AN AUTOMATED INVENTORY TRACKING SYSTEM : A CASE STUDY OF J AND J GROCERY STORES

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A DISSERTATION SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

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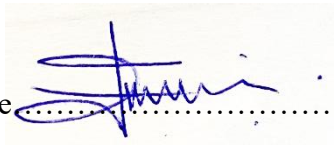
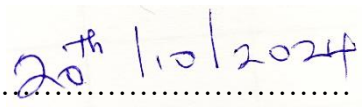
Declaration

I NATUKUNDA TRICKET declare that this report is my original work and has never been presented by anybody to the Uganda Christian University, Bishop Bahram University College, or any other institutions of higher learning for the award of a Bachelor's degree in science and information technology.

Signature…… Date…30.04.2024…….

Approval

This dissertation has been submitted to the Uganda Christian University, Bishop Barham University College for examination under the Supervision of

Signature  …… Date  ……

Supervisor: NIWENYESIGA EMMANUEL

Dedication

I dedicate this dissertation to my young siblings Ahimbisibwe Jollet, Abigaba Martinson,

Abimanya Paul, and Arinda Trevor. It is because you've always looked up to me and counted on me every time you encounter challenges big or small that I have lived to have such a strong problem-solving mind and

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The researcher has first-time experience with most of the knowledge and activities that are done within the period of this study. Firstly, the researcher does not have any knowledge regarding a retail store managing inventory where she did research and studies on sample demo websites, journals, and survey questionnaires. Secondly, the researcher also learned new programming language frameworks which she used for the first time which are Django and Bootstrap. Thirdly, the researcher also experienced the pressure of handling multiple tasks besides this study where multitasking skills and proper planning are important. All these could never be possible without the contribution of different people and I sincerely would like to that each one of them

I thank the Almighty God for all the blessings I cannot write down here and most importantly for guiding me and enabling me to come up with this project proposal successfully.

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To my family, My mother Nyinamatsiko Esther, my sisters, Owembabazi Patricia, Nasasira Beckie, and Ahimbisibwe Jollet Khei, my brothers, Atusingwize Philip, Musinguzi Gideon, Abigaba Martin, Abimanya Paul, Arinda Trevor. To Auntie Faith Rwegyemera, Engineer Maureen, and Racheal Kentenyingi. I can never afford to pay you back for all the support you give every day. You are a strong pillar and I am blessed to have you as a family. May God bless you so much.

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Abstract

This study aims to develop an Inventory Tracking Systems (ITS) that can provide better control and handling of product stock, customer order, customer service and order delivery that relates to company inventory information. The target user is the business owner, some administrators and a few trusted partners. ITS helps the company to track down the next arrival of product stocks and record customer order for reservation for the product in the store inventory. In this study, the developer used DJANGO framework for backend system development and HTML, CSS, JavaScript for frontend system development. This study also applies Evolutionary Prototyping Development methodology that emphasizes incrementally adding features and functionality to working prototype until it becomes fully functional. Even though the inventory tracking system has been fully developed by the developer, there are still limitations found and future enhancement that can be made towards the system.

Chapter one

General Introduction

Inventory management is one of the crucial supply chain components in retail stores. Every day or weekly, the store needs to update the stock that is coming in or out. Most of the retail store must at least have a warehouse to store their products. To maintain customer satisfaction whenever the shop does not have the product, the retail company provide delivery service through customer orders for product that comes from warehouse inventory. Having an inventory tracking system within an organization is important because the business can monitor and control their product stock and business revenue that is going on within the organization. At the same time, it is also to determine the suitable product quantity to restock according to customer and market demand which will reduce business loss of overstocking (Plinere & Borisov, 2016). Without having a good inventory tracking system within an organization, it can cause many businesses risk especially for retail stores such as being out of stock and products that are not sold due to market demand which will bring dissatisfaction to customer and business lost (Patil & Divekar, 2014). Moreover, inventory management in an organization are done manually such as updating and checking inventory stocks in an excel and or logbook in some company nowadays and in the old days.

Nowadays, there are many webs application on inventory tracking system for businesses that deals with managing product and stock. Even if there are inventory tracking system in the market, there are many companies that still managing their stock in the inventory manually. This is due to company owner finds the inventory tracking system is costly, unattractive, inflexible, or unsuitable for their business. Therefore, this study is to develop a web application of inventory tracking system that is less costly and suitable for small to medium business

1.1Background of the study

1.1.1 Historical Background

The evolution of inventory management can be traced back to ancient civilizations where rudimentary forms of inventory control were practiced. In Mesopotamia, clay tablets dating back to 4000 BCE reveal records of inventory transactions, indicating the early efforts to track goods and resources. Similarly, ancient Egyptian hieroglyphs depict scenes of inventory management in the form of tallying and recording goods in warehouses.

The Industrial Revolution marked a significant turning point in the history of inventory management. With the advent of mechanized production and mass manufacturing, businesses faced the challenge of managing increasingly complex supply chains and inventories. Innovations such as the steam engine and the assembly line led to greater production capacities but also necessitated more sophisticated inventory management techniques to ensure the efficient flow of materials and goods.

In the early 20th century, pioneers such as Ford W. Harris and Frederick W. Taylor laid the foundations for modern inventory management principles. Harris's Economic Order Quantity (EOQ) model, published in 1913, introduced the concept of balancing ordering costs and holding costs to determine the optimal order quantity. Taylor's scientific management principles emphasized efficiency and standardization in production processes, influencing inventory management practices across industries.

The mid-20th century saw the emergence of new approaches to inventory management, most notably the development of computer-based systems. With the advent of computers and electronic data processing, businesses gained the ability to automate inventory tracking, streamline order processing, and analyze inventory data more effectively. The introduction of barcode technology in the 1970s further revolutionized inventory management by enabling rapid and accurate identification of products.

In the late 20th and early 21st centuries, the rise of e-commerce and globalization reshaped the landscape of inventory management. Retailers faced new challenges in managing omnichannel distribution networks, coping with fluctuating demand, and meeting the expectations of increasingly demanding customers. Web-based inventory management systems emerged as a

solution to these challenges, offering real-time visibility, scalability, and flexibility to businesses of all sizes.

Today, the field of inventory management continues to evolve rapidly, driven by advancements in technology, changes in consumer behavior, and shifts in global supply chains. Businesses are increasingly turning to data-driven approaches, artificial intelligence, and automation to optimize their inventory management processes and gain a competitive edge in the marketplace.

1.1.2Contextual Background

In the context of small to medium-sized retail businesses, inventory management poses unique challenges and opportunities. SMEs often operate with limited resources, making it imperative to adopt cost-effective and efficient inventory management solutions. However, many SMEs continue to rely on manual inventory tracking methods due to concerns about the cost and complexity of implementing web-based inventory management systems.

The contextual background of this study lies in bridging the gap between the theoretical principles of inventory management and the practical needs of SME retailers. By developing a web application for inventory tracking that is tailored to the specific requirements of SMEs, this study seeks to address the barriers to adoption and empower retailers to optimize their inventory management processes, improve business performance, and achieve sustainable growth in today's competitive marketplace.

1.1.3Theoretical Background

Several theoretical frameworks underpin the study of inventory management, including Economic Order Quantity (EOQ), Just-in-Time (JIT) inventory management, and the ABC analysis.

- EOQ theory, developed by Ford W. Harris in 1913, seeks to determine the optimal order quantity that minimizes total inventory costs, taking into account factors such as ordering costs, holding costs, and demand variability.

- JIT inventory management, pioneered by Toyota in the 1970s, advocates for minimizing inventory levels by synchronizing production with customer demand. JIT aims to eliminate waste, reduce lead times, and improve efficiency throughout the supply chain.
- The ABC analysis categorizes inventory items into three categories (A, B, and C) based on their value and significance. This classification helps prioritize inventory management efforts, focusing attention on high-value items while minimizing resources allocated to low-value items.

These theoretical frameworks provide valuable insights into the principles and strategies of inventory management, guiding the development and implementation of inventory tracking systems in retail businesses.

1.1.4 Conceptual Background

Inventory management is a critical component of supply chain management, encompassing the processes and systems used to oversee the flow of goods from suppliers to customers. At its core, inventory management involves the strategic balancing of inventory levels to meet customer demand while minimizing costs associated with holding excess stock. Key concepts in inventory management include inventory control, demand forecasting, order management, and stock replenishment.

In the context of retail businesses, effective inventory management is essential for ensuring product availability, optimizing sales, and enhancing customer satisfaction. Retailers must maintain an optimal balance between stock levels and customer demand to avoid stockouts, reduce carrying costs, and maximize revenue. Traditional inventory management methods, such as manual tracking using spreadsheets or logbooks, are labor-intensive and prone to errors, limiting their effectiveness in today's dynamic business environment.

1.2 The Statement of the problem

Inventory Tracking system is essential for enabling employees or managers to monitor, record, and oversee the movement of products in and out of company inventory, ensuring optimal stock

levels without experiencing unexpected shortages or overstock situations. However, many small companies still rely on manual inventory management processes due to the perceived unnecessary investment in inventory tracking systems. This reluctance is primarily attributed to the prevalent subscription-based nature of most inventory tracking software available on the Internet. These systems often come with limitations, high maintenance costs, and complexity, rendering them unsuitable for many businesses (Jallow, 2018). Consequently, there is a pressing need for a more accessible and cost-effective solution tailored to the needs of small businesses, offering general inventory management features while minimizing development costs.

Furthermore, research conducted at AIKTC Server Centre underscores the inefficiencies and challenges associated with manual inventory management. With an increase in client orders, manual tracking and recording of product movements have proven to be labor-intensive and error prone, leading to reduced employee productivity and the risk of inaccuracies in inventory data (Aamir Khan, Aasif Ansari, MD Ghalib, 2019). To address these issues and enhance efficiency, there is a demand for a system that provides user-friendly templates for recording and searching product stocks within the inventory easily.

Moreover, manual creation of product stock and sales reports poses additional challenges, including the potential for human error and the lack of comprehensive summary reports for effective decision-making. Managers and employees often resort to forecasting stock requirements based on customer demand, leading to instances of overstocking or stockouts (Patil & Divekar, 2014). To mitigate these issues, there is a critical need for a system that generates summary reports in a dashboard format, offering insights into company sales performance and product inventory conditions at a glance.

1.3Research Objectives

1.3.1 General objective

To develop an automated inventory tracking system with features tailored to improve general inventory management features while minimizing development costs.

1.3.2 Specific Objectives

To identify the current state of the available inventory management systems at J and J Groceries.

To design and implement an inventory Tracking system

To test the functionality of the inventory tracking system

1.4 Research questions

- How does the development of the improve general inventory management features while minimizing development costs at J and J Grocery Stores?
- What is the current state of inventory management at J and J grocery stores?
- How best can we design an automated inventory management system? Does the system function as expected?

1.4 Justification of the Study

Addressing Operational Inefficiencies: The manual inventory management processes currently employed by J and J Grocery Store are inefficient and prone to errors. Implementing a web-based inventory tracking system will streamline inventory management operations, reduce manual labor, and improve overall efficiency. By automating tasks such as stock tracking, order processing, and reporting, the proposed system will enable employees to allocate their time more effectively, leading to increased productivity and reduced operational costs.

Enhancing Inventory Visibility and Control: The lack of real-time visibility into inventory levels poses significant challenges for J and J Grocery Store in maintaining optimal stock levels and preventing stock outs or overstock situations. By implementing an inventory tracking system, the store will gain centralized visibility and control over its inventory, enabling timely decision-making and proactive inventory management. This enhanced visibility will ensure that the store can meet customer demand more effectively, leading to improved customer satisfaction and retention.

Cost-Effectiveness and Accessibility: Many existing inventory tracking systems available on the market are costly and may not be suitable for small businesses like J and J Grocery Store. The proposed system aims to provide a cost-effective and accessible solution tailored to the specific needs of small businesses. By offering general inventory management features at a lower cost and with simplified usability, the system will empower small businesses to adopt modern inventory management practices without incurring significant financial burden.

Improving Decision-Making Processes: Manual inventory management processes hinder the ability of J and J Grocery Store to generate accurate and comprehensive reports for informed decision-making. The proposed system will provide summary reports in a dashboard format, offering insights into sales performance, inventory conditions, and trends. These actionable insights will enable store managers to make data-driven decisions regarding stock replenishment, pricing strategies, and product offerings, leading to improved business outcomes and competitiveness.

Supporting Growth and Scalability: As J and J Grocery Store continues to grow and expand its operations, the need for scalable inventory management solutions becomes increasingly critical. The proposed system will be designed to accommodate future growth and scalability, allowing the store to adapt to changing business requirements and market dynamics. This scalability will ensure that the system remains relevant and effective in supporting the store's long-term growth objectives.

In conclusion, the implementation of an inventory tracking system at J and J Grocery Store is justified by the need to address operational inefficiencies, enhance inventory visibility and control, provide cost-effective solutions, improve decision-making processes, and support the store's growth and scalability objectives. By investing in modern inventory management practices, the store will position itself for long-term success and competitiveness in the retail market.

1.5 Significance of the Study

Improving Business Efficiency: The implementation of an inventory tracking system at J and J Grocery Store will significantly enhance business efficiency by automating manual

inventory management processes. This automation will reduce the time and effort required for tasks such as stock tracking, order processing, and reporting, allowing employees to focus on more strategic activities that contribute to business growth and customer satisfaction.

Enhancing Customer Satisfaction: By ensuring optimal stock levels and minimizing stock outs, the inventory tracking system will improve customer satisfaction at J and J Grocery Store. Customers will have greater confidence in the store's ability to fulfill their orders promptly and accurately, leading to increased loyalty and positive word-of-mouth referrals.

Minimizing Costs and Losses: The system will help minimize costs associated with overstocking, stock outs, and manual inventory management errors. By providing real-time visibility into inventory levels and trends, the store can make informed decisions regarding stock replenishment, pricing strategies, and product offerings, reducing waste and maximizing profitability.

Enabling Data-Driven Decision-Making: The inventory tracking system will generate comprehensive reports and insights that enable data-driven decision-making at J and J Grocery Store. Managers will have access to accurate and up-to-date information on sales performance, inventory conditions, and customer trends, empowering them to make informed decisions that drive business growth and competitiveness.

Facilitating Business Growth: The implementation of modern inventory management practices will position J and J Grocery Store for sustainable growth and scalability. By streamlining operations, enhancing efficiency, and improving inventory control, the store can expand its product offerings, enter new markets, and serve a larger customer base with confidence.

Contributing to Industry Knowledge: The study will contribute valuable insights and knowledge to the field of inventory management, particularly for small businesses in the retail sector. The findings and recommendations can serve as a reference point for other businesses facing similar inventory management challenges, helping to advance best practices and standards in the industry.

Overall, the significance of this study lies in its potential to drive positive change and improvements in business operations, customer satisfaction, cost management, decision-making processes, and industry practices at J and J Grocery Store and beyond

1.6 Scope of the study

1.6.1 Geographical Scope

The study was conducted specifically for J and J Grocery Store, located in Katuna, Kabale District, Uganda. The implementation and evaluation of the inventory tracking system were limited to the operations and needs of this specific store within its geographical location.

1.6.2 Time Scope

The study covered the development, implementation, and evaluation phases of the inventory tracking system within a specified timeframe. This included conducting requirements gathering, system design, software development, testing, and deployment activities. The entire study was conducted over a period of one month, from 19th march to 19th April

1.6.3 Disciplinary Content of the Study

The study drew upon interdisciplinary knowledge and methodologies from fields such as computer science, information technology, and business management. It integrated principles of software development, database management, user interface design, and inventory management practices to design and implement the inventory tracking system. Additionally, the study incorporated principles of project management to effectively plan, execute, and evaluate the project within the specified timeframe and resource constraints.

In summary, the study's geographical scope was limited to J and J Grocery Store in Katuna Town council, Kabale District, Uganda. The time scope encompassed the entire duration of the study, from requirements gathering to system deployment. The disciplinary content of the study integrated principles from computer science, information technology, business management, and project management to develop and implement the inventory tracking system.

1.7 Theoretical Framework:

The theoretical framework for this study was informed by established theories and models in the fields of inventory management, information systems, and organizational behavior. These theories provided a foundation for understanding the underlying principles and dynamics shaping inventory management practices and the development of information systems tailored for small businesses like J and J Grocery Store.

Inventory Management Theory

Economic Order Quantity (EOQ): This theory provided insights into optimal order quantities that minimize total inventory costs, considering factors such as ordering costs, holding costs, and demand variability. The EOQ model guided decisions related to stock replenishment and inventory control strategies to ensure efficient use of resources and minimize holding costs.

Just-in-Time (JIT) Inventory Management: JIT principles emphasized the importance of minimizing inventory levels by synchronizing production with customer demand. The JIT approach informed decisions regarding inventory turnover, lead times, and stock replenishment schedules to reduce waste, improve efficiency, and enhance responsiveness to customer needs.

Information Systems Theory

Technology Acceptance Model (TAM): TAM provided insights into users' acceptance and adoption of information systems by examining perceived usefulness and ease of use. The study considered TAM principles to ensure that the inventory tracking system was user-friendly, intuitive, and aligned with the needs and preferences of employees at J and J Grocery Store.

System Development Life Cycle (SDLC): The SDLC framework guided the systematic development and implementation of the inventory tracking system, encompassing stages such as requirements gathering, system design, software development, testing, deployment, and maintenance. This framework facilitated a structured approach to project management and ensured that the system met quality standards and user requirements.

Organizational Behavior Theory

Technology-Organization-Environment (TOE) Framework: The TOE framework provided a lens for understanding the interactions between technological innovations, organizational factors, and external environmental influences. The study considered organizational factors such as management support, employee training, and organizational culture to facilitate the successful implementation and adoption of the inventory tracking system.

Change Management Theory: Change management principles guided efforts to mitigate resistance to organizational change and promote user acceptance of the inventory tracking system. The study employed change management strategies such as communication, training, and stakeholder engagement to facilitate smooth transitions and maximize the benefits of the new system.

Chapter Two

Literature Review

2.1Overview of Inventory Management System

Inventory management systems are integral to modern businesses, streamlining processes and ensuring efficient control over inventory levels. Many existing systems leverage web applications to track and record inventory, addressing common challenges such as manual errors and inefficiencies. Pasaribu (2021) developed an inventory tracking system for an Indonesian company, emphasizing error reduction in stock recording and improved warehouse inventory processes. The system provided a straightforward interface for viewing inventory data and managing product information.

Similarly, Aamir Khan, Aasif Ansari, and MD Ghalib (2019) focused on developing an inventory tracking system for AIKTC Server Centre, aiming to streamline inventory management processes and enhance data security. Their system generated various reports, including inventory transactions and maintenance reports, to facilitate more efficient tracking and recording of product stock.

2.2 Overview on Tools and Programming Languages for Inventory Management Systems

Researchers have explored diverse tools and programming languages for developing inventory management systems, with a focus on simplicity, reliability, and efficiency. Yuvaraj et al. (2020) employed Python with the Tkinter library and SQLite for developing a desktop inventory tracking system, emphasizing simplicity and reliability, with potential for future IoT enhancements.

In another study, Srivastava et al. (2020) investigated programming languages and tools for implementing an inventory management system in an e-commerce store. They developed a hybrid system using Java and MongoDB, prioritizing structured data storage and efficient query processing, resulting in a clean user interface and effective data management.

Additionally, Arina Ramlee and David Henry (2019) developed a web-based inventory tracking system using Java JSP and MySQL, considering cost constraints and project timelines. However, Pasaribu (2021) utilized legacy PHP, potentially impacting system efficiency and supportability.

2.3 Comparison of Similar Systems

Comparing similar inventory tracking systems offers insights into their respective strengths and weaknesses. Unlike subscription-based systems such as Zoho and Delivrd, the proposed system offers free access to features and resources, with resource usage dependent on the hosting device. Additionally, the proposed system integrates various modules, such as Customer Feedback and User Management, enhancing its functionality compared to existing systems.

However, even though the inventory Tracking system may lack certain features present in other systems, such as barcode or QR code scanning furthermore, its usability may be moderately challenging due to extensive data validation requirements. Despite these limitations, the system stands out for its unique features, such as low stock reminders and visualized dashboard, offering a compelling alternative for businesses seeking a comprehensive inventory management solution.

Chapter 3

Methodologies

3.1 Introduction

This chapter presents the methodologies employed in the research study aimed at evaluating the effectiveness and implementation of the ITS The methodologies outlined here provide a structured approach to collecting and analyzing data, ensuring rigor and reliability in the research process. Through a mixed-method research design, incorporating both qualitative and quantitative techniques, this chapter seeks to comprehensively explore stakeholders' perceptions, system effectiveness.

3.2 Research Method

The researcher uses quantitative research method by conducting survey. The questionnaires were distributed to IT and business groups which have some IT knowledge and experience of inventory management. This is because the project developer lacking knowledge of inventory management and how to design web page that visualize report information that is ease for company manager or manager to do analysis. Therefore, the main objective of conducting the data gathering through questionnaire survey was to get better understanding of inventory management and participant opinion based on their knowledge or working experience as the researcher needs to know whether the proposed system is suitable to solve the manual inventory management process that is still practice daily in some retail store. Furthermore, the researcher also needed to know whether there is suggestion from participants regarding to report data that is useful for observing product sales and inventory condition of the company and the way to represent the report data for better view of analysis.

3.4 Area of Study

The study zoomed into the implementation and efficacy of the Inventory Tracking System (ITS) within retail settings, focusing particularly on inventory management optimization. Technical users, such as IT administrators and developers, played a crucial role in the evaluation process.

3.5 Sources of Information

A wide array of sources including scholarly articles, conference papers, industry reports, and online resources were tapped to gather insights into inventory management systems, software development methodologies, and user interface design principles. Technical documentation and forums also provided valuable input

3.6 Technical methods

3.6.1 Target Users

The target users for the system is the owner and employee that is related or working to the grocery store that involves in using the inventory tracking system for track and manage product information store in the warehouse inventory. In the inventory Tracking system, each target user has their own role and feature based on given user roles of login credential. There are 5 target users with different login credential role which is Super Admin User for system admin and company owner, Admin User for employee that handles inventory information, Delivery Staff, Customer Service Staff, and Human Resource Staff. Since the web application, every target user is being able to use the system through devices web browser including mobile phones that can help some employee to work at home and helps packaging staff efficiently without walking back and forth from the computer to track and update product status.

3.6.2 Tools

The developer decided to choose Django framework for backend system development of proposed inventory tracking system. This is because Django provides integration capabilities, Open Object Relational Mapping, Security, and scalability.

Then, the developer also chose HTML, CSS, JavaScript for frontend system development of the inventory tracking system. Components design of web pages was done using HTML while CSS is to make the web pages and the components to be more attractive. After that, the developer utilized JavaScript which was used for making web pages to be interactive where user experience is concern.

IDE (Interactive Development Environment) chosen

An Interactive Development Environment (IDE) is a software development application that provides developer various tools such as code editor, debugger and many others depending on which IDE is being used. Throughout the development in this study, the developer used Visual Studio Code a due to the developer preferences of code editor in the IDE.

In Visual Studio Code, the IDE also have highlighted syntax error, auto code completion, snippets, also Visual Studio Code a has Git or GitHub support that allow developer to manage project development progression easily through version control.

Libraries

Django is a Python framework that have good reputation on developing and delivering web application on both frontend and backend at a rapid speed. This is because Django framework is easy to understand as most of the design pattern are following model, view, and controller (MVC) which is commonly well-known in developer community (Tutorialspoint, 2021a) .

As for frontend development on CSS, the developer decided to include Bootstrap 4 framework in the project as it is free to used and mostly known for developed interactive and responsive website design (Ayushjoshi, 2022). The developer chose Bootstrap framework because it is widely used in the community and ease to implement compared to normal CSS language. Furthermore, any developer unfamiliar with Bootstrap can learn the usage in short amount of time as developer must know pre-defined class stated on Bootstrap documentation. This is because the design code is already provided by Bootstrap pre-defined class where developer do not need complex code on CSS to design the website. Bootstrap framework is continuing their support on their framework which the newest Bootstrap 5 has just been released in recent months.

Database Tracking system Chosen

A normal database management system(DBMS) is normally store in a server where it is used for managing data such as accessing, delete, update, and store new data to the database. There are many types of database management system in market nowadays. One of the types of database management system that was used in this project are relational database management system(RDBMS) which is common in both educational and market purposes. The relational database tracking system(RDBMS) such as My SQLite exists to make better performance on database in terms of speed and flexibility compared to normal database management system(Xiaojie, 2011). This is because MySQLite database store data in relational way by separating tables which consist of their relationship between tables and data field which is suitable for the inventory tracking system. By doing separation of table and relationship, it can help most application to avoid any inconsistence outdated, or duplicate data (Oracle, 2022). Moreover, MySQL has released its license as open source which is free for every developer for personal use since the year 1995 (Xiaojie, 2011).

The first advantage of using MySQL in this project is that it provides good compatibility with most application or platform that can be found in the market nowadays (Alexandrea, 2022). This is because, MySQL is maintained and supported by Oracle where various updates of MySQL version and documents are provided over the years. After that, MySQL is also good for web application as data can be store or fetch according to business logic or use cases. Lastly, the data store in MySQL is secure and fast in processing rate due to data masking and flexible data column (Alexandrea, 2022).

Operating System Chosen

The developer used Windows 10 version 21H1 with 64-bit that is install in laptop. This is because Windows operating system is being used widely and common in the market. Moreover, the developer hardware device does not meet the requirement of receiving Windows 11 update. **Web browser Chosen**

In this inventory tracking system, any web browsers are be able to access the web application. However, there is a web browser that can get the best performance which is Google Chrome where the developer chose to focus while developing. The options stated is easily access and owned by most user in their devices and getting support to increase performance in processing web pages.

Rapid Application Development Methodology (RAD)

Rapid Application Development (RAD) is a software methodology that emphasize on iterative development process. The RAD software methodology was introduced by James Martin in the year of 1991 to solve the problems of slow development process in waterfall methodology (Agrawa, 2019). The slowness of using waterfall methodology in software development is due to the documentation activity such as data gathering and analysis in early phases which often lead to project failure in software development (Unhamzah, n.d.). With RAD methodology, data gathering is done during the project planning phase which it is done in a short time. In RAD methodology, prototype and system design is the most crucial part as it provides client and stakeholder an overview of how the web application going to works. Hence, RAD methodology is a trend in the market due to its fast development that produces results in a project (Creatio, 2022).

The characteristic of RAD methodology works around software reusability or software development frameworks with a small to medium team structure which its aim is to achieve project completion according to schedule. At the same time, project that uses RAD methodology must progress each task with caution to avoid any confusion and miscommunication for both project team and client/stakeholders (Unhamzah, n.d.). Lastly, software application develops using RAD are mostly suitable for client usage as constant testing on prototype are conducted.

The advantage of using RAD in this project is developing a quality web application of inventory management system. This is because prototype of the web application that is close to the real implementation system is given as a test for client and stakeholder which will get higher success rate of getting approve in user acceptance testing (Agrawa, 2019). After that, RAD methodology will provide a better management of project risk (Agrawa, 2019). This is because problems and issues are identified and solved efficiently in a short time. At the same time, the project development can be finished according to schedule if the task progress is run smoothly. Lastly, RAD methodology allows a project to have flexibility on requirement changed during prototype and design phase only (Creatio, 2022).

There are also disadvantages of using RAD in this project where it relies individual developer creativity to produce functionality during the project planning phase (Unhamzah, n.d.). This will make developer to have many works on the researched and gathering functionality which in the end some of the functionality will be removed from the list. At the same time, prototype that is completely rejected by client/stakeholder can also be seen as wasted effort and time as developer

need to produce a new design and prototype (Creatio, 2022). Moreover, RAD methodology requires a team of developer to be experienced on doing the task they receive (Agrawa, 2019).

This is due to the nature of RAD methodology as it requires the product to deliver at a short amount of time which inexperience developer might not contribute much to the project as they require training on the technology used which requires time.

A. RAD Phases and Stages

As shown in Fig 1, the first stage of RAD for this project is Requirement Planning or Defining Project Requirement where this project activity is mainly on the developer to define all general features and requirement after research and explore on all the existed inventory management system. The definition of features and requirement for the proposed system will be based on user role to ensure it is agreed by projects stakeholders or participants. Also, there will be minor customization apply for this phase which does not follow original RAD activity where the developer will state the expected deadline in each phase of RAD using Gantt Chart to ensure the developer can track of the project progress.

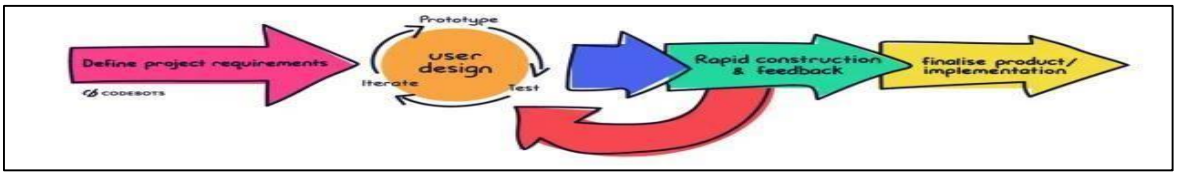

Fig. 1. RAD Phases and Stages (Chien, 2020)

The second stage of RAD is User Design where this project activity is mainly on developer to produce system model such as flowchart, some UML diagram, and prototype of web page design with interaction of the proposed inventory management system. Once the prototype and system design are done, it will be given to the experienced project participant with IT knowledge on validating the user interface and experience of the prototype and system design of the feature process flow are correctly stated and drawn.

The third stage of RAD is Rapid Construction where the developer will be focus on developing backend feature based on the system model. Then, the developer in this stage also will integrate the backend feature with the frontend web page that is done in stage 2. The expected result of this stage will be an inventory tracking system is fully working and run normally on the developer local device.

The last stage of RAD is Finalize Product where the developer will be conducting User Acceptance Testing with the project stakeholder or participants to ensure the proposed inventory tracking system is ready to be released and used (Bajjouk, et. al., 2021). There will be 1- or 2-week time for extending project duration for fixing the developed proposed system according to participant comment in UAT result. Once the change and fixes on proposed system is ready, the developer must prepare documentation such as user manual to ensure it can guide any new user.

Population and Sampling Techniques:

The study's population spanned across various stakeholders including owners, managers, employees, and technical users engaged in retail operations utilizing inventory management systems. Purposive sampling techniques were employed to select participants with diverse expertise in both inventory management and IT.

Variable Definitions and Measurement Levels:

Variables such as system usability, efficiency, and effectiveness were operationally defined and quantified using Likert scale-based questionnaires, enabling participants, including technical users, to rate their agreement with related statements. Technical metrics such as system response time and error rates were also considered.

Procedure of Data Collection:

Questionnaires, tailored to different user groups including technical users, were disseminated both online and in-person. Clear instructions were provided for completion, ensuring consistency in responses. Anonymity and confidentiality were upheld, with data validation checks conducted during entry to ensure accuracy.

Quality and Error Control:

Rigorous questionnaire design, piloting, and revision were undertaken to ensure data quality. Participants were encouraged to provide truthful responses, and data entry underwent validation checks to mitigate errors. Technical validation tests were also conducted to assess system functionality and reliability.

Data Processing and Analysis:

Collected data were meticulously coded and entered into statistical analysis software for processing. Descriptive and inferential statistical techniques, including frequency distributions and correlation analyses, were employed for comprehensive analysis. Technical data such as system performance metrics were also analyzed.

Ethical Considerations:

Ethical guidelines, encompassing informed consent, anonymity, and confidentiality, were strictly adhered to throughout the study. Institutional review board protocols were followed to ensure ethical standards were met, with particular emphasis on safeguarding sensitive data.

Methodological Constraints:

Challenges encountered included limitations in sample size, potential biases in responses, and resource constraints. Additionally, the study was susceptible to inherent limitations in self-reported data and response biases. Technical constraints such as system compatibility issues and data integration challenges were also addressed.

Chapter four

Data Analysis, Presentation and Interpretation on Results

4.1 Requirement Analysis

Based on the analysis conducted by the researcher, there are good and bad outcomes that was gathered from the participants in this questionnaire survey. This research was to get better idea of the data and features that is needed to be included into the system to ensure the report information will be useful for all retail company usage.

Moreover, the researcher also got a better idea of the problem in managing and tracking inventory manually in a book based on participants respond and answer. Therefore, most of the features for the system that is stated in the deliverable will be remained while there are additional report data to be included such an automatic update dashboard and integration capabilities.

4.2 System Architecture

Fig 2. shows the architectural diagram for the ITS project which follows MVC pattern that is automatically provided by Django Framework during the creation of new project. MVC indicates for Model, View, and Controller which is a logical component in the software architecture diagram. In Django framework, MVC pattern will help separating business logic and application of the software project into the 3 logical components as stated (Kausar Bagwan & Swati Ghule, 2019). This is to ensure each component will handle their own task on the website (Tutorialspoint, 2022).

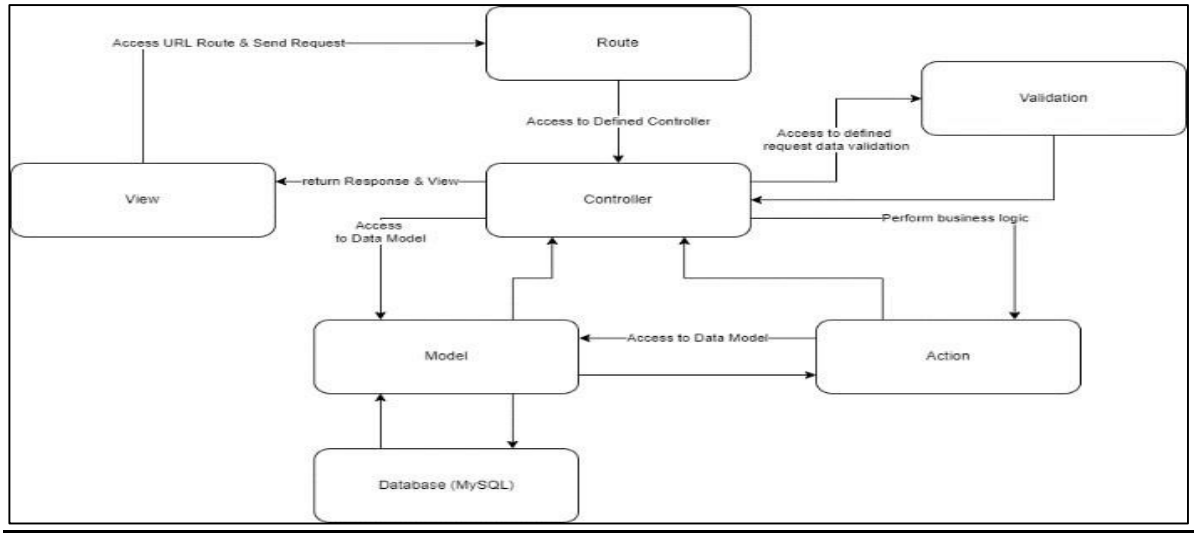

Fig. 2. Architecture diagram for the ITS project

As shown in Fig 2, there is some decouple component being made from normal MVC pattern which is the validation and action component. As normal MVC pattern, the controller is being made into handling both request, response, and business logic. By decouple business logic from controller to action class and validation class, it can help other developer to read the code more easily during the maintenance as each class will only have 1 public method name execute (Collin, 2018). At the same time, it will save any code duplication by calling action class to desirable method in different controller class (Collin, 2018).

In Fig 2, there are 7 different components of the project system which are Route, View, Controller, Validation, Action, Model, and Database. To start, the route component is a file where all URL names are stored which also contains their defined controller class for behaviour and view name. View in the project component is user interface for web pages that stores HTML, CSS, and JavaScript, and others related web user interface library inside blade file. After that, there is controller component where all the controller class are used for handling request that is given from route and return a response or view of web pages (Aakashpawar, 2019). Then, there is validation component where all the validation class are used for validating request data according to stated coded rule function. As for action component, it is classes used for storing business or functional logic that is like an API. At the same time, model component is like an API that allows developer to code for storing, update, and fetch data from database component using Django eloquent and

query builder feature which it is being utilise in action class or component (Kausar Bagwan & Swati Ghule, 2019).

The flow of Fig 2. starts with user using a specific URL from route component. With the specific route, it will access to the defined controller class with declared method which will normally return result of view or JSON response based on controller class function behaviour. Within the controller class of specific method, it will either perform business logic for backend data through action class then only return response with view or return response and view directly to the user. At the same time, the action class will access to specific model to query data from database like get, add, delete, and update while Controller class only access for getting data. Meanwhile, the validation component will only apply on controller component of specific method when there is request data received from the route.

4.3 Project Plan

Release plan for a software application normally describe what features and changes has been done like adding, remove, or update/improved of existing component. In this study, the researcher will discuss what has been added, remove, or update on each version towards the inventory tracking system with the stated released date. There are 3 release version that is done on the inventory management system.

Inventory Tracking system(IMS) Version 1

The inventory tracking system(IMS) version 1 was released on the 1st of April 2024 where basic functionality like add, delete, update, and view for manage information feature that is used by super admin, admin had been created

Inventory Tracking system(IMS) Version 2

The inventory tracking system(IMS) version 2 was released on the 10th of April 2024 where additional features like orders and suppliers and the dashboard were added to the system.

Inventory Tracking system(IMS) Version 3

The inventory tracking system(IMS) version 3 was released on the 16th of April 2022 where minor changes on password data for update user information was done.

4.4 System Validation

Upon completing the development of the Inventory Tracking System (ITS), rigorous validation processes were undertaken to ensure its functionality, usability, and reliability.

Unit Testing:

Comprehensive unit testing was conducted to verify the functionality of critical system features, including adding, deleting, and updating inventory information. The tests were primarily focused on the backend components of the system. While frontend testing was not explicitly included in unit testing, minor frontend validation was performed during the process. Unit tests were executed iteratively throughout the development phase, allowing for the identification and resolution of small errors and bugs.

User Acceptance Testing (UAT):

Three selected testers, representing various user roles within the retail environment, were enlisted to perform user acceptance testing. The objective was to evaluate the system's usability, performance, and alignment with user expectations.

- **Tester 1:** Acknowledged the system's utility in managing inventory, particularly appreciating the email notification feature for low and out-of-stock products. Additionally, provided valuable feedback on enhancing the system to record return products and addressed a minor business logic error related to feedback submission.
- **Tester 2:** Found the system beneficial but highlighted difficulties in using certain features, notably the process of creating customer orders. Specifically, mentioned challenges in locating products within dropdown menus, suggesting improvements for ease of use.
- **Tester 3:** Overall, found the system acceptable, emphasizing its significance in managing product stocks within their store. However, raised concerns regarding the system's interface aesthetics, suggesting enhancements such as incorporating product images.

4.5 Implementation of Feedback

Feedback gathered from user acceptance testing was meticulously analyzed and categorized for future implementation and system improvement. The identified business logic error and usability challenges were promptly addressed by the development team. Solutions were devised to record return products, optimize the process of adding items to customer orders, and enhance the system interface with visual elements

Chapter Five

Discussion and Findings

Bridging Theory with Practice

The investigation into inventory management systems, informed by both theoretical literature and practical development, yielded significant insights into addressing manual inventory management challenges and advancing industry practices. By synthesizing the findings from the literature review with the outcomes of the study, this final chapter presents a comprehensive discussion and analysis of key findings, implications, and recommendations.

Addressing Manual Inventory Management Challenges: The study reaffirmed the challenges associated with manual inventory management, including inefficiencies, errors, and limited visibility. By highlighting these issues, the need for automated solutions, such as the developed web application, became evident. The findings align with existing research by Pasaribu (2021) and Aamir Khan et al. (2019), who emphasized the importance of error reduction and streamlined processes in inventory management systems.

Trends in Web-Based Inventory Tracking: The findings supported the trend towards adopting web-based applications for inventory tracking, aligning with the study's focus on developing a solution tailored to small and medium Enterprises(SMEs). By addressing the gap between traditional methods and modern solutions, the study contributed to advancing industry practices.

Barriers to Adoption Among SMEs: Identified barriers like cost, complexity, and suitability were addressed through the development of a user-friendly, affordable, and customizable web application. By overcoming these barriers, the study aimed to facilitate greater adoption of inventory management systems among SMEs. The insights from the literature review underscored the importance of considering cost constraints and project timelines, as highlighted by Arina Ramlee and David Henry (2019).

Aim and Objectives of the Study: The study aimed to develop a cost-effective, user-friendly, and customizable web application, aligning with the identified needs of SMEs. Through rigorous technical research, development methodologies, and validation processes, the study demonstrated a commitment to achieving its objectives.

Impact on Retail Businesses: By relating the findings to the broader context of retail operations, the study highlighted the potential impact of the developed web application on inventory management processes, customer satisfaction, and business growth. Through technological innovation, the study aimed to drive efficiency and competitiveness in the retail sector.

Comparative Analysis with Existing Research: The study's findings aligned with existing literature on inventory management systems, emphasizing user-centric design and iterative development methodologies. While some deviations were observed, the underlying principles remained consistent with industry standards. Comparative analysis with similar systems highlighted the unique features and functionalities of the developed system, offering a compelling alternative for businesses seeking comprehensive inventory management solutions.

Chapter Six

Recommendations, and Conclusion

6.1 Implications

The implications drawn from the study's findings offer valuable insights into the practical application of inventory management systems and their impact on retail businesses. These implications, coupled with recommendations for future research and a conclusive summary, provide a comprehensive perspective on the significance of the study.

The findings underscore the transformative potential of web-based inventory management systems in streamlining operations, enhancing data accuracy, and improving decision-making in retail settings. By addressing the challenges associated with manual inventory management methods, businesses can leverage technology to optimize resource utilization and drive growth.

Moreover, the identification of barriers to adoption among SMEs highlights the importance of user-centric design and affordability in system development. Understanding the unique needs and constraints of small to medium-sized enterprises is crucial for developing solutions that cater to their requirements effectively.

The technical research and system development methodologies discussed offer practical insights into the selection of tools, frameworks, and methodologies for building robust inventory management systems. By adopting best practices in system architecture, development, and validation, businesses can ensure the successful implementation and adoption of inventory tracking solutions

6.2 Recommendations

Advanced Features Integration: Exploring advanced features such as AI-based forecasting, IoT integration for real-time tracking, and predictive analytics can further enhance the capabilities of inventory management systems, enabling proactive decision-making and resource optimization.

Continuous User Feedback: Implementing mechanisms for gathering continuous user feedback and conducting usability testing can facilitate ongoing improvements to the system's user interface, functionality, and overall user experience. Incorporating user feedback loops ensures that the system evolves in alignment with user needs and preferences.

Enhanced Data Visualization: Investing in enhanced data visualization tools and techniques can provide stakeholders with intuitive insights into inventory trends, stock levels, and performance metrics. Visualizing data through interactive dashboards and reports enhances data-driven decision-making and facilitates strategic planning.

Scalability and Flexibility: Designing inventory management systems with scalability and flexibility in mind enables businesses to adapt to changing requirements, scale operations seamlessly, and accommodate future growth. Modular architectures and flexible deployment options contribute to the system's long-term viability and sustainability.

6.3 Future Direction

Meanwhile there is also future enhancement that can be made on the system that is based on the feedback given by the tester in UAT test and the researcher ideas due to time constraint of the project.

The first future enhancement that can be made is to provide a search feature inside dropdown value especially for searching products in report or add customer order form. This will provide better user experience where user can design the desirable product in the dropdown component more easily.

Secondly, an additional data of product picture needs to be added to the system as requested by the tester. This is because the picture helps staff to identify variety and description the product. For example, there are varieties of milo flavors such as original, caramel, vanilla and cocoa.

Lastly, the system also needs an additional module for recording return product data that is based on customer order after valid feedback were given. Sometimes, product will be delivered at faulty condition due to unexpected circumstances.

6.4 Conclusion

The developed inventory tracking system aims to provide a free software that can be used by small to medium retail store that stills manages inventory manually in Uganda. Moreover, it also helps a retail store to track down the next arrival of product stocks and record customer order for reservation for the product in the store inventory. In overall, the inventory tracking system achieved the general of inventory management activities but there are more additional features like recording feedbacks and assigning staff for order delivery and many more that can be used by the user if needed. Even though the inventory tracking system has been fully developed by the developer, there are still limitations found and future enhancement that can be made towards the system.

6.4.1 Limitation

The first limitation of inventory tracking system is that the system only stores inventory, product, and sales information of the retail store based on only one inventory location. This is because most huge retail store businesses will have multiple inventory location to store their assets and products. However, small retail store will have only one inventory location as their businesses is small while medium size business retail stores that have more than one inventory location for storing their assets and product will face the limitation of using the proposed inventory management system. As the project timeline is very short, the developer did not aim to store inventory information from multiple locations.

Secondly, the customer order payment collectible only manually updates and records how much amount that is collected by the customer into the system. This is a system limitation as record or process payment transaction of credit card, debit card, or online banking is not useable on personal websites.

Lastly, the inventory tracking system is also not open to IOT features like scanning barcode on the arrival product. Features like barcode scanning can help to staff identify and search the product faster in the inventory without opening the product package itself which is useful for inventory management. This is because website application development for Django currently does not have a way to implement for scanning product barcode even if the website is developed dynamically for

mobile phone browser to use. defect product return by the customer to view how much loss affected to the company.

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