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Artificial Intelligence in a Main Warehouse in Panasonic: Los Indios, Texas

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ARTIFICIAL INTELLIGENCE IN A MAIN WAREHOUSE IN PANASONIC: LOS INDIOS, TEXAS

A Thesis

by

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ABSTRACT

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The PANASONIC Company warehouse is located in Los Indios Texas. The warehouse presents the limitation of the great distances between its headquarters and the Main Warehouse for supplying the branches and main customers, which requires a considerable amount of time to maintain effective communication in the inventory area. In addition, during an online review, it can be confirmed that the website is disabled, contradicting its corporate policy.

The structure of the thesis proposal is arranged in four chapters from the Introduction, Statement of the Problem and Purposes; Previous Studies and Definition of the literature; the Research Methodology and the resources for data collection, the results, the proposal, and the conclusions. This paper ends with a list of references from different substantial sources that facilitated the research.

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CHAPTER I

INTRODUCTION

Large supply chain companies are generally oriented on the basis of a storage structure that ensures the continuity and preservation of their products, as well as ensuring timely delivery in the branches and to their customers. However, the emergence of small businesses has impacted in such a way and all over the world that in each country, large product distribution companies need to negotiate their inventory in a faster and more efficient way to cover the exponential growth of said demand.

However, when retail customers order large quantities of products, they do so in order to guarantee the availability of the products in possible periods of shortage or simply because they prefer to save time. For this reason, some drawbacks appear when there is no available quantity of products in stock to dispatch orders and in the worst-case scenario the customer leaves, looking for a supplier that guarantees continuity of supply. In addition, when there are large distances between the main warehouse and the rest of the branches, it is essential to facilitate the internal communication process (branches) and external (customers).

From an administrative and technical approach until now this minimizes using an administrative system for a fluid and efficient management of the warehouse infrastructure from the aspect of organization, quality control and final distribution. To achieve this, the person in charge can opt for administrative tools such as business software that allow them to check the existence of products, plan storage and show when they need to be restored. But this is a job that requires constant review and for that they must have a staff that keeps the information updated, as well as carrying out a fluid communication dynamic for the attention of customers and

distribution companies with web pages also need constant updating to maintain the availability of the products in the warehouse. And in the case study, the company PANASONIC at its warehouse located in Los Indios Texas has invested in this type of administrative solutions to improve its internal management.

This process described in the previous paragraph seems already somewhat outdated in this era of high technology, where Artificial Intelligence (AI) has become a key element for the management of large companies dedicated to the distribution and sale of products. Now, the experience of shopping with a Smartphone or some other device connected to the internet is more and more frequent. In fact, an Android System watch has been invented that allows people to send a message on social media.

Into this context, an investigation is proposed with the aim of implementing the use of an intelligent cellular device with Android system for managing the PANASONIC Main Warehouse in Los Indios Texas of large distribution companies that also allows customers to stay informed in real time of the existing inventory, as well as the store offers, products with a close expiration date, among others.

The structure of the thesis proposal is arranged in four chapters: Chapter I where the Introduction, Statement of the Problem and the Purposes are exposed; then Chapter II, made up of Previous Studies and Definition of the literature, which includes a series of basic concepts; followed by Chapter III, which describes the Research Methodology and the resources for data collection. Finally, the bibliographic references and annexes.

Problem Statement

A company like PANASONIC in its warehouse located in Los Indios Texas presents the limitation of the great distances between its headquarters and the Main Warehouse for supplying the branches and main customers because this requires an effective communication process and a considerable investment in hours / time, also during the review on the web it can be confirmed that the website of this company is disabled, which is contradictory to its corporate policy since in July 2014, the company secured a partnership with Denver to implement related smart city systems with energy efficiency, transportation, internet connectivity and other technological frameworks. Now, to carry out a more detailed analysis of the company's situation, the SWOT Analysis technique and its corresponding strategies are used, to carry it out, opinions of customers and employees of the Panasonic Company located in the city of Texas (United States) were considered, and the result is shown in table 1 below:

Table 1: Panasonic SWOT analysis

STRENGTHS	THREATS
• One of the largest manufacturers of electronic products in the world • High quality and its sophisticated products. • Innovative technology. • Employee commitment. • Environmental care. • Respect for people's rights.	• Current competition • Products that fail to work in the market cause losses for the company. Great demand in similar products, and may have losses • Limitations regarding Internal and External communication.
OPPORTUNITIES	**WEAKNESSES**
• It is an energetic, creative and proactive organization, striving to constantly exceed customer expectations and to get them to trust and believe in the Panasonic name. • Panasonic relies on the support of a number of events and activities worldwide that resonate with our philosophy of contributing to society through cutting-edge technology. Product recycling.	• Reduction of the impact of chemical substances. Programs to promote employee development. • The branches are at a great distance. • Los Indios Texas warehouse Website is disabled.

From the analysis of the SWOT Matrix, a table with crossovers of solution strategies is drawn up in order to select the most appropriate to solve the most obvious and feasible problems of the company.

Table 2: Panasonic's strategic advantages

SO Strategies	ST Strategies
Given its proactive approach and the importance given to the customer as the axis of action of the company, you can take advantage of its technological innovations to improve your communication processes.	Panasonic is one of the electronic products company with a high demand and quality products that is why it has the technological tools to improve communication between the sites despite the great distance that separates them.
WT strategies:	WO strategies:
Something that should stand out in the company is that the branches are in a very long distance, and with the products that have failures and must be attended to in the company it can generate losses, the approach to this problematic nucleus with technology Android communication will be a key to the continuity of its development and growth.	With the support of events and activities worldwide this is a point in favor of the company since it is something that gives more guarantee to its products and the branches to verify errors can go unnoticed, the important thing in this case is to have a real-time application that allows you to take advantage of those moments.

The strategies and SWOT analysis indicate where the company should focus to improve its internal and external communication processes. It is contradictory that this company does not use the opportunity of web connectivity to improve and modernize its processes, for example, such as inventory control that currently requires investing long hours and personnel to keep

inventory updated, monitor and communicate to keep the data also up to date. . And although there is an administrative software, this in turn will need a staff in charge of this task that depending on the increase in the volume of requests and sales will need support of more human resources. Based on the above, this study suggests the following four significant questions:

1. What is the most suitable artificial intelligence application in inventory management of Panasonic's primary warehouse?
2. How does the application of artificial intelligence impact Panasonic's inventory control at the latter's warehouse?
3. What external and internal communication perspectives would necessitate the need to install AI-enabled applications at Panasonic's warehouse?
4. How will employees and consumers cope up with the proposed artificial intelligence framework?

Statement of Purpose

General purpose**:** To implement the management of Panasonic's primary warehouse in Los Indios, Texas using an Android technology smartphone that enhances internal and external organizational communication processes.

Specific purposes: This research also has particular objectives that it strives to achieve, which includes:

- To identify the AI-based application installed in smartphones that facilitates inventory management at Panasonic's data center.
- To analyze how the implementation of AI-enabled applications impact various business processes at Panasonic.

- To evaluate significant opportunities that can enhance effective communication between the company and its consumers.
- To analyze various employee and consumer expectations concerning the use of AI-based applications at the company.

The Research Context

The Japanese electronics firm Panasonic founded by Konosuke Matsushita and began manufacturing independent parts and then expanding to produce complete appliances. The company, which today has been operating for 100 years since its founding, survived World War II, benefited from the post-war period of abundance, and struggled to navigate the political fallout of the conflict. This company experienced several economic crises that forced the management to change the business model as they seek to leverage on the losses. Panasonic has also ventured into the global market, where it seeks to embrace advanced technology through a collaboration with Tesla (Panasonic, 2020) .

Panasonic has continuously produced more electronic products over the past decades, with more focus on customer-centric solutions. Mr. Matsushita, the company's founder, sought how home appliances could be assembled from electric motors, enabling Panasonic to release its first model in 1934 (Panasonic, 2020) . Panasonic was first incorporated as Matsushita Electric Industrial Co. in 1935, and the firm started establishing businesses around to its various products. The company acquired the services of at least 3,500 employees during that time, producing approximately 600 different products (Panasonic, 2020) .

In addition to expanding globally and becoming a large employer, as well as one of the companies with an essential contribution to the economy of different countries. In July 2014, the company made a significant announcement of its intentions to invest millions in the Gig factory

plant to supply batteries for Tesla Motors Models S, X and 3, and also partnered with Denver to implement smart city technologies related to energy efficiency, connectivity to Internet, transportation and more.

Panasonic's mission has been marked is the care of the environment through the application of responsible practices. Find all the actions that are being carried out to preserve the environment, while its Vision is framed in "being number 1 in brand", it is also associated by the expectations of its overwhelming number of consumers that use the company's different electronic products daily for work or entertainment purposes.

CHAPTER II

LITERATURE REVIEW

The History of Artificial Intelligence

There have been three significant industrial revolutionary milestones that have occurred over the past years. The first Industrial Revolution occurred in Europe and the United States in the mid-18th century with the transition from steam power consuming manufacturing process. The second Industrial Revolution occurred from the late 19th century to the early 20th century. During the second revolution, rapid standardization and mass industrialization has increased with the progress of electricity use, oil and steel production.

The third Industrial Revolution began with the emerging computing power and digital transformation of many manufacturing industries around the world. The cornerstone of this period was the innovation of internet technology and renewable energies that have brought solutions to establish commercial infrastructure and the serial model for many commercial sectors. For many reasons, the technology capability of the Internet has outlined more aspects of society across civilizations than any previous invention in past industrial revolutions.

To date, humanity has gradually moved towards the fourth Industrial Revolution, an era that will be categorical and will be driven by the intense modernization of artificial intelligence and automation. The potential of Artificial Intelligence has captured the attention of not only scientists and doctors but also not only politicians and business entrepreneurs. In the coming years, adequate dietary consumption is set to become a huge industry that unleashes a wealth of financial opportunities and will provide industry pioneers, both governments and corporates, with an exceptional technological edge.

From 1938 to 1946, it was called the “Golden Age of Science Fiction” (Anyoha, 2017). In particular, in 1943, scientists Warren McCulloch and Walter Pitts had published a book called "A Logical Calculus of Ideas Immanent in Nervous Activity." The writers had proposed a model of an artificial neuron that could be voice active within a fully functioning or “of” brain and detect a neural learning network.

In 1950, Alan Turing introduced the Turing experiment, machine learning, genetic algorithms and reinforcement learning in his article "Computing Machinery and Intelligence." The test was with a small copper coin from ancient Rome to apply a method that would allow to verify the intelligence behavior of the machine. Then, in the summer of 1956, "the Birth of Artificial Intelligence" was enacted when the term was coined by McCarthy at the first Artificial Intelligence convention (Stuart and Pedro, 1995, p.17). After two years, John McCarthy started the programming language that is one of the most used in the field of Artificial Intelligence.

After the innovative technology in the world, around 1961, the first Robot called Unimate was introduced on an assembly line at General Motor by George Devol and his co-workers (Rebeca, 2011). After two years, the first chat system was designed by a professor in the area at the Massachusetts Institute of Technology Joseph Weizenbaum at the mercy of Natural Language Processing (Manisha, 2016).

In the 1980s, scientist Edward Feigenbaum set up expert systems that simulated the knowledge and analytical ability of one or more human experts. Today, the expert system is applied to analyze future data, statistics and predictions (Anyoho, 2017). Finally, as Raymond Kurzweil (1990) writes: “Today, many thousands of Artificial Intelligence applications that are deeply embedded in the infrastructure of each industry”. Until the appointment, there were

various programs that were produced to serve human life such as self-contained home vacuum cleaner, Siri, Google Now, self-driving car, and other technologies.

Artificial Intelligence and Manufacturing

The Fourth Industrial Revolution is attributed by artificial intelligence and machine learning systems by altering people's interaction with computers and information along with revolutionizing the manufacturing sector. Machine learning and automated production attracts a lot of interest in high-tech manufacturing industries. Most companies strive to automate manufacturing to increase productivity and minimize human errors. They are also aiming at reforming people's efforts to non-repetitive tasks that involved human interventions. The rise in demand for customized products at reasonable rates triggered the invention of machine learning systems and artificial intelligence in the manufacturing sector. Today, most manufacturing plants have fixed schedules to avoid regular maintenance costs.

With the assistance of cognitive artificial intelligence technology, smart sensors, plat engagers alongside interconnected network machines, enable us to monitor devices. Consistent monitoring assists floor managers in generating predictive analytics. For many years, technology has been restricted to high-end applications used in conducting space simulations. The increased use of artificial intelligence and allied technologies are driving technology towards the manufacturing sector. It can also diagnose and track anomalies, resulting in improvement and effectiveness. Companies across the globe are striving to reduce downtime via various artificial intelligence technologies. For instance, in India, general eclectic has built a brilliant factory powered by Predix, an Industrial Internet of Things (IoT) platform. This technology utilizes sensors to monitor every step of the manufacturing and prevents downtime by approximately 18% (Aghion, Jones, & Jones, 2017) .

AI-Based Machine Learning for Demand Estimation

Organizations have in the past decade put in considerable efforts to integrate computing technology and statistical methods to model precise consumer demands. The need to use advanced technology for modeling consumer purchasing behaviors have been necessitated by the increased volumes of big data in industries such as healthcare, retail, and supply chain management systems. Research by (Bajari, Nekipelov, Ryan, & Yang, 2015) presents a comparison of various consumer modeling techniques supported by machine learning to establish their performance against the commonly used approaches. Bajari et al., (2015) acknowledge that organizations face considerable difficulties as they strive to find the most effective tools for estimating consumer demands in large-scale scenarios. The literary work of Bajari et al., (2015) is relevant to this research because it justifies how Panasonic precisely estimates consumer demands using machine learning. It also justifies why companies should consider deploying automated consumer modeling methods to increase their sales volumes.

Though machine learning offers outstanding modeling techniques and other approaches such as linear regression and the conditional logic that offer automated forecasting on big datasets (Bajari et al., 2015) . This literature discusses six different machine learning techniques that model consumer demands in various industries and compares them with the commonly used traditional approaches. Accurate forecasting help organizations increase their return on investments by only focusing on products with substantial market demand. Machine learning is the most suitable paradigm for bridging the gap between parametric models with user-selected covariates and completely non-parametric approaches (Bajari et al., 2015) . This research acknowledges that logit and linear regression models are inferior to machine learning techniques in terms of prediction accuracy. The table below summarizes the research results:

Table 3: Model comparison highlighting prediction errors

	Validation		Out-of-Sample		Percent
	RMSE	Std. Err.	RMSE	Std. Err.	Weight
Linear	1.169	0.022	1.193	0.020	6.62
Stepwise	0.983	0.012	1.004	0.011	12.13
Forward Stagewise	0.988	0.013	1.003	0.012	0.00
LASSO	1.178	0.017	1.222	0.012	0.00
Random Forest	0.943	0.017	0.965	0.015	65.56
SVM	1.046	0.024	1.068	0.018	15.69
Bagging	1.355	0.030	1.321	0.025	0.00
Logit	1.190	0.020	1.234	0.018	0.00
Combined	0.924		0.946		100.00

Though most economics are yet to integrate machine learning in their forecasting analysis, Bajari et al (2015) argues that the automated model offers user-friendliness, scalability, and flexibility in various business environments. The research concludes that machine learning models simplify the construction of standard prediction errors, making them more reliable and consistent compared to the linear regression techniques.

Artificial Intelligence and Demand Forecasting in Supply Chain Management

During demand signal processing, all parties in the supply chain usually process specific datasets before handing them over to the next party. There is a possibility of demand signal distortion if one of the members involved conveys contradicting information, and this is likely to trigger poor decision-making. The consumer's demand signals often get distorted gradually as it propagates up the supply chain. The distortion usually occurs despite the signal being consistent in all the parties involved in the supply chain.

The success of a business entity in a dynamic environment largely relies on the effectiveness of its supply chain management techniques. However, the intermediaries involved within the supply chain are likely to alter the initial consumer demands by distorting the latter's original message on specific products or services (Carbonneau, Vahidov, & Laframboise, 2007) . These significant drawbacks necessitated Carbonneau et al (2007) to conduct a research that

compares the traditional forecasting approaches with AI-based machine learning techniques and highlight how the latter outshines the former in terms of accuracy, efficiency, and user-friendliness. Supply chain primarily focuses on precise forecasting by providing significant information to facilitate decision-making processes in organizations.

Traditional demand forecasting approaches**:** Forecasting techniques are primarily facilitated by supply chain academic outlets, statistics, mathematics, and operations management. Simple predictive approaches often have better accuracy than the complex methods, hence most traditional approaches tend to be more complex compared to their successors. The simpler methods are often deployed by the practicing economists with more dynamic perspectives compared to the complex methods. These include neural networks, decomposition, naïve models, and the Auto-Regressive Moving Average (ARMA) model, all of which prove to be more consistent and user-friendly (Carbonneau et al., 2007). Traditional forecasting models often involve the use of more critical analysis, which are rarely supported by advanced technology.

AI-based Demand Forecasting Models: The increased number of available forecasting techniques makes it challenging for organizations to pick the most suitable model that can address their specific organizational requirements. This is because most modern techniques often account for demand signal distortion along the supply chain. Universal approximations are necessary for accurately providing precise forecast using situational functions. These approximates can easily model past and future trends to give a better overview of the supply chain in terms of consumer purchasing behavior and other focused market analysis. Machine learning techniques utilizes universal approximation in support vector machines and artificial neural networks that use other approaches as subsets of the provided function to maintain consistency (Carbonneau et al., 2007).

Figure 1: Supply chain demand modeling neural network design.

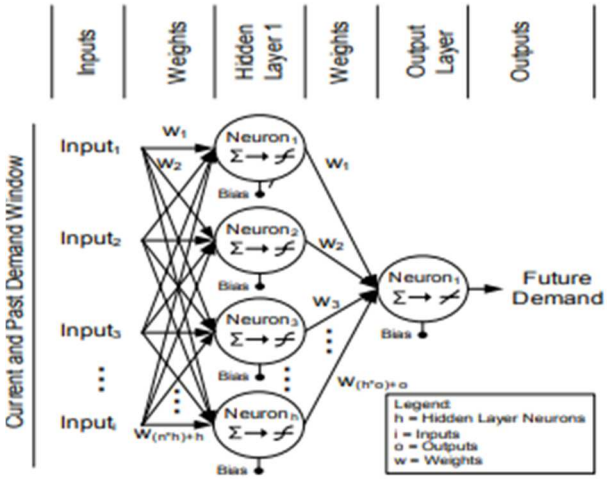
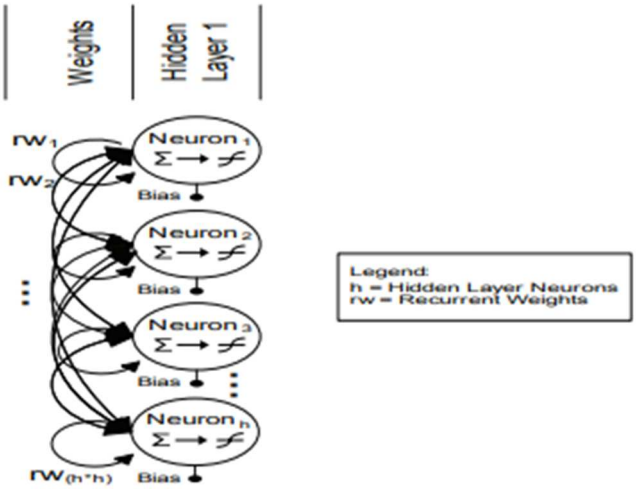


Figure 2: Recurrent subset of supply chin demand modeling neural network design.

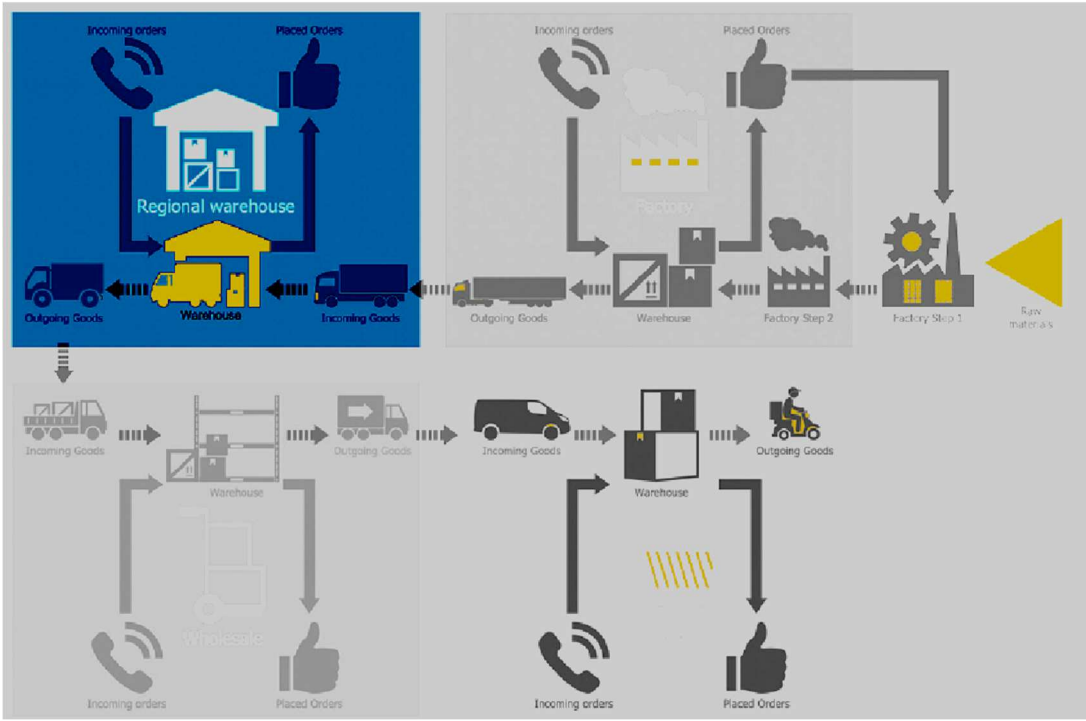


This research recommends the deployment of machine learning to minimize the distortion of demand signals in the supply chain. Though there are several forecasting techniques that can be used to model precise consumer demands, experts usually encounter difficulties in

identifying the most suitable model. This is primarily because despite the techniques, there is no significant research that offers guidelines on how to pick the most appropriate approach. Automatic exponential smoothing remains one of the best traditional forecasting techniques, which minimizes distortion by using the first value provided in the series as the initial signal. This research has established that considerable substandard performance in some machine learning techniques, which is mostly attributed to the limited number of past time periods for the products in question (Carbonneau et al., 2007) . The traditional exponential smoothing techniques has proven to be better than other machine learning approaches in terms of consistency, simplicity, and minimal consumer signal distortion in the supply chain.

Warehouse Definition

Figure 3: Warehouse overview



A warehouse refers to a place / building to store goods, considering it as an industrial building where products are categorized and for the most part it is located on the outskirts of cities. They are usually large flat buildings in which the goods can be kept as articles to be imported and for export, packaging and delivery for customers, and so on. Standard "operations" in today's warehouses include loading and unloading products, warehousing, distribution and ordering of products, packaging, labeling, and even delivery, with administrative activities. There are different types of warehouses with some differences in their properties and their operations.

Most traditional warehouses are typically large empty buildings for the bulk storage of goods while modern warehouses are equipped with shelves and other modern organization facilities to use space in its most efficient way. More contemporary companies have automated some activities such as the placement of goods and other jobs.

Warehouses are often associated with consumer goods, therefore, they are indirectly related to the economy as well. What we see in most of these is due to an economic model in which the goods are all produced elsewhere, imported and stored in a warehouse in bulk quantities, to be packed and delivered to the following parties and clients. As the industries are all following the Ford model of mass production, large quantities of manufactured products should be stored somewhere to be further distributed or sold. Any change in this economic model (which is the case that is occurring in the problem formulated in this study), will affect the operations and as such, the spatial qualities of the wineries as well. This would be one of the main areas of concentration in this investigation.

Operating a Warehouse

Warehouse operations have gradually been turning into a scientific model with computational operations, thanks to technological advancement. The main purpose of transforming is to enable companies to improve winery activities more effectively. Also, customer service and demand variability are acting optimistically. Although warehouses serve many different purposes, they generally operate in the same logical pattern of essential flow.

Unloading

This refers to the process of receiving goods and is the first to be done in a warehouse. In this phase, the goods should be verified to ensure that the warehouse will receive the correct product, they should model the quantity, condition and take advantage of the right moment. When the warehouse receives notification of the arrival of goods, they will schedule reception and unloading of the load to coordinate effectively with all subsequent operations within the warehouse.

Products are usually inspected and recorded as soon as they arrive in the warehouse. If there are exceptions like damage, wrong accounts or wrong descriptions, they will be recorded. Optimizing the warehouse by unloading the process is to avoid hoarding in the receiving docks. Power pallet forklifts and haulers will be supported tools to unload cargo and empty dock areas faster. Additionally, delivery management systems and dock planners can accurately forecast upcoming shipments to properly assign the correct number of personnel.

Put-Away

It is the process of transferring material from a port or dock to storage in a warehouse. Generally, a distribution manager or a logistics specialist could put the goods away on the same day of arrival to use the storage space, minimizing costs and could limit congestion and undesirable damage. Before starting the process, it is very crucial to identify the appropriate storage location because it will help to retrieve the product for the customer quickly and efficiently. Therefore, the warehouse manager needs to Lower Load (Receiving).

Order Handling and Picking

Picking is the storage process where goods are assembled to respond to customer orders. Upon receipt of the customer's order, the available inventory must be checked. Then you need to provide pick lists to specify what is requested in the order. The collecting list will include the item and the quantity ordered. The process typically takes up 55% of the total warehouse operating cost. (Hackman & Rosenblatt, 1990).

Cargo Loading and Picking

This is primarily done to ensure that the best condition of the goods is maintained throughout the warehouse and then destined for the customer. On top of that, good packaging can avoid some damage or insurance claims. The packaging should be chosen following the general rules so as not to increase the weight of the products and to minimize packaging costs. Most customers usually prefer to receive all the items in their order at the same time. This means that the warehouse must try to get all the parts of an order and pack it together. However, the package must be delayed to ship until they have adequate vacancy in packaging.

Products are usually reviewed before being shipped to ensure that they do not contradict the customer's choice. Based on the registry items, the route of the shipments is coded and can be reviewed by customers and the warehouse manager just before being delivered. When the product is loaded in freight forwarders, the shipment. It is considered successful if the correct order is delivered and dispatched on time and without any damage.

Product Storage

This is where products are usually placed within the most appropriate space to keep them safe and orderly in a suitable place. Taking full advantage of all the available space in the warehouse will bring about an efficient storage process. Storage is necessary for keeping actions organized and limit asset surcharge. If the cellar is not functionally compiled, it is often managed storage excursion due to factors such as dynamism, seasonal peak, and difficult sales (Rushton, Croucher, & Baker, 2014) . It is inevitably to increase a considerable investment of time and money in the effort to optimize the storage activities of the winery.

This promises long-term positive impacts that will enhance the company's development. Sunol (2020) asserts that there are five significant optimization steps involved in the storage process, which include the following:

1. The calculation of warehouse storage utilization
2. The measurement of KPIs to define particular aspects that require improvement
3. Increasing the storage space by reducing redundant aisle spaces
4. Space maximization by using them most appropriate storage plan
5. Availing different sizes of containers to maximize the storage space

Managing the Inventory

Managing the inventory is a vital process that determines the company's ability to monitor its stock effectively. It contains substantial portion of a company's assets such as raw materials, work in process, all supplies used in making, and finished items (Muller, 2003) . Inventory management is concerned with managing availability of company assets. It has a function to coordinate and manage the flows of goods ordered for the business to function. Managing the inventory also facilitates the ordering and reordering stocks, product selection, forecast inventory analytics, and ensuring safety actions are accessible for manufacturing or supply.

The use of artificial intelligence in inventory control offers better analytics for companies, spreading more towards the trend of meeting customer demands, processing large volumes of data that help store departments to better control routine inventory management assignments. Many Artificial Intelligence applications had been used to achieve real-time inventory management. At the mercy of outdated data, artificial intelligence can predict scenarios, suggest appropriate solutions, and even work independently or with human acceptance.

Enhancing Security and Safety in Warehouse Management

Security remains a significant priority in the effective management of warehouses. Ensuring the safety of a warehouse will avoid occupational risk and promote a positive environment in the workplace that prioritizes employee health and well-being. There are warehouse methods that offer different degrees of security and security management that the company can adopt (Richards, 2017) .

CHAPTER III

RESEARCH METHODOLOGY

Research refers to the academic practice of seeking relevant knowledge to facilitate decision-making and serve as future references. It is also defined as the scientific and systematic search for relevant information on a certain topic. The Oxford definition of research defines it as a careful inquiry or exploration especially through the search for new facts in any branch of knowledge (Dictionary, 1989).

Type of Methodology Approach

The qualitative and quantitative research are the method to investigate. The quantitative method emphasizes the statistical, mathematical, or numerical data collected. The quantitative method is termed as surveys, questionnaires and surveys. While qualitative research is concerned with the qualitative phenomenon through indefinite and conversational communication. The result of qualitative methods is obtained by interviews (one group, one, or focus) (Kothari C.R, 2004) .

In this thesis, the use of quantitative methods during the research stage is proposed. The thesis intends to investigate how the impact of Artificial Intelligence revolutionizes the inventory management of the PANASONIC Main Warehouse in Los Indios Texas with the use of a smartphone that allows improving internal and external communication processes.

Sampling of the Population

In order to facilitate the information gathering process, some clients will be contacted via WhatsApp with the express collaboration of PANASONIC management in order to consider their participation in the proposal, however, it is to be considered that they can also be oriented as an academic-scientific contribution by the researcher, considering taking documentary sources as a reference to build projections of data necessary for the design of the proposal, if the problem generated by the COVID-19 pandemic prevents access to the main sources.

Collection of Data

This refers to the process of evaluating relevant responses that were answered by target participants (Lopez & Whitehead, 2013) . The data collected will make a direct dent for the research analysis. The data collection consists of primary data and secondary data. The execution of assembling these data used for theoretical and empirical research will be proposed.

CHAPTER IV

RESEARCH RESULTS, RECOMMENDATIONS, AND CONCLUSIONS

This chapter presents the results obtained by developing the objectives planned at the beginning of this investigation. The first objective is assessed by applying a survey via WhatsApp to employees and customers of the PANASONIC Main Warehouse located in los Indios, Texas. Given the current situation due to the COVID-19 Pandemic, it is decided to do it in this way, in addition to presenting itself as a great opportunity to be able to encompass opinions and not just be limited to a series of pre-established options.

The first questions are investigative and are aimed at assessing the dynamics in the inventory area, then in another section the need for the proposed system is assessed, finally the opinion of customers who generally purchase products in a considerable quantity is assessed. Another aspect addressed was the acceptance of the employees of the proposed designs, for this an opinion matrix was also generated through a query via WhatsApp, the results of which are presented in a section to respond to the last objective of this research.

Presentation and Analysis of Results

Table 4: Responses from Panasonic employees

Items	Description	Average Summary of Answers
1	In approximate, how many product references do you handle?	101 or more
2	On average, how many units of products are sold monthly?	500 or more
3	How many units of products do you get returned for defects per month?	11-25
4	How often do you order?	Daily-Weekly
5	Do you manage an information system to know inventory availability ?: Administrative Manual or Software	Software Administrative
6	Would you like to have a more efficient inventory control system that you can consult through a web platform?	Yes
7	What platforms would you like the system to be on?	Cellular Application

In table 4, it is observed that in the consultation made to the inventory personnel, in items 1 and 4 there is an important reference of movement of products from this warehouse, while there is also an important report of failures as indicated on average in the answer to question number 4. Regarding the periodicity of requesting orders, they are between daily and weekly, while the management is carried out with an administrative software that could easily be fed and adapted to the web application through the information modules issued or reports. Finish the consultation with the preference of the system they would like to handle: mobile application.

Table 5: WhatsApp consultations with Panasonic clients at the Texas warehouse

Business Name	How often do they order?	Do you have any access via the web to know the availability of PANASONIC inventory?	Would you like the system to indicate how many units per product you can order?	What platforms would you like the system to be on?
Minimarket Roseblanc	Monthly	No	Yes	Mobile app
Minimarket The Hen House	Monthly	No	Yes	Mobile app
Warehouse The News	Monthly	No	Yes	Computer application
Wharehouse D cabins	Monthly	No	Maybe yes	Mobile app
Minimarket Valery	Monthly	No (phone call)	No	
Sales M&3S	Monthly	No (phone call)	Yes	Mobile app
Supermarket Santi	Monthly	No	Yes	Mobile app
Sales Spring	Monthly	No (phone call)	Yes	Mobile app
Supermarket Texas	Monthly	No (phone call)	Yes	Mobile app
Wharehouse Liem	Monthly	No	No	
Varieties Paty	Monthly	No	Yes	Computer application
Store 20	Monthly	No (phone call)	Yes	Mobile app
Store 32B	Monthly	No	Yes	Mobile app
Store The Frontier	Monthly	No	Yes	Mobile app
Store 35	Monthly	No	No	Web
Supermarket Centennial	Monthly	No (phone call)	No	
Supermarket The Wharehouse	Monthly	No	Yes	Mobile app
Store Mundo	Monthly	No	Yes	Mobile app
Supermarket Emerald	Monthly	No	Yes	Computer application
Sales Zarate	biweekly	No	Yes	Computer application
Sales Technology	Anual	No	Yes	Mobile app
Wharehouse Nova	Anual	No	Yes	Computer application
Store The Republican	Anual	No	No	Computer application

The clients of the PANASONIC Main Store in Texas were located by telephone (WhatsApp) and the responses indicate that if they are interested in receiving updated information on the store's inventory, the telephone consultation also stands out as the current way to verify before placing orders. But this would rather congest the attention-inventory area.

Justification of the Proposal

Android is a free development platform, and open source, the kernel of the system is based on Linux 2.6 to which certain modifications have been made so that it can run on phones and mobile terminals, which, although they are increasingly powerful, do not stop have fewer resources than a desktop computer. The fact that it is free and open source means that mobile manufacturers can use it in their new terminals without paying user licenses.

Android has a large number of services available, for example GPS service including maps, barcode readers or even databases that will serve to keep all the data of our application conveniently organized and all this without having to install external libraries or complex configurations as in other environments, the terminals also have a great variety of sensors that allow to have knowledge of the environment that surrounds them and thus be able to access the information to know the exact position of the device, temperature, etc.

The internal architecture of the Android platform is basically made up of four components:

Applications: All applications created with the Android platform will include an email client (email), calendar, SMS program, maps, browser, contacts, and some other minimal services as a base. All of them written in the Java programming language.

Application framework: All Android application developers have full access to the source code used in the base applications. This has been designed in this way, so that hundreds of different

application components are not generated, responding to the same action, giving the possibility that the programs are modified or replaced by any user without having to start programming their applications from the beginning.

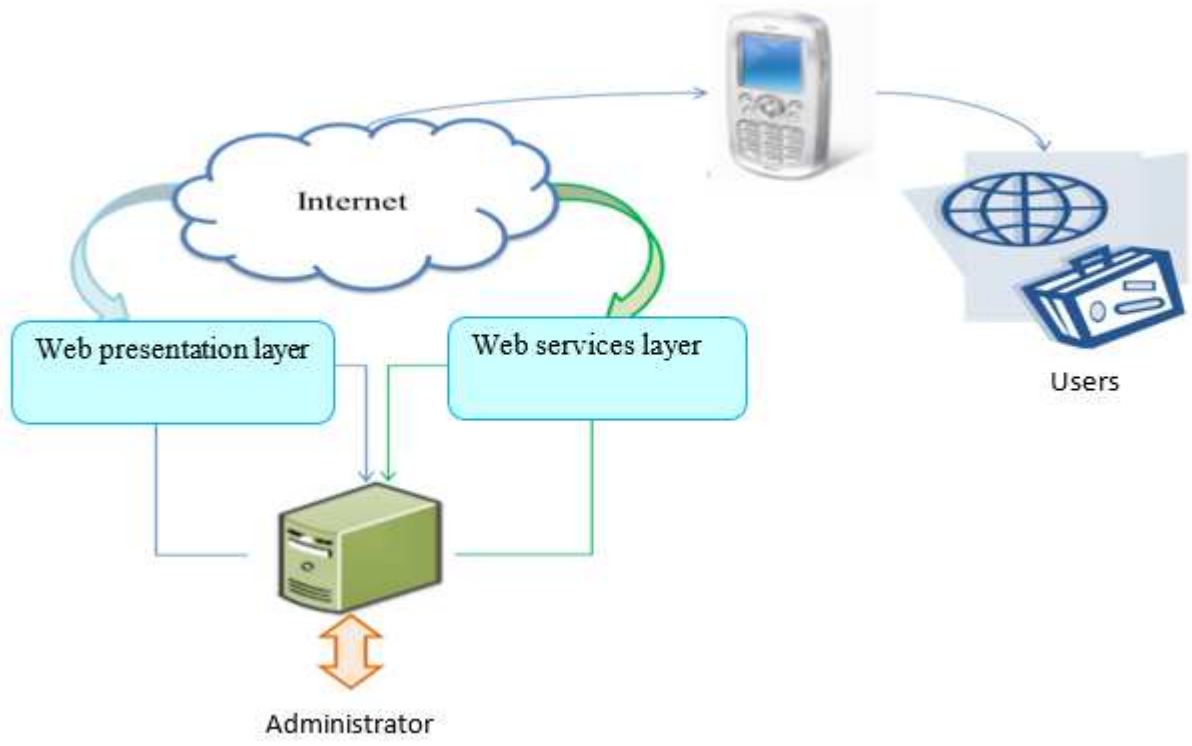
Libraries: Android includes in its database a set of C / C ++ libraries, which are exposed to all developers through the Android System C library application framework, media libraries, graphics libraries, 3D, SQlite, etc.

Android Runtime: Android incorporates a set of libraries that provide most of the functionalities available in the base libraries of the Java programming language. The Virtual Machine is record-based, and runs classes compiled by the Java compiler that have previously been transformed into the .dex format (Dalvik Executable) by the " dx " tool. (MundoManuales, 2010)

System Architecture Design

The software will be handled mainly under a paradigm of a service-oriented architecture, under the Java platform, for the management of the mobile application and for a better integration with other development languages that will be published web services. The architecture that will handle the software is represented in the following figure:

Figure 4: System architecture



The software will be managed mainly under a paradigm of a service-oriented architecture, the services that the website manages will be Java services, for the management of the mobile application and for a better integration with other development languages, and web services will be published. The architecture that will handle the software is represented in figure 1 and as shown, both the web page and the web services will be deployed in the cloud or internet, so the mobile application will be able to access the data from anywhere with internet access. As well as the person in charge of managing the website, you can enter the inventory control system from anywhere.

Designing the Web Services and Communication Protocols

Web services will be used mainly by the mobile application that will be developed for Android, although web services allow data to be exchanged between applications developed in different languages, for this case two applications developed in Java will communicate. The web services will be responsible for providing information regarding product stocks.

As the mobile application will have the ability to read barcodes, a service that is capable of consulting the barcode number and returning the information of the consulted product by reading a barcode will be necessary.

The construction of the web services is done using the JAXWS development API, mainly because this API helps to simplify the development and deployment of the web services clients and endpoints.

Selecting the Development Technologies and Database Design

One of the requirements of this proposal is that it be developed with free tools, in this case one of the most widely known and used free languages in the world was chosen: Java. The website will be developed using the Java Sever Faces framework in its version 2.0, the development of the application will be carried out using more than one development IDE but two Netbeans and Eclipse (Oliveira, 2019).

Netbeans will be the development IDE that will be used to program the website, while eclipse will be the IDE in which the mobile part on Android will be developed. One of the most complete database engines is PostgresSQL which is the one that will be used in this project, the software will also be developed using hybrid technology for data management, which allows greater control regarding security and management of the data. The website interfaces will be developed using

one of JSF's own libraries and PrimeFaces, these libraries help to generate dynamic interfaces quickly and generate the JavaScript code necessary for the execution of the pages in the different browsers.

Functional System Requirements

Figure 5: System requirements

Registration: You must allow registration with a Google account in the case of Android, Apple in the case of IOS, or Microsoft mail in the case of a computer application for basic data. Once registered, you will create your username and password to start the application, in addition, the administrator will be able to add to your vendors-clients-suppliers of raw materials, inventory personnel, among others; you can also view basic information from the applicants to prevent hackers.

Authentication: The administrator or registered applicant can log in with a registered username and password (the latter after being admitted by the administrator). You can make use of the forgotten password option to reestablish it with the mail and the system must allow viewing

in tables the products that are being sold for any user who enters and requests said data, likewise, the system will allow the administrator to enter, modify or delete: brands, categories, products, people, and suppliers.

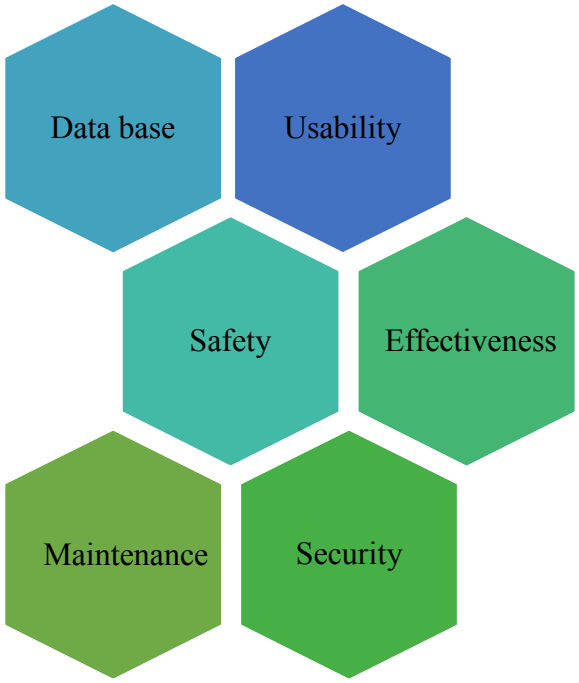
Database Information: To register the delivery of an order, the products must be registered, in case you cannot find it, allow the administrator to register it. In the event that there is an expired product, or with physical damage (dents, broken, etc.), a movement to the product will be recorded, the employee can send a message to the administrator using internal chat indicating the cause and the amount, so that it can be updated in system. If there is an exchange of a product for another product, a return, and exchange will be made, referencing that the return is being made, indicating which products are. You can also check the price of a product without registering it, making and canceling purchase requests via chat.

Security: In the event that an administrator (Warehouse Manager) goes on vacation, has disability or some other cause that does not allow him to attend work, he will be deactivated until he returns.

Reports: The system must show a PDF with the data of the products: indicating how to order, filter by supplier, sales, stocks in inventory, among others, referring to the last time the data was updated.

Non-functional System Requirements

Figure 6: Non-functional system requirements



Usability: The application must be displayed correctly on any screen size, smartphone. For this it is good to use a framework that uses View-Web. It should allow easy use for cases where the person who will use it is a senior citizen.

Efficiency: It must allow the rapid registration of products in a time no longer than 3 seconds to search for the product by its barcode, reports must not exceed 15 seconds to generate and when lists are used, they must have pagination to avoid a delay greater than 5 seconds.

Security: Customers will not be able to register information that alters the sequence of the page, only use the chat section. The login credentials will generate a token based on OAUTH 2.0, so that it continues to validate the token and not the credentials. The user's password must be encrypted with SHA2-512, records must be encrypted with at least AES-128, and automatic backup must be performed every 24 hours (Sabale, & Dani, 2012).

Reliability: It must have the ability to reestablish itself with a minimum loss of information, control exceptions so that they do not allow unexpected closure and that they leave a log in order to make the corresponding arrangements.

Maintainability: You must have the technical, installation and user manual documentation and if there are several error or fault logs, these must be corrected as soon as possible.

Database: In order to take into account the inventory control information system by mobile application, the administrator must record all the movements of a product, so that the app works correctly. The entry of orders with the batch is established and as an additional alert for the dates close to offers and product availability. It is used as the primary Binary key because it follows the UUID (Universal Unique Identifier) standard.

Figure 7: User roles

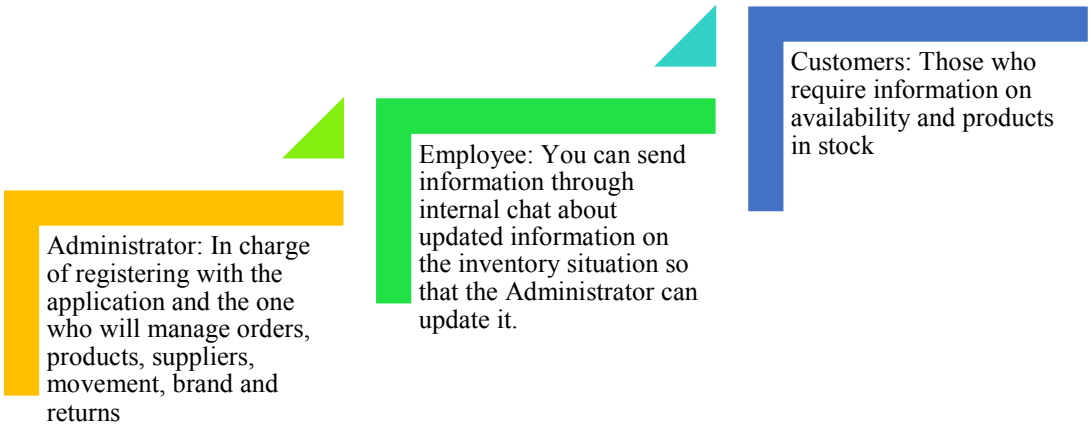
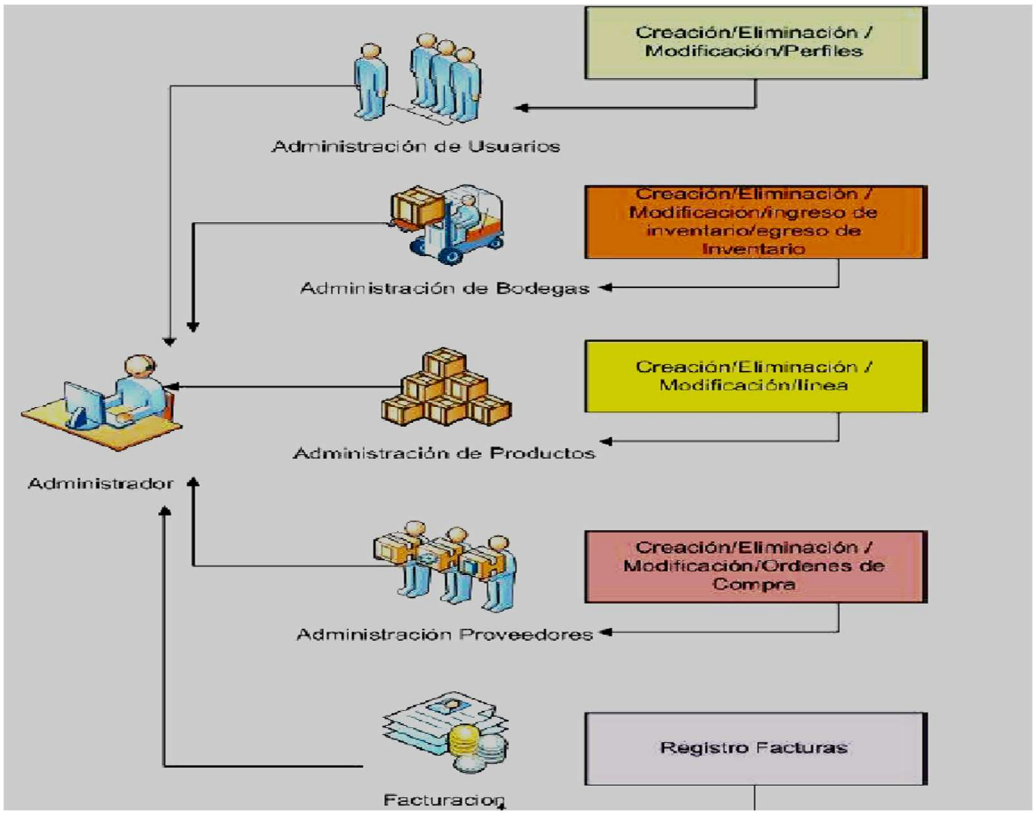


Figure 8: Definition of user roles



Software Architecture

It is suggested that for the construction of the application a Client-Server scheme based on micro services architecture be used, allowing the creation of a system with modules separated from each other, easy to scale, that has fault tolerance, adequate log management, and that it can be developed for any operating system and with any programming language.

Sequence diagram Administration Screens

Administration screens are understood to be all the screens that allow inserting, modifying or deleting a specific data in the database, whether it refers to a product data or a product brand data. All the system administration screens have a process of use very similar to each other, the difference between each screen is the types of data that each one of them requires to carry out a

specific process. The sequence of any administration screen begins when the user enters the system and ends when the user has completed the changes.

Constructing the Web Services

For the construction of these web services we use the java JAX-WS development API which provides simple annotations to build the web service. Building a web service is simple since all you have to do is create a common JAVA class and create the necessary methods for the functionality to be exposed as a web service. What really makes a class a web service is the interface from which it is implemented, since this is where they use the necessary annotations so that it is exposed as a web service on the application server.

The annotations used are as follows

@WebService: used to define the class as a web service.

@SOAPBinding: we define the web service as a SOAP type

@WebMethod: defines as web method the operations to expose in the web service.

@WebResult (name = "productDto"): defines the name of the result that the web service will return, in this case a product object.

@WebParam (name = "idProduct"): defines the name of a parameter that will receive the web method that will be exposed.

Once the web service is exposed on the application server, the use of annotations in the WSDL structure can be verified.

Constructing the Web Interfaces

The web interfaces are developed using JSF so its operation is divided into several layers, the presentation layer or frontEnd uses PrimeFaces to handle the JavaScript and control the different events that the page needs to control. Each of the pages is made up of two main parts: the xhtml page and the bean that controls the page.

Creation of XHTML Files

The xhtml page is almost the same as an html page with the difference that this page handles JSP tags for handling web objects. In this page you will find the references of JS and CSS files as it is handled in normal html. As can be seen in the following figure:

Figure 9: Input interface

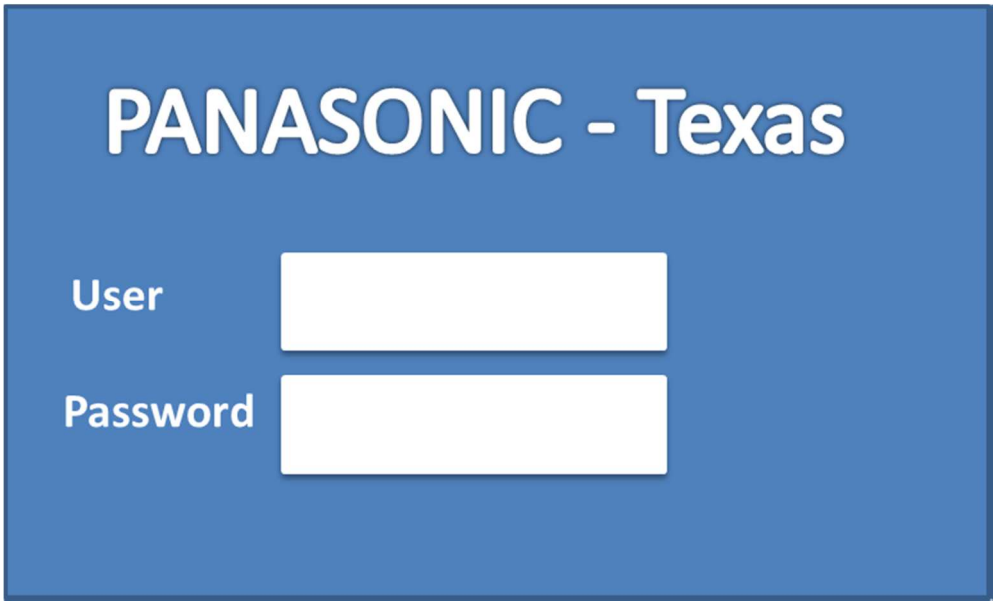


Figure 9 above shows a screenshot of the program's start screen. As you can see, the user and password input text field is generated with a design that is handled by the PrimeFaces library, the same case can be seen in the design of the login button.

Generation of Beans and Data Management

The data control is carried out through the beans, a bean can be of a different type, from a session bean as well as an administration bean, and to better explain how the project beans are formed we will take the home page as a reference.

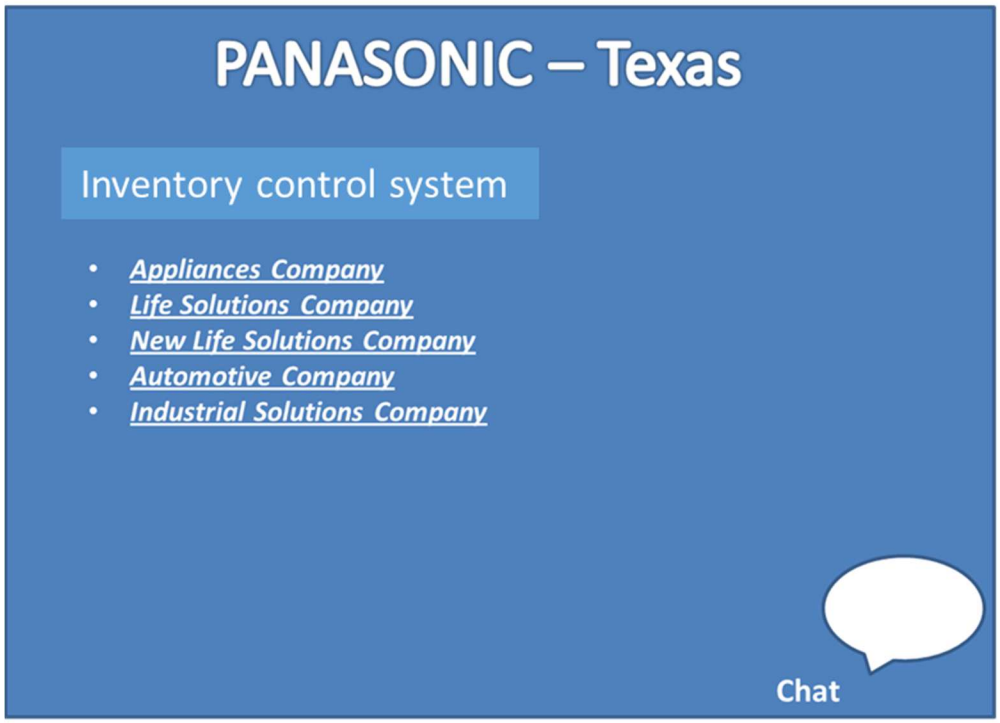
The page to enter the system requires the entry of two parameters: the user and the password, as the bean will handle this data, it is necessary to create two variables to manage them. These variables must be instantiated and the respective getters and setters generated so that they can be called from the xhtml side. For example, in the case of the user parameter, we have generated the variable of the String type named user, to call the reference of this variable simply put its name in the jsp label as it handles objects.

<p: inputTextvalue = "# {loginUsuario.user}" rendered = true />. The p tag was designated for the primefaces library. The xhtml management bean communicates with the database through the java services, for that it is necessary to instantiate the java service variable, for example to verify the correct user and password entry in the call to the java services. For the verification, the User service is used, the same that is used in the user administration screen, for this service to work correctly it is also necessary to call the properties method, which initializes the necessary data for object mapping (Buchalcevova, 2018) .

After the user's data has been verified, the page will proceed to create the corresponding session variables to control its entry and redirect to the next page of the flow. Each bean was designed and developed according to the needs of the page it is going to handle, the necessary methods were also developed for the user to perform different verification and functionality processes. All beans are in the ec.com.bower.beans package.

In the case of administration screens, lists of bean objects are first generated. These objects are loaded into the grid that presents the data of the respective entity. Figure 6 shows the system user management screen.

Figure 10: Administration interface

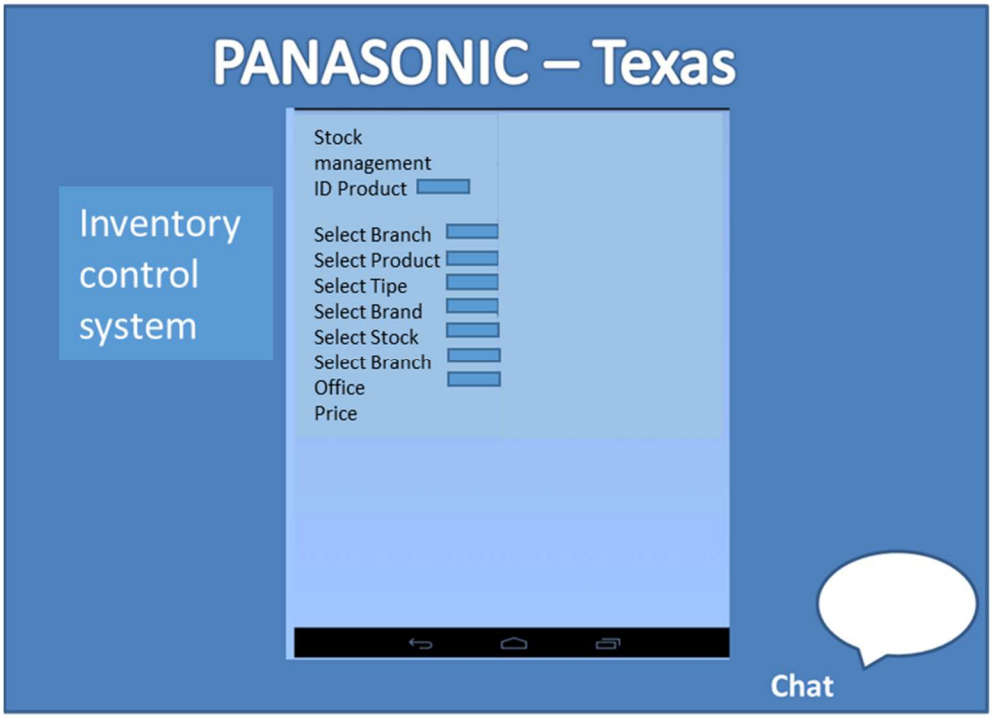


The user interface or screen is defined in the XML files in the res / layout directory. Each screen will have a different XML file. Designing a screen using Java can be complex and inefficient, however, Android supports XML for designing screens and defines custom elements, each representing a specific "subclass" called view.

Screens can be created in the same way that HTML files are designed. Each file describes a layout (a screen) and each layout in turn can contain other elements to manage the user interface. A view is an object whose class extends from the android view. View class, this is a data structure whose properties refer to the data on the screen. A view has properties such as: layout, drawing, focus, change, scrolling, etc.

The view class is useful as a base class for widgets, which are already implemented subclasses that draw elements on the screen. The list of widgets that you can use includes Text, Edit Text, Input Method, Movement Method, Button, Radio Button, Checkbox, and Scroll View. The development IDE allows you to create these interfaces in a very simple way, as it has a graphical wizard which allows you to drag the necessary components to the screen and automatically generates all the necessary code in the corresponding .xml and .java files (Pane, Awangga, & Azhari, 2018).

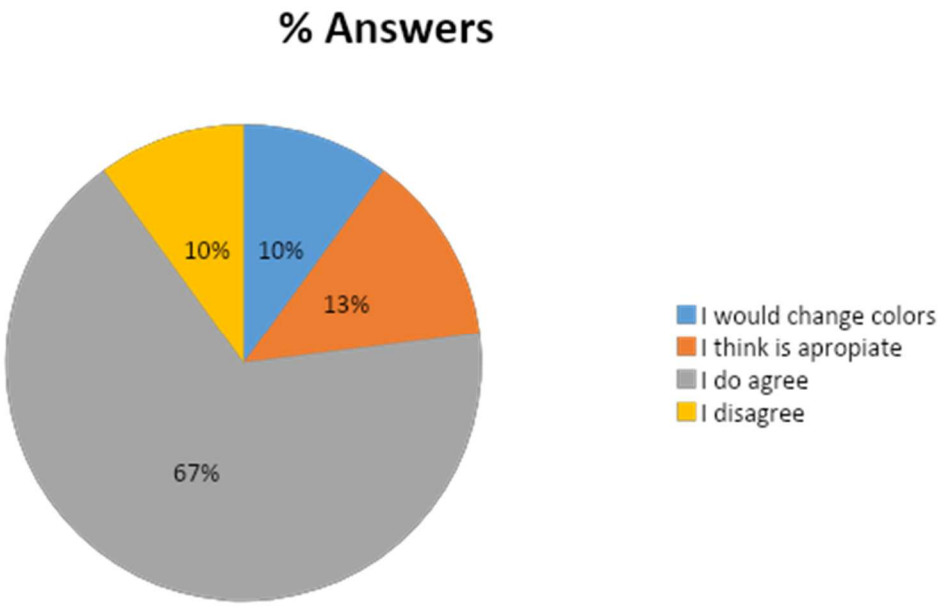
Figure 11: Stock management inventory control system



In this way, a model proposal is presented to the employees of the PANASONIC Main Warehouse in Los Indios, Texas and to describe the impact of this Artificial Intelligence application that was made as a first contact with the possibility of its subsequent acquisition and design by the company. A consultation, via the web with the question: Does the proposal presented through the drawings-diagrams on the proposal for the application of Artificial

Intelligence in the management of the Main Warehouse of PANASONIC in los Indios Texas seem acceptable? The responses can be visualized through the following graphics:

Figure 12: User response on the use of artificial intelligence at Panasonic's Texas warehouse



As can be seen, the acceptance was very positive, although some suggestions that are considered necessary when designing and executing the interface will be considered. Therefore some scenarios are established.

Other Alternatives

UML Diagrams

A Unified Modeling Language (UML) refers to a set of integrated diagrams used by system developers to document, specify, construct, and visualize the system's artifacts (Khan, Mallet, Rashid, 2019) . UMLs provide excellent software development practices for developing complex systems that support real-time processes. They primarily help engineers by ensuring that all the requirements have been met before beginning the development process. The development methodology known as Unified Modeling Language (UML) is a standard language with a graphic vocabulary and rules for the presentation of information systems, applying a design pattern called MVC (model - view - controller).

The Significance of UMLs

Visualization: UML allows a system to be expressed graphically in a way that another can understand it.

Specification: UML allows you to specify the characteristics of a system before its construction.

Build: The designed systems can be built using the specified models.

Documentation: The graphical elements themselves serve as documentation of the developed system that can be used for future review.

UML models comprise of three significant blocks, which include the following:

Elements: Elements are abstractions of real or fictitious things (objects, actions, etc.)

Relationships: They relate the elements to each other.

Diagrams: They are collections of elements with their relationships.

The central technique in the UML is Object Modeling, which is a language that allows the specification of classes, their data or attributes (private) and methods (public), inheritance and other relationships between classes.

Stages and Activities involved in UML-based Development Approaches

In the definitive version of the methodology published by Booch, Rumbaugh and Jacobson, the following stages can be taken into account:

- Requirements analysis.

- System design.

- Detailed design.

- Implementation and tests.

Each stage consists of activities that give it body and the documents that are expected at the end of each one of them. In UML, three types of fundamental classes are proposed for the development of the Application Analysis Model, with which we can express all the functions of any software, with their respective responsibilities.

Class Interface <<Interface>>

- Reception of requests from the system.

- Show system responses.

Entity <<Entity>> class

- Manage data (information) necessary for the system.

- Store persistent system data (information).

- Provides the main functionality of the application.

Controller Class <<Controller>>

Process system information.

Manage system response display.

Gets the data from the model.

Open-source Technology

The Open-source tool or free software this means that it is free to be distributed, Ruby on Rails is an open source framework for web applications in AJAX, the characteristics of Open source software we have:

- The source code must be freely obtained with its exceptions depending on the author.
- Access must not discriminate against any group or person.
- The license cannot restrict the types of software such as the different platforms.
- The license cannot enforce the use of dependency on other software forcing it to use open source throughout.
- You are not allowed to access licenses through a dialog box, forcing you to authorize it with the click of the mouse.
- When we talk about Open Source redistribution it indicates that the software can be freely given away or sold.

Ruby on Rails Framework

Ruby originated in Japan in the early nineties, its creator Yukihiro Matsumoto combined the characteristic elegance of SmallTalk, the ease of use of Phyton and the pragmatism of Perl. As a result, he obtained a very efficient and powerful language with a very clean syntax. (Munetoh & Yoshioka, 2013) . In recent years, Ruby and Rails have gained a lot of strength, and there are already a good number of resources on the web, in addition to the fact that large companies such as Sun Microsystems, are betting heavily on this language that is already considered part of the web2.0.

Definition of Ruby

Ruby is a programming language focused on simplicity and productivity, with an elegant and natural syntax, which makes it very easy to understand. It is a scripting language (not compiled) , fully object-oriented. While other languages have primitive types (such as numbers, Booleans, etc.) that are not objects, here everything is an object and therefore properties and methods can be associated with it, as well as redefining or extending its behavior.

Definition of Rails

Rails is a framework created for the development of web applications. That is, a series of utilities and tools to create web applications faster than doing it from scratch.

Using a framework we avoid reinventing the wheel, we save a lot of work and we can concentrate on what really matters: the logic of the application, it is not writing the same forms and process scripts over and over again to create, read, modify and delete data in our database. Other web development frameworks include Cake for PHP, Django for Python, and Java's Spring.

Rails is a framework that uses the Ruby language, and that is why the set is known as Ruby on Rails. But there are also other Ruby frameworks that are not Rails, such as the Camping micro framework. Rails was developed by David Heinemeier from Denmark, as a tool to make your work easier when programming the Basecamp web application for Signals. In July 2004 he released the code as free software, and in February 2005 he began accepting collaborations to improve Rails, forming a large team of programmers, the core team (Munetoh & Yoshioka, 2013). Among the features of Ruby on Rails we can highlight that it is based on the MVC design pattern.

Model-View Controller (MVC) Framework

MVC is a development framework used for developing user interfaces to show the relationship between the interconnected components by dividing the program logic (Jailia, Kumar, Agarwal, & Sinha, 2016) The logic of the presentation is separated, which allows us to stop always thinking about SQL to start thinking about objects, which has utilities to quickly generate administration interfaces, it is independent of the database, we can perform continuous tests to guarantee that Our application works as we expect, it can be extended by using plugins, it integrates very easily with effect libraries such as script.aculo.us ... and all this by writing very few lines of code, very clear and easy to understand.

Conclusion

Multinational organizations with a robust reputation such as PANASONIC handles a large quantity and variety of articles that it has positioned over many years in terms of quality, but it has also distinguished itself by its policy of innovation and the search to form a proactive work team. Another interesting aspect is the high competitiveness where this company operates, hence it is of great importance that it is constantly seeking to improve its processes and strive to maintain its long-term customers. Throughout the study it is possible to verify that the company PANASONIC in its warehouse located in Los Indios Texas has maintained an inventory policy that, given current technological advances, can already be considered somewhat "outdated" and that does not allow it to position itself in the range of other companies in the area that have taken advantage of new communication technologies to reach a greater number of clients and offer them cloud-based services.

This research has established that this represents a need on the part of the workers in the inventory area, while the clients feel interest in generating changes in this section, so a capable mobile application is designed and proposed to make inquiries to products and inventory management of the Warehouse of the company PANASONIC located in Los Indios, Texas. The implementation of AI-based applications can improve the internal communication processes to manage the information on reservation of the products in the warehouse area from a mobile device and this can be a great advance because it would also improve communication with customers, becoming a possible successful marketing strategy. The implementation of automated systems enhances service availability, reducing direct telephone consultations, and indicates the possibility of adding an interactive chat section, in this way it will be possible to fulfill a large part of PANASONIC's business vision, which strives to achieve customer satisfaction.

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