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## An Inventory System for Ilocos Sur Polytechnic State College



**Abstract:** - This research presents an inventory management system designed for the Ilocos Sur Polytechnic State College (ISPSC) to enhance the efficiency of its property and supply operations. The system integrates technological advancements, including web-based frameworks and web 3.0 technologies such as blockchain, to streamline inventory processes. Utilizing an Agile framework and Design Thinking methodology, the research identifies user requirements, designs, iterates, and tests the system for usability. Through interviews, user narratives, and SUS evaluations involving 137 participants from ISPSC Main Campus, the system demonstrated excellent usability, with an overall SUS score of 82.9. The results underscore the system's effectiveness in addressing inventory management needs, providing a valuable resource for academic institutions aiming to optimize their inventory processes and enhance operational efficiency.

**Keywords:** Inventory Management, Agile Framework, Design Thinking, Web 3.0 Technologies, Usability Evaluation.

### I. INTRODUCTION

The inventory management system encompasses a combination of technological advancements, including hardware and software components, as well as processes and methodologies that facilitate the monitoring and maintenance of stocked items. These items may consist of organizational assets, raw materials and supplies, or finished products ready for distribution to retailers or end consumers. An inventory management system encompasses a framework for identifying each inventory item and its relevant information, such as barcode labels or asset tags. It also includes hardware devices for scanning barcode labels, such as handheld barcode scanners or smartphones equipped with barcode scanning applications. The board programming encompasses various functionalities, including the centralization of stock information, data analysis capabilities, report generation, future demand forecasting, and more. Additionally, it encompasses processes and strategies related to branding, documentation, and reporting. It is recommended to implement a stock management strategy such as Just in Time, ABC Analysis, First-In First-Out (FIFO), Stock Review, or another established methodology. Individuals who are trained to adhere to these strategies and processes should be involved.

The concept of materials management refers to the strategic planning and control of the acquisition, storage, and utilization of materials within an organization. <sup>[1]</sup>Khobragade, Punam, et al. (2018) is related to organizing, getting, taking care of and giving the reasonable material of right quality, perfect sum at right spot in fortunate time to coordinate and schedule the creation development in an integrative course for a mechanical undertaking. Stock Management is fundamentally the technique by which an affiliation is given the items and undertakings that it needs to achieve its objectives of buying, amassing and improvement of materials. Stock organization systems are critical to how associations track and control inventories. The ability to accurately and precisely quantify inventory is essential for maintaining consistent business operations, as inventory often represents one of the largest current assets on a company's financial statement. Stock refers to a comprehensive compilation of items and materials, or the actual products and materials themselves, that are maintained and available for sale by a business entity.

An optimal inventory management system provides information regarding product availability, current stock levels, anticipated arrival dates, and sales records. By utilizing this framework, one can effectively strategize purchases and promptly identify items that require reordering, as well as items that should be documented or promoted with special attention due to their slow sales. <sup>[2]</sup>Mendhe, Utkarsha, et al. (2017) Some retailers track stock utilizing a manual label framework, which can be refreshed day by day, week after week, or even month to month. In a manual label framework, you eliminate sticker prices from the item at the place to checkout. You at that point cross-check the labels against the actual stock to sort out what you have sold. A key stock organization measure is restoration.

A good inventory management system will make the user be informed what product is available, what is on hand, when it will show up and what you've sold. With such a framework, you can design buys wisely and rapidly perceive the quick things you need to reorder and the sluggish things you should write down or extraordinarily advance. <sup>[2]</sup>Mendhe, Utkarsha, et al. (2017). A few retailers track stock utilizing manual methods or manual

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systems, which can be refreshed day by day, week by week, or even month to month. In a manual system, you eliminate sticker prices from the item at the place to checkout. You at that point cross-check the labels against the actual stock to sort out what you have sold.

The objective of good inventory management is to "meet or surpass clients' assumptions for item accessibility with the measure of everything that will augment an association's net benefits or limit complete inventory venture".<sup>[3]</sup>Rawat, Kalpana (2015) This goal is very difficult if not impossible to reach without a comprehensive inventory management system. In the retail industry, the ability to maintain constant access to information can determine whether the company would survive the competition or not. An Inventory Management System is needed to provide accurate information to all levels of the organization, from top management located at the corporate headquarters to the individual store managers. For example, corporate management may need to monitor same-store sales, where as store managers may need real-time access to inventory and ordering information<sup>[4]</sup>(Intellisync).

In today's business environment, even the smaller businesses have come to rely not just with hardware technologies but also in software systems. Automating every processes is a scheme that is embraced in every modern organization of today. It demands employees that could perform his duties in fast, accurate and effective way with less amount of resources wasted. Business experts often say that managing and controlling inventories is an important component in conducting business and can be a basis for the company's top placement over their competitors.

Inventory management exists only to serve the customer with a company's inventory. The inventory can include finished goods or materials. If a company wishes to service a customer, they must put the customer's viewpoint first and consider factors such as availability in the correct quantity at the right time, place, and cost. The author further states that good inventory planning covers fluctuations in demand, forecast errors, and supply errors, since customer demand is always changing and can never be predicted to a high level of accuracy. The primary goal of a company is to minimize costs on inventory while still meeting the functional requirements. Here, improved forecasting and process reliability allows for reductions in inventory, but keeps the same level of manufacturing efficiency and customer service.

The process of inventory management is continuous, meaning that standards have to be maintained constantly. A basic understanding of the processes within inventory management is the minimum requirement for all involved personnel<sup>[5]</sup>J. W. Toomey (2020). Companies must carefully consider inventory management, as any errors can result in significant financial losses. Effective inventory management is associated with increased profitability and decreased susceptibility to competitive pressures and the challenges posed by globalization. Hence, the evaluation of strategy and the attainment of optimal decision-making play a crucial role in optimizing the overall flow of materials within the company, encompassing suppliers, manufacturers, and end users. According to the authors, it is imperative for managers to make sound decisions across various levels, including operational, strategic, and tactical. In order to sustain competitiveness within the industry, it is imperative for a company to uphold resilient supply chains, ensuring their ability to promptly adapt to fluctuations and modifications. The authors subsequently delve into a comprehensive analysis of two distinct methodologies aimed at resolving inventory-related challenges: the analytic approach and the simulation approach. The simulation approach entails the systematic evaluation of various scenarios by managers prior to selecting the optimal course of action based on the outcomes. The analytic approach is characterized by its simplicity, making it the preferred method for decision makers.<sup>[6]</sup>N. El Alami (2017).

In the past, the Ilocos Sur Polytechnic State College (ISPSC) campuses did not utilize software technology for the integration and implementation of inventory management systems for supplies and assets. Regarding the examination of the present state of ISPSC's property and supply office, the sole method employed for conducting an inventory of its stocks entails the conventional process of physically inspecting and documenting them. Therefore, the data is recorded using a spreadsheet application and stored on the hard disk drive of a standalone computer, while monitoring and verification are conducted using a printed checklist form.

The current mechanism in place poses obstacles to productivity, lacks the ability to provide real-time insights, places less importance on strategic endeavors, and results in administrative backlogs that may disrupt the operations of the property and supply office at ISPSC. Consequently, it is imperative to develop a cost-effective software solution to address the aforementioned issues currently faced by ISPSC.

## II. LITERATURE

Inventory management plays a crucial role in the decision-making process pertaining to the handling of inventory within an organization. This encompasses various activities, policies, and procedures aimed at ensuring an adequate quantity of each item is consistently maintained within the warehouse. Inventory management is a fundamental component of the supply chain framework, serving as the essential element that facilitates its smooth operation.<sup>[7]</sup> (Wild, 2017). Inventory is an essential factor in SME production costs to boost competitive advantage<sup>[8]</sup> (Hasbullah et al.,2021).<sup>[9]</sup>Singh and Verma (2018) highlighted the scope of inventory management that covers many topics, such as replenishment scheduling, managing costs of storage and inventory, asset

management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space, quality management, replenishment, returns and defective goods, and demand forecasting.

Inventory is essential in manufacturing production costs <sup>[10]</sup>(Hasbullah and Santoso, 2020). The existence of inventory will cause certain risks that the company must bear due to the stock <sup>[11]</sup> (Rossit et al., 2019). The fluctuations and risks of mismatch predictions with actual demand impact on changes in production planning made so far <sup>[12]</sup>(Shao et al., 2021). Safety stock determines how much inventory is needed during the Grace period in meeting the amount of demand <sup>[13]</sup> (Godichaud and Amodeo, 2019). Inventory management can play a positive role in small firms' growth. This has brought important messages that the input markets and the business environment in Vietnam have not yet stimulated well-economic activities, so they exploit and create additional financial resources such as borrowing to consolidate their endogenous resources <sup>[14]</sup> (Park et al., 2020).

The suppliers also have scarce resource sources in the import of raw materials. In this way, synchronizing demand and supply is becoming a pressure point for small businesses <sup>[15]</sup> (Muchaendepi et al., 2019). <sup>[16]</sup>Atnafu and Balda (2018) found that a higher level of inventory management technique can improve competitiveness and lead to higher organizational performance. An effective technique for inventory management should analyze the cost associated with different levels of inventory. An SME should optimize its inventory with the cost for effective stock management to expedite a dependable forecast of sales <sup>[17]</sup> (Atrill, 2006).

Many factors may affect inventory management effectively. These factors include the seasonality of demand and supply dynamics, related batch sizes, and the necessity of keeping buffer stock for meeting supply uncertainty <sup>[18]</sup>(Cachon and Olivares, 2010). Three trends were identified for understanding the logistics solution, one of these trends was proper integration of logistics activities can reduce the material flow cost and also the cost of inventory maintenance <sup>[19]</sup>(Hakansson and Persson, 2004). In another study, it was found that supply chain management comprises three important components, which are effective management of customers, utilization of organizational resources and efficient use of inventory <sup>[20]</sup>(Singh and Kumar, 2020).

The inventory investment for a small business takes up a big percentage of the total budget, yet inventory control is one of the most neglected management areas in small firms. Many small firms have an excessive amount of cash tied up to the accumulation of inventory sitting for a long period because of slack inventory management or the inability to control the inventory efficiently. <sup>[21]</sup>Rajeev (2008) found major problems in the inventory management practices of small businesses based on machine tool production. The problems include using the rule of thumb for IM, lack of forecasting, frequent ordering of materials, inadequate training and development, low use of information technology and also negligence in managing the purchase and variable lead time. The study confirmed the need for managers in the machine tool sector to alter their approach to inventory management drastically.

<sup>[22]</sup>Karim et al. (2018) revealed that a company practices risky inventory management in keeping stock, as it relies heavily on third-party warehousing services beyond the company's control. This study also revealed that the standard operating procedures are too general and lack specificity. However, poor inventory management has a modest influence on the company's financial performance. Poor inventory management translates directly into strains on a company's cash flow <sup>[23]</sup>(Bai and Zhong, 2008). To manage inventory at an optimum level, the main challenge is the difficulty faced to forecast demand and targeting customers' expectations of product availability in the market <sup>[24]</sup>(Coyle et al., 2003). The challenge in managing inventory is to balance the supply of inventory with demand. A company would ideally want to have enough inventories to satisfy the demands of its customers-no lost sales due to inventory stock-outs.

On the other hand, the company does not want too much inventory to stay on hand because of the cost of carrying inventory <sup>[24]</sup>(Coyle et al., 2003). An increase in inventory efficient use gives a jump-start to small business economic efficiency growth. Application of the system approach to inventory management allows monitoring of the whole material flow process and minimizes randomness of this process. For managing optimum inventory level, material flow needs to be streamlined and understood as a system for a consolidated integration among material, financing and information flow <sup>[25]</sup>(Viktorovna and Ivanovich, 2016 a, b). Managing shelf space is important for controlling inventory and stock management. It has a strong impact on stock-outs and the allocation of shelf space should be decided based on case pack quantity and also consider the demand of customers in the market <sup>[26]</sup>(Eroglu et al., 2011). Deloof (2003) established that shortening the inventory conversion period is a precursor to increasing stock out costs and will eventually result in loss of sale opportunities hence poor performance.

<sup>[27]</sup>Juan and Martinez (2002), in their study of 8,872 small and medium-sized Spanish firms, also demonstrated that managers of firms could create value by reducing the number of days of inventory. Effective inventory management processes help to increase the operational efficiency of firms, improve customer service, reduce inventory and distribution costs, and enable businesses to track items and their expiration dates, consequently balancing among availability and demand <sup>[28]</sup>(Pandey, 2004).

<sup>[29]</sup>Hong Shen, Qiang. Deng, Rebbaca Lao, Simon Wu (2016) The primary objective of an inventory management practices in order to optimize the efficiency and effectiveness of the company's supply chain. The reduction in

inventory is regarded as one of the most crucial elements of inventory management. In practical application, it is not universally advantageous to maintain a small inventory level. Consequently, manufacturers must ensure that their inventory is maintained at an appropriate level to optimize operational efficiency. As mentioned by <sup>[30]</sup>Sunitha, K. V. (2012) in her thesis, Effective inventory management plays a crucial role in cost reduction and compliance with regulations. Achieving equilibrium between demand and supply, as well as effectively managing inventory, presents a challenging task in maintaining the delicate balance.

The utilization of proficient inventory management techniques and high-quality software can significantly contribute to the successful implementation of inventory management strategies. The return on investment (ROI) of inventory management has demonstrated enhanced revenue and profits, a favorable work environment for employees, and an upsurge in customer satisfaction. <sup>[31]</sup>Plinere, D. & Borisov, A. (2015), concluded that, Inventory management is an essential aspect for every company that possesses inventories. Organizations possess stocks, albeit in quantities that are carefully managed to avoid both excessive inventory and insufficient supply situations. Effective inventory management can enhance a company's existing inventory control system and lead to cost reduction. <sup>[32]</sup>Jose, T., Jayakumar, A., & Sijo, M. T. (2013) found the difference between EOQ & number of pieces purchased. It is observed that the company is not using EOQ for buying the materials. Therefore, inventory management is not reasonable. From estimate of safety stock, company can decide how much inventory the company can keep in back stock per annum.

<sup>[33]</sup>Mohamad, S. J. et al. (2016) concluded that efficiency of inventory management is a major concern area of business. Suggestions are given to improve the performance of inventory management, demand forecasting, scattered inventory & cycle counting. <sup>[16]</sup>Atnafu, D. & Balda, A. (2018) focuses on inventory management & explains the relationship between inventory management practices, competitive advantage & organizational performance. The finding of the study on basis of data analysis is that there is a positive relationship between competitive advantages and inventory management performance. And better organizational performance gives a firm bigger capital to apply various inventory management techniques.

Inventory management is critical to many firms' success and sustainability. Therefore, it requires management priority and scrutiny. <sup>[34]</sup>Golas (2020) states that, "based on panel regression models, one study demonstrated that an improvement in inventory management efficiency is positively correlated with financial performance, measured as the return on operating assets." (ROA). Additionally, statistical evidence conveys the significance of inventory impact on the global and domestic economy and as a macroeconomic indicator. "Historically, a declining growth rate in the inventories-to-sales ratio has coincided with increased economic output." <sup>[35]</sup>(Kalivas, 2018). Moreover, inventory is a critical component in many categories of firms, industries, and supply chain investments. "Companies can reap a 25% increase in productivity, a 20% gain in space usage, and a 30% improvement in stock use efficiency if they use integrated order processing for their inventory system." <sup>[36]</sup>(EasyPost, 2019). Before exploring specific inventory management practices and their impact on profitability, it is essential to review the relevant research on fundamental inventory practices. The review of these practices will help provide a framework for our discussion.

The generation of purchase orders and the recording of inventory utilization are inventory control functions that are currently handled by store managers under the existing system. Currently, ISPSC's property and supply department gives the administration office weekly or monthly reports on inventory usage and ordering. As a result, the administration office is unable to get daily updates on the inventory levels in the stores. Inventory management is a part of the supply chain in big companies where inventory and quantities of stock are tracked in and out of the stockroom. Proper handling of inventory will lead to successful supply chain management in any organization. Web 3.0 like Blockchain Ether or Metamask facilitates manufacturers to connect each party from distribution centers and retail partners, to suppliers and production sites with an abiding record of each, single exchange that occurred. These put away records are available to everybody inside the P2P organize and gives decentralization. The degree of straightforwardness and permanency gave in blockchain are frequently useful for manufacturers to oversee item roots and traceability. Smart contracts, one of the features of blockchain, have built-in automation, which makes a lot of sense for transaction management.

The goal of this study is to evaluate how well the current property and inventory management system supports ISPSC's transactions, after thorough evaluation, a proposed inventory management system integrated with web 3.0 technology was designed and developed for the delivery of high-quality supplies and goods for the Ilocos Sur Polytechnic State College.

### III. METHODOLOGY

This section introduces the principles of Agile framework and Design thinking process. Agile framework promises faster delivery, changing customer requirements, and gaining customer satisfaction.

## Agile framework

The agile framework provides iterative and incremental process for developing software. When compared to planned software development, Agile framework has a smaller number of software failures because it includes changing customer requirements <sup>[37]</sup>M. Sameem (2019).

Agile framework is a people process, although it includes changing customer requirements, many software developed are still unused Customer do not use them because it does not target at solving the problem completely. This results in software use failures.

The researcher utilized the Agile Driven framework as presented in figure 1, setting proper collaboration open with the client of this research paper which is the personnel of the property and supply unit of ISPSC will be a good one for the agile driven framework of this study.

Requirements gathering and Analysis. The researcher will contact the client once a week to discuss their business process further, as well as identify the various roles and responsibilities within the needed process.

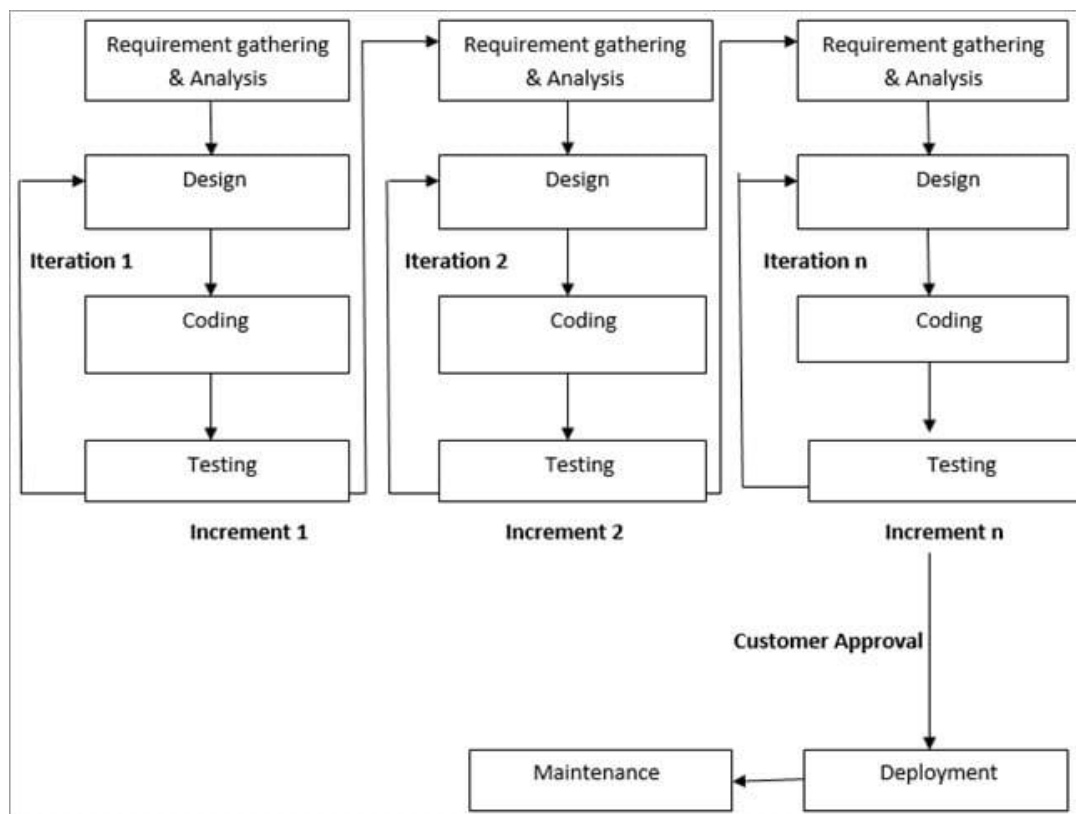
Design. This design stage, known as the inception phase, consists of two parts:

- a) UI/UX design, where designers create a mock-up of the user interface and experience, thoroughly analyzing their competitors' strengths and weaknesses.
- b) Product architecture, where the dedicated team discusses the most suitable tools to meet business requirements, including frameworks, containers, programming languages, etc.

Coding/Iteration. In agile iterations are termed as sprints. Each sprint lasts for 2-4 weeks or a sprint lasts for 30 days, and during the end of each sprint, the researcher will present the system design to the client. Then, the client will provide feedback needed for the system.

Testing. Customer feedback is taken for improvement and his suggestions and enhancement are worked on in the next sprint. Testing is done in each sprint to minimize the risk of any failures. Based on the feedback provided by the client, in which it shall be taken into account and implement within the next sprint.

Figure 1. Agile Development Framework



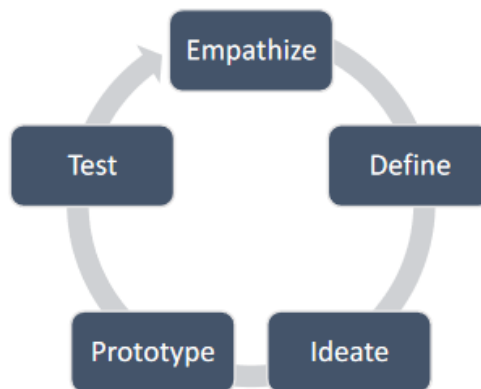
## Design Thinking Process

Developing wasteful application results in wastage of a lot of resources including time, money, and workforce. To avoid such wastage, steps should be taken early in the development process.

Design thinking framework as presented in figure 2. This process helps in creating great customer satisfaction. Design thinking framework has several benefits associated to it including customer, better decision making, and innovation. It is a way to gain empathy with the customer to find their needs <sup>[38]</sup>R. Razzouk and V. Shute (2015). Thus, a meaningful product can be build using design thinking.

There are several stages in design thinking which includes – Empathize, Design, Ideate, Prototype and Test. By conducting these steps, customer requirements and motivation to use the new solution can be identified. Design thinking helps the team to stay motivated and innovative <sup>[39]</sup> (www.interaction-design.org). It helps to reduce wasteful software which in turn helps to reduce wastage of resources. It brings the members of the organization together to tackle ill-defined and unknown problems.

Figure 2. Design Thinking Process



**Empathize** – this is the first stage of design thinking framework. The researcher will consider various methods are used to understand the customer’s requirements.

**Define** – In this stage, customer needs and problems are well defined in a formal manner. The information will be analyzed and synthesized in this stage by the researcher.

**Ideate** – this is a fun stage where the team must think out of the box to find solutions of the problems defined in the previous stage. The researcher will consider to create as many ideas as possible to formulate a solution.

**Prototype** – In this stage a minimum viable product (MVP) is created to test whether the customer is motivated to use this proposition rather than the present alternative. The researcher will consider creation of MVP using inexpensive products.

**Test** – In this stage, the MVP prototype created will be tested by the researcher, which will be anchored to the Agile Framework.

While Agile framework is a technique to solve a problem, design thinking is a technique to find what the problem is, this is according to <sup>[40]</sup>“Design Thinking vs. Agile: Combine Problem Finding & Problem Solving,” Mendix, Oct. 25, 2017. <https://www.mendix.com/blog/design-thinking-vs-agile-combine-problem-finding-problem-solving-better-outcomes/> (accessed Feb. 08, 2023).

## Scope and Limitation of the Study

The current system depends upon the store managers for inventory control functions like purchase order creation and inventory usage recording. Currently, property and supply of ISPSC sends the inventory consumption and ordering information to the administration office on a weekly or monthly basis. As a result, the administration office doesn't get up-to-date information on inventory level in the stores on a daily basis. To improve the inventory management process, this project aims to analyze the current inventory management processes and determine the possible areas of improvement. The project would also analyze whether the current system should be migrated to a different architecture like web-based system.

The purpose of this study is to assess the current process of the property and inventory management system in facilitating the delivery of high-quality goods and supplies transactions of ISPSC.

The primary objective of this study was to design and implement a property and inventory management system for ISPSC, with the aim of replacing the conventional method of doing inventory for products and supplies. An evaluation of the system will also be carried out in order to assess its level of usability.

The participants selected for the usability assessment will consist of the personnel belonging to the property and supplies unit of ISPSC Main Campus.

The system that was designed had a limited scope, namely catering to three users. Its primary function was to capture data and facilitate the checking and inventory management of items and supplies.

### Data Gathering Techniques

The following methodologies were utilized by the researchers to collect data:

Interview/ User Stories/ Analysis. This will be catered by this technique for the first objective by using the standard techniques in requirements gathering using the user stories of the Agile Development Framework.

Online Sources for Development. The online sites of the technologies that will be used in the development of the software will be visited and reviewed with its functions and proper usage which is made available through their documentation.

Survey Instrument. The online presentation of the Software Usability Scale (SUS) instrument, plus the standard additional questions will be utilized for the testing of usability of the developed application.

### Sources of Data

The information needed for this study will be gathered using this approach, which will serve as the primary source of data for the purpose of the research.

Through the personnel from the Property and Supply Unit of ISPSC, the staff will offer details in the process flow and transaction in the property and supply unit of the institution that will be needed in the development and testing of the software web application that will be produced to cater to this first objective, which will be catered to by this source.

## IV. RESULTS AND DISCUSSIONS

This section encapsulates the findings and discussions arising from the investigation. By means of interviews, user narratives, and analysis, it was revealed that the inventory process currently operates through manual procedures. Utilizing the Agile Framework and Design Thinking methodology, the technological requisites were identified. Accordingly, the chosen technology will leverage a web technology framework complemented by the integration of cutting-edge web 3.0 technologies like blockchain. The application's usability was assessed using the Software Usability Scale (SUS), involving 137 participants selected through random simple sampling. The sample size was determined using an automated software program, Raosoft sample size calculator (available at <http://www.raosoft.com/samplesize.html>), which calculated the required sample size based on a confidence level of 95% and a margin of error of 5%. Out of an initial pool of 211 potential participants, a total sample size of 137 was determined. The Raosoft software is renowned for its robust and reliable database management system and provides an accurate sample size computation. In terms of the extent of usability of the inventory system, the researcher used the System Usability Scale (SUS), a questionnaire used to evaluate the usability a wide variety of new systems, whether software or hardware. The system usability scale consists of only 10 questions, which are answered using a Likert scale:

Strongly disagree					Strongly agree
1	2	3	4	5	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

1. I like to use this system frequently.
2. I find this system to be more complicated than it should be.
3. I think the system is simple and easy to use.

4. I need technical support to use this system.
5. I find the system functioning smoothly and is well-integrated.
6. I think there are a lot of irregularities in the system.
7. I think most people can learn this system quickly.
8. I find this system to be time-consuming.
9. I feel confident while using this system
10. I think there are a lot of things to learn before I can start using this system.”

Through the SUS evaluation, the usability of the application developed participated by 137 employees from ISPSC Main Campus generated an impressive overall SUS score of 82.9, corresponding to an "excellent" rating. This outcome underscores the application's usability, indicating that users perceive it as effective, efficient, and satisfying in addressing their needs throughout the testing phase.

#### CONCLUSION

In conclusion, the findings highlight the tangible benefits of the application in facilitating efficient inventory management processes. With a notable SUS score of 82.9, categorizing the application as "excellent," it is evident that the developed software not only demonstrated its functionality but also emerged as a valuable tool in enhancing the overall effectiveness of inventory processes. This achievement represents a significant contribution to the field, positioning the application as a reliable and impactful resource for academic institutions seeking to strengthen their inventory mechanisms.

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