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An Adaptive Web-Based Inventory Control System for Universities

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Abstract:
Managing inventories is one of the major challenges that organizations such as tertiary institutions are facing. Most of the stocks kept in organizations are characterized by excessive inventory on hand, raw materials losing their quality, improper sourcing methods, poor personnel management skills, etc. There also exists a lack of accurate and timely information. In order to arrest these deficiencies, an adaptive web-based inventory control system was developed. The current inventory in the storage unit of Olusegun Agagu University of Science and Technology (OAUSTECH), Okitipupa was captured. Collection of data from the Procurement and Store Unit was done through interviews, observation of record books, and some printable data. The system was implemented using PHP, HTML files, BOOTSTRAP, and MySQL. The outcomes are the generation of timely alert messages and reports to management when the inventory level reaches an out-of-stock threshold, computation of various inventory analyses such as price levels, lead-time analysis, replenishment period demand analysis, vendors' delivery performance, and generation of low-cost stock recommender system.

Keywords: *Control system, inventory, university, web-based*

1. Introduction

Nowadays, it is observed that a small retailer/organization knows roughly the demand of his/her customers in a week or a month and accordingly places an order on the supplier/wholesaler to meet the demand of his customers. However, this is not the case with a manager of a big organization/departmental store because the stocking in such cases depends upon various factors. Hence, the real problem is to have a compromise between over-stocking and under-stocking (Verma, 2013).

Inventory is the number of raw materials, consumables items, components and spares, semi-processed materials, fuel and lubricants, finished goods, etc., that should be stocked for the smooth operation of a plant (Dessalegn & Roy, 2002). Inventory is 'usable but idle resources'. Inventories are stores of goods and stocks which are kept due to uncertainty. Most of the stocks kept in organizations are characterized by excessive inventory on hand, raw materials losing their quality, improper sourcing methods, poor personnel management skills, poor delegation of responsibilities, inefficiencies, and ineffectiveness of inventory management control system (Liu et al., 2010). Miller (2010) states that effective inventory can determine the profit-making capacity of an establishment directly or indirectly.

According to Lwiki et al. (2013), inventory management is the processing of maintaining stock levels of a given set of items incurred to meet the objectives set by management. Naliaka and Namusonge (2015) described inventory control as a means by which associated materials of the right quality and quantity are made available when required with due regard to the economy of shortages, ordering cost, purchase price, and working capital. Effective inventory management can help guide against storage costs, spoilage of stocks, pilferage, and obsolescence of materials (Adeyemi & Salami, 2010).

Enterprises like Universities must necessarily maintain inventories for the smooth and efficient running of the organization. The university's current system operates a manual inventory system; stocks, products, ordering, purchases, etc., are recorded in a book which can lead to errors and inadequate data for analysis. Information regarding stocks, products, sales, and purchases is still in black and white, which is not properly organized and managed. While the increasing pressure on the requirement of working capital suggests minimum or no inventories, it is practical to locally dispense with inventories. Loss of production due to the non-availability of materials to be used means irretrievable loss of time/profit. Non-availability of an item, when required by a staff/user, is not only a loss but could mean a loss of goodwill as well. Seasonal items necessarily have to be stocked when available to cater to the off-season requirement. In view of all these factors, 'Inventory Control' is a must for any organization. However, inventory is a necessary evil if not handled properly.

Maintaining accurate inventory levels as a decision-making process affects several areas throughout the University. The store/procurement unit/department will have to deal with an increasing demand for several items due to an increase in the number of faculties, departments, and units of the University. Attempting to contend manually with this obvious and inevitable problem will ultimately lead to a loss of productive time and money, which will result in inefficiency and, eventually, poor management. Having accurate inventory at all times allows this department/unit to make smarter decisions, and this can only be achieved through a web-based inventory control system.

Good and effective management of inventories remains critical and aimed at improving the effectiveness of an organization (Chukwuemeka & Onwusoronye, 2013). An inventory control system is a set of hardware and software-based tools that automate the process of tracking inventory (Yinyeh & Alhassan, 2013).

Chaffee (2009) states that a web-based application has been found to be essential in recent years as more organizations have started to realize the importance of applying new technology to assist current inventory practices. The importance of implementing a web-based inventory system is thus becoming vital as most of the time the information is accessible instantly, thereby making the details of the usage of the equipment available, and improving the movement and anticipation of their demand as well as the productivity of the system as a whole.

The object of this work is to present an integrated and systematic approach toward the management of independent demand inventories using a web-based inventory control system. An Adaptive Web-based Inventory Control System for Stock management in universities is a computer-based system that is capable of maintaining the flow of information within the different departments of an organization and the external environment. With this computerized system, the control of inventories which ordinarily is cumbersome and monotonous in nature as a result of thousands of different items that are to be managed manually, stocks are properly controlled and secured. The painstaking task of creating too many documents and data processing will be reduced as well. Moreover, accurate stock records can also be maintained. In today's competitive and global market scenario, managers should use computer technology in data processing and communication networking through which they can access and manipulate huge amounts of data.

2. Literature Review

Over the years, several works have been carried out by many researchers in the area of inventory control. Manthou (1994) presents a case study on the use of computer information systems in the tile of inventory management for medium to large companies in northern Greece. For manufacturing companies to satisfy the customer's demand with a delivery time shorter than the total lead-time required at least a part of the manufacturing process must have been started before the customer order arrives. To achieve this, Segerstedt (2000) has recommended a reorder point system (ROP) or material requirements planning (MRP) algorithm to be used in a practical inventory system. For the items stored, the reorder level is decided such that the available inventory will satisfy the demand until replenishment arrives. The order size is settled by a calculated economic order quantity and/or decided by the user adjusted to a suitable packing, price discount, annual demand, etc.

Dessalegn and Roy (2002) present an integrated and systematic approach to the management of independent demand inventories using computer database systems. This has to do with the integration of information to ease the flow of materials in, through, and out of a manufacturing firm in an acceptable way to meet the customer's demand.

Nemtajela and Mbohwa (2016) focused on the use of inventory models to control the material flow and purchased inventory items in manufacturing companies. The authors try to assess the effects of demand uncertainty on inventory management and also evaluate the difference in uncertain demand subject to demand controls as determined and the models used.

Manual, Barcode technology, Radio Frequency Identification (RFID), and Warehouse are the types of inventory management systems.

In the manual inventory management system, spreadsheets are used by small business owners to keep track of inventory records manually, which is done daily, weekly, or monthly. The objective is to determine whether the quantity of stocks on hand is enough to continue operations or to purchase more. The good side of this method is its cost-effectiveness in relation to the training of personnel. The main setbacks of this system are maintaining data reliability, labour-intensive technique, being easily prone to error, and not being easy to update.

The Barcode technology comprises a series of straight perpendicular lines, or bars, applied to allot a single, distinctive identification code to a material. It is used to identify and keep a record of stocks. At present, the majority of material tracking systems make use of two facets of barcodes which should be near to and within the 'line of sight' of the barcode reader. The set of this system is that the barcodes stand the risk of not working well which may result in inaccurate reading when not used well or when in contact with wet surroundings or peeled off.

Radio frequency identification (RFID) is comparatively fresh and employs a mark that transfers records assembled by a reader from a set spaced-out position. RFID applies two forms of technology to direct stock movement and they are:

- Active, and
- Passive technology

Active RFID technology is used to capture stocks in motion or move across them. Passive RFID technology involves the application of manual readers that can be handled by hand to inspect inventory movement. It greatly enhances the accuracy of transferring stocks within a stockroom (Hamlett, 2006).

Sande (2003) sees the warehouse management system as a chief fraction of the supply sequence and principally with the intent to manage the transfers and conservation of stocks inside a stockroom and bring about the related business deals together with shipping, receiving, keeping the stocks in the right place and selecting the items.

An automated inventory control system software is a computerized platform for keeping an eye on stock levels, movements, order placement, sales, and deliveries. This software package can generate bills/records for stocks, job orders, and relevant transaction papers in production outfits. The software is made up of mechanisms working together to generate a unified inventory control system.

3. Methodology

3.1. OAUSTECH Existing Inventory System

OAUSTECH inventory system follows an interconnected system of personnel from the inventory Senior Executive Officer (SEO) down to the Consumers (schools and departments/units) including the control system (Inventory management tools) which depends on the use of manual record keeping and cannot be accessed anywhere but only in the office or shelf where the records are being kept.

OAUSTECH inventory management system operates on the physical store with manual record keeping. The inventory has ten categories of items which are:

- Computer consumables,
- Computer software,
- Office equipment,
- Diesel,
- Stationeries,
- Office furniture,
- Chemical and reagents,
- Motor vehicles,
- Furniture, and
- Fitting store

The University has one store; hence, a single inventory is used. Record books, such as stock cards, goods received notes, store ledgers, and store requisition forms, are tools used to manage the inventory. Any newly received items are recorded in the ledger for easy tracking. The store ledger possesses code and folio number to make this tracking much easier.

Figure 1 illustrates the workflow of the University's inventory system, which shows that the system depends on the use of manual record keeping and cannot be accessed anywhere but only in the office or shelf where the records are being kept.

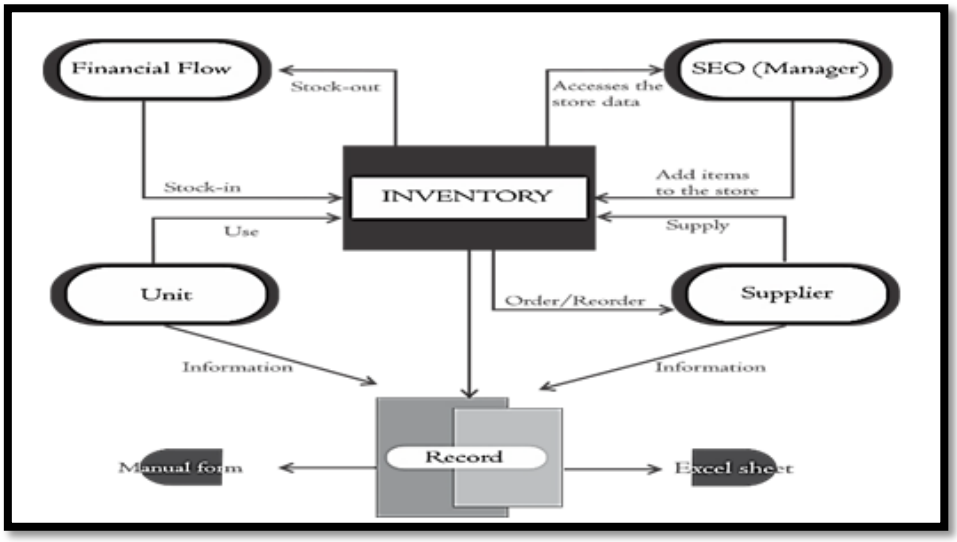

Figure 1: OAUSTECH Existing Inventory System (Work) Dataflow Diagram

3.2. Architecture of the Proposed System

The architecture of an adaptive web-based inventory control system for the university is shown in figure 2. The system comprises a user authentication process, the user interfaces for user interaction and feedback, the controller, which acts as the processor and relays infrastructure for the application, connecting the view with the controller, the model also, which is in charge of all data-related concerns and lastly the database where the inventory data are stored. The user interface acts as the interface through which users can interact with the underlying infrastructure of the application.

To access the system, the user must pass through the authentication phase, which is handled by the controller. The controller receives the user credentials from the view, validates that all the checks defined in the controller have been passed, and forwards a request to the model to spool the records. If the user exists, an appropriate response is returned, and the user is redirected to the respective page.

The controller ensures that only users with the right privileges are allowed to manage an item. Before an item can be entered into the system, users must interact first with the categories and code page. This is categorized under the view

component of the architecture. The controller handles actions done on this page and dispatches them to the model for further processing to make the data available while setting up an item. The user with the right privilege (administrator) can then make these items available on request and can track every activity related to the items. Administrators can also place a backorder or request an item on a user's behalf, making it dynamic (this is adaptable). Also, it has a notification system that triggers when an item is going out of stock or about to expire so that the appropriate steps can be taken to keep the inventory working smoothly.

The model adopts, firstly, a security approach in handling all data-related requests to ensure that the integrity of data is maintained during processing before it is stored in the database.

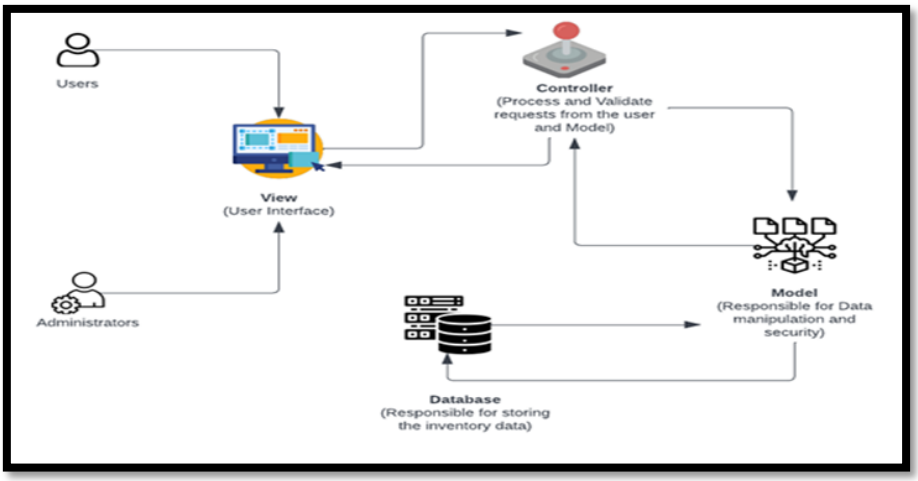

Figure 2: Architecture of an Adaptive Web-Based Inventory Control System for University

3.2.1. Components of the Proposed System

3.2.1.1. User

The system is designed for two types of users, namely: the regular users and the administrators. The regular users are the ones who are restricted to only placing an order for items and other related functions but have no administrative privileges that may relate to managing the items or users of the application**.** The administrators are the users with an elevated privilege that involves all administrative functions of the application, from managing items to creating and updating users' data and other related functions.

3.2.1.2. User Interface

The user interface is the tool through which the users interact with the underlying functions of the application. It is tightly connected to the application controller and responsible for feeding the user with the appropriate response based on user interactions. The first interface the user interacts with is the Login interface which provides a form for users to enter their credentials and navigates the user to the appropriate page based on the correctness of the inputs.

3.2.1.3. Controller

The controller is like the processor of the application. It handles every request from the user. This consists of a security layer that validates the user's input before it is allowed into the model for computing. It acts as the middleman between the user interface and the model. When a user logs in, the controller immediately invokes and starts the validation of the user's input and then passes it on to the model to find the required data. The model returns a response which is then handled by the controller, and a corresponding message or feedback is sent back to the user interface for consumption. This process is the same for every activity carried out in the system.

3.2.1.4. Model

The model is the data link of the application, which is responsible for managing any data-related requests. It uses the PHP Document Model (PDO) to handle data manipulation. This adds a level of security to ensure that there is no data breach in the process of handling such requests. The model is the only component with a direct link to the database.

4. Implementation and Results

The web-based inventory control system front-end design requires several web tools, such as Hypertext Markup Language (HTML), and BOOTSTRAP, while the back-end design tools include Hypertext Preprocessor (PHP) and MySQLi.

4.1. Preliminary Testing of an Adaptive Web-Based Inventory Control System for Universities

There are two categories of users in the application: The Administrators (The Procurement & Store Unit officer) and the Regular Users (These are staff in the other departments/units of the University who may need to request some items from the store). The system is smart enough to know which category a user belongs to and redirects the user from the

unified login interface to the appropriate page. When the user starts the web-based inventory software, the user can carry out several activities concurrently on the system through the web.

Figure 3 shows items currently in stock and available for order. It describes the categories of items in stock, the items' names, codes, folio, quantity, and price. With first-hand information on the item in stock, the user can now place an order for items in the store.

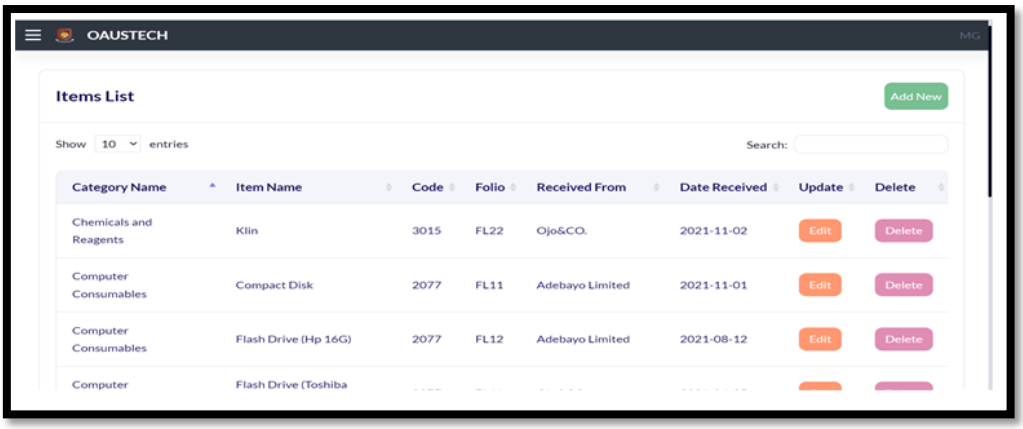

Figure 3: Items in Stock

Figures 4 and 5 show the pages for notification of expiry product(s)/item(s) and low item(s) that are in stock. One of the adaptabilities of the system is its ability to notify the administrators about items that are about to expire or running out of stock. The administrator is also notified of items in the stock that has reached a certain threshold, that is, an alert is triggered immediately after the items reach the threshold level, which has been predefined in the system. Likewise, the expiry item alert is also triggered ten days before the actual expiry date of the items, and the alert persists until the item is updated or removed.

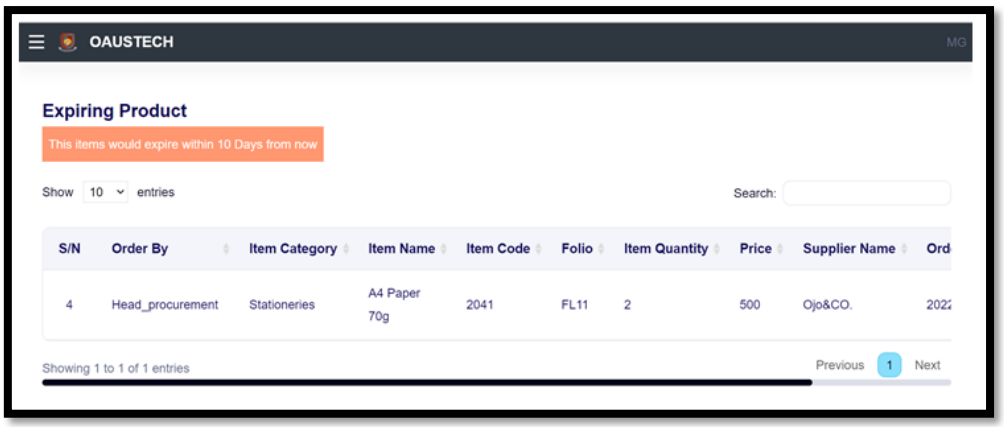

Figure 4: Expiring Items

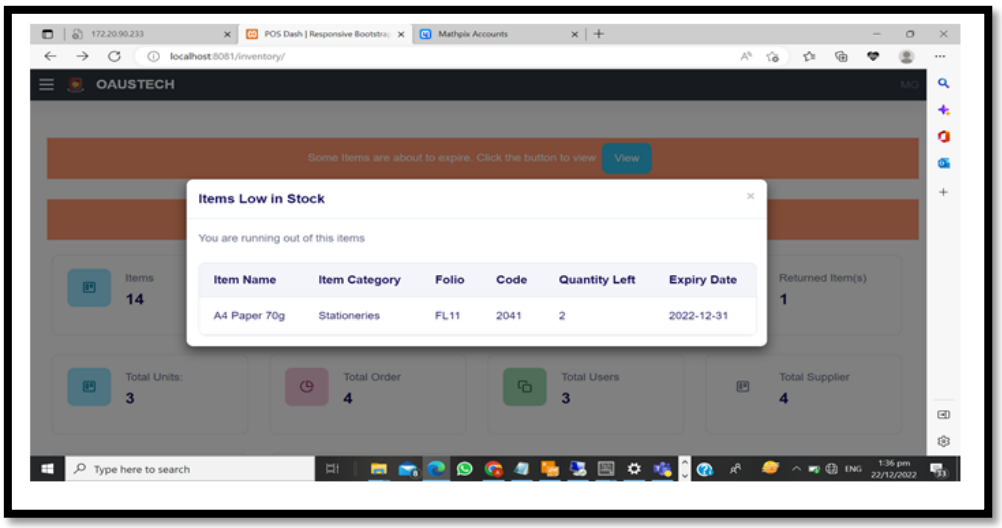

Figure 5: Low Item in Stock

This work aimed at developing an adaptive web-based inventory control system for Olusegun Agagu University of Science and Technology, Okitipupa. The work solved the challenges faced by users with the method currently used. The benefits of using the developed application for the institution include:

- To generate reorder of product
- Keep track of the on-hand balance and perform other functions, such as reporting items that are below their reorder levels
- Generate summarized reports to different levels of management for operational convenience by giving flexibility in decision-making actions
- Stored issue documents in a database to carry out various inventory analyses
- Notify by generating timely alert messages and reports to management when the inventory level reaches an out-of-stock threshold

5. Conclusion

Tracking inventory items is one of the major tasks carried out daily in the procurement and store unit of the university. An adaptive web-based inventory control system was designed to make this task easy. This system generates timely alert messages and reports to management when the inventory level reaches an out-of-stock threshold.

6. Acknowledgments

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