrators (Fig. 5). The system incorporates security measures to prevent fraudulent activities and unauthorized access. Customers must successfully complete the registration process before they are permitted to place orders (Fig. 6). This ensures that only verified users can access the ordering system, reducing the risk of potential attacks and fraudulent transactions. Administrators have comprehensive control over the system, including access to customer orders, product and user management, graphical order analytics, order forecasting, and report generation (Fig. 7). These features enable efficient monitoring, data-driven decision-making, and streamlined operations.

Figure 5.

Home Page

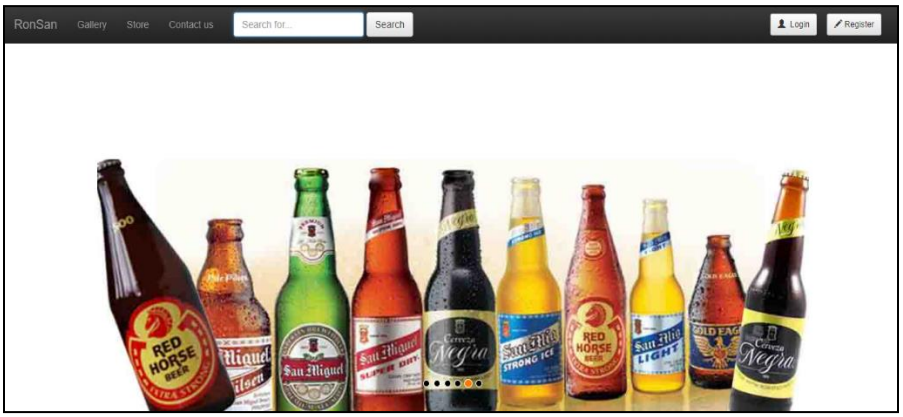


Figure 6.

Home Page for Customer

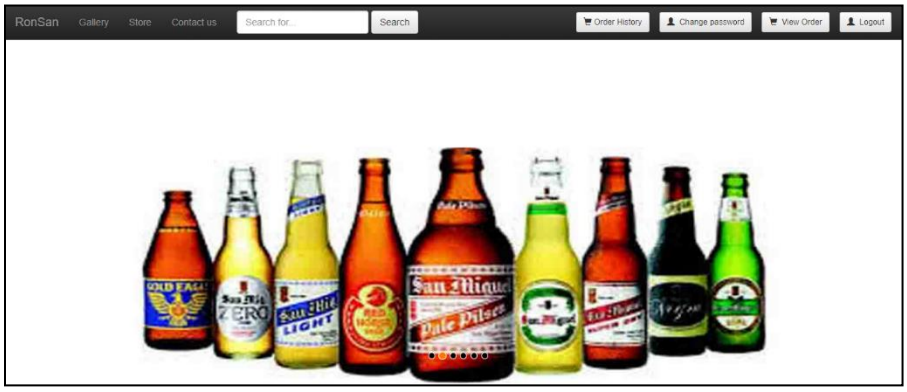
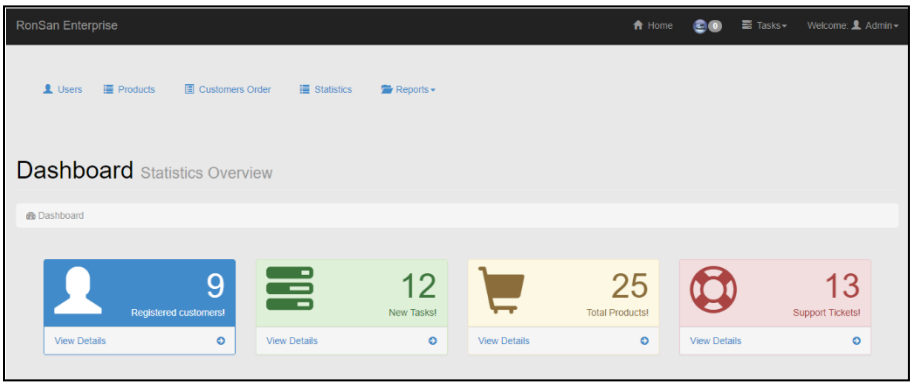


Figure 7.

Home Page for Administrator(End User)



Different statistical analysis is presented in a graphical form. A forecasted number of orders in the following month is shown if fig. 8, forecasted amount of sales fig. 9, list of products that has possibility to be ordered fig. 10, and the most ordered products.

The "Assessing Sales Potential: (Forecast Result) YEAR" table provides a detailed overview of sales performance trends, order processing, and product availability throughout the year. The data indicates that from January to September, sales remained stagnant, with ₱0 recorded in last month's sales and a "Nothing Change" status. No orders were placed, approved, or delivered during this period, reflecting a lack of business activity. However, a significant shift occurred in October, where the sales status changed to "Increased", leading to 40% pending orders, 50% approved orders, and a rise in delivered orders.

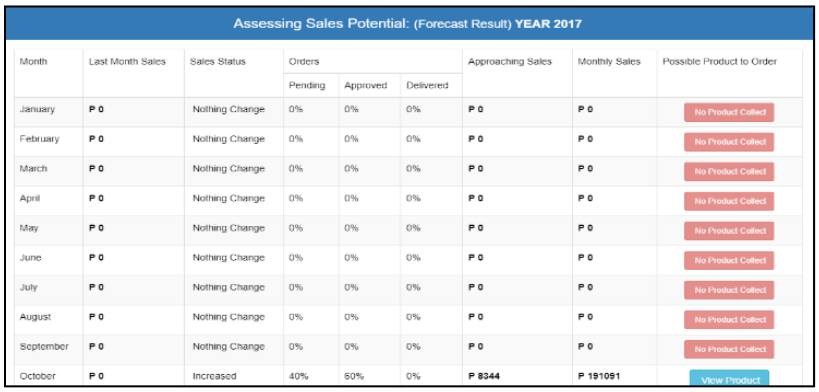
The Approaching Sales column, which remained at ₱0 for the first nine months, saw an increase to ₱8,944 in October, while Monthly Sales surged to ₱191,091, demonstrating a notable improvement in business performance. Additionally, product availability for ordering followed a similar trend. From January to September, the "Possible Product to Order" column displayed "No Product Called," indicating that no products were being ordered or listed for

purchase. However, in October, the system allowed users to view available products, further reinforcing the rise in sales activity.

Overall, the forecast data highlights a lack of sales growth for most of the year, followed by a sudden increase in October, possibly due to changes in business strategy, marketing efforts, or product availability. The system effectively tracks order phases, providing valuable insights into sales trends and delivery efficiency. Moving forward, improvements could focus on boosting sales activity earlier in the year, potentially through enhanced marketing strategies, product diversification, or system optimizations to encourage more consistent customer engagement and purchases.

Figure 8.

Forecasted Amount of Sales in the Following Month

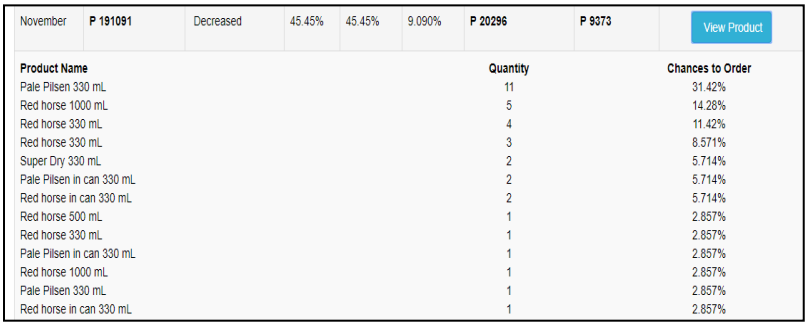


Assessing Sales Potential: (Forecast Result) YEAR 2017

Month	Last Month Sales	Sales Status	Orders			Approaching Sales	Monthly Sales	Possible Product to Order
			Pending	Approved	Delivered			
January	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
February	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
March	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
April	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
May	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
June	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
July	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
August	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
September	₱ 0	Nothing Change	0%	0%	0%	₱ 0	₱ 0	No Product Collect
October	₱ 0	Increased	40%	60%	0%	₱ 8344	₱ 191091	View Product

Figure 9.

Percentage that a Product Will Be Ordered the Following Month

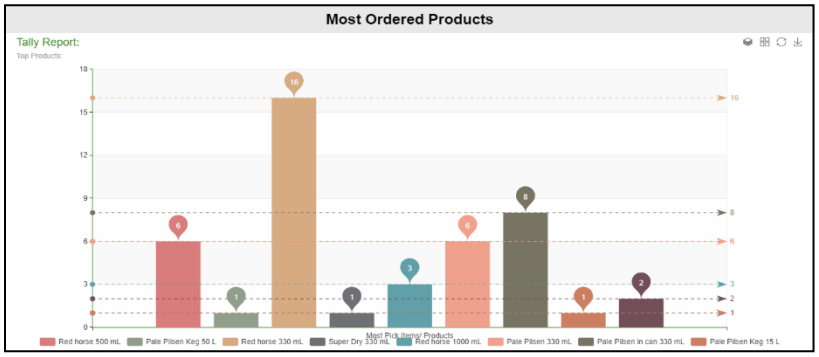


November	₱ 191091	Decreased	45.45%	45.45%	9.090%	₱ 20296	₱ 9373	View Product

Product Name	Quantity	Chances to Order
Pale Pilsen 330 mL	11	31.42%
Red horse 1000 mL	5	14.28%
Red horse 330 mL	4	11.42%
Red horse 330 mL	3	8.571%
Super Dry 330 mL	2	5.714%
Pale Pilsen in can 330 mL	2	5.714%
Red horse in can 330 mL	2	5.714%
Red horse 500 mL	1	2.857%
Red horse 330 mL	1	2.857%
Pale Pilsen in can 330 mL	1	2.857%
Red horse 1000 mL	1	2.857%
Pale Pilsen 330 mL	1	2.857%
Red horse in can 330 mL	1	2.857%

Figure 10.

The Most Ordered Products



To assess whether the system met both client requirements and the standards of a high-quality website, a project evaluation was conducted. The evaluation utilized a questionnaire based on the ISO 9126 quality model and involved 40 respondents, including 30 customers (sari-sari store owners) and 10 administrative end users. Respondents were instructed to navigate the system's functionalities to evaluate its effectiveness in meeting their needs. The overall results of the evaluation are presented in Table 2.

Table 2.

Overall Results of the Evaluation

Criteria	Mean	Adjectival Rating
Functionality	4.28	Excellent
Reliability	3.96	Very Good
Usability	3.95	Very Good
Efficiency	4.32	Excellent
Maintainability	4.12	Very Good
Portability	4.26	Excellent
Mean	**4.15**	**Very Good**

The functionality criterion received the highest score of 4.28, indicating that the system is fully operational and has met all the essential requirements of high-quality software. While the usability criterion had the lowest mean score of 3.95, it still attained the highest adjectival rating of "Very Good," confirming that the system is intuitive, user-friendly, and easy to navigate.

Summary of Findings, Conclusions, and Recommendations

Customers can use the internet and their computers or mobile devices to place orders through the Online Ordering System, a web-based platform. The system provides different levels of access for two user types: customers, who can browse products and add items to their shopping carts, and administrators, who manage site content, oversee customer orders, and generate reports but cannot place orders themselves.

The Sashimi Model was implemented in the system's development to enhance flexibility and efficiency. Unlike the traditional Waterfall model, which follows a strict sequential process, the Sashimi Model allows overlapping phases, such as requirements, design & architecture, development & coding, quality assurance and software testing, implementation, and maintenance & support. This overlapping approach enables early detection and resolution of issues, iterative improvements throughout development, and better adaptation to changing requirements.

Based on the findings summary and the overarching goal of the system, several conclusions were drawn. The website successfully provides an online purchasing platform and

has the potential to integrate machine learning for order prediction on a weekly basis. Additionally, it features a graphical representation of order volumes by barangay, which helps optimize delivery planning and resource allocation. The system was evaluated using an ISO 9126-adapted assessment tool, where it received a mean score of 4.15, indicating that it meets the standards for good-quality software.

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