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AUTOMATED INVENTORY CONTROL SYSTEM FOR A UNIVERSITY CAFETERIA MANAGEMENT

Odili J.B.; Iheanacho U.

Department of Mathematical Sciences, Anchor University Lagos

***Corresponding author:**

E-mail: jodili@aul..edu.ng

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ABSTRACT

Background: The manual method of inventory control is labor intensive, costly, and error-prone and cannot ensure the inventory remains up-to-date due to oversight and internal shrinkage. With the proposed system, cafeteria inventory can be updated in real time. The automated system allows inventory status to be determined and recorded.
Objectives: This paper presents the design and implementation of an automated inventory control system for a University Cafeteria in Nigeria.
Methods: The system is designed to efficiently handle the movement and tracking of goods without human involvement. The study outlines the main concepts of the analysis and design methodology of the proposed system, compares it to the existing and goes further to explain the design and implementation of the system using Python as the primary programming language; it uses an object oriented database. The validation of the finding of the new technique is done by observation and interview of the users.
Results: The designed system in this study is able to efficiently handle the movement and tracking of goods without human involvement. It allows inventory status to be determined and recorded and automatically update.
Conclusions: Based on the results obtained from this study, we recommend that Universities all over the world should adopt the automated cafeteria inventory management systems in order to avoid the pitfalls associated with manual management system.

Keywords: Cafeteria, Inventory, Inventory management systems, Universities

INTRODUCTION

Inventory refers to the quantity of goods and materials on hand that a manufacturer uses to replace those items that are exhausted with those available for sale (Ugboya 2019). An inventory control system is a set of hardware and software based tools that automate the process of tracking inventory. The kinds of inventory tracked with an inventory control system can include almost any kind of quantifiable goods including food, clothing, books, equipment and other items that consumers, retailers, or wholesalers may purchase (Alqahtani, Buijs et al. 2020). Modern inventory control systems are exclusively based on using technology to track and control inventory (Patel and Chowdhury 2020). Inventory control systems work in real time using technology to transmit information to a central computer system (Madamidola, Daramola et al. 2020).

Companies often use inventory control systems to reduce their carrying costs (Muchaendepi, Mbohwa et al. 2019). The system is used to track products as they are transported from a vendor to a warehouse, between warehouses, finally to a retailer or directly to a customer (Ananthi, Rajavel et al. 2021). The purpose of a good inventory control system is to maintain a balance between too much and too little inventory (Purnamasari, Almira et al. 2021). It provides the foundation for monitoring product sales and measuring inventor levels. Inventory control systems acts as a blueprint for picking, packing and shipping

items from a warehouse and receiving items into a warehouse or other storage locations to cut down product obsolescence and spoilage.

Properly managing inventory requires a system of some sort (Odili, Kahar et al. 2017). It does not matter if the system consists of writing inventory levels on the back of an envelope or using the most sophisticated radio frequency identification system (Odili, Noraziah et al. 2021). As the old saying goes, "there are many ways to skin a cat", the different types of inventory control systems all have pros and cons. choosing the right one boils down to which system holds the most value for the company.

The Anchor University Cafeteria was established in the year 2017 (ODILI, NORAZIAH et al. 2018). It aims at providing satisfaction and nourishment to the University community through the distribution of food and drinks such as Coca-Cola, Fanta, Sprite and malt drinks etc. It is an important part of the university experience and for this reason, the demand is high and the university responds to the increasing demand by stabilizing supply to strike a balance. In spite of the noble efforts of the University in this direction, she has the problem of keeping adequate record of goods transfer and since it is done manually, there are associated problems of insecurity, high cost of operation and delay in supply. Data processing in Anchor University Cafeteria is presently carried out using people, pens, and paper to control stock and inventory.

The design and development of an automated inventory control system for the Anchor University Cafeteria will, no doubt, bring immeasurable relief from the problems associated with the manual system.

The rest of this paper is organized in the following way: section two presents the literature review; section three, the materials and methods; section four details the implementation of the proposed system and section five, the results and discussion of results and section six, the conclusion.

2. Literature Review

Broadly speaking, inventory may refer to a list of resources/ items/materials that are virtually or fully ready to be delivered or sold to consumers (Patra, Baral et al. 2021). Depending on the nature or type of goods or services, there are, generally, three categories of inventory (Lei, Zhang et al. 2019). For instance, in a manufacturing establishment, there will be raw materials, materials-in-process and finished products inventory. The raw materials inventory (Perminova, Lobanova et al. 2019, Odili and Fatokun 2020) as used here refers to those items which have not undergone that undergone any advanced form of processing . On its part, Materials-in-process inventory refers to those materials or items at their initial conversion stages. For instance, in a bread bakery, a batter could be said to be to be material-in-process since it is no more a raw material nor is a finished product (Odili 2017, Bhat, Kale et al. 2019). Finally, a finished products inventory contains a list of items that are ready for the market (Firdaus and Widjaja 2019).

On its part, inventory control systems are those processes deployed to track and manage inventories to ensure that the business has sufficient products for the consumers without delving into product-warehousing that could attract further costs. Inventory control could be manual or automated (Jackson, Tolujevs et al. 2020). Basically, there are four types of inventory control systems: manual inventory management system, barcode technology, Radio Frequency Identification (RFID) and Warehouse Management System (Al-Momani, Al Meanazel et al. 2020).

Manual inventory control systems refer to those systems where the records are maintained by a duty staff with little or no electronic assistance. Manual inventory control system is useful to very small businesses that may not be able to afford automated systems. Manual inventory control systems have a number of advantages: requires little investment of training time, less expensive to use, greater sense of control over her inventory and easy to dispense with. However, it is prone to several demerits: prone to human errors, slow, easy to manipulate, labor-intensive, time-consuming etc.(Odili 2018, Doss, Trujillo-Rasua et al. 2020) The three other inventory systems can be grouped together as automated inventory control systems (Sharma and Garg 2016, Odili, Noraziah et al. 2020).

Many medium- and large-scale business concerns deploy automated solutions to

keep and update their inventories. Automated inventory control systems allow such companies to better manage the inventory, identify items that are slow-moving as well as reorder fast-moving inventory before such items run out. Businesses can use several automated inventory control methods to track inventory including bar codes, RFID tags, and computerized systems (Chaudhari 2019).

Bar codes contain a series of numbers and vertical lines to identify each inventory item uniquely. When items arrive at the dock, employees simply have to scan the bar codes of individual items, and the computer system will update the quantity of inventory automatically. When a stock is sold, the cashier scans the bar code over a barcode reader, and the computer system reduces the quantity of the available inventory. Similarly, radio frequency identification tags (RFID) which are, basically, computer chips with in-built antennas that organizations attach to inventory items. Such tags use radio waves and employees are able to read the information on the tag using a special RFID reader. Whenever an employee scans the chip, information is relayed to the organization's computer system about the quantity and type of inventory (Nikonenko and Korotka 2019).

In general, whether in the automated or manual control systems, there are certain symptoms which are helpful in discovering poor inventory control. Following elements are symptoms of poor inventory control (Saha and Ray 2019).
1) An increase in the number of back orders
2) Increasing investment in inventory while back orders remain constant
3) High turnover rate of customer.
4) An increase in the number of cancelled order.
5) Periodic dearth of adequate storage space
6) Wide inconsistency in turnover of inventory circulation centres and among foremost inventory items.
7) Abating relationships with arbitrators as typified by supplier cancellations and declaring orders.
8) Enormous quantities of obsolescent items.

Finally, it may be important to note that, in literature, several researchers agree that inventory control levels can be compressed by one or more of the following steps:
(i) Multi-echelon inventory forecasting. ABC analysis is an example of such forecasting
(ii) Lead time analysis.
(iii) Delivery time analysis. This may lead to an amendment in carriers or intervention with existing carriers.
(iv) Exclusion of turnover and / or obsolescent items.
(v) Analysis of pack size and concession structure.
(vi) Investigation of returned goods system.
(vii) Reinforcement / automation of product substitution.
(ix) Setting up of formal re-order review system.
(x) Depth of fill rates by stock-keeping unit (SKU).
(xi) Analysis of consumer demand individualities (Chinello, Herbert-Hansen et al. 2020)

In the past few decades, major research efforts on inventory management control system revolves around barcode technology, radio frequency identification (RFID) and ware house management systems. The design of the Inventory control system in this study uses the combination of three popular systems, namely, barcode, RFID and the warehouse management systems. It is our belief that such a system harnesses the strength of each system leading to an improved inventory control management system.

3. Materials and Methods

3.1 ***System design***

The design of this system follows the following architectural pattern
Before login
Login
File
Account
Add new inventory
Enter product name
Enter product quantity
Enter product price
View inventory
Search Inventory
Reset inventory
Delete inventory
Exit

3.2 **Database design**

Table 1: Database design t

Field description	Field type	Field size
Search	Text	10
Reset	Button	10
Delete	Button	11
Product name	Text	10
Product quantity	Number	11

Table 2: Login table

Field description	Field type	Field size
Username	Text	11
Password	Text	11

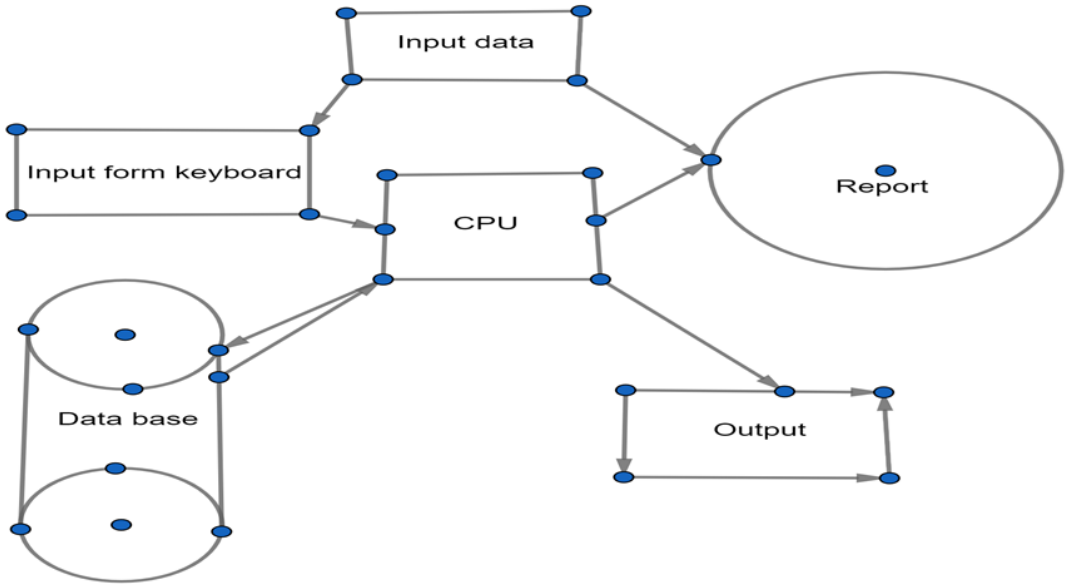

Fig. 1: System flow datagram

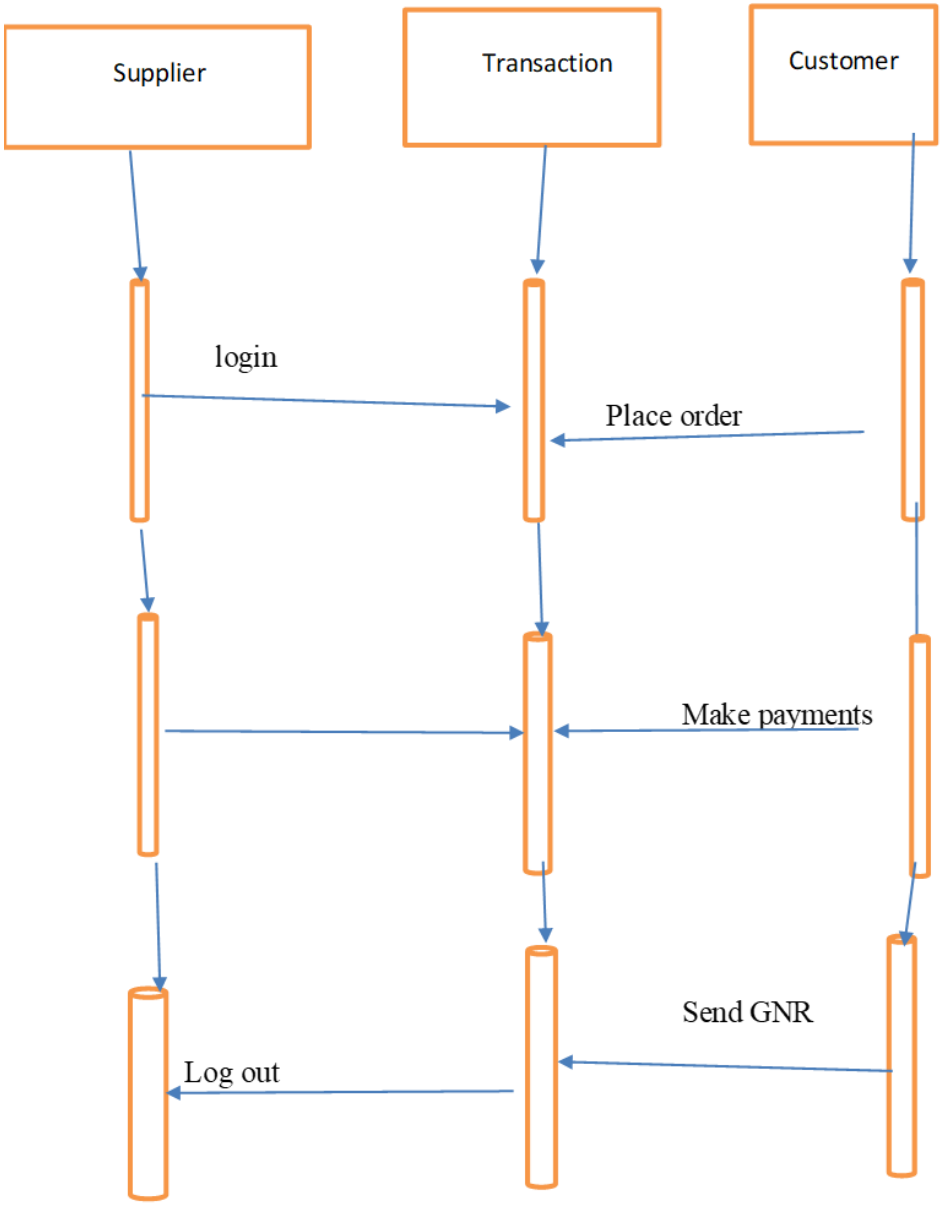

Fig. 2: A UML design for the program

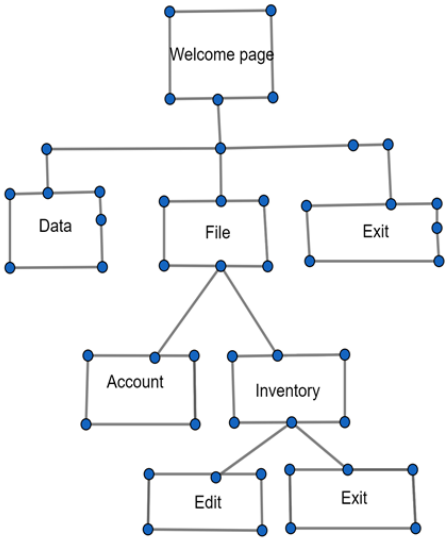

Fig. 3: Implementation process

3.3 **System requirement**

The requirements for the implementation of this system are as follows;

1) Software requirement.
2) Hardware requirement.

3.3.1 ***Software Requirements***

The following specification is needed:

a) Operating system-Windows..
b) Front end- Visual studio.

Programming languages supported include; C++, Python, F#, C#, C

c) Back end- Python

3.3.2 ***Hardware Requirements***

For effective operation of the newly designed system, the following minimum hardware specifications are recommended:

b) The computer system processor to be used should be at least Pentium technology.
c) The minimum Random Access Memory (RAM) should be at least 128MB.
d) The system should have a hard disk of at least 20GB, 3.5 floppy drive.
e) The system to use should be equipped with a VGA or SVGA monitor (colored).
f) The mouse, keyboard and printer are also required.

4. Implementation and Results

System implementation follows the system proposals and its objectives, thus its goal is to arrive at a satisfactory, implemented, completed, and function-evaluated automated system. It also embodies the preparation of resources including equipment and other resources. The supplier log-in password and identification is entered, checked, views available products, makes adjustments to the product quantities and prices then updates the records.

4.1 ***Program design***

The inventory system program for this study was designed using the top-down approach. The entire problem associated with the existing system were broken down into smaller units and processed differently. The units were developed into modules and there are a total of three modules. However, the implementation of this process follows a certain procedure to enable user access the program software effectively as shown in the diagram below:

4.2 The entry module / welcome page

The entire module is responsible for all input data requirements. It receives input data from the computer users and then stores them appropriately into the welcome file. The entire provisions are made very flexible and precise as shown in the diagram above. .

4.3 The update module

The update module is responsible for modifying stored data or record in the files which are kept on the database. The records are searched for in the file and retrieved as required and then, the update data are retrieved and necessary corrections are made automatically by the computer. Moreover, this module is responsible in keeping track of all the transactions that takes place. It is also known as main menu transaction process as shown below.

4.4 Implementation of the login form

This form allows a user to input his or her username and password. After the username and password are implemented and the okay button pressed, the form automatically takes the user to the main menu. However, if a wrong user name and password is keyed in, a warning alert displays on the screen. The login page is displayed in Figure 5.

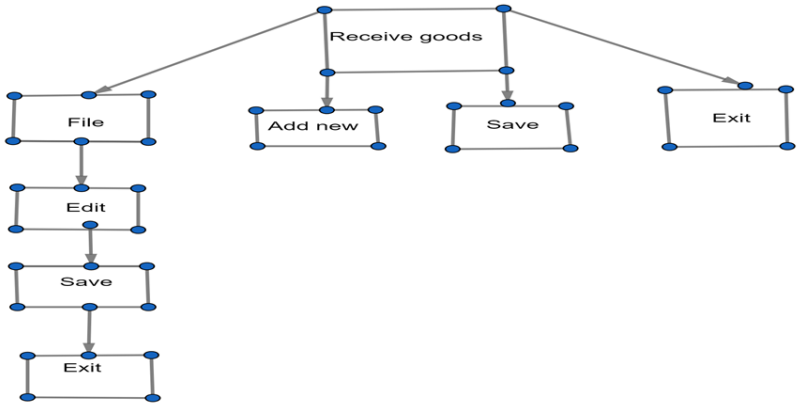

Fig. 4: Update module

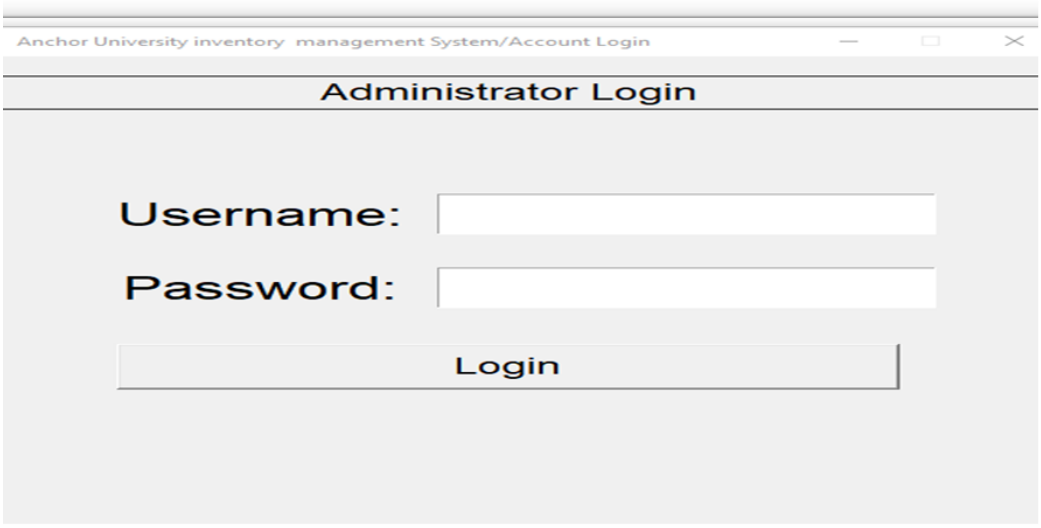

Fig. 5: Login page

4.5 Implementation of main login form

This form contains buttons which are Add new inventory forms and Exit button. The inventory (add new) button when pressed, takes the user to the product edit. Here the product quantity, product price and name can be added to the system through the save button. Please see Figure 6.

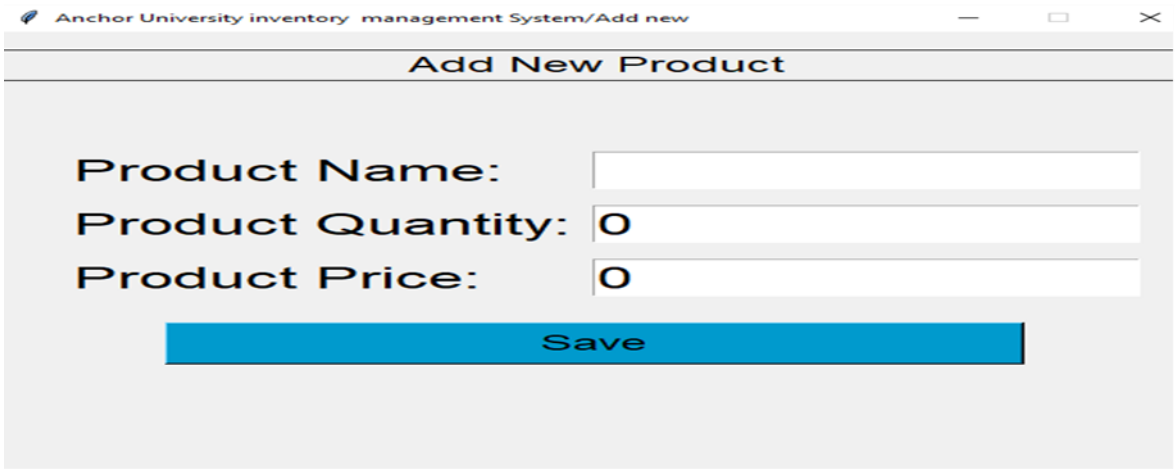

Fig. 6: Add new product form

4.6 Implementation of the edit form

The Edit form is located after the view button has been clicked, The options lists out the Search, Reset and Delete inventory transaction and allows the Administrator to edit prices of items, delete items and also search the items in the inventory list. Please see Fig. 7.

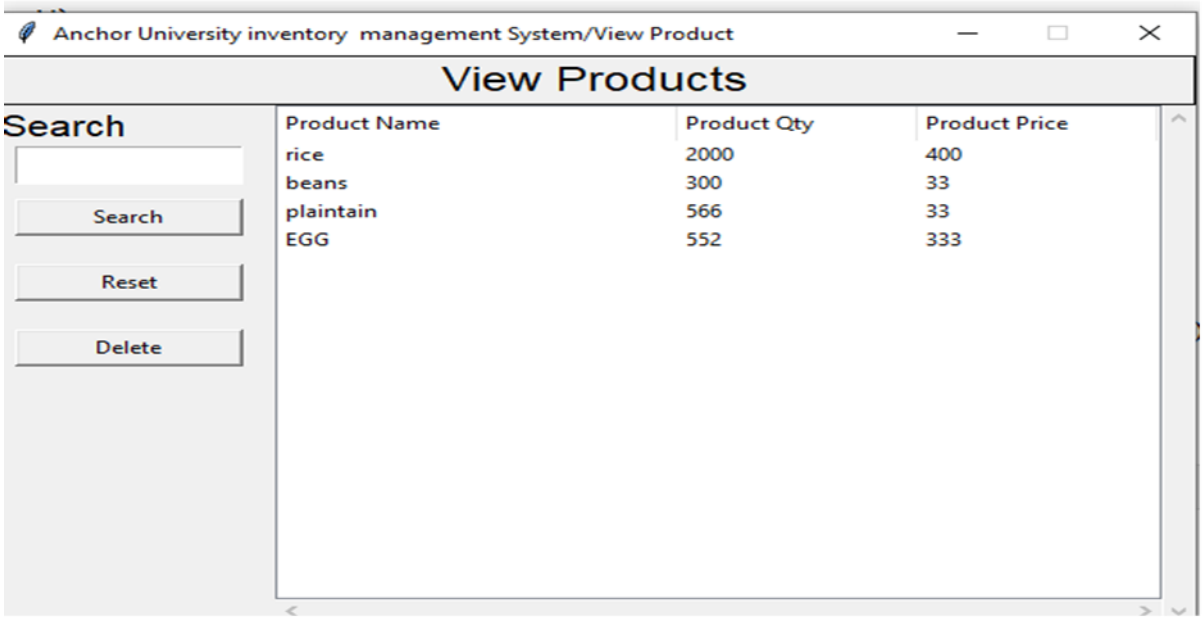

Fig. 7: Edit form

5. Conclusion

Having Inventory proportionality is the goal of this inventory management system. The primary desired outcome is to have the same number of time worth of inventory on hand across all food products in the cafeteria so that the run out of all products would be simultaneous. In such a case, there is no such "excess inventory," that is, inventory that would be left over of another product when the first product runs out. Excess inventory is disadvantageous because the money spent to obtain the excess could have been utilized elsewhere. The secondary goal of inventory proportionality is inventory minimization. By integrating accurate demand forecasting with inventory management, replenishment inventories can be scheduled to arrive just in time to replenish the product destined to run out first, while at the same time balancing out the inventory supply of all products to make their inventories more proportional, and thereby closer to achieving the primary goal.

Similarly, accurate demand planning allows the desired inventory proportions to be non-static by determining expected sales out into the future. This allows inventory to be in proportion to the expected short-term sales or consumption rather than to past averages that have been collected in the cafeteria. With this new system, the problems encountered with the manual inventory control system are overcome. The automated inventory control system reduces the workload of the staff, saves a lot of time and increases efficiency. The records of the company are safe and secure, distribution process is well managed, errors are minimized, and reports generated for the Cafeteria Management are accurate thereby increasing the profit gained by the refectory. So it's an all-round win

Having carefully examined the usefulness of computers in eliminating most of the errors and hindrances that emanates from manual paper work, I recommend this automated inventory control system to Anchor University Lagos Nigeria as well as other cafeteria to enable them produce an efficient inventory management and likewise reduce the complexity of manual inventory.

Just as research and development are continuous processes, so are they in computer and software development. This system will be useful since it is computerized and will promote effectiveness, efficiency and service delivery thereby enhancing profit. For optimal result, there is the need to engage competent computer personnel for an effective maintenance of the system.

For any organization adopting this application, the following should be taken into consideration, training of staff, adequate security measures, and the provision of dependable real time processing system for speedy responses..

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References

Al-Momani, H., O. T. Al Meanazel, E. Kwaldeh, A. Alaween, A. Khasaleh and A. Qamar (2020). "The efficiency of using a tailored inventory management system in the military aviation industry." Heliyon 6 (7): e04424.

Alqahtani, M., A. Buijs and S. Day (2020). "Serpent -2 and OSCAR-4 computational tools compared against McMaster nuclear reactor improved operational data history for U-235 fuel inventory tracking, local power tracking and validation of multiplication factor." Annals of Nuclear Energy 145: 107590.

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

Bhat, N., S. Kale and P. Shrivastava (2019). "A study of efficiency of inventory management using financial ratio." Think India Journal 22(33): 213-217.

Chaudhari, N. (2019). "Impact of automation technology on logistics and supply chain management." American Journal of Theoretical and Applied Business 5(3): 53-58.

Chinello, E., Z. N. L. Herbert-Hansen and W. Khalid (2020). "Assessment of the impact of inventory optimization drivers in a multi-echelon supply chain: Case of a toy manufacturer." Computers & Industrial Engineering 141: 106232.

Doss, R., R. Trujillo-Rasua and S. Piramuthu (2020). "Secure attribute-based search in RFID-based inventory control systems." Decision Support Systems 132: 113270.

Firdaus, I. H. and A. W. Widjaja (2019). 5S Application and Semi-Finished Products Inventory Monitoring to Create Clean Work Area in PT Asta Kriya. 12th International Conference on Business and Management Research (ICBMR 2018), Atlantis Press.

Jackson, I., J. Tolujevs and Z. Kegenbekov (2020). "Review of inventory control models: A classification based on methods of obtaining optimal control parameters." Transport and Telecommunication 21(3): 191-202.

Lei, T., Y. Zhang, Z. Lv, S. Li, S. Liu and A. K. Nandi (2019). "Landslide inventory mapping from bitemporal images using deep convolutional neural networks." IEEE Geoscience and Remote Sensing Letters 16(6): 982-986.

Madamidola, O. A., O. Daramola and K. Akintola (2020). "Web–based intelligent inventory management system." Education 2023.

Muchaendepi, W., C. Mbohwa, T. Hamandishe and J. Kanyepe (2019). "Inventory management and performance of SMEs in the manufacturing sector of Harare." Procedia Manufacturing 33: 454-461.

Nikonenko, A. and L. Korotka (2019). "Recognition and generation of QR/bar codes in mobile applications." Êîìï'þòåðíå ìîäåëþâàííÿ: àíàë³ç, óïðàâë³ííÿ, ïîòè³çàö³ÿ: 36.

Odili, J. B. (2017). "Implementation analysis of cuckoo search for the benchmark rosenbrock and levy test functions." Journal of Information and Communication Technology 17(1): 17-32.

Odili, J. B. (2018). "The dawn of Metaheuristic Algorithms." International Journal of Software Engineering and Computer Systems 4(2): 49-61.

Odili, J. B. and J. O. Fatokun (2020). The Mathematical Model, Implementation and the Parameter-Tuning of the African Buffalo Optimization Algorithm. 2020 International Conference in Mathematics, Computer Engineering and Computer Science (ICMCECS), IEEE.

Odili, J. B., M. N. M. Kahar, A. Noraziah, M. Zarina and R. U. Haq (2017). "Performance Analyses of Nature-inspired Algorithms on the Traveling Salesman's Problems for Strategic Management." Intelligent Automation & Soft Computing: 1-11.

ODILI, J. B., A. NORAZIAH, R. AMBAR, M. H. ABD WAHAB and M. Fakheraldin (2018). "Teaching Computer Science in the Universities in Third World Countries: Challenges." The Eurasia Proceedings of Educational and Social Sciences 9: 354-358.

Odili, J. B., A. Noraziah and A. E. Babalola (2020). "Flower Pollination Algorithm for data generation and analytics-a diagnostic analysis." Scientific African: e00440.

Odili, J. B., A. Noraziah and M. Zarina (2021). "A Comparative Performance Analysis of Computational Intelligence Techniques to Solve the Asymmetric Travelling Salesman Problem." Computational Intelligence and Neuroscience 2021: 6625438.

Patel, A. D. and A. R. Chowdhury (2020). Vision-based object classification using deep learning for inventory tracking in automated warehouse environment. 2020 20th International Conference on Control, Automation and Systems (ICCAS), IEEE.

Patra, S. K., S. K. Baral and D. M. Mahapatra (2021). "Inventory management practices and operational performance of entrepreneurs: An empirical analysis of steel industry of India." Manthan: Journal of Commerce and Management 8(1): 79-97.

Perminova, O. M., G. A. Lobanova and R. V. Faizullin (2019). "Raw materials inventory model applied by regional enterprises of the industrial cluster." Acta logistica 6(2): 35-41.

Purnamasari, D., A. Almira and N. Della Savira (2021). "The accounting for inventory from a commercial point of view." Research Horizon 1(2): 81-85.

Saha, E. and P. K. Ray (2019). "Modelling and analysis of inventory management systems in healthcare: A review and reflections." Computers & Industrial Engineering 137: 106051.

Sharma, M. and N. Garg (2016). Inventory control and big data. Optimal Inventory Control and Management Techniques, IGI Global: 222-235.

Ugboya, P. A. (2019). "Process Inventory Management in a Production Company." Journal of Advances in Science and Engineering 2(1): 53-59.