Covenant Journal of Informatics & Communication Technology. Vol. 12, No. 1, June, 2024
ISSN: *print* 2354 – 3566 *electronics* 2354 – 3507 DOI:

An Open Access Journal Available Online

Development of Academic Warehouse Inventory Management System for Educational Institutions

Abraham Ayegba Alfa[1], Lateef Caleb Umoru[2], Daniel Jonah Idoko[3], Mohammed Babatunde Ibrahim[4]

[1&2]Confluence University of Science and Technology, Osara, Nigeria
[3]Kogi State College of Education, Ankpa, Nigeria
[4]Kwara State University, Malete, Nigeria.
alfaaa@custech.edu.ng, umorulc@custech.edu.ng, dannyidoks@gmail.com, imbamok@gmail.com

Received: 10.03.2024 **Accepted: 21.06.2024**

Publication: June 2024

Abstract—Inventory control and management are a core in assessing operational efficiencies of organisations. Reasons being that, understocking, overstocking, out-of-stock, material theft, and delivery delays hampers operations of organizations like educational institutions. In developing economies, there is still slow and little adoption of advanced technologies in the services rendered by warehouses of organization including quantity of items held, monitored, recorded and tracked, which are performed manually causing large delays in processing inventory, inaccuracies and inconsistencies of stock records, duplication of stock requests, slow or delays in processing inventories. These renewed the calls among researchers as to the need to properly and securely maintain and control inflows and outflows of items, materials and equipment necessary for effective learning and experiences of the learners. To this end, this paper developed an academic warehouse inventory management system for effective services delivery and prompt responses to needs of the educational institutions. The prototype system was developed using HTML, JavaScript, PHP, and MySQL database web programming tools. This offers better speed, accuracy, and security of inventory control and management when compared to manual approach currently in use.

Keywords/Index Terms—Automation, Inventory, Management, Manual, Stores, Records Keeping, Stock Replenishing, Academic Warehouse

1. Introduction

The warehouse management systems are intended to increase the operations, speed, accuracy, and output while monitoring inventory on real-time basis hitherto absent in contemporary inventory approaches of organizations (Zaman et al., 2023). Inventory management enables enterprises' decision makers when addressing the uncertainties and circumstances such as overstock, understock, through strategic feedback on diverse activities and events overtime like inbound, outbound, and up-to-date stock data (Marziali et al., 2021; Pasaribu, 2021).

Inventory-aggravated challenges exist for businesses and organizations in the quest to maintain balance between excess inventories, insufficient inventory; and to fulfill demands of the clients (Mulandi et al., 2019; Akinlabi, 2021). The inventory control forestalls excess items, which raise investment capital requirement, expanded storage facilities, and costs expended on stored goods (Pasaribu, 2021).

The drastic shift from the traditional inventory management systems, like the Lean manufacturing and Just-In-Time, towards technology-driven approaches is to cope with increasing demands for variability in products, customer service, workloads, efficiency, and turnaround of companies (Paul et al., 2019). Also, the electronic inventory management systems decentralize decision-making processes, generate comprehensive and timely reports, and prompt products movements across the value chain of the organizations (Marziali et al., 2021; Paul et al., 2019; Kaewchur et al., 2021; Mashayekhy et al., 2022).

The recent entrant into the world of electronic warehouse inventory management is educational institutions whose performances, survival and service delivery rely on essentials goods/items availability at any point in time (Mohammed et al. 2019; Sauer et al., 2022; Ahunanya et al., 2022; Edem et al., 2022). The paper designs and implements a prototype electronic warehouse inventory system for educational institutions in low-income countries.

The structure of the paper for the subsequent sections include (Misra, 2021): section 2 is the related studies. Third section is the materials and methods. Section 4 is the system implementation. Fifth section 5 is the conclusion.

2. Related Studies

Azeta et al. (2016) developed an academic research management system for the use of the scholarly communities. The system was built on HTML, MySQL server database, hypertext preprocessor, and unified modeling language to increase learning and access to research items.

Sowunmi et al. (2016) developed expert system for recommending suitable academic majors to cover the human career counselors' paucity. To validate the aptness of intelligent systems like expert systems in overcoming educational advisory tasks. Authors added that ontologies (expert systems)

could offer higher robustness with the help of human career counselors. The HTML/CSS based web system is most beneficial to users like students and staff members.

Adewumi et al. (2016) built an automated emergency report and response system to overcome maintenance and management of infrastructure on educational campuses in low-income regions. The android mobile app platform was used for the implementation.

Paul et al. (2019) developed a warehouse inventory management system for monitoring and tracking position of items in the warehouses using RFID and web technologies. The system is a low-cost solution and user friendly and increases performances of staff in delivering services to customers in marketplaces.

Li et al. (2019) adopted machine learning strategy to effectively identify key parameters, and sales record information to project the expectations to basic trend fit. The enterprise resource management system was capable of coordinating, optimizing, and managing warehouse supply chain globally.

Yuvaraj et al. (2020) developed an inventory management application with Tkinter and SQLite platform that creates a way towards progressively from traditional applications to a fully connected and customized inventory management system. The digitized inventory management system rises flexibility, smart storage, reliability, resource utilization, easy access to product location and warehouse management.

Abayomi-Alli et al. (2020) developed an automated system for managing transport system on academic campuses. A smart system for ticketing using RFID, microcontroller, and Bluetooth was designed and implemented. This solves mismanagement, poor accounting, cost, and ineffectiveness of old system.

Cristiani et al. (2020) introduced the use of small Unmanned Aerial Vehicles to automate warehouse inventory process in order to improve workers safety and proficiency. This approach provided better success rate in identifying package detection and inventory completion time.

Pasaribu (2021) introduced a web-based inventory information system using YII framework and model view controller to overcome the problems with manual management (or paper-based records keeping). It enables accurate and prompt displays of incoming and outgoing products transactions, which can be recording, processing and reporting of inventory data for CV T. Kardin Pisau Indonesia manufacturing company.

Ananthi et al. (2021) proposed an industrial inventory control system, which is based on the Internet of Things technology. It tracks the inventories attached to the card, stock data and timestamps for more confirmation. The Raspberry Pi serves as a cooperative controller for all data management. The entire mechanism generates an archetype that corresponds to data and information flows. The web page was designed for ease of monitoring items and interacting with users. In comparison to the current warehouse inventory system, the developed management system is a very low-cost system that operates

dynamically.

Ashari et al. (2022) developed a Web-based Inventory System for gathering information about inbound and outbound goods in PT Telkom Akses, Indonesia. The system was built with CodeIgniter3 Framework and Scrum methodology. Scrum utilized the Agile principal, which refers to team collaboration, product incremental, and iterative processes to achieve goals.

Wu & Lu (2022) built an enhanced YOLOv3 for detecting the cups stored on the warehouse shelves by counting quantity to obtain automated inventory management. Cameras were mounted in the warehouse to collect images and transmitted to the industrial computer, which runs the YOLOv3 network for high detection rate.

Lorenzo et al. (2022) proposed omnichannel replenishment process for dynamically optimizing a shop or intermediate warehouse inventory for a wide range of products using a sales forecast for the purpose of fulfilling the demand of all of the channels. The proposed method relied on simulated annealing and particle swarm optimization (PSO) metaheuristic, which offered higher sensitivity for replenishing inventory across several channels and products.

A company needs to have products control system for the purpose maintaining sales and sell quality products and compete effectively with competitors. But the current product inventory processing is not optimal because it uses previous inventory data; the varying amount of inventory and the high frequency of ordering.

Kholil (2022) compared the Continuous Review System (Q) and the Periodic Review System (P) methods. The most suitable method was the Q method based the total inventory cost of Vegetable Oil Products of Rp.

Okoye et al. (2022) examined availability of EMs, stock-out duration, and accuracy of record keeping in health centers, which were unsatisfactory low. The absence of computer-related solutions and health personnel, and long bureaucracy continue impact negatively on the inventory management systems of health centers and facilities in Nigeria scenarios.

Argun & Alptekin (2023) developed a variational autoencoder unsupervised learning approach for detecting stock inaccuracies in a biggest supermarket chain in Turkey. The outcomes revealed that, low and high inventory quantities of product or product categories were easily detected using the proposed approach.

Dharmayanti et al. (2023) examined the impact of the digital innovations in supply chain management effectiveness of Indonesian firms. The financial performance of firms improved while the supplier risk evaluation and reduction were better after adopting digital technology.

Zaman et al. (2023) noted that, digital technology had a big role to play in warehouse management systems especially in raising the comparative advantage and effectiveness of supply chain management of enterprises. Such a system takes account of all transactions, assets of the company, stores and report accordingly. There is a little done in

educational sector.

Zhang et al. (2023) understudied the relevance of ICT in the advancement of smart supply chains among academic. The data propelled services, quality, traceability, risk reduction, etc., are a few benefits of digital incursion in organizations. Automation of warehouses and the prospects of involving ICT for warehouse management are still open research.

Richey et al. (2023) discussed about the potentials of overcoming stockouts and fill rates in many logistic problem of enterprises. The Deming, Just-in-Time, and learn experts are gradually less applicable because of the focus on customer and service level measurement. Educational institutions can leverage on the digital innovations of automated inventory controls systems.

There are still issues of transparency, security, trust, and decentralization of supply chain management for e-commerce and organizational operations. Rejeb et al. (2023) introduced the blockchain to address the traceability issue, which enable data verification, and standard practice.

Soni et al. (2023) built a web system for managing the financial transaction in an academic institution. The HTML, JavaScript, Bootstrap, PHP, CSS, SQL, and Ajax tools were used for the implementation. The outcomes include: managing data, tracking transaction, and raising efficiency. Other forms of transactions can be managed too.

The summary of the trends in the literature on the inventory management and control systems research over the past seven years is presented in Table 1, which revealed slow start in educational sphere.

Table 1 Trends in inventory management research.

Year	Scope of study	Methods	Gaps
2016	Academic research inventory system, academic majors counselling ontology.	Web platform, mobile app.	Scholarly material, advisory /recommender services.
2019	Sales and items warehouse inventory.	RFID web technologies.	Non-educational.
2020	Sale and items warehouse inventory, Transport ticketing sales inventory, product inventory and packaging control.	Tkinter and SQLite, RFID, Bluetooth, Microcontroller, UAV	Non-educational and educational.
2021	Enterprise sales inventory system.	Web tool, YII framework, model view controller, Raspberry Pi, IoT.	Non-educational.
2022	Enterprise sales inventory system, product inventory system, health inventory system.	Web tools, CodeIgniter 3, Scrum, YOLOv3, cameras, images, PSO metaheuristic.	Non-educational.

2023	Enterprise product inventory system, supply chain management system, enterprise warehouse process automation,.	Variational autoencoder unsupervised learning algorithm, blockchain, web tools.	Non-educational.

3. Materials and Methods

3.1 Analysis of the System

The traditional warehouses are responsible to the host community and operations of the educational institutions. It renders services to individuals like supply of educational materials, items, equipment in the right quantity at the right time. This paper provides enhancement over the traditional warehouse inventory system in the following ways:

a) Accurate identification of materials supplied to the warehouse.
b) Speedy operations of the warehouse due to improved storage of relevant information about the various materials.
c) The ledger charge is replaced with digitalized records.
d) Ease of modifying, adding and removing items maintained at the warehouses.
e) Restricted access to information and records with users' login privileges.
f) The status of different items available in the warehouses is promptly determined for necessary actions.
g) There is capability of verifying accurate stocks available in the stores at any point in time, and control and track movements of items to and out of the stores premise.

3.2 System Requirements

The minimum hardware and software required for building the proposed warehouse inventory management system are shown in Table 2.

Table 2 The system requirements.

Parameter	Attribute
Operating system	Windows 8
HDD	180GB
Processor speed	2.0GB
System processor type	64-bit
Database	MySQL
Application platform	WAMP Server 2.5
User Interface	PHP
Server	Apache Web Server
Browser display	IE 10

3.2.1 Functional Requirements

The required functionalities and operations of the proposed system include:

a) The system should accept have submissions in form of raw items, equipment, disposable items, staff and transaction at the point submission.
b) The system should perform analysis of items and resources, inventory, orders, updates and monitoring deliveries.
c) The system should authenticate the system users.
d) The system should generate reports whenever demanded.
e) The system should disallow indiscriminate deletion, update and retrieval of records in the database.

3.2.2 Non-Functional Requirements

The non-functional requirements of the proposed system include:

a) The system should verify and validate all user input.
b) Users must be notified in case of errors detected whenever system is deployed.

c) The system should have allowance for expansion.
d) A system should have a high performance and reliability level.

3.2.3 User Requirements

The user is required to operate the proposed system as follows:

a) Search for items, equipment and resources
b) Register users, items.
c) Update, transaction records, users, items, orders
d) View and display of reports of all sorts.
e) Allocation of users' access rights and privileges to the system.

3.2 System Flowchart

The sequence of steps for operating the prototype of the proposed college stores inventory system is illustrated in Figure 1.

4. System Implementation

4.1 Setup of the Application Packages

The warehouse inventory management system application was installed on the local disk drive (C:\) of the target PCs, by hitting the "create database" link as shown in Figure 2.

The process of setting up of the application program ensure that the database and its elements are created to ensure proper management of inventories and warehouse transactions effectively.

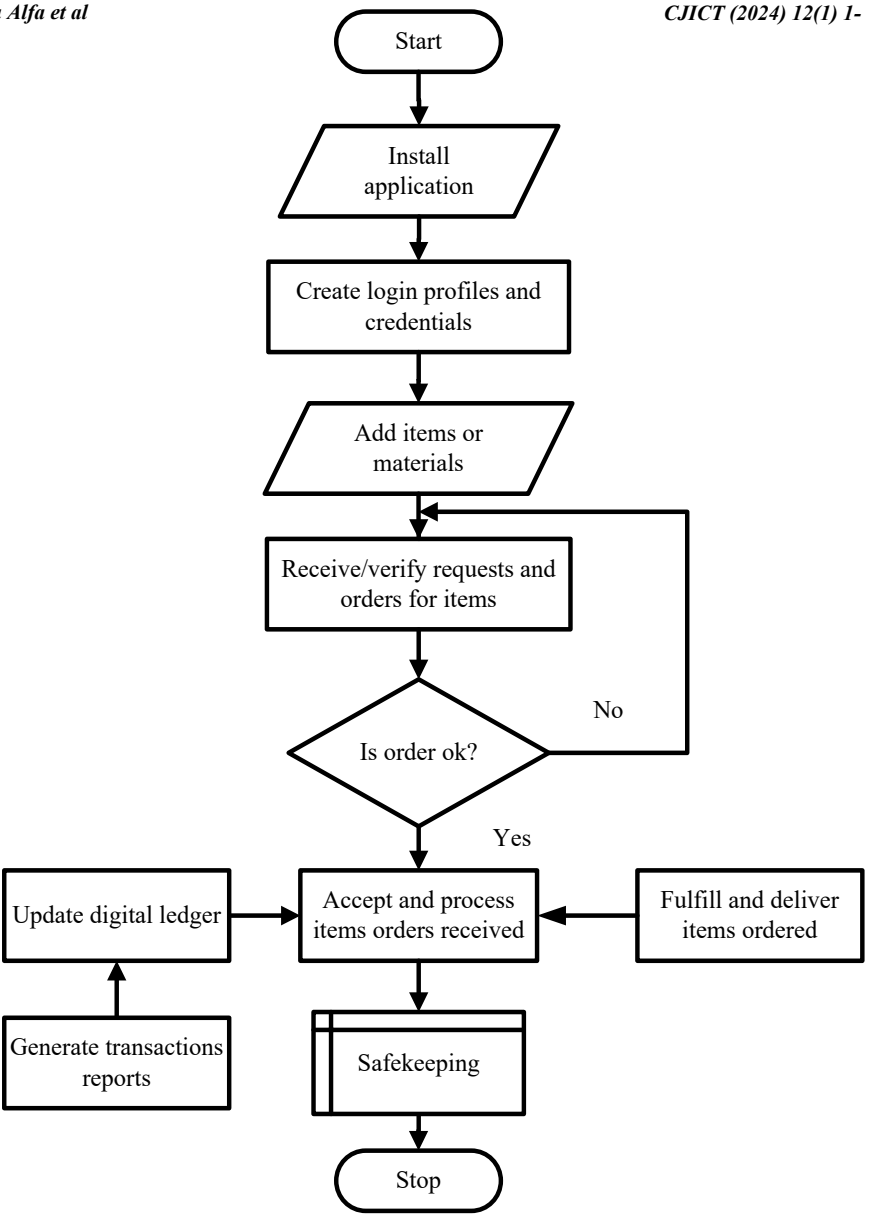


Figure 1 Flowchart of the Proposed Warehouse Inventory Management System.

4.2 Staff Account Creation

After successfully setting up the application program, the system users are expected to generate their login details by supplying information such as Username and Password as shown in Figure 3.

The security of the application system provides the effectiveness control and regulation of items and materials in and out of the college stores. The result is prompt and adequate supplied of various educational materials to support research, teaching, and learning activities.

Consequently, the password information was scrambled (or encrypted) to avoid sniffing and unauthorized accesses of persons.

The login form verifies the username and password provided by the system users before granting sessions to the application environment as illustrated in Figure 4.

The username is unique to every staff user and cannot be duplicated throughout the lifespan of application usage for the purpose of accountability. The dynamic webpage is displayed upon successful verification and validation of system users' username and password as shown in Figure 5.

From Figure 6, the homepage is the dynamic webpage that serve as links for the various operations of the proposed system such as Staff details creation, Receive Items, Deliver Items and Status, which are discussed in next subsections.

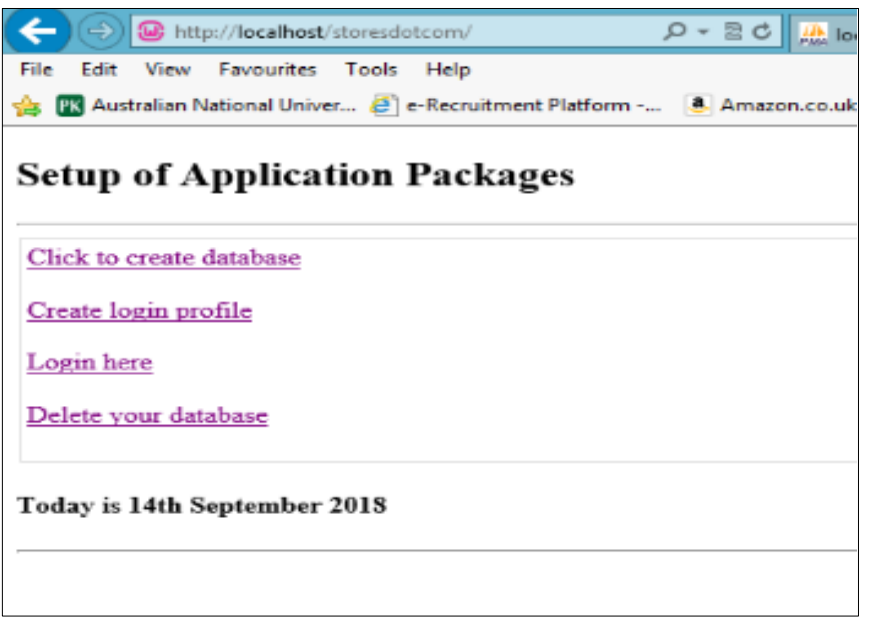


Figure 2. The Application Setup Page.

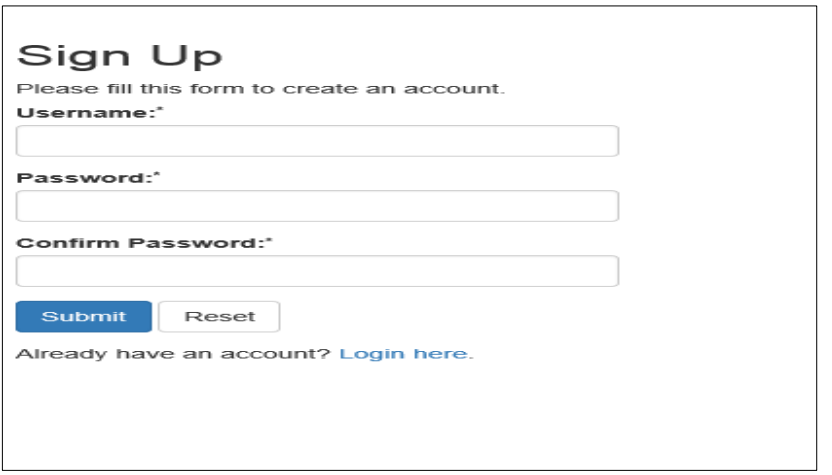


Figure 3 User Account Registration Form.

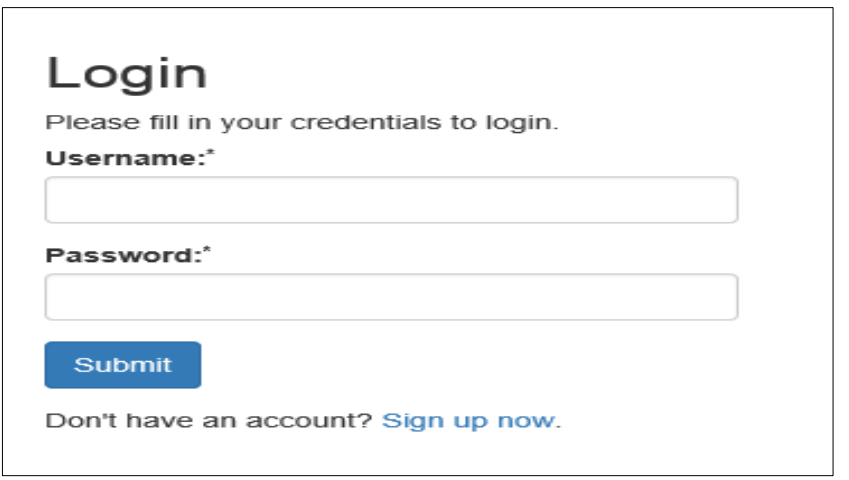


Figure 4 User Login Form.

4.3 User Details Creation Functionality

The warehouse staff users' personal information can be created, edited and deleted for as shown in Figure 6.

After entering correct users' contact information, unique identifications are generated automatically for ease of recognition and verification management. These unique identifications numbers are required for all transactions relating to stores inventory throughout all the services points of the college stores.

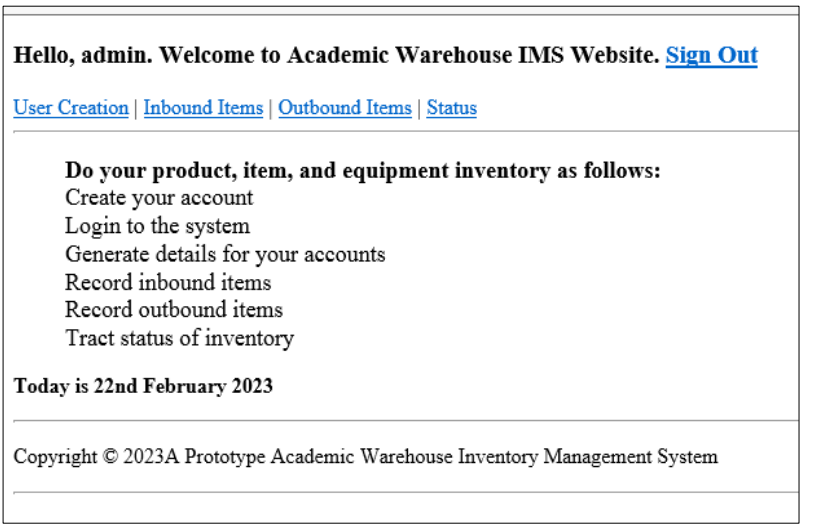


Figure 5. Dynamic Homepage Interface.

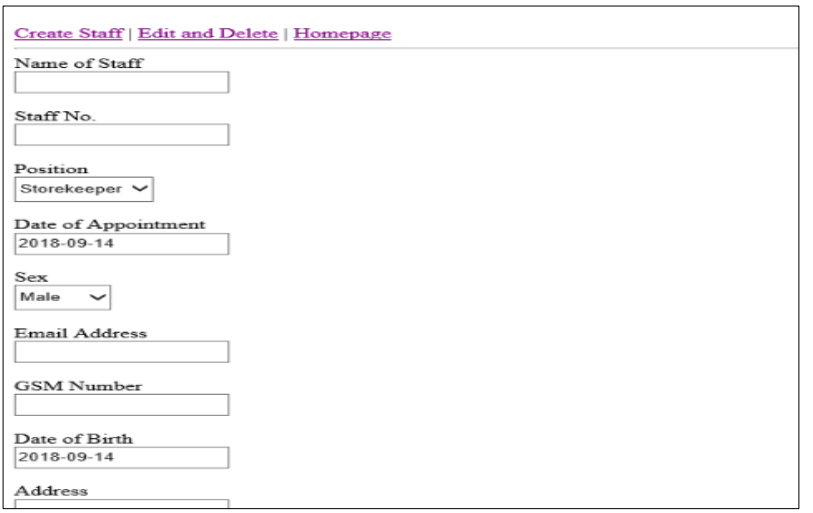


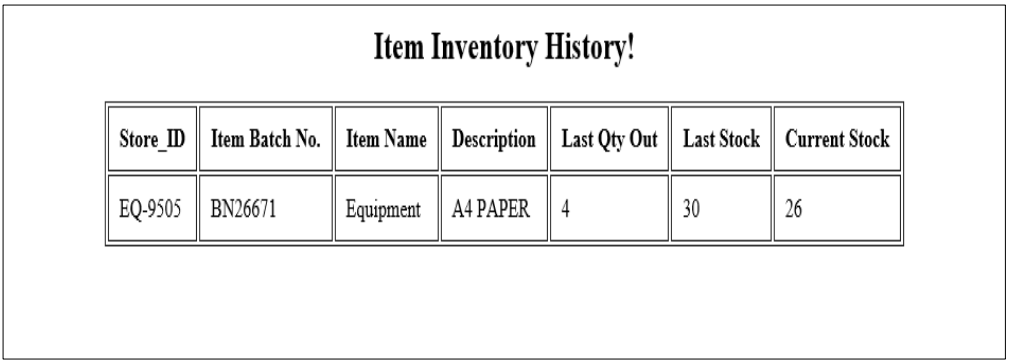
Figure 6. Warehouse Staff Users' Creation Form.

4.4 Item Inbound Records

The process of documenting the details about items, materials and equipment arriving or supplied to the warehouse are performed electronically using the Add Item Link on the homepage as shown in Figure 7. The items, equipment and materials as shown in Figure 7 are accurately and timely entered to the system with unique code, store_id. Again, updates, search and viewing of records can be accomplished.

Figure 7. Inbound Item Entry Form.

Figure 8. Item Outbound Records Entry Form.



Item Inventory History!

Store_ID	Item Batch No.	Item Name	Description	Last Qty Out	Last Stock	Current Stock
EQ-9505	BN26671	Equipment	A4 PAPER	4	30	26

Figure 9. Item Inventory Information Interface.

4.2 Item Outbound Records

The details concerning items, materials and equipment leaving the stores upon request are appropriately the documented digitally using the deliver items link as on the homepage as shown in Figure 8.

From Figure 8, the items, equipment and materials outbound are accurately and timely entered to the electronic database using store_id of item. Again, updates, search and viewing of records can be done. The reports of items, materials and equipment availability, and quantity available in stores can be generated automatically for assessments, audits, appraisals, services improvement, inventory control and management as shown in Figure 9. In Figure 9, the values of stock and last transactions details can be generated such as store_id, item batch no, item name, description, last qty out, last stock and current stock position for items. Therefore, this system can effectively assist college stores unit to control and monitor items, materials and equipment under their care for prompt fulfilment of educational needs, inventory control, accounting and audit purposes at any given point in time. This is not the case of the existing stores inventory system which is manually driven.

5. Conclusion

This paper developed warehouse inventory management system for educational institutions in Nigeria for effective record keeping, items estimation, status update, accurate inventory information which was previously carried out manually. The proposed system monitors and forecasts items/stocks shortages on timely basis. It assists the administrations and stores departments to timely make replenishing and restocking, and process orders effectively. It improves the service delivery and report generations. It provides detailed trails of items to and from the warehouse facility for accountability and monitoring. The incidences of organized theft and misuse of organizational items by staff are reduced to barest minimum. The process of learning and teaching can be greatly improved with prompt supply of required materials such as examination answer booklets, chalks, dusters, pens, desks, chairs, and other stationaries. However,

the paper could not measure the usability of the develop prototype system.

5.1 Recommendations

This paper offers the following recommendations:

a) There is the need to formalize and deploy the new system across educational institutions in Nigeria to improve their warehouses inventory operations and services delivery to their host communities.
b) There is the need to improve on the new system design to include more personalized services such as institutional procurement processes.
c) of education in Nigeria to improve warehouses operations and services delivery to their host communities.
d) There is the need to improve on the new system designs to include a more personalized services such as institutional procurement processes.

References

Adewumi A, Misra S, Parejas FJ, Crawford B (2016) Mobile-based emergency report and response system for academic instiurions of developing countries.

Ahunanya V, Ovharhe OH, Emenike CG, Otto G. (2022) Consignment Inventory System and Entrepreneurial Success among Micro Warehousing Firms. Int J Soc Sci Manag Res 8 (5) 18–28.

Akinlabi BH (2021) Effect of Inventory Management Practices on Operational Performance of Flour Milling Companies in Nigeria. Int Acad J Manag Mark Entrep Stud 8 (2) 137–74.

Ananthi K, Rajavel R, Sabarikannan S, Srisaran A, Sridhar C (2021) Design and Fabrication of IoT based inventory control system. In: 2021 7th International Conference on Advanced Computing & Communication Systems 1101–4.

Argun H, Alptekin SE (2023) Variational autoencoder-based anomaly detection in time series data for inventory record inaccuracy. Turkish J Electr Eng Comput Sci 31 (1).

Ashari IF, Aryani AJ, Ardhi AM (2022) Design and build inventory management information system using the Scrum method. J Sist Inf 9 (1) 27–35.

Azeta AA, Ikpefan O, Gberevbie D, Omoregbe NA, Misra S, Olowonihi P (2016). Closing institutional gaps through academic research management system and implications in Nigeira. International Journal of Pharmacy & Technology 8 (4) 2296-22914.

Cristiani D, Bottonelli F, Trotta A, Felice MD (2020) Inventory Management through Mini-Drones: Architecture and Proof-of-Concept Implementation. In: 2020 IEEE 21st International Symposium on A World of Wireless, Mobile and Multimedia Networks 317–22.

Dharmayanti N, Ismail T, Hanifah IA, Taqi M (2023) Exploring sustainability management control system and eco-innovation matter sustainable financial performance: The role of supply chain management and digital adaptability in Indonesian context. Journal of Open Innovation: Technology, Market, and Complexity 9 (3) 100119.

Edem B, Anane A, Awuah G (2022) The Effects of Inventory Management Practices on Educational Service Delivery: A Case Study of Sunyani Technical University, Ghana. Asian J Econ Bus Account. 22 (20) 55–68.

Kaewchur P, Sritong C, Sriard B, Nima T (2021) Role of Inventory Management on Competitive Advantage of Small and Medium Companies in Thailand. Turkish J Comput Math Educ 12 (8) 2753–9.

Kholil M (2022) Inventory Control of Vegetable Oil Products Using Continuous Review System (Q) Approach and Periodic Review System (P) Methods in Retail Companies: A Case Study of Indonesia. Int J Sci Acad Res 2 (4) 11–6.

Li J, Wang T, Chen Z, Luo G (2019) Machine Learning Algorithm Generated Sales Prediction for Inventory Optimization in Cross-border E-Commerce. Int J Front Eng Technol 1 (1) 62–74.

Lorenzo-Espejo A, Munuzuri J, Guadix J, Escudero-Santana A (2022) A Hybrid Metaheuristic for the Omnichannel Multiproduct Inventory Replenishment Problem. J Theor Appl Electron Commer Res 17 476–92.

Marziali M, Rossit DA, Toncovich A (2021) Warehouse Management Problem and a KPI Approach: a Case Study. Manag Prod Eng Rev 12 (3) 51–62.

Mashayekhy Y, Babaei A, Yuan X-M, Xue A (2022) Impact of Internet of Things (IoT) on Inventory Management: A Literature Survey. Logistics 6 (33) 1–19.

Misra S (2021) A Step-by-Step Guide for Choosing Project Topics and Writing Research Papers in ICT Related Disciplines, Communications in Computer and Information Science 1350 727.

Mohamed RA, Kibet Y (2019) Effect of Inventory Management on Customer Satisfaction In Public Institutions of Higher Learning in Kenya. Int Acad J Procure Supply Chain Manag 3 (1) 198–216.

Mulandi CM, Ismail N (2019) Effect of inventory management practices on performance of commercial state corporations in Kenya. Int Acad J Procure Supply Chain Manag 3 (1) 180–97.

Okoye BI, Ndugba AC, Okonkwo JI, Chibuogwu J, Okafor CE, Orji FU, et al (2022) Evaluation of Essential Medicines Management in Public Health Facilities in Ekiti State

Nigeria. Int J Sci Acad Res 03 (09) 4359–65.

Pasaribu JS (2021) Development of a Web Based Inventory Information System. Int J Eng Sci InformationTechnology 1 (2) 24–31.

Paul S, Chatterjee A, Guha D (2019) Study of Smart Inventory Management System based on the Internet of Things (IOT). Int J Recent Trends Bus Tour 3 (3) 27–34.

Rejeb A, Rejeb K, Simske S, Keogh JG (2023) Exploring blockchain research in supply chain management: A latent Dirichlet allocation-driven systematic review. Information 12 14 (10) 557.

Richey Jr RG, Chowdhury S, Davis-Sramek B, Giannakis M, Dwivedi YK (2023) Artificial intelligence in logistics and supply chain management: A primer and roadmap for research. Journal of Business Logistics 44 (4) 532-49.

Sauer PC, Orzes G, Culot G (2024) Blockchain in supply chain management: a multiple case study analysis on setups, contingent factors, and evolutionary patterns. Production Planning & Control 35 (9) 901-16.

Soni S, Chandra P, Gupta A, Netam DK, Kumar S, Tiwary K (2023) Design and implementation of inventory management system for university. Eur Chem Bull 12 (4) 13746-13759.

Sowunmi OY, Misra S., Fernandez-Sanz L, Medina-Merodio, JA (2016) Framework for academic advice through mobile applications. 25th International Conference on Information Systems Development 332- 344.

Wu W-S, Lu Z-M (2022) A Real-Time Cup-Detection Method Based on YOLOv3 for Inventory Management. Sensors 22 (6956) 1–17.

Yuvaraj K, Oorappan GM, Megavarthini KK, Pravin MC, Adharsh R, Kumaran MA (2020) Design And Development of An Application For Database Maintenance In Inventory Management System Using Tkinter And Sqlite Platform. IOP Conf Ser Mater Sci Eng 995 012012.

Zaman SI, Khan S, Zaman SA, Khan SA (2023) A grey decision-making trial and evaluation laboratory model for digital warehouse management in supply chain networks. Decision Analytics Journal 100293.

Zhang G, Yang Y, Yang G (2023) Smart supply chain management in Industry 4.0: the review, research agenda and strategies in North America. Annals of operations research 322 (2) 1075-117.