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ISTANBUL AYDIN UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

ENHANCING WAREHOUSE EFFICIENCY THROUGH AN INTEGRATED STOCK MANAGEMENT SYSTEM: A COMPREHENSIVE STUDY

MASTER'S THESIS

Suh Nji ERNEST

Department Of Computer Engineering

Computer Engineering Program

SEPTEMBER, 2024

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(Y2213.011012)

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Thesis Advisor: Asst. Prof. Dr. Alper FİDAN

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THESIS EXAM REPORT

Istanbul Aydın University Institute of Graduate Studies Board of Directors …….....date and .....……. The thesis of ……..,.....whose thesis defense .....exam was held on …… .....before the jury .....members formed at the .....meeting no. ……..…..……. * and.....** decision was made.

JURY

1st Member (Thesis Advisor)	: DR. ÖĞR. ÜYESI ALPER FİDAN
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APPROVAL

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(*) Unanimity/Majority vote will be written in writing.

(**) Acceptance decision will be written in writing.

DECLARATION

I hereby declare with the respect that the study “enhancing warehouse efficiency through an integrated stock management system: a comprehensive study”, which Isubmitted as a Master thesis, is written without any assistance in violation of scientific ethics and traditions in all the processes from the project phase to the conclusion of the thesis and that the works I have benefited are from those shown in the References. (September, 2024)

Suh Nji ERNEST

FOREWORD

I am delighted to present this project, which has been divided into various modules for better understanding. These modules are arranged in a logical sequence and feature an appealing Graphic User Interface to ensure smooth progression.

The fulfillment of completing this task would be incomplete without acknowledging those who made it possible with their guidance and encouragement.

I extend my sincere gratitude to Asst. Prof. Dr. ALPER FİDAN for his invaluable support and encouragement. We have made every effort to present this project accurately on the given topic.

Lastly, I would like to thank all the guest faculty, friends, and non-teaching staff who assisted me throughout this project.

September, 2024 Suh Nji ERNEST

ENHANCING WAREHOUSE EFFICIENCY THROUGH AN INTEGRATED STOCK MANAGEMENT SYSTEM: A COMPREHENSIVE STUDY

ABSTRACT

The paper presents a thesis for an integrated stock management system that increases the effectiveness of the warehouse with AI in image detection and classification. The ineffectiveness in warehousing could increase operational costs and bring about delays within the supply chain management environment. This proposed AI system seeks to streamline inventory processes, reduce human errors, and ensure data accuracy in real-time. The research starts with an analysis of the stock management practices in place and their inadequacies. The research then reviews developments in AI for developing a system that correctly identifies and classifies stock items, more so in the areas of image detection and classification. This will be evaluated in terms of effectiveness using the inventory accuracy, processing speed, and overall efficiency metrics with empirical data drawn from the case studies conducted in different warehouses. Results indicate a huge enhancement in inventory management, with a reduced number of cases of stock misplacement and misidentification. This thesis will discuss whether the AI system is generalizable across different settings of warehouses and can be scaled up concerning large-scale operations. It has implications for how AI-driven stock management systems will affect costs associated with their implementation, workforce training, and system maintenance. It concludes that AI has huge potential to revolutionize warehouse efficiency and set new standards in inventory management. Further research and development should be done in the light of changing needs of global supply chains.

Keywords: warehouse efficiency, integrated stock management system, artificial intelligence, image detection, image classification, machine learning, inventory tracking, supply chain management, operational optimization.

ENTEGRE BİR STOK YÖNETİM SİSTEMİYLE DEPO VERİMLİLİĞİNİN ARTIRILMASI: KAPSAMLI BİR ÇALIŞMA

ÖZET

Makale, görüntü algılama ve sınıflandırmada AI ile deponun etkinliğini artıran entegre bir stok yönetim sistemi için bir tez sunmaktadır. Depolamadaki etkisizlik, operasyonel maliyetleri artırabilir ve tedarik zinciri yönetimi ortamında gecikmelere neden olabilir. Önerilen bu AI sistemi, envanter süreçlerini kolaylaştırmayı, insan hatalarını azaltmayı ve gerçek zamanlı veri doğruluğunu sağlamayı amaçlamaktadır. Araştırma, yürürlükteki stok yönetimi uygulamalarının ve bunların yetersizliklerinin analiziyle başlar. Araştırma daha sonra, özellikle görüntü algılama ve sınıflandırma alanlarında stok öğelerini doğru bir şekilde tanımlayan ve sınıflandıran bir sistem geliştirmek için AI'daki gelişmeleri inceler. Bu, farklı depolarda yürütülen vaka çalışmalarından alınan ampirik verilerle envanter doğruluğu, işleme hızı ve genel verimlilik ölçütleri kullanılarak etkinlik açısından değerlendirilecektir. Sonuçlar, stok yanlış yerleştirme ve yanlış tanımlama vakalarının sayısının azalmasıyla envanter yönetiminde büyük bir gelişme olduğunu göstermektedir. Bu tez, AI sisteminin farklı depo ortamlarında genelleştirilebilir olup olmadığını ve büyük ölçekli operasyonlar açısından ölçeklendirilebilir olup olmadığını tartışacaktır. AI destekli stok yönetim sistemlerinin uygulama, iş gücü eğitimi ve sistem bakımıyla ilişkili maliyetleri nasıl etkileyeceği konusunda çıkarımları vardır. AI'nın depo verimliliğini devrim niteliğinde değiştirme ve envanter yönetiminde yeni standartlar belirleme konusunda büyük bir potansiyele sahip olduğu sonucuna varır. Küresel tedarik zincirlerinin değişen ihtiyaçları ışığında daha fazla araştırma ve geliştirme yapılmalıdır.

Anahtar Kelimeler: depo verimliliği, entegre stok yönetim sistemi, yapay zeka, görüntü algılama, görüntü sınıflandırma, makine öğrenmesi, envanter takibi, tedarik zinciri yönetimi, operasyonel optimizasyon.

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LIST OFABBREVIATIONS

AI	**:** Artificial Intelligence
WMSs	: Warehouse Management Systems
PDF	**:** Portable Document Format
CRUD	**:** Create, Read, Update, Delete
AMP	**:** Windows, Apache, MySQL, PHP
PHP	**:** Hypertext Preprocessor
HTML	**:** HyperText Markup Language
CSS	**:** Cascading Style Sheets
RAM	**:** Random Access Memory
PNG	**:** Portable Network Graphics
JPEG	**:** Joint Photographic Experts Group
PDF	: Portable Document Format
SVG	: Scalable Vector Graphics
ISMS	**:** Integrated Stock Management System
IoT	**:** Internet of Things
AR	**:** Augmented Reality

I. INTRODUCTION

Warehouse efficiency is critical in modern supply chain management, as streamlined operations can dramatically improve cost-effectiveness, customer happiness, and overall profitability. This section examines the importance of integrated stock management systems in increasing warehouse efficiency, based on academic studies, industry reports, and practical implementations. Warehouse management is one of the most important areas of corporate operations, especially when it comes to meeting high client demands. Technological developments have increased the speed, diversity, and quality of production, exacerbating the issue. (Sila Çetinkaya, February 2000). Systematic warehouse management allows for cost savings on inventory, stock-out charges, and purchase costs by purchasing in bulk and betting on price fluctuations (Kamilah Ahmad, January 2018).

Warehouses also play an important role in the supply chain procedures of enterprises (Hanafi., April 2023). Well-managed warehouse systems allow a corporation to maintain proper inventory management, maintain inventory levels as needed, boost dependability, minimize labor costs, and ensure correct maintenance and inventory processing (Duong Hanh Tien, July 2018). Effective warehouse management positively impacts an organization's overall success. However, most organizations today must address the warehousing issue seriously. For example, commodities and shipments from the same warehouses are stored and dispatched in an unorganized manner. According to Kallina & Lynn, products are transported from the storage area to a different position and picked to fulfill pending orders. However, the difficulty is with product location in the staging area, which is caused by poor warehousing management, resulting in excessive manpower expenses.

Thus, this study will look at stock management from both a theoretical and empirical perspective. stock management is widely used in retail establishments around the world due to its numerous benefits for businesses. The retail outlet controls stocks to select and maintain the best stock rate investment for achieving the desired operational quality. Retailers have retained inventory to enhance operations and meet

customer demand. To meet client demand, firms must prevent stock-outs and minimize inventory costs. Previous study has not explored how inventory management systems impact retail warehouse storage efficiency.

As a result, this study sought to investigate the impact of stock management strategies on warehouse efficiency among retail outlets by evaluating stock re-order points, supplier management, and information technology.

A. Background

From manual inventory management to computerized ones like WMS, the journey has been tremendous for any business enterprise, especially in the retail sector. Before modern technology came into the picture, it was quite a task to maintain efficient operations because of the labor-intensive nature of various aspects associated with manual inventory management processes that were in use by grocery stores and big retailers. Traditional methods were no longer sustainable as the retail growth and increase in consumer demand became unsustainable. (Wild, 2017)

These very challenges thus marked the inception of sales and stock management systems as attempts to rationalize daily activities in the interest of better operational efficiency. Such systems digitalized the framework of managing inventory, sales, and other relevant aspects of retail operations. Order processing, stock reordering, and inventory management, among other features, removed much of the burden of manual labor and increased overall productivity. (Muller M. , 2011)

Research at the hands of professionals like (Chopra, 2016),, has clearly elaborated how sales and stock management helped the companies rationalize the utilization of resources and spending towards optimum inventory management practices. With the ability to automate routine tasks and repeatedly provide useful insight into the amount of inventory on hand along with changing sales trends, businesses have gained a better place in the market and are able to quickly respond to change.

In addition, the adoption of automated systems has overcome the problems of manual data entry, that is normally associated with inaccurate and inefficient inventory management. In this regard, (Chase, 2017), argues through research that manual entry possesses a risk of human error, duplication of efforts, and discrepancy in inventory

record. Excel spreadsheets were one of the very fundamental tools applied in data entry, which are now superseded by affluent inventory management software with powerful features such as barcode scanning, real-time data synchronization, and more.

Literature available on the topic reveals that the benefits of automated inventory management systems are a reality. According to studies by (Stephen E. Chick, 1 Dec 2008) , and (Keely L. Croxton, 2001), there is a high level of change in operational effectiveness, inventory accuracy, and customer satisfaction after the implementation of WMS. These at present are the most important tools for firms seeking to align their operations in the warehouse, reduce costs, and remain effective in the modern retail environment characterized by dynamism.

In short, this automation of inventory management has enabled the retailing industry to handle all business activities efficiently, enhance the preciseness of inventory at different stages of the supply chain, and improve customer satisfaction as well. While there are still some issues related to a WMS, its benefits certainly offset the investment made in it; therefore, it is the most essential tool for any retailer who wants to stay competitive in the intensely competitive market of today. (Kumar P. &., 2016)

B. Significance

In store management, the shift from manual methods like Excel sheets to an incorporated WMS has been a relevant factor. Inconveniences and difficulties associated with data entry and management in Excel sheets declare the need for a finer solution with reduced, or rather encoded, errors. This importance can come out via a number of factors such as excel sheet data entry has intrinsic errors. These intrinsic errors cause a domino effect, resulting in inaccuracies on sales and stock records. The cumulatively misinformed decision making, inventory discrepancies, and monetary losses increase. The possibility of reducing these errors through an integrated WMS is very high due to automated data capture and synchronizations. Higher levels of accuracy with regard to sales and stock management are attracted through this approach. (Chase, 2017). Next, we have Scalability and Efficiency in which excel sheets can only deal with data in bulk, which raises scalability concerns as the business continues to grow. With an integrated WMS, a business can process and handle a high

volume of data in real-time, outperforming any scale of operations. This scalability ensures that increasing business needs are accommodated by the system without a drop in efficiency and performance. (Stephen E. Chick, 1 Dec 2008). Also, we have interoperability and Integration where excel sheets mostly work in a silo and are incapable of intercommunicating with other systems, for instance, point-of-sale systems or inventory databases. This lack of interoperability really affects the sharing and integration of data among different departments or functions within the organization. The integrated WMS scales all these challenges by integrating with a number of systems and databases, promoting the exchange of data in real-time and collaboration; (Keely L. Croxton, 2001). Also, real-time monitoring and decision-making in the manual methods of management of data. Very often there are delays in accessing critical information, due to which timely decisions cannot be made. Through an integrated WMS, companies get real-time views of the sales and stock data through which monitoring of the level of inventory is possible, and there can be detections regarding the sales trend and making decisions supported by updated information. This real-time monitoring offers added operational agility and responsiveness. (Chopra, 2016). Finally, we have firms operating in the present competitive market attach great importance to customer service. This integrated WMS will hence be in a position to serve customers more effectively, with assurance of product availability to customers, reduction in stock-out, and resultant increase in speed for filling orders. These strides forward on customer experience are likely to improve customer satisfaction and loyalty, which in consequence will improve business growth. (Plossl, 1998).

This makes the shift from such manual methods—a simple Excel sheet—to integrated warehouse management systems quite significant in store management. This adds up to a good number of benefits, which include reduction of errors, scalability, interoperability, and real-time monitoring, improving customer experience by designing an end-to-end solution that can help overcome the limitations of manual data entry and management. One of the investments that have to be made by any business in order to remain competitive, efficient, and profitable under the current market demands is a truly integrated WMS. (Plossl, 1998).

This project will help to transform operations within the warehouse by using advanced AI technologies integrated into the management of stock management systems. The global supply chain grows progressively complex; therefore, the need for

effective, accurate, and expandable inventory management solutions has never been critical. This project takes up the challenge of demonstrating how AI-driven image detection and classification can be used to achieve better warehouse efficiency, reduce operational cost, and improve the overall performance of the supply chain. (De Vries, 2018)

The contributions of this research in the area of warehouse management and logistics are multifaceted:

1. **Accurate Stock Management:** By detecting images via AI, proposed system drastically cuts down on errors associated with manual handling of stock. This improvement leads to more accurate inventory tracking, which by itself may be worth the means of maintaining optimal stock levels. (Wuest, 2016)
2. **Increased Operational Efficiency:** Automating the process of stock identification and grouping accelerates the speed of stock management. Faster processing times mean an improved workflow. Such a gain can result in significant time and money savings for warehouse operations. (Bowersox, 2013)
3. **Scalability and Adaptability:** The AI-based system is designed to be flexible for different warehouse environments and scalable for large operations. This makes it applicable in various settings, from small warehouses to big distribution centers, without its ability or performance being affected. (Ghobakhloo, 2018)
4. **Reduction in Labor Costs and Human Error:** Automating a number of boring operations decreases reliance on manual labor, lowering labor costs and reducing the risk of human error. This shift allows warehouse employees to focus on other critical duties that demand human knowledge and decision-making. (Bughin, 2018)
5. **Real-Time Data and Analytics:** AI technologies can be integrated for real-time data collection and analyses, providing valuable insights into trends in inventory and warehouse performance and informing decision-making processes and continuous improvement initiatives. (Waller, 2013)
6. **Future Implications in Supply Chain Management:** The potential of AI to achieve this, as demonstrated in the warehouse management environment, anticipates larger future advances in supply chain technologies. It opens the

path for advanced AI, predictive analytics, and self-learning robot applications, while also increasing supply chain efficiency and resilience. (Schwab, 2017)

As a result, the project makes an enormous advance into the warehouse management area by demonstrating the actual benefits of AI integration in comparison to the current limitations of traditional stock management systems. This becomes a template for how cutting-edge technologies might assist deliver operational excellence while also laying the groundwork for future supply chain management breakthroughs.

C. Problem Statement

Effective stock management lies at the heart of warehouse operations and efficiency, but conventional methods of inventory control are prone to being inaccurate, delayed, and associated with high labor costs. These cause operational inefficiencies and higher costs. According to (Kumar R. &., 2017), the shortcomings in manual systems and semi-automated systems manifest greatly with increasing volume and complexity of inventory. (Kumar R. &., 2017).

Almost all contemporary stock management systems utilize manual data entry, hence the effect of the occurrence of human error cannot be avoided; this might cause a huge difference between the recorded and the actual quantity in stock, (Sanchez-Rodrigues, 2020). This causes inconveniences in supply chain operations: stock-outs and overstocking, delayed fulfillment of orders. (Ramaa, 2012).

Artificial intelligence and machine learning offer promising prospects for tackling these challenges that have just emerged. These AI-driven image detection and classification technologies are capable of revolutionizing inventory management by identification and categorization of stock items quickly and with a very high degree of accuracy (Zhong, 2017).Companies, though, have been quite slow to integrate AI in their relevant processes associated with warehouse operations because of apprehensions related to the complexity of implementation, cost, and special expertise required for the same (Gu J. L., 2021), even when there are several advantages associated with such integration. The research will seek to help fill the gap in research and application with respect to using an integrated stock management system augmented with AI-based image detection and classification regarding its different faces of effectiveness. The study evaluates how this system improves inventory accuracy, processing speed, and general efficiency in the warehouse. Such research as

portrayed herein provides partial empirical evidence and practical insights to seek and establish the feasibility and advantages brought by AI-driven stock management systems in further developing warehouse operations and supply chain management.

D. Purpose Of Study

It means that a simple management system, therefore, should be able to realize the main goals of a warehouse management system, which are optimization of warehouse operations and improvement in inventory management procedures. This puts into perspective functions like streamlining inventory tracking, improving order fulfillment, minimizing stockouts, and maximizing the efficiency of the warehouse in general.

The following are the main goals of the WMS, which are supported by relevant references:

1. **Optimize Inventory Management:** To optimize inventory management, real-time visibility into inventory levels, locations, and movements is a necessity for a WMS. It enables firms to follow up on inventories and avoid extra stock while enhancing the inventory turnover ratios. (Chase, 2017).
2. **Improved Order Fulfillment:** WMS also aims to improve order fulfillment by improving picking routes and simplifying order processing. Improved flow in order fulfillment can help companies reduce order cycle times and improve customer satisfaction. (Stephen E. Chick, 1 Dec 2008).
3. **Minimize Stock-outs and Overstocking:** A WMS reduces the danger of stock-outs and overstocking by including accurate demand forecasting, inventory replenishment, and stock optimization features in its inventory. In this way, it helps the business maintain ideal inventory levels, which reduces carrying costs and the risk of lost sales. (Chopra, 2016).
4. **Increase Efficiency of a Warehouse:** The WMS attempts to improve warehouse productivity by optimizing layouts, increasing storage capacity, and reducing needless movements. This increases workforce productivity, lowers operational expenses, and improves overall warehouse performance. (Keely L. Croxton, 2001).

5. **Facilitate Compliance and Reporting:** A WMS makes it easier to comply with regulatory regulations and reporting standards by providing inventory management, and reporting capabilities. It would enable firms to keep correct records and follow industry rules while meeting the demands of their clientele. (Plossl, 1998).

Main purposes of WMS The goals of using this management system are to create ideal warehouse management, smoothen a working process, and streamline inventory management operations. By attaining these goals, organizations will be able to save money, increase customer satisfaction, and improve their competitiveness.

As a result, the project makes an enormous advance into the warehouse management area by demonstrating the actual benefits of AI integration in comparison to the current limitations of traditional stock management systems. This becomes a template for how cutting-edge technologies might assist deliver operational excellence while also laying the groundwork for future supply chain management breakthroughs.

E. Motivation

Success in the highly competitive business environment today calls for a very fine balance between fulfilling operational requirements and keeping expenses as minimal as possible. One big tool that businesses depend upon to strike this balance is a warehouse management system. WMSs play a supervisory role in controlling and managing goods and materials that are involved in various business operations. (Frazelle E. , 2016)

A WMS lies at the heart of operations in that it enables a business to monitor and maintain control over its stocks with accuracy and speed. The accurate recording of the quantity of supplies and their location ensures that the right materials are available at the right time and in the right place to meet the demands of operations. This level of control is not only able to enhance operability efficiency but it can also control the possibilities of stockouts and the risks of overstocking, maintaining equilibrium inventory levels at all times and reducing the associated holding costs. (Richards G. , 2017)

Besides, a WMS goes beyond simple inventory tracking features, such as timely forecasting demand and managing the company's assets. In the place of this, a

WMS would ensure a higher degree of accuracy in the prediction of future demand through an analysis of historical data and market trends. This action ultimately guarantees that businesses balance inventory levels and procurement strategies with demand. As such, this proactive inventory management ensures not only maintained customer satisfaction through the availability of products but also enables businesses to keep excess inventory low and avoid costly stockouts. (Frazelle E. , 2016)

Besides forecasting of demand, a WMS will contribute significantly to asset management and inventory valuation. Through costing of inventory items and tracking the movement of inventory items down the supply chain, a WMS provides businesses with valuable insights and the financial implications of inventory management decisions made in regard to the value of their inventory. The information is used in the business domain to make informed decisions on pricing, procurement, and inventory optimization ensuring maximization of profitability and keeping costs to a minimum. (Silver E. A., 2016)

Besides, a WMS permits the validation of products such that in-stock counting and shipping take place only with authorized, quality-checked items. With validation and quality control processes instilled into business procedures, the possible risk for returns and customer dissatisfaction, which might bring damage to the business' reputation, could be eliminated.

Overall, the Warehouse Management Systems help businesses achieve an equilibrium between operational demands and objectives of cost reduction. With a WMS capable of providing business applications with predictable inventory tracking, demand forecasting, asset management, and validation of products, businesses can now design their inventory management processes to maintain better operation performance while still satisfying customers' needs. As business enterprises face more and more challenges in the present marketplace, investment in a powerful WMS uniquely becomes the key to remain viable, profitable, and sustainable. (Coyle, 2016).

F. Proposed Approach and Study

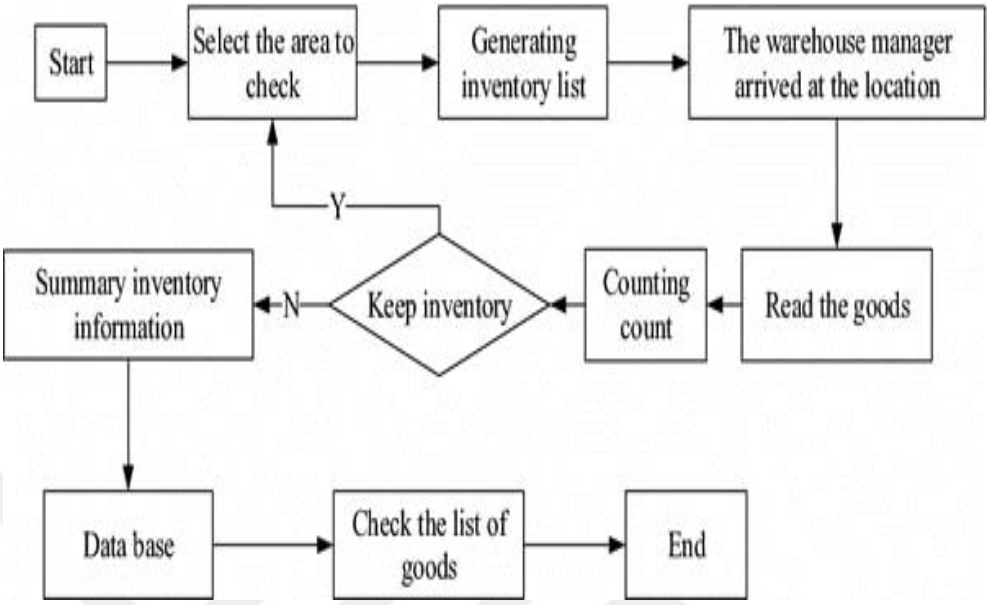

Figure 1: Flow Chart for inventory business (Jing chen)

The above flowchart for inventory business begins with Stock Arrival at the very top. Upon delivery, warehouse staff inspect and verify items against delivery documentation. On verification, the stock entered into the integrated stock management system updates the inventory database in real-time.

Subsequently, items are detected and classified using either AI-driven video detection and classification or updated manually. This step will enable the reduction of errors while one is trying to log each item correctly. The system records the details of the storage of the classified stock in locations within a warehouse for future retrieval.

These are certain alerts or warnings against inventory thresholds reached or when stock is required for order fulfillment. Staff is prompted to retrieve the items required from such system-generated warnings. After looking through the system for the staff to know where to locate such items in the most efficient manner, the retrieved stock is then prepared for dispatch and status updated accordingly.

In the picking and packaging stages, the progress of the order is updated, so every item becomes traceable and ready for shipment. After shipping, the inventory levels are changed accordingly. Information flows without any glitch now to the

respective areas, improving decision-making and eliminating any chances of delays. This increases warehouse efficiency.

It changes traditional warehousing practices as to how stock management is done, replaced by new technologies of AI. This introduces agility and accuracy in a responsive operation that modern supply chains demand.

II. LITERATURE REVIEW

This chapter looks at what other authors have said and written about the issue. We will explore the perspectives of critics, software experts, and other researchers. Previous research regarding inventory control of this company will be explained in this subchapter. It is hoped that the research that has been done will later become a reference and benchmark to help to solve current problems in the research. Some of the previous researchers who have studied inventory control in the company for different objectives are believed to have reduced avoidable costs such as storage costs, maintenance costs among others. (Silver E. A., 2016)

Warehouses are one of the most important components in the supply chain architecture because they allow product storage, handling, and distribution; they therefore have strategic importance while operating at times as liaison agents between manufacturers and suppliers, and at other times as end users. Strong stock management systems, in light of this, form an important working component if warehouse efficiency and overall operating performance are to be upgraded or improved. Stock management systems are at the core of activities in a warehouse, as they involve appraisals, organization, and movement of stock within the warehouse. In this view, therefore, the integration of such systems will help the warehouse to Leverage Procedures, Manage Resources, and act Appropriately towards the Changing Market Demand. Through this literature study, the intrinsic features of an integrated stock management system have been drawn out, together with some of its underlying principles, general obstacles, potential benefits, and new trends impacting the operations of warehouses. Knowledge of the intricacies of the integrated stock management system by the stakeholders in the warehouse is therefore essence for enhancing efficiency and productivity. This review intends to hunt for effective insight on how the systems can be different and take a detailed understanding of how they function and how vital they are in the larger setting of warehouse management. We earmark a review of the different ways integrated stock management systems achieve warehouse operations optimization and strategic business objectives by surveying relevant literature. (Waller M. A., 2013). This

literature study aims to provide warehouse managers, supply chain professionals, and all stakeholders in this industry with actionable insights and knowledge of the central principles, benefits, problems, and developing trends surrounding the subject of an integrated stock management system. With increasing warehouse management changes brought on by advancing technologies and shifting market dynamics, innovation and strategy in using an integrated stock management system are critical for long-term growth and competitive advantage. (Richards G. , 2017)

The key components of an integrated stock management systems are **inventory (stock) management in which accurate** real-time monitoring of inventory levels, locations, and movement by means of barcode scanning. It will help the warehouses trace any goods individually throughout a supply chain, **order Fulfillment in which** automation of incoming and exiting items of the warehouse to eliminate errors, raise the speed of delivery of orders. Most of the modern WMS have sophisticate algorithms which optimize order picking routes to get the orders faster and allocate the work efficiently to employees working in the warehouse, **warehouse Layout Optimization where** to visualize the optimum layout of the warehouse as well as the storage combinations to maximize the space with effective material flow. (Gu J. G., 2010). The benefits of integrated stock management systems are Stock Accuracy in which High accuracy in inventory is quite important to the efficient running of the warehouse. Inbuilt real-time tracking methods within integrated stock management systems are, therefore, vital in meeting such goals. Warehouses will be able to improve overall inventory accuracy with the latest technology, including barcode scanning and computerized inventory tracking software, thus minimizing the occurrence of stockouts and overstocking on goods and hence bridging inventory discrepancies. Due to real-time tracking, they can trace the exact inventory level so that the stock levels are exactly matched with any change in demand and requirements at the operating end. Integrated stock management systems capture information pertaining to the movement and various transactions of inventory in real-time, enabling the managers of the warehouses to have regular updates on stock levels, locations, and movements within a facility. Fast identification and rectification of inconsistencies in inventory levels are key to preventing stockouts—this will avoid operational interruptions and customers losses. On the other hand, too much inventory ties up much of the warehouse space and resources, thus creating inefficiency and higher carrying costs for goods. Through

real-time tracking, warehouses can ensure that inventory levels are optimized, improving space utilization and resources usage by reducing the possibility of both stock outs and overstocking. (Richards, 2017). Higher inventory accuracy also offers greater reliability of inventory data for a number of warehouse decision-making processes. Accurate inventory data enable warehouse managers to make appropriate decisions on stock replenishment, priorities in order fulfillment, and inventory optimization techniques. This will also help in compliance with provisions of regulatory and auditing standards by ensuring that inventory data are correct and current. In other words, the integrated stock management system incorporates real-time tracking mechanisms that increase inventory accuracy to a great extent in a warehouse. These technologies reduce stockouts and overstocking, thereby enabling warehouses to reduce discrepancies in inventory levels for running the operations more effectively and saving money in the process to bring more customer satisfaction. Warehouses now could be successful in maintaining a competitive edge in the fast-changing business environment by complete integration of new age innovative technologies along with robust inventory management techniques. (Waller, 2013). Also, data accuracy and integrity are essential foundations of warehouse management, supporting effective decision-making, inventory control, and overall operational efficiency. The consistency of data across systems is crucial because it serves as the foundation for making critical business choices. In light of this, warehouse managers must take proactive steps to ensure data accuracy and integrity across their operations. (Ramanathan, 2014)

Establishing strong data governance principles is a critical step in ensuring the accuracy and integrity of warehouse data. These rules establish explicit norms and protocols for data management practices, which include data collection, storage, processing, and dissemination. By defining roles, responsibilities, and data management standards, warehouse managers may assure consistency and coherence in data handling operations throughout the business. Stringent data validation techniques are critical for ensuring data accuracy and integrity. These processes include systematic checks and validations to ensure the correctness, completeness, and consistency of warehouse information. Warehouse managers can quickly identify and correct data discrepancies or abnormalities by utilizing validation rules, data profiling techniques, and exception handling procedures. (Silver E. A., 2016). Furthermore, the

use of data quality management tools and technology can help to ensure data accuracy and integrity. These solutions allow warehouse managers to automate data validation duties, simplify data cleansing operations, and reliably enforce data quality requirements. Data cleansing tools, deduplication techniques, and master data management systems can help warehouses improve the correctness and dependability of their data assets. In addition to preventive measures, continual monitoring and auditing of warehouse data are critical components for ensuring data accuracy and integrity. Regular audits and reviews enable warehouse managers to spot any data errors or anomalies and take appropriate corrective action. Regular data audits and performance reviews allow warehouses to proactively identify areas for improvement while also ensuring compliance with data governance standards and legal requirements. Finally, the pursuit of data quality and integrity necessitates a collaborative effort and commitment from warehouse managers and employees alike. By cultivating a culture of data stewardship and responsibility, warehouses may create an atmosphere in which data accuracy and integrity are emphasized and upheld as essential principles guiding decision making and operational effectiveness. Warehouses can protect the integrity of their data assets and open up new opportunities for efficiency, innovation, and growth in the ever-changing landscape of warehouse management by implementing strong data governance policies, rigorous validation processes, and continuous monitoring mechanisms (Schwab, 2017).

The warehouses should manage to reduce costs to increase efficiency and competitive advantage. Effective and efficient management of inventory will help reduce storage, labour, and other associated costs. We have some advantages of implementing a stock management system.

Effective inventory management lowers storage expenses by maximizing space and eliminating waste. The development of effective inventory control systems enables warehouses to make maximum use of available storage space, reducing the need for new storage facilities and, ultimately, lowering overhead expenses. No surplus inventory means lower carrying costs and a lower risk of obsolescence thanks to strategies like just-in-time replenishment and demand forecasting. (Tompkins, 1998)

A huge constituent that makes up the cost of a warehouse is labor. It follows, therefore, that an increased speed in labor-intensive activities such as order picking

would help reduce labor costs. Slotting optimization algorithms arrange inventory with respect to demand and picking frequency. In this way, fast-moving items can quickly be displayed across easily accessible locations near picking stations for easy retrievability, reducing time, distance, and effort taken for order picking. This improves efficiency and hence labor costs. (Bartholdi J. J., 2016)

Proper inventory management would use the resources, such as equipment, manpower, and warehouse space, to the fullest extent. With insights and analytics by using data, warehouses can spot inefficiencies in the operations and take remedial measures accordingly. For example, analyzing order data from previous periods and inventory trends will help utilize the available resources without facing bottlenecks during peak periods, thereby improving throughput. (Choi, 2017)

Effective inventory management tends to keep costs low, thereby achieving higher profitability and sustainability in any warehouse. Slotting optimization algorithms, coupled with best inventory management practices, can help a warehouse reduce storage and labor costs by working its resources efficiently. This comprehensive cost-cutting approach opens the avenue for new opportunities toward operational efficiency, innovation, and growth in the competitive industry. Essentially, cost optimization through appropriate inventory management in a warehouse aid in storage optimization, reduces labor expenses, and guarantees that deployed resources are used to their full potential. This strategic approach will result in higher profitability for warehousing, allowing them to maintain long-term growth and competitiveness in today's rapidly changing business environment. (Bartholdi J. J., 2014)

One of the paramount elements in warehouses is improved customer service, if not the most paramount, in a very competitive sector. In this regard, there exists huge potential for improving customer satisfaction and the retention rate by focusing on faster order processing and accurate inventory information at warehouse premises. Proper utilization of Warehouse Management Systems can be an efficient means to achieve these goals. Faster processing of orders is one major factor for customer satisfaction, as it helps warehouses to deliver their orders quickly and efficiently. Through the automation of order processing and order fulfillment operations, warehouses can speed up order delivery. For example, a warehouse using WMS software can automatically route orders, expedite orders based on priority, and

efficiently deploy resources toward Customer Demand Fulfillment. This makes sure that the order is processed on time and accurately. (Simchi-Levi, 2007)

Accurate inventory information is also vital for providing excellent customer service. Customers want openness and visibility into their orders, including real-time updates on product availability, order status, and delivery times. WMS features enable warehouses to give customers with timely and accurate information about the status of their orders. For instance, customers can monitor orders in progress, view inventory availability, and even provide notifications for any update of status in regard to their orders through web portals or mobile apps connected to the WMS. This type of transparency gives confidence to the clients and really enriches their whole experience with the warehouse. Additionally, WMS helps warehouses to give practical delivery estimations to their respective clients, thereby helping in setting expectations and minimizing the occurrence of delays or uncertainties. Warehouses will, therefore, be capable of offering accurate delivery predictions based on actual information on inventory levels, order volumes, shipment schedules, duration taken in the processing of orders, transit times, and delivery routes. Customers shall schedule accordingly, and the orders shall be successfully delivered within the said time frame, hence giving satisfactory outcomes that would enhance long-term loyalty. Faster order processing and correct information about inventory levels are critical to improved customer service, key to increased customer happiness, and retention. Using WMS features, a warehouse can streamline operational activities in order fulfillment and provide the customer with a window into orders in real-time as it works on creating superior service experiences. Sketching out such customer-centric activities gives a competitive edge to the warehouses in today's market by using technology to improve service delivery. (Coyle, 2016).

III. METHODOLOGY

This section will perform an in-depth analysis of the WMS to evaluate its functionality and how it attains its objectives. This is a warehouse management system web-based application that will be written in PHP, utilizing the CodeIgniter framework, with MySQL as the database. The objective of the project is to provide an online and automated solution for the management of products or goods belonging to a company. It helps a company in storing, managing, tracking, and retrieving records of products effectively.

It uses Bootstrap Framework to provide an attractive user interface. It is also user-friendly in terms of its functionality and features to engage the end-user. The succeeding sections show the detailed list and descriptions of the different components and features of the system.

1. **WAMP Server:** WAMP server is a word that stands for Windows, Apache, MySQL and PHP. It is a software that comes with a package installing MySQL, and PHP on your operating system. In other words, it is a local server. (DuBois, 2013)
2. **JavaScript:** This is simply a programming language allowing us to do web developments. (Duckett J. , 2014)
3. **GUI:** Graphical User Interface will be the front-end interface to display information since it's easy to use even for non-techy users, it's beautiful, has shortcuts and allows multitasking. (Krug, 2014)

1. **Html:**

Hyper Text Markup Language is used to develop front-end Graphical user interface. It's the standard language for web pages. (Duckett J. , 2011)

2. **CSS:**

Cascading style sheets is a style sheet language used to show a document or content written in markup language.

3. **Bootstrap:**

Bootstrap is used for front end framework which enables global options like gradients and shadows and writes own CSS with our variables, maps, functions. (it is a CSS library) (Spurlock, 2013)

4. **Php**:

The system is built with Laravel PHP framework. The software will be developed using PHP one of the most used and trusted technology for developing custom software solutions. (Ullman, 2017)

5. **MySQL:**

MYSQL is used for database. This will ensure the software is scalable, reliable and secure. (DuBois, 2013)

6. **Https**:

It keeps conversations between web browsers and servers private and secure, protects users' privacy and shields sensitive data from hackers. This is important for transactions that involves personal or financial information.

The Warehouse Management System can be accessed by 3 user roles. The system user roles are Administrator, Supplier Staff and Customer Staff. Each of the roles has different permission or restriction from each other. Users must login using their current user credentials to use the system features and functions according to their roles.

The Administrator role has full access to the system's features and functions. Admin Users are responsible for managing the system's lists. They are the only ones who can enter data into the system. Supplier and Customer Staff Users are primarily view-only. Supplier Staff can see all the company's suppliers and incoming stock, whereas Customer Staff can see all customers and outgoing stock. The system has multiple features and functionality with CRUD (Create, Read, Update, Delete) operations. Supplier, Customer, Stock/Goods and Transaction management. Also generates Incoming Goods, Outgoing Goods and Adjustment Reports. Each of the said reports can be exported as PDF File.

A. System Snapshots of Some Feature

1. Login Page

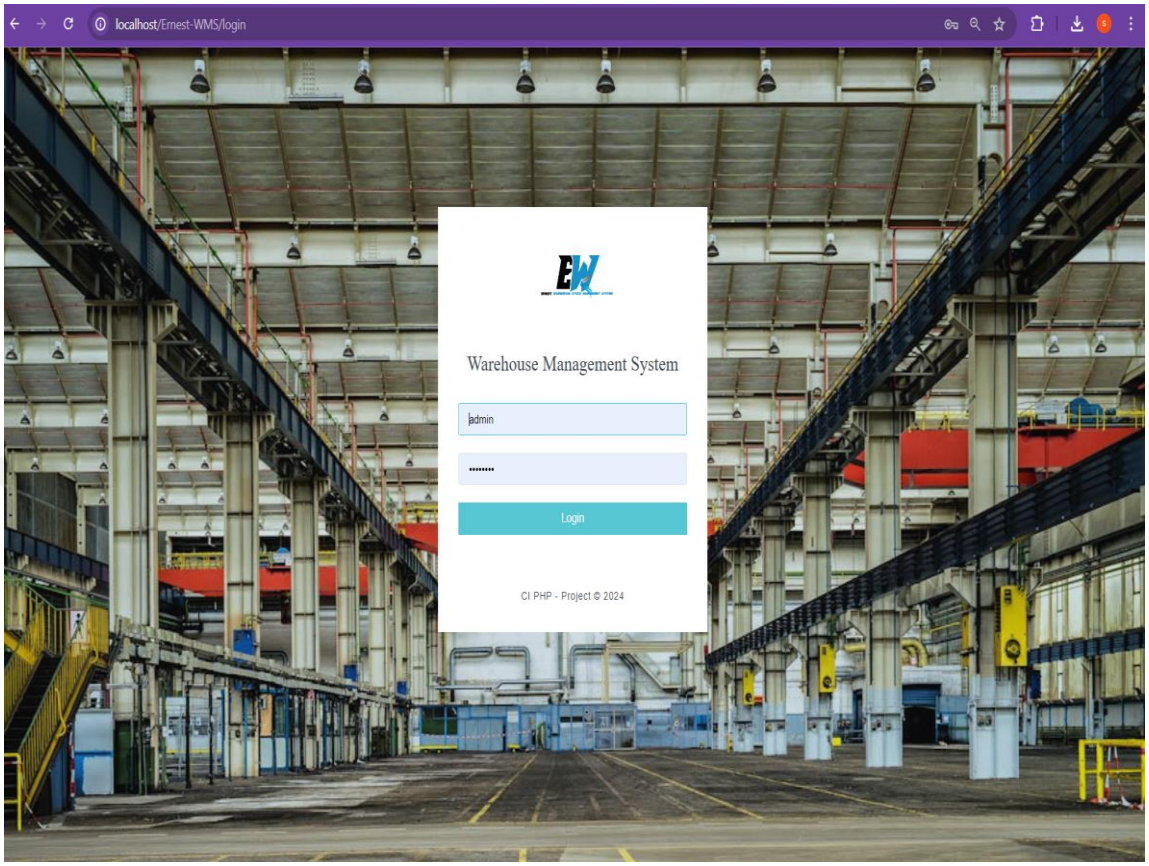

Figure 2: Login page of my Warehouse management system

The login page of the Warehouse Management System (WMS) is the entry point for users. Working algorithm is described below:

1. User Interface:

- The login page has fields for users to enter their credentials, usually a username and password.

2. Input Validation:

- When a user enters their credentials and clicks the "Login" button, the system checks if both fields are filled out.

3. Authentication:

- The entered username and password are sent securely to the server.
- The system compares the entered credentials with the data stored in the database, usually by hashing the password.

4. **Access Control:**

- If the credentials match, the user is logged in to the WMS and their role (admin, manager, staff etc.) is loaded to determine what features and permissions are available to them.
- If the login fails (wrong username/password) an error message is displayed and the user is prompted to try again.

5. **Session:**

- Once logged in a session is created for the user so they don't need to log in again during that session.

6. **Security: The system has:**

- Account lockout after multiple failed logins attempts to prevent unauthorized access.

7. **Logout:**

- Users can log out at any time which will end the session and require re-entry of credentials to access again. This will Improve protection of sensitive information when the system is not in active use by the user.

The login page of the WMS safeguards secure, controlled access to the system; only users with proper authorization should gain access to warehouse data and functionalities. By checking the validity of credentials, managing sessions, and taking security measures, the log-in process safeguards warehouse operations and information.

2. Dashboard Page

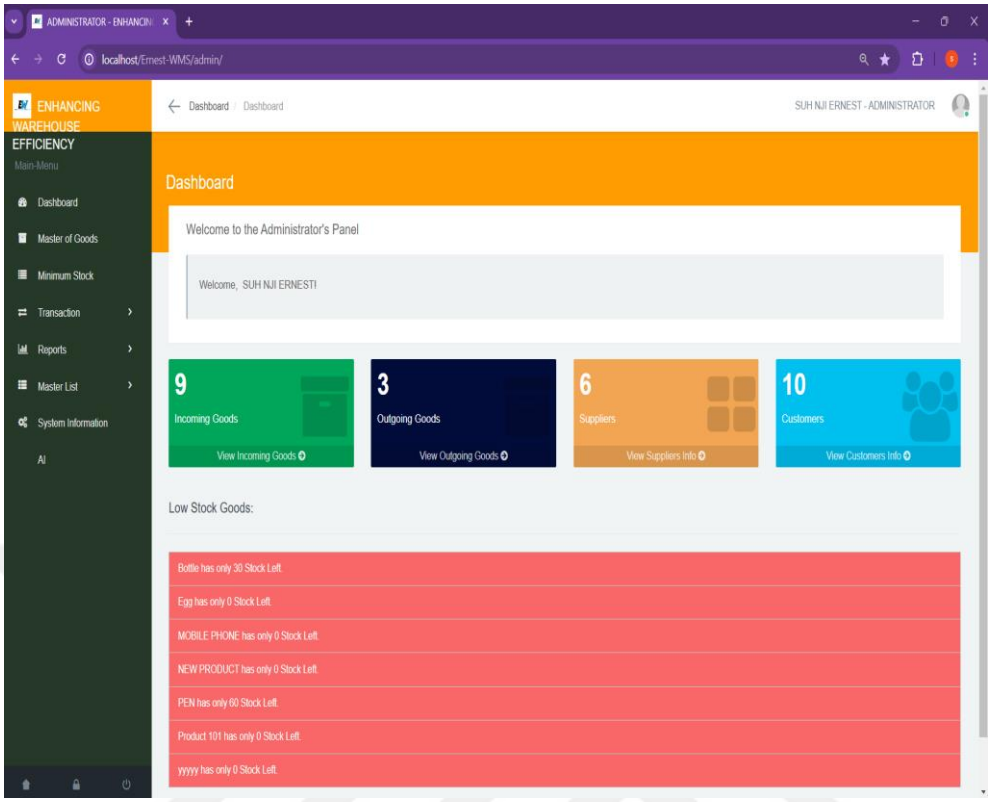

Figure 3: Dashboard page of my Warehouse management system

Our Warehouse Management System (WMS) dashboard is the central place for users to go to see all the key metrics and info. Here's how it works:

1. User Interface:

- The dashboard is laid out in sections or widgets that show different types of info, like inventory levels, recent transactions, low stock alerts and more. Visuals like tables make it easy to see the important stuff at a glance.

2. Real-Time Data Updates:

- The dashboard pulls data from the WMS database in real-time so the info is up to date. For example, stock levels update as soon as items are added or sold.

3. Key Performance Indicators (KPIs):

- The dashboard will show the key KPIs:
- Total inventory value (stock value)
- Incoming and outgoing shipments or goods
- Low stock alerts

- Order fulfillment rates

  These KPIs allow users to see how the warehouse is performing at a glance.

4. Interactive Elements:

- Users can often click on sections or metrics to drill down to more detailed reports or data. For example, clicking on a low stock item will take them to the inventory management page to reorder.

5. Notifications and Alerts:

- The dashboard shows notifications or alerts for urgent things like low stock warnings, pending orders or system updates so users are aware of things that need attention.

6. User Customization:

- Dashboards allow users to customize what info is shown based on their role or preferences. This helps users see the metrics that matter most to them.

7. Quick Links:

- The dashboard has quick buttons to frequently used features like adding new stock, managing suppliers or generating reports. This safe clicks and time.

In summary the dashboard page of our WMS is a user-friendly interface that shows the important info and insights at a glance. By showing real-time data, highlighting key metrics and interactive elements the dashboard helps with decision making and streamlines the warehouse.

3. Stock Or Goods List (Master Of Goods)

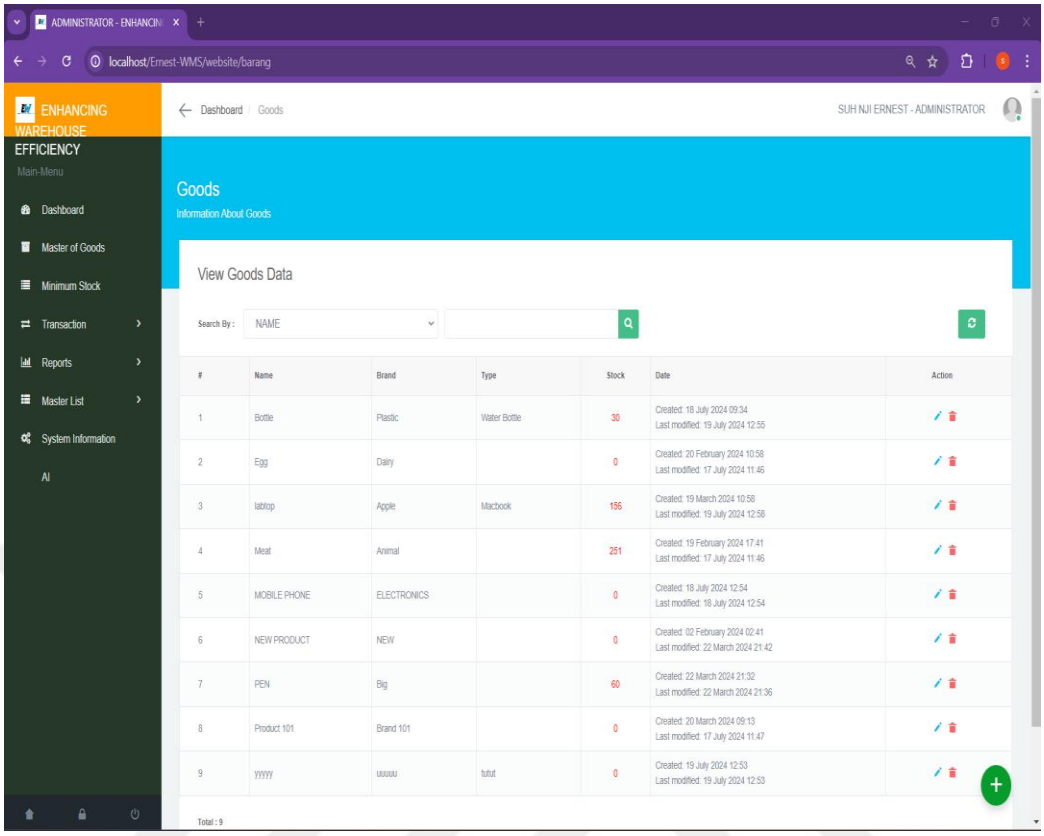

Figure 4: Stock or goods list page of my Warehouse management system

Stock or Goods List page of our Warehouse Management System (WMS) is where you can manage and view all items in stock. Here's how it works:

1. **User Interface:**
   - The page shows a list of all stock items in a table format. Each row is an item and columns are item name, brand, quantity on hand, date, stock.
   - Users can search for particular items using the search bar. Filtering options can filter by category, stock level, location or status so you can find specific goods.
2. **Add Goods:**

   You can add goods either via **image video detection** which uses the camera or manually.

3. **Sorting:**

   The list can be sorted by item name, quantity or date added.

4. **Stock Management Actions:**

Users can perform actions directly from the Stock or Goods List page:

- Add New Stock: A button to enter details for new items to be added to stock.
- Edit Stock: Select an item to edit (e.g. update quantity, change location, change price).
- Delete Stock: If an item is no longer needed, delete from the list.

5. **Low Stock Alerts:**

The page will give the number of items that are low in stock with to remind users to reorder.

In summary the Stock or Goods List page of your WMS is where you can view, manage and interact with stock items. With search, filtering, sorting and direct-action buttons users can keep stock levels up to date and inventory management processes streamlined.

4. Minimum Notification Page

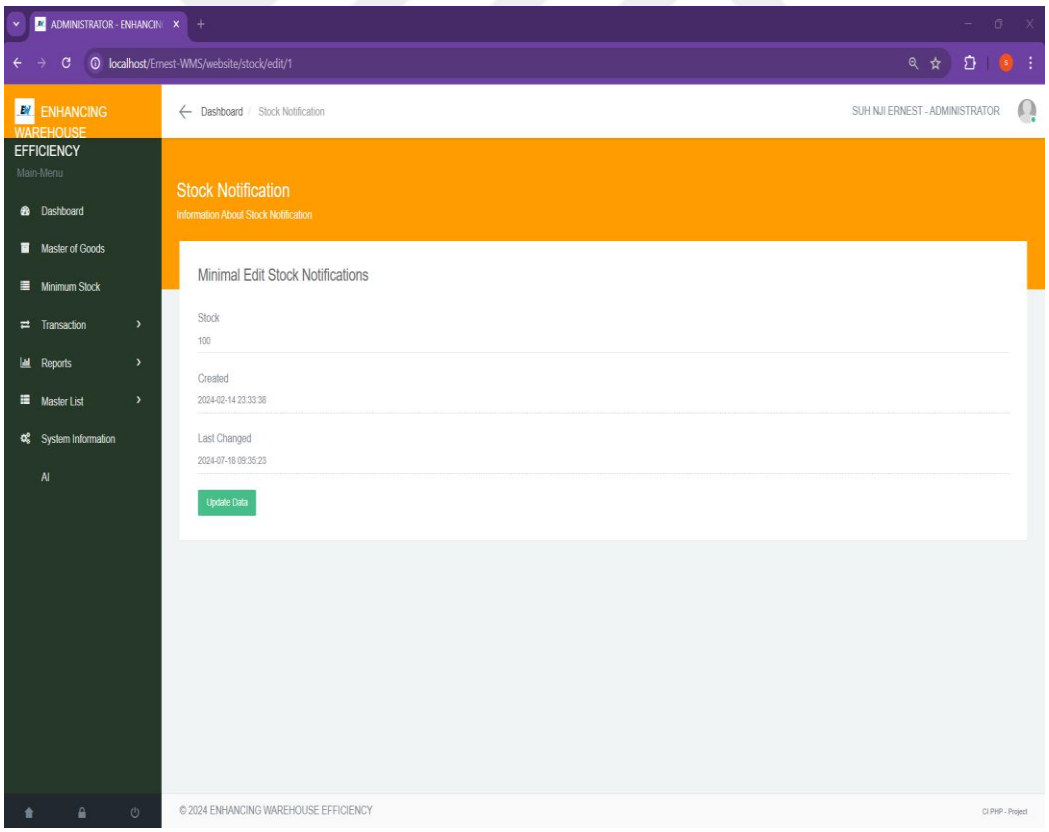

Figure 5: Stock or goods list page of my Warehouse management system

5. Purpose of this page

The purpose of the minimum notification page is to notify you when the available quantity of any particular item reaches a certain predefined level. That is, the objective is to retain an average stock level to avoid a stock-out situation that may hamper the normal operation.

6. How It Works

Set Minimum Stock Levels:

You can set a minimum quantity level for each item in your stock from this page.

Minimum stock level is the lowest quantity of the item that you want to have in stock. When this stock level reaches a breaching point, that is your indication to reorder the item so you do not run out.

Notification Mechanism:

After setting a minimum stock level, the WMS constantly monitors the stock levels.

In case the stock level reaches below the set minimum level for any item, a notification will be automatically triggered.

Such a notification may be in the form of an alert within the interface of the WMS, via email, or even a text message—depending on how your system has been configured.

Benefits:

Proactive Inventory Management: Through these timely notifications, you may work out reordering the stock before it runs out to ensure that the operation runs smoothly.

Lower Stock outs: Minimizing the risk of stock-outs helps to retain customer satisfaction and avoids possible loss in sales or delays in production.

Optimized Inventory Levels: It helps in maintaining optimal stock levels to reduce excess inventory and concerned holding costs.

Example Situation

Say you work in a warehouse, dealing with storage for all kinds of electronic components. For some type of resistor, you set a minimum quantity stock of 100 pieces. As time goes by and your warehouse is processing the orders by shipping out resistors, the stock level will decrease to 90 units. Seeing that the stock level has fallen below the minimum threshold, the WMS sends out a notification to you. You can then place a reorder for more resistors to ensure you won't run out and that you will be able to fulfill customer orders without delay.

This proactive approach to managing the inventory helps to keep your warehouse running properly and efficiently.

7. Incoming Goods Page

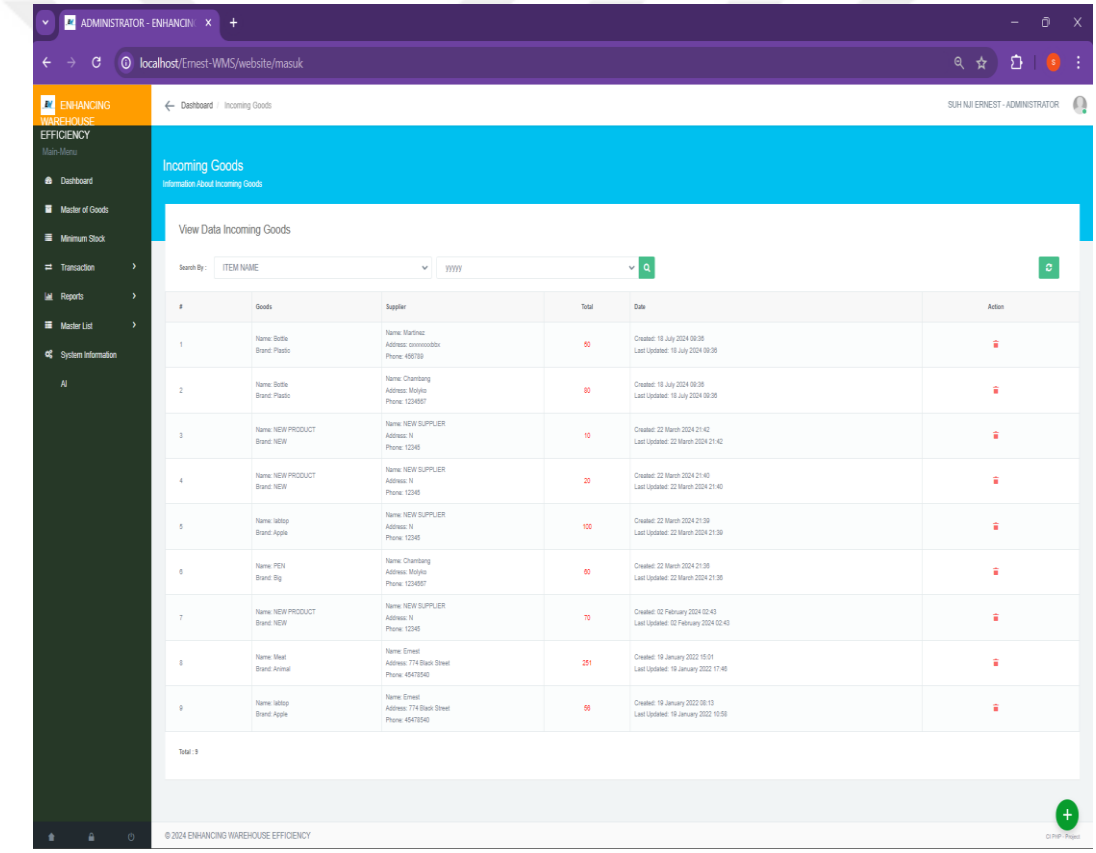

Figure 6: incoming goods page of my Warehouse management system

8. Purpose

This page will help the warehouse manager or staff record information of new stock about to be received in the warehouse. This ensures that all incoming stocks are acknowledged and introduced into the inventory system accordingly.

9. Components

Goods:

Identifies information about the items received.

Items include, but are not limited to, the item name, corresponding SKU, or Stock Keeping Unit, with a brief description of the item. Brand:

This is the field that records the brand of stock being received. It helps in distinguishing between items that may bear some similar names but different brands so as not to miscount during stock-keeping.

Supplier:

This field keeps a record of the supplier from whom the goods are obtained.

It mainly comprises the name of the supplier, address, telephone number, and, in some cases, purchase order numbers.

Total Number of Goods:

It captures the total number of each good received.

It ensures that the correct count displays within the inventory system and matches the actual physical count.

Date:

The date field is where the exact date and time are recorded when the merchandise is received.

It is very important for record accuracy in inventory but also for tracking the flow of goods into the warehouse.

10. How It Works

Receiving Merchandise:

When a shipment arrives at a warehouse, the receiving personnel will log in to the WMS and proceed to the incoming goods page. After this, they enter the received items detailing the item name, brand, supplier, quantity against each item, and date of receipt.

Verification:

Staff verify that the entered details match the physical goods received.

This check shall involve the items' quantity, brand names, and item descriptions against the supplier's delivery note or purchase order.

Updating stocks:

In case of verification, inventory records are updated regarding the new stock level.

This would ensure that the inventory database is error-free and equipped with the latest stock.

Notification:

The system can also generate notices or alerts for items received.

For example, backordered items or items that require special storage may generate a notification to concerned departments or employees.

10. Outgoing Goods Page

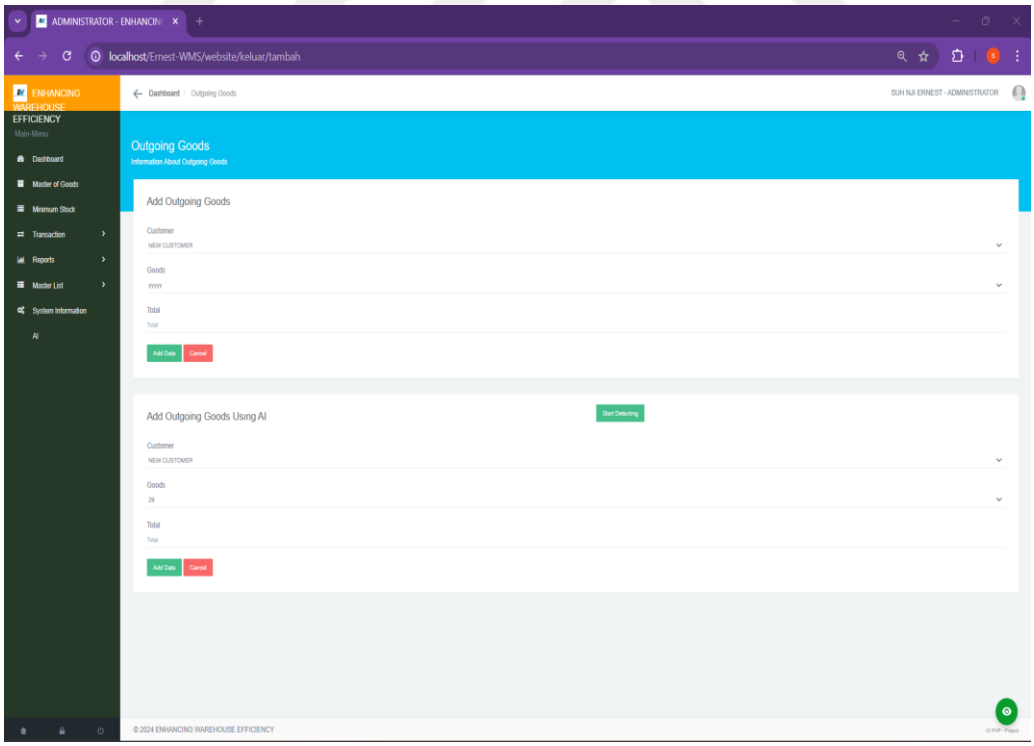

Figure 7: Adjustment list page of my Warehouse management system

11. Purpose

The outgoing goods page is used by the warehouse manager or staff to clearly record information about items dispatched from a warehouse. This ensures real-time inventory records are updated and hence show the actual stocks at hand.

12. Components

Goods:

This represents the capture of information concerning particular items being dispatched.

This includes the information about the name of the item, the SKU—Stock Keeping Unit—and a small description of the same. Brand:

This field describes the brand name of the outgoing merchandise.

It helps distinguish between items that may be of similar names but differ in their brands, thus ensuring proper accounting of the inventory.

Supplier:

Although normally associated with incoming goods, this field can still be used to track goods belonging to a particular supplier or even return them to that supplier.

It contains information about the supplier, such as their name and contact details, where applicable.

Total Number of Goods:

This field outlines the total number of each merchandise being dispatched.

This ensures that the correct quantity of items is recorded as leaving the warehouse, thus this physical count corresponds.

Date:

The date field captures the exact date and time at which the goods are dispatched.

This is important in ensuring that inventory accounts are accurate and also in keeping track of the flow of goods out of the warehouse.

13. How It Works

Manual Registration:

Staff can manually input details of each item to be dispatched, such as the name of the item, brand, supplier, if necessary, quantity, and date.

This is useful for small quantities or when barcode scanning is not available.

Automated Registration with AI via Barcode Scanning:

In aid of speeding up the process and increasing the accuracy in registration, outgoing goods can be recorded with automatic means through barcode scanners by the staff. AI-based recognition means it can identify whatever is scanned and record this information to help reduce the chance of a mistake occurring.

The information on the scans will be updated instantly in a WMS for real-time accuracy of the inventory levels.

14. Adjustment List

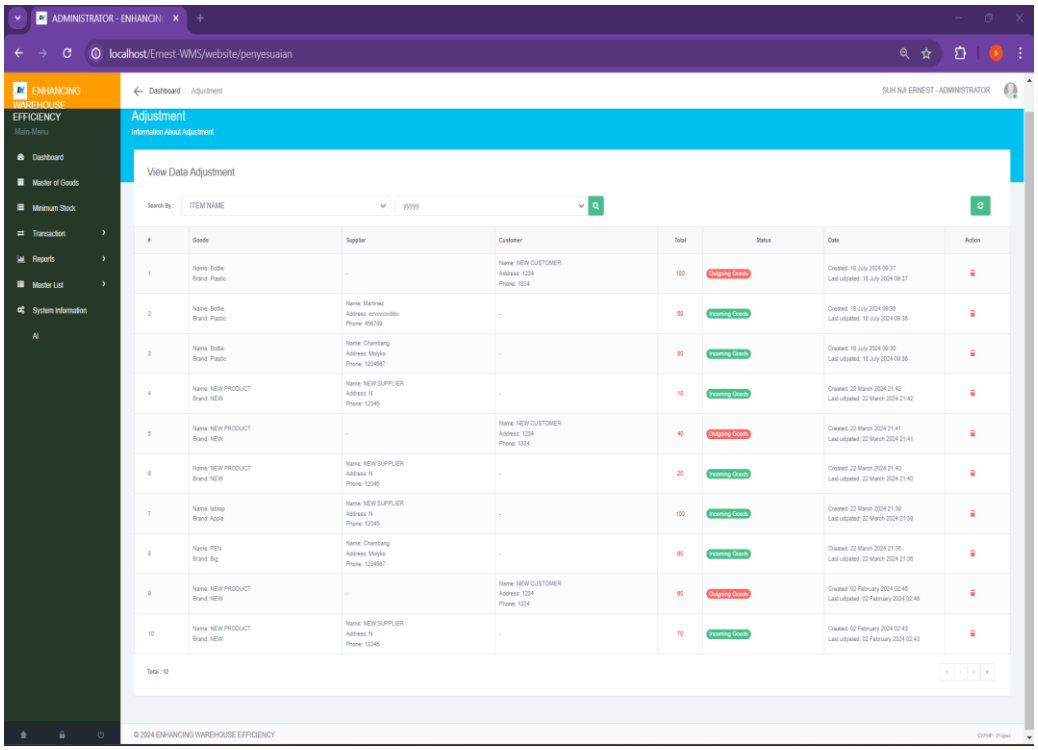

Figure 8: Adjustment list page of my Warehouse management system

The Adjustment List page of our Warehouse Management System (WMS) is where you track changes to stock levels. Here's how it works:

1. User Interface

- The page shows a list of all inventory adjustments in a table. Each entry shows item name, adjustment type (add or subtract), quantity adjusted, date adjusted and reason for adjustment. In other words, the adjustment page shows products

names and brands, suppliers' details, customer details, total stock, incoming goods, outgoing goods and records created dates and updated dates.

2. **Search and Filter**

- Users can search for specific adjustments using the search bar. Filter options allow users to view adjustments by date range, item category so they can find relevant entries quickly.

In summary, the Adjustment List page in your WMS is where you can monitor and manage inventory changes in an easy and organized way. With search, filter, sort and detailed views, users can track adjustments, keep stock levels accurate and be accountable in the warehouse.

15. Reports

The Report Section of our Warehouse Management System (WMS) is essential in providing a details report of all the inventories, below are the various reports sections:

16. Incoming Goods Report

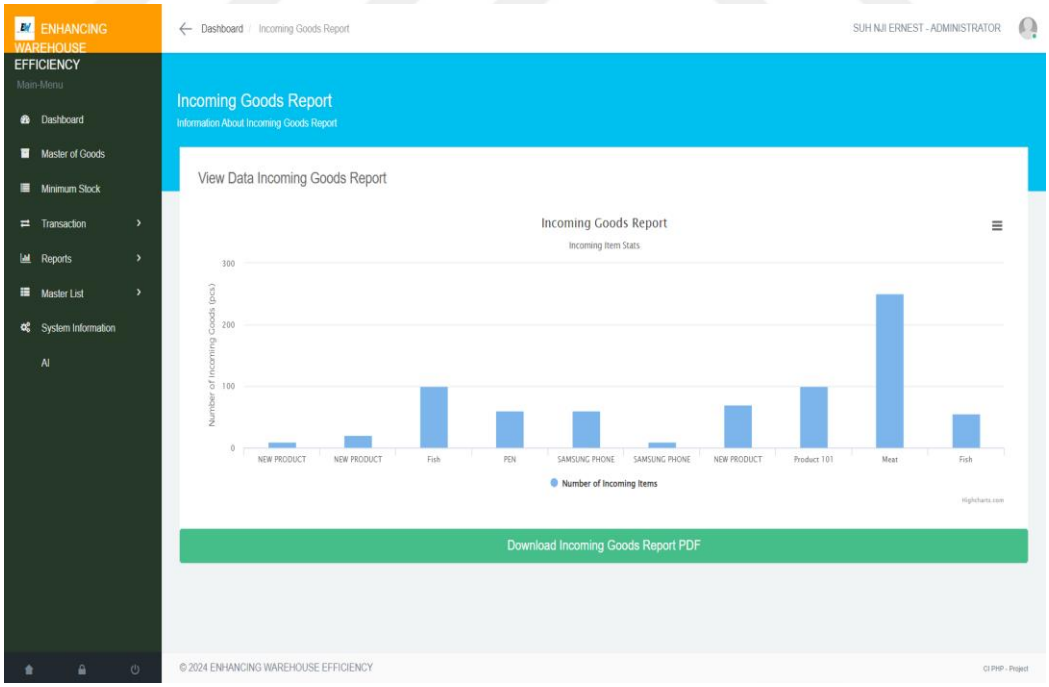

Figure 9: Incoming Goods report page of my Warehouse management system

The Incoming Goods Report in our Warehouse Management System (WMS) is a visual breakdown of the number of incoming goods against the number of

incoming items. You can also download the report in different formats for sharing and record keeping. Here's how it works:

a. Data Collection and Integration:

The graph pulls in data from all incoming goods transactions in the WMS. This includes number of goods received, item types, dates and supplier details.

b. Graph Axes:

- X-Axis (Horizontal): List of incoming goods. Helps users track current incoming goods.
- Y-Axis (Vertical): Y-Axis: Number of incoming goods (quantity) or pieces

c. Interactive Elements:

- Hover/Tooltip: When users hover over a bar or data point, a tooltip appears with detailed information, such as quantity received, number of items and incoming item name.
- Export and Reporting: Users can download the graph and underlying data in different formats for sharing and further analysis:

– **PNG:** High quality image file for embedding in presentations or documents.

– **JPEG:** Compressed image file for sharing via email or web.

– **PDF:** Portable Document Format for a printable professional report.

– **SVG:** Scalable Vector Graphics for high resolution, scalable images for detailed analysis and publication.

d. Summary and Insights:

The graph has a summary section with key insights such as total goods received, average daily/weekly receipts and notable trends or changes compared to previous periods.

In summary, the Incoming Goods Report graph in our WMS is a great tool to visualize and analyze the relationship between number of incoming goods and number of items received. With detailed data visualization, interactive elements, filtering options and multiple download

formats, users can monitor inventory flow, identify trends and make informed decisions. Users can also export the graph in different formats to share and present their findings.

17. Outgoing Goods Report

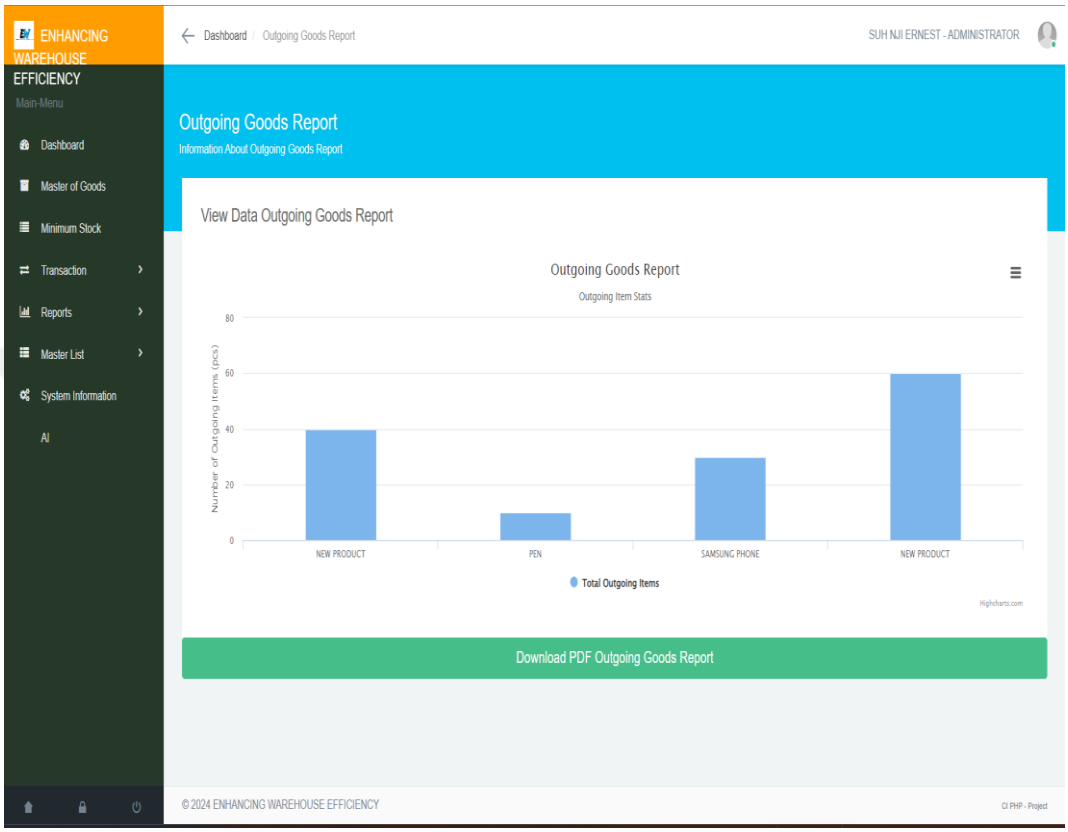

Figure 10: Outgoing Goods report page of my Warehouse management system

18: Outgoing Goods Report Graph Functionality in Your WMS System

The Outgoing Goods Report graph in our WMS shows the number of outgoing goods against the number of outgoing items. You can also download the report in different formats to share and analyses. Here's how it works:

a. Data Collection and Integration:

- The graph pulls all outgoing goods transactions from the WMS. This includes item name and number of outgoing items

b. Graph Axes:

- **X-Axis (Horizontal):** Outgoing goods list. Helps users see current outgoing goods.

- **Y-Axis (Vertical):** Y-Axis: Number of outgoing goods (quantity) or pieces

c. Interactive Elements:

- **Hover/Tooltip:** When users hover over a bar or data point, a tooltip appears with detailed information, item name and total outgoing item.

d. Export and Reporting:

Users can download the graph and underlying data in different formats to share and analyses:

- **PNG:** High quality image file to embed in presentations or documents.
- **JPEG:** Compressed image file to share via email or web.
- **PDF:** Portable Document Format to print a professional report.
- **SVG:** Scalable Vector Graphics to high resolution, scalable images for detailed analysis and publication.

In short, the Outgoing Goods Report graph in our WMS is a tool to visualize and analyses the relationship between the number of goods shipped and number of items dispatched. With detailed data visualization, interactive elements, filtering options and multiple download formats, users can monitor shipping activity, spot trends and make decisions. Ability to export the graph in different formats means users can share and present their findings easily, making it a must have for inventory and logistics management. Sample of the code is shown below

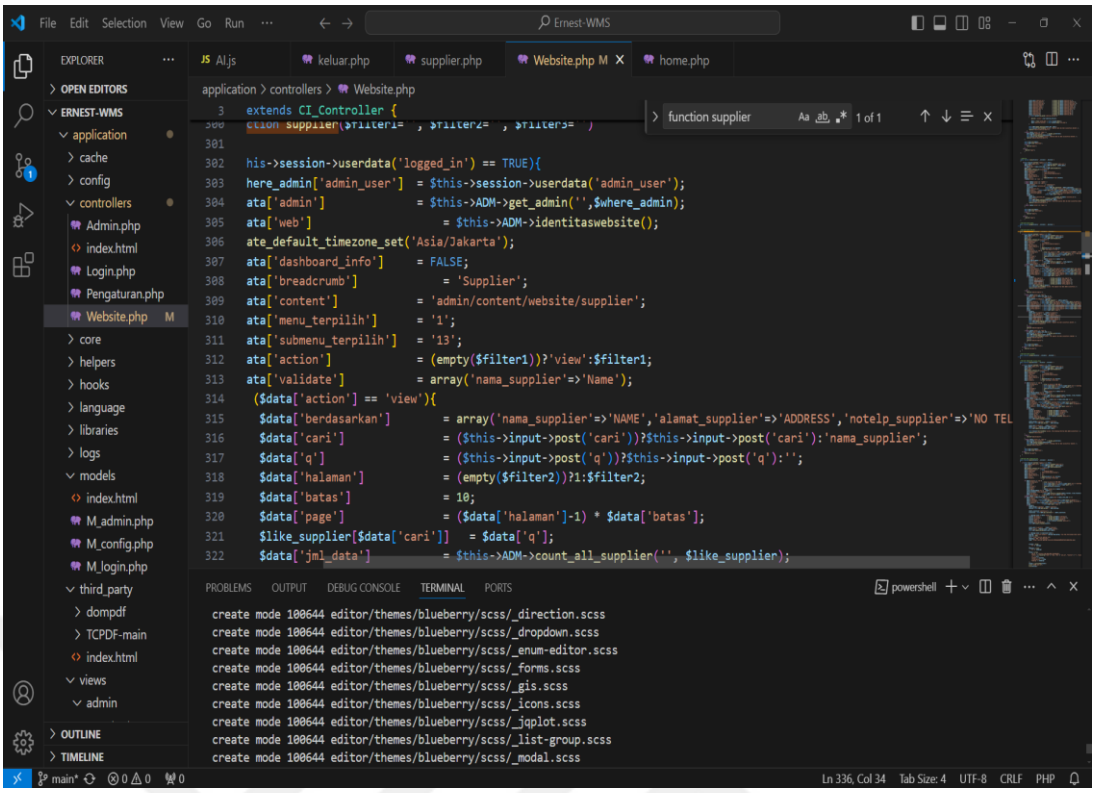

Figure 11: The sample code

B. Artificial Intelligence Section

The system has an artificial intelligence part for incoming goods. It can recognize supplier's logo and gives automatically an ID for each shipment. It uses coevolutionary network for logo recognition. The working principle of the recognition system is describing below:

When the logo of the supplier is shown to the camera, the system recognizes and brings predefined item list which is coded and supplied by the supplier. Then the operator selects manually the item and the number of packages. Furthermore, the system automatically creates an Id code for each item. Additionally, if the given Id is shown to the camera, the system directly brings the shipment information.

The coded items and supplier logo are shown in the table below.

Table 1: The coded suppliers and items

		SUPPLIERS				
		1	**2**	**3**	**4**	**5**
CODES	**ITEMS**	**A**	**B**	**C**	**D**	**E**
1	MILK	OK				OK
2	WATER	OK				OK
3	COKE	OK				OK
4	MEAT		OK			OK
5	FISH		OK			OK
6	CHICKEN		OK			OK
7	MOBILE PHONE			OK		
8	LABTOP			OK		
9	MOUSE			OK		
10	PRINTER			OK		
11	SCANNER			OK		
12	IRON				OK	
13	CEMENT				OK	
14	GLASS				OK	
15	FRIDGE			OK		
16	APPLE	OK				
17	GRAPES	OK				
18	BANANA	OK				
19	MELLON	OK				
20	PEAR	OK				

To give an example of Id system, let us think that company A sends water in the date of 07-26-2024 for first time. The system will assign the code 1-2-07-26-2024-1 for the first shipment. If the same company sends the same item on the same day, it will be coded like 1-2-07-26-2024-2 for the second shipment. Her the first 1 is the code of the company, 2 is the predefined code of water and then the shipment date is followed then the last number is the shipment sequence.

To see all the shipments that are done by the company A, the operator can make read the logo of the company to the camera. If the operator make read a certain Id to the camera, the information of that shipment will be shown in the screen.

C. Working Algorithm Of The System

1. Download and install any local web server such as **WAMP Server**.
2. Download the provided source code zip file.

- System Installation/Setup. Open your WAMPP Control Pane land start Apache and **MySQL,** Next, extract the downloaded source code zip file**.**

1. Copy the extracted source code folder and paste it into the WAMP's "**htdocs**" directory**.**
2. Browse the **PhpMyAdmin** in a browser. i.e. **http://localhost/phpmyadmin**
3. Create a new database naming **ernestdatabase.**
4. Import the provided **SQL** file. The file is known as **ernestdatabase.sql** located inside the database folder.
5. Browse the Warehouse Management System in a browser**.** i.e. http://localhost/Ernest-WMS/admin

IV. RESULT AND DISCUSIONS

Research into an integrated stock management system (ISMS) shows big improvements in operational performance, inventory accuracy and overall productivity. By adding AI for image detection and classification the ISMS simplifies inventory management, reduces human error and optimizes stock control. The research shows that putting these technologies into warehouse operations means faster processing times, more accurate inventory tracking and better decision making. In short, this research proves ISMS can transform warehouse management, a robust and scalable solution to the many challenges of modern warehouses.

A. Challenges Of Implementing Integrated Stock Management Systems

Despite the benefits, warehouses face many challenges when implementing integrated stock management systems:

1. Integration Complexity

Many technologies and systems to integrate means planning, cost and expertise. Warehouse managers need to make sure all software platforms and hardware can talk and share data. (Bowersox, 2013)

2. Data Accuracy and Integrity

Means planning, cost and expertise to integrate so many technologies and systems. Warehouse manager should be able to make sure all software platforms and hardware can communicate and flow data. (Kim Y. &., 2012)

3. Labor Management

It presents challenges when utilizing labor resources efficiently and productivity. More training and support within the warehouse must be given to warehouse employees so they can handle integrated stock management system and adapt to changes in workflows and processes. (Harrison, 2011)

4. Technology Obsolescence

With technology improving fast, there will be continuous updating and changing of the warehouse management system. Warehouse manager must stay updated on product and process technology and industry trends to stay competitive. (Klaus, 2004)

B. Project Limitations

1. **Cost:** The cost of implementing AI and other advanced technology into the **ISMS** is high. This high upfront cost may deter small to medium sized businesses with tighter budgets. Cost includes not only the software and hardware but also training and customization of staff and system. (Deloitte., 2021)
2. **Data Quality and Availability:** AI in image detection and classification relies heavily on the quality and amount of data. Poor or insufficient data will impair the system's performance and accuracy and can be inefficient. Getting consistent high quality data input can be a challenge especially in diverse and dynamic inventory environment. (Zhang, 2020)
3. **Technical Difficulty:** The technical complexity of an integrated stock management system presents a significant challenge. Warehouses without a specialized IT team or technical experience may have difficulties with system integration, troubleshooting, and maintenance, resulting in operational disruptions. (Kim Y. H., 2018)
4. **Flexibility:** The system's flexibility to different warehouse environments and product types may vary and may require extensive customization to meet operational needs. This can add time and cost to deployment especially for warehouses with unique or specialized inventory. (Zamboni, 2020)
5. **Technology Reliance:** High technology reliance brings in risk of system failure or cyber-attack. This can cause major disruptions to warehouse operations so a robust cybersecurity and contingency plan is required. (Smith, 2020)

C. Future Prospects

1. **AI:** As AI and machine learning gets better and better, image detection and classification will get more accurate and efficient. Future systems will be able to do more complex analysis and therefore more inventory management and operational efficiency gains. (Baryannis, 2019)
2. **IoT:** The integration of the Internet of Things (IoT) with the ISMS will allow for real time data collection from various sensors and devices. Real time data will enable inventory tracking, environmental monitoring and predictive maintenance and give a complete view of the warehouse and allow for more proactive management. (Li, 2018)
3. **Flexibility:** Future developments will focus on making the ISMS more flexible so it can be rolled out across warehouses of all sizes and types. This will enable wider adoption and more businesses from small local operations to large multinationals to benefit from ISMS. (Melnyk, 2014)

In summary, while an integrated stock management system will bring big benefits to warehouse efficiency and operational performance there are still limitations and challenges to be addressed. But with technology advancing and focus on scalability and sustainability the future for ISMS looks good. By utilizing these advancements businesses can get even more efficiency and transform their warehouse management and create more resilient and responsive supply chains. (Richards G. , 2017)

Following with regards to our warehouse system and references are a few expected enhancements for our warehouse stock management system:

Product Detection Improvement: The AI can be trained with a wider range of products. These would include those sourced from various places and may appear very different in shape and packaging.

Handle more suppliers and consumers: This will make the system capable of handling a large number of suppliers and consumers. It will thereby be in a position to handle full variability within products and orders without slowing down.

Detection of various types of packaging: The system will be able to realize that there is one product that comes in a box, a bag, or a crate of products. It is with

each added type of packaging that exists of a particular product that the system becomes more flexible.

Let the system learn from data fed by the customers. When something goes wrong in the processing of orders, the information can be utilized by the system to show more accuracy next time.

In general, such suggestions tend to enhance the capacity of our system in recognizing items much faster and handling more suppliers and consumers quicker, hence speeding up your warehouse operations.

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RESUME

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