

Food Retail Company Web-Based POS with Inventory and Stock Management

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Abstract. Automation generates a lot of savings in that it eliminates errors, reduces the time to perform a certain task, and reduces the need for a large number of employees to perform the same function. The researchers have focused on this specific food retail company named True North Empanada which sells Empanadas which are Latin-American baked or fried pastries.

This study aimed to address the problem of the company with its current inventory system which is not yet automated. Data processing is manual. The consolidation and preparation of their reports is time consuming and prone to errors which often results to a big discrepancy in the actual and recorded inventory. This often leads to problems particularly in estimating, ordering, and supplying of raw ingredients.

The researchers intended to improve the food retail company's inventory management by developing a Web-based system that automates the inventory management process. With the system, the preparation of inventory reports is made easy and fast making them readily available upon request. The automation facility allows the bill-of-materials to be computed in real-time per product sale. This helps a lot in determining immediately the status of the inventory of raw ingredients and in minimizing spoilage. The automated functions also minimize the possibility of human errors in data entry and computations.

The functions and features included in the developed system were based from the actual reports used in the current inventory management process particularly the computation of the raw ingredients per product. The automated computation of bill-of-materials has minimized the discrepancy in the actual and recorded inventory.

To analyze the current system, the researchers used a variety of methods and tools. The Usability Review Survey that was conducted was composed of four sections, and the average mean of each of these sections was calculated. The result showed a favorable response from the respondents. They perceived that the developed web-based system, with regards to its functionalities and features, has improved their inventory management process. They believe that the system will benefit them a lot.

Keywords: NoSql, automation design, PSSUQ, Usability Review

1. Introduction

Most businesses nowadays have automated business functions. Automation generates a lot of savings in that it eliminates errors, reduces the time to perform a certain task, and reduces the need for a large number of employees to perform the same function. Correct automation allows you to easily identify inefficiency points and delays, which can be corrected immediately [1]. Inventory management is a component of the supply chain which supervises the flow of goods from the manufacturer to the warehouse. From there, these facilities are then transported to the final buyer. Any trivial mishaps along this sequence of events can cause a lot of damage, and the consequences for the company can be too large to bear [2]. Aside from improving time-consuming tasks and streamlining workflows, an automated inventory management system can also generate documentation for work orders, shipping, and invoicing, which will ultimately lower inventory management costs [3].

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True North Foods Co., formed in the year 2017, is a family-run start-up business dedicated to providing authentic Ilocano food that is very popular as every day, any time snack and comfort food in the whole northern province of the Ilocos Region. The researchers have focused on this specific food retail company named True North Empanada which has several branches. The company sells Empanadas which are a Spanish or Latin-American pastries filled with savory ingredients that are either baked or fried. The company's main problem with their current inventory system is the manual inputting and processing of data to which they use Excel. Each branch submits end-of-day reports and orders to the commissary once every week. This is so because the consolidation and manual preparation of their reports is taking a lot of time. The process is time consuming and prone to errors. This often results to a big discrepancy in the actual and recorded inventory. This often leads to problems particularly in estimating, ordering, and supplying of raw ingredients.

The researchers intended to improve the food retail company's inventory management by developing a Web-based system that automates the inventory management process. With the system, the preparation of inventory reports is made easy and fast making them readily available upon request. The automation facility allows the bill-of-materials to be computed in real-time per product sale. This helps a lot in determining immediately the status of the inventory of raw ingredients and in minimizing spoilage. The automated functions also minimize the possibility of human errors in data entry and computations.

1.1 Current Process of the Company

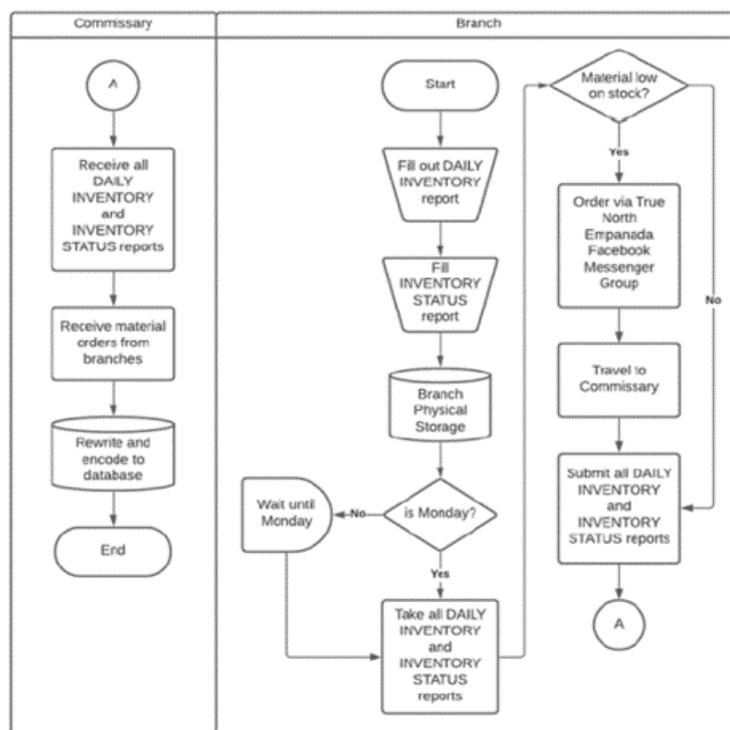


Fig. 1: Current Inventory Process Flow

Figure 1 shows the current inventory process of True North Foods Co. The process applies to all branches of the retail food company and it starts after the workday. The branch manager fills the DAILY INVENTORY and INVENTORY STATUS reports which are to be kept in the branch's physical storage. This report is then submitted every Monday to the Commissary. The branch manager also sends orders through the Facebook Messenger group chat if they have a material or ingredient that is already low in stock. The Commissary then encodes the reports into a digital version of the printed report. If there are orders from the branches, the Commissary will send a request order to the Supplies and Logistics Department.

1.2 Objectives

The researchers aimed to develop and improve upon the inventory management system of food retail companies.

Specifically,

- To decrease the amount of time it takes to manage the inventory.
- To use a unified database that can help track the branches inventory quickly.
- To record daily inventory reports on the system
- To order materials that are low on stock directly to the commissary.
- To generate automated reports that will aid in the commissary's decision-making such as sales reports and inventory
- To automatically compute the inventory using the bill of materials
- To create a POS system that is connected to the inventory for the system to be unified

1.3 Scope and Delimitations

The researchers have focused on the food retail company's inventory management system which encompasses all the other branches.

The system allows the system administrators to maintain the inventory specifically, create a new item/material, delete an item, or display the inventory of each branch. The system administrator can also manage user accounts. There would be three types of users: Branch User, POS User, and Commissary User. All data inputs coming from these three users can be made using the system including the orders and reports. The system can display the inventory of each branch in a dashboard along with graphs for easy viewing and analysis of the commissary. A POS is also included to unify the whole process. The POS contains the bill of materials that will help monitor the inventory. The Bill of Materials contains the details about the empanada (product). This will help in estimating the quantity of each main ingredient of the individual product. There are three variants of the empanada. Maysa, Awan, and Dua. The mixture of the cabbage will also be included as it is required to make the empanada. The spoilage of ingredients is limited to one item only since the delivery of items is based on the order placed by the branches. The only item that can spoil is the dough. Spoiled doughs are disposed of right away to prevent accidental use. However, to prevent it from spoilage it has to be placed inside a cold place which would be the refrigerator. All the ingredients are always fresh when delivered to the branches.

1.4 Research Question

How can the developed web-based inventory management system help decrease the discrepancy between the actual and recorded inventory and reduce inventory cost?

1.5 Significance of the Study

The study's outcome will benefit the food retail company, which can help the business be more efficient in time management and reduce errors in inventory data. Future researchers can use this research as their reference in developing their inventory management system.

2 Review of Related Literatures

[4] According to Madamidola, O. A., Daramola, O. A., Akintola, K. G. (2017), they made an intelligent system implemented in a web-based environment to integrate multiple stores, also providing an effective coordination of all of the stores, intelligently determining the different reorder points of all the disparate stores in the systems and communicating the information back to the centralized store using Java Remote Method Invocation (RMI) with a secure socket layer (SSL), implemented using My Structured Query Language (MySQL), Database Management System, Hypertext Markup Language (HTML), JavaScript, Hypertext Preprocessor (PHP) and Xampp (Apache). Due to local and global competition any company that must survive in the competitive world must take an advantage of effective management of its inventory seriously therefore the use of intelligent approach for effective and efficient inventory management system has become indispensable. The control and maintenance of inventory is a problem experienced virtually by all business sectors. Inventory management is crucial for the sustainability and growth of any organization. Excess or shortage of inventories has remote effects on the supply chain cost therefore the need for inventory management has been articulated. Management System is a real-time inventory system designed using client

– server model capable of connecting multiple stores. This is used to track the inventory of a single store, or to manage the distribution of stock between several branches of a larger organization.

[5] Memon, A. B., Meyer, K. (2017) said that organizations require some sort of intermediating platforms that facilitate such a process by searching for and matching potential partners according to their goals, needs, and competencies, and subsequently enabling the undertaking of mutual activities between the selected partners in an efficient and effective manner. The mechanism of web-based communication brings a potential solution by enabling the organizations to interact with each other across the globe in a similar way as in physical spaces.

[3] According to Inegbedion, H., Eze, S., Asaleye, A., Lawal, A. (2019), the inventory level in a system has significant implication on its profitability because it determines understocking and overstocking and the attendant shortage cost and holding cost. This inventory level is a function of the rates at which inventory flows into and out of the system.

[6] Agarwal, M. (2017) said that a POS system provides a systematic and computerized business environment where real-time information available, whereas manual cash register is complex and has limited capacity in terms of storage and information collected. POS system also integrates with order and sales so that better inventory management can be done. Effective POS data in retailing can be used for better supply chain management. One can easily identify the area where POS can be used and benefited from this technology in the competitive market.

[7] In the study of Lal, Mukesh & Shukla, Apratul & Tarangini, A. (2018), it was mentioned that a Bill of Materials (BoM) is an extensive list of raw materials, by-products, components, assemblies, and packaging material needed to make a finished product. You can say that it's actually a blueprint for product development from start to finish. BOM saves both time and money of a manufacturer as it offers inventory control throughout the lifecycle of a product. It also instructs for every equipment, component, and step in the manufacturing process that allows to calculate accurate lead times and regulate the cash flow for inventory payments accordingly. To have highly effective inventory control, manufacturers need to get a tight hold on BOM management.

[8] (Thakur, 2020) said that an inventory management software with BOM capabilities regulate the inventory flow excellently. An inventory management software assisted with BOM features enables better decision-making, boosts production efficiency, cost-effectiveness and helps in enhancing product quality

[9] A Point-of-Sale System with Inventory is a PC based method for checking and examining offers of the business; it is quicker and more robust. The framework can diminish mistakes in altering and can be effective. The purpose of Sale System with Inventory is to make the business increasingly gainful, proficient, and helpful to the company and its clients (Mendoza et al, 2019).

[10] [11] Firebase uses Google Cloud service accounts to operate and manage services without sharing user credentials. The Firebase Realtime Database is a NoSQL database from which it can store and sync the data between users in real-time (Firebase, 2021). NoSQL databases are purpose-built for specific data models and have flexible schemas for building modern applications. NoSQL databases are widely recognized for their ease of development, functionality, and performance at scale (Menegasso, 2018).

[12] [13] Angular 5 is a new version of the Angular framework developed by Google. Angular five comes with improvements, including optimized builds and faster compile times (Moiseev, 2018). Angular is a platform and framework for building single-page client applications using HTML and TypeScript. Angular is written in TypeScript. It implements core and optional functionality as a set of TypeScript libraries that you import into applications (Angular, 2021).

The literatures above gave the researchers a better understanding of processes and benefits of automated inventory management systems and an idea of which software tools are more appropriate to use in developing the proposed system.

3. Methodology

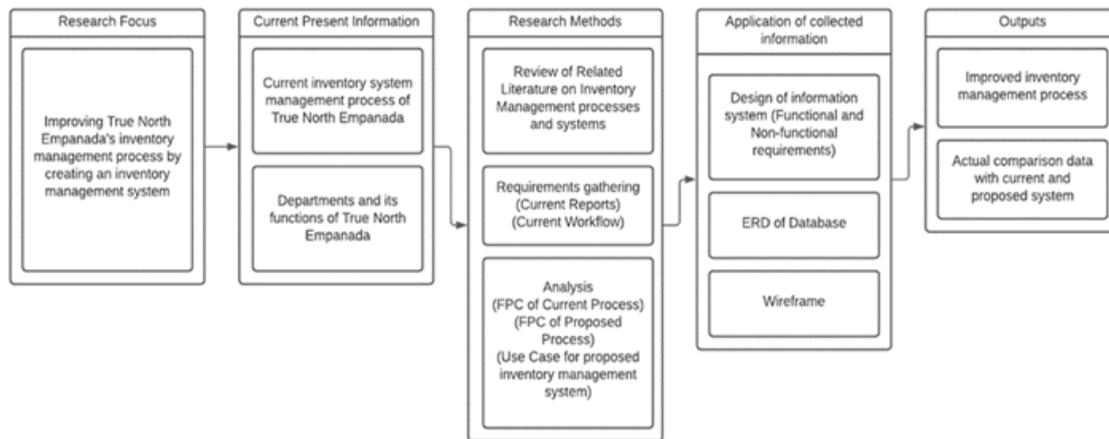


Fig. 2: Research and Development Methodology

The research is about improving the food retail company's inventory management process by creating an inventory management system. The researchers followed the research and development methodology shown in Figure 2. They started with the analysis of the current process of the food retail company and used the Flow Process Chart to understand and model the current and proposed processes. They have investigated the current process of the food retail company specifically their branch's inventory management and the documents that are essential to its process, namely the Daily Inventory report and the Inventory Status report.

All the information collected served as the basis for the user interface, functions and database design of the proposed system which is made accessible from a website. The output of the research is an improved inventory management process. It is a Web-Based POS with Inventory and Stock Management System.

The discrepancy between the actual and recorded inventory was also checked and verified to have improved with the use of the developed system.

3.1 Design of Information System (Functional and Non-Functional Application Requirements)

3.1.1 Functional Requirements

Administrators should be able to:

- Create new accounts.
- Give different level of access based on user type
- Delete accounts.

Commissary should be able to:

- Display all branch inventories.
- Create new materials
- Receive material orders from branches.

Branch Managers should be able to

- Input end of day inventory.
- Input inventory status.
- Send material orders to commissary.
- Login to the POS System.
- Use POS System

3.1.2 Non-Functional Requirements

- Should be able to handle numerous accounts at a time.
- Should be at least available during branch workdays.
- Both users should be secure.
- Simple to use system.
- Able to complete the tasks and scenarios quickly using this system.
- Easy to learn to use this system.

- Organization of information on the system screens should be clear.
- Should have system gave error messages

3.2 Tools for Development

Web Application Frameworks.

The following web application frameworks were used to develop the POS system for the mobile application.

Angular

It's an open-source web application framework and platform for developing single-page web applications – developed by google. Its programming language is typescript.

Ionic

This framework was used alongside angular for the basic templates of UI components such as buttons and cards.

Angular Fire

This library was used for communicating with the firebase backend.

Firebase CLI

The command line interface for deploying the compiled web application to Firebase.

4. Results and Discussion

4.1 Developed Application Interface Design

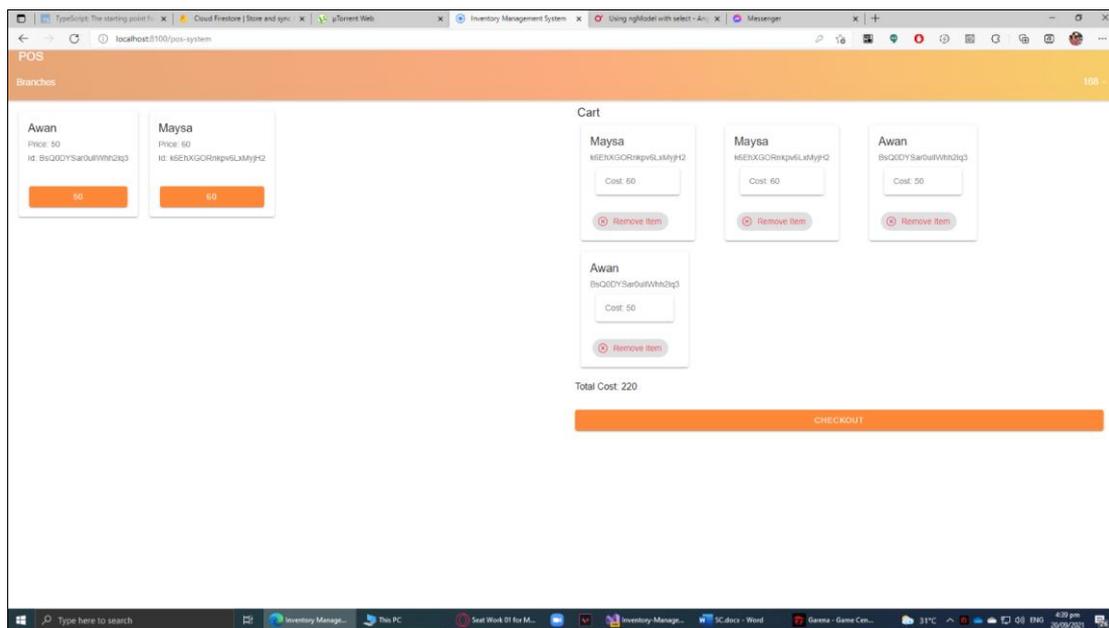


Fig. 3: POS Page

Figure 3 shows the POS page which contains the different product or orders along with the cost of each product. The branch can be chosen below the POS header. The orders can be added, and the total cost will be shown. The receipt will pop-up after pressing the checkout button in the POS page.

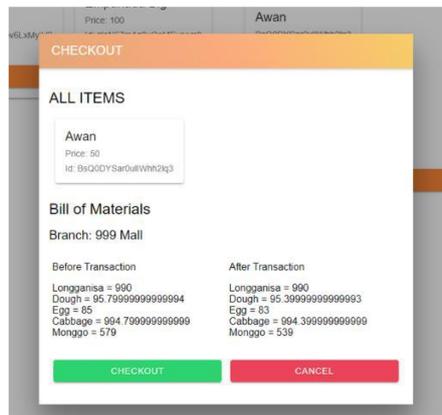


Fig. 4: Checkout Form

The receipt shown in Figure 4 shows the total amount of items and price with each purchase. The bill of materials and the branch where the purchase was made is also shown. The number of materials shown in the bill of materials will also change after the transaction. It will show the decrease in the quantity/amount and will be recorded in the database. The Bill of Materials are calculated based on the Required Materials of the product. The required materials are set in the Data Maintenance -> Products.

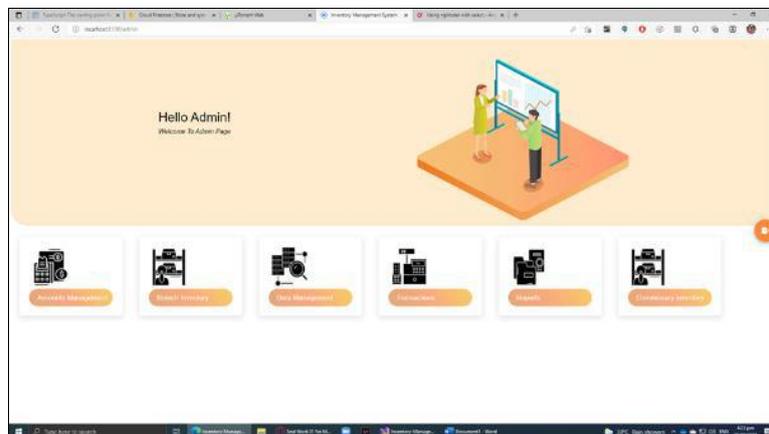


Fig. 5: Admin Home Page

The admin home page is the first page that the system administrator will see after logging in. The page is shown in Figure 5. It contains different functions and actions such as, accounts management, branch inventory, data management, transactions, reports, and commissary inventory.

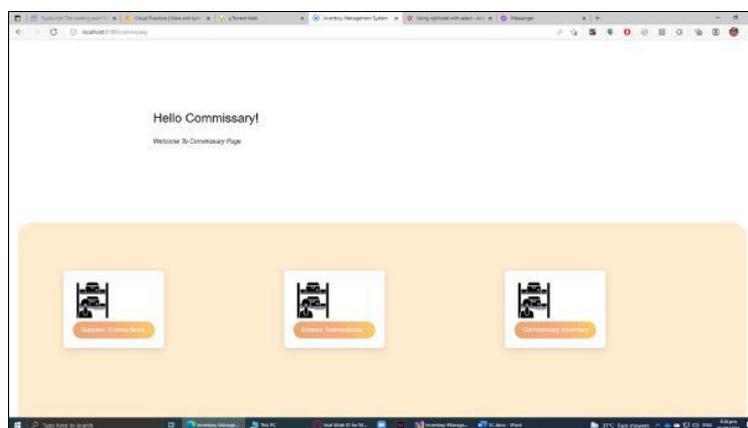


Fig. 6: Commissary Home Page

Figure 6 shows the home page that is being used by the commissary. It is just the same as the admin's page but with additional features and restricted access. The users can only access the transaction and

commissary inventory part. The features in the commissary like the supplier and branch transaction are the same as in the admin side.

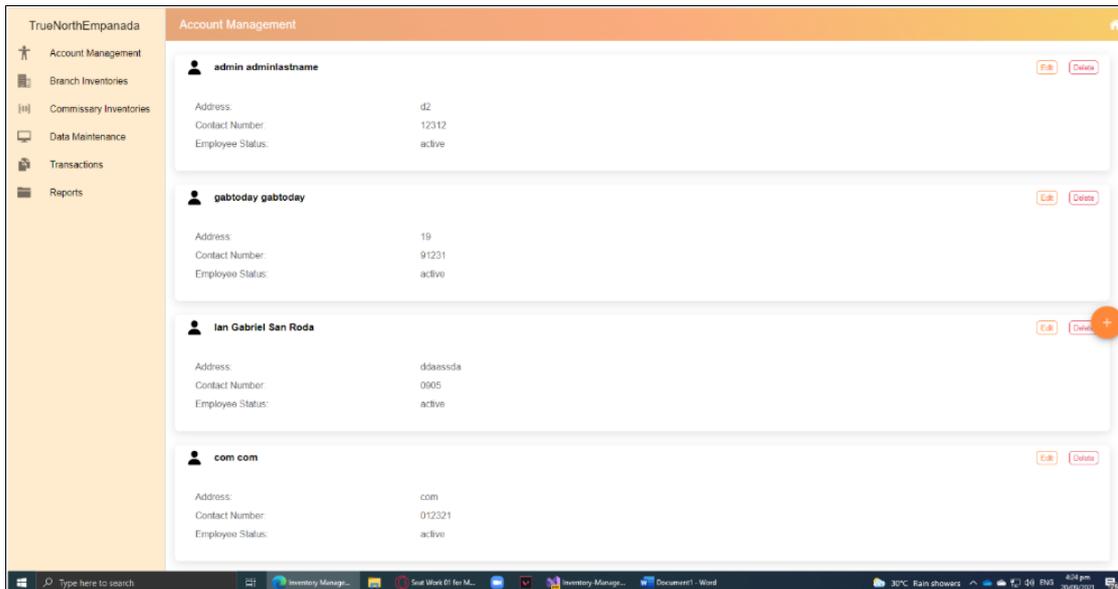


Fig. 7: Account Management

In the account management page shown in Figure 7, the administrator can see the different accounts of different branches. The administrator can also perform a variety of actions about the accounts.

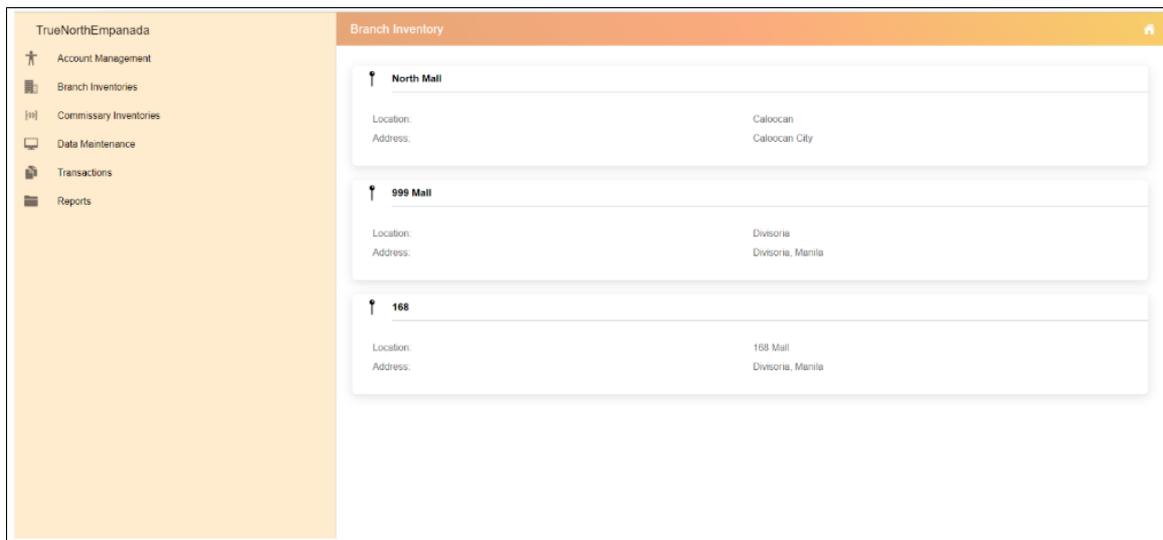


Fig. 8: Branch Inventory

Figure 8 shows the branch inventory menu where the administrator can check the inventory of the different branches.

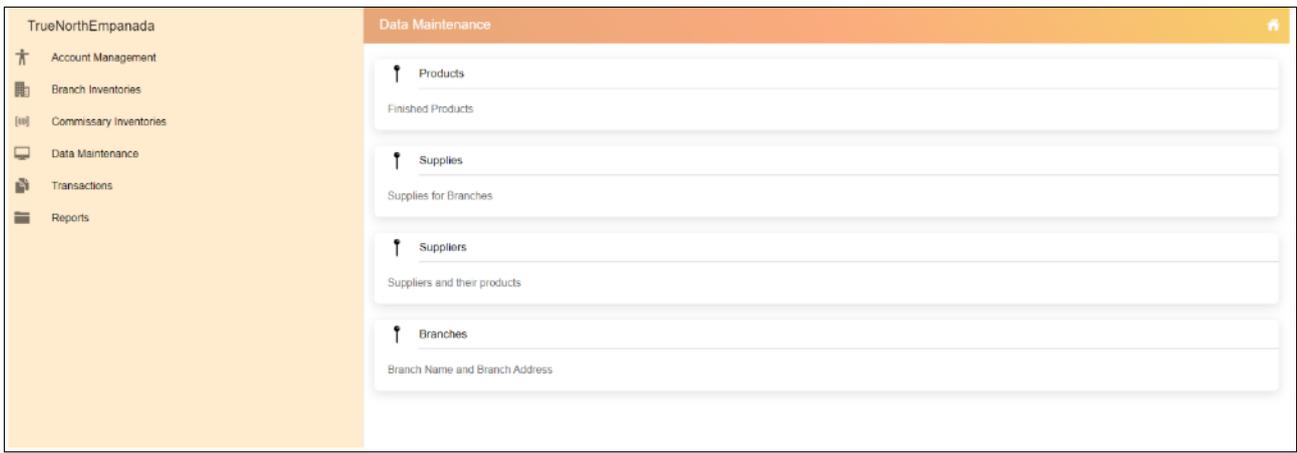


Fig. 9: Data Maintenance Page

The data maintenance page shown in Figure 9 allows the administrator to maintain and organize the data of products, supplies, suppliers, and branches.

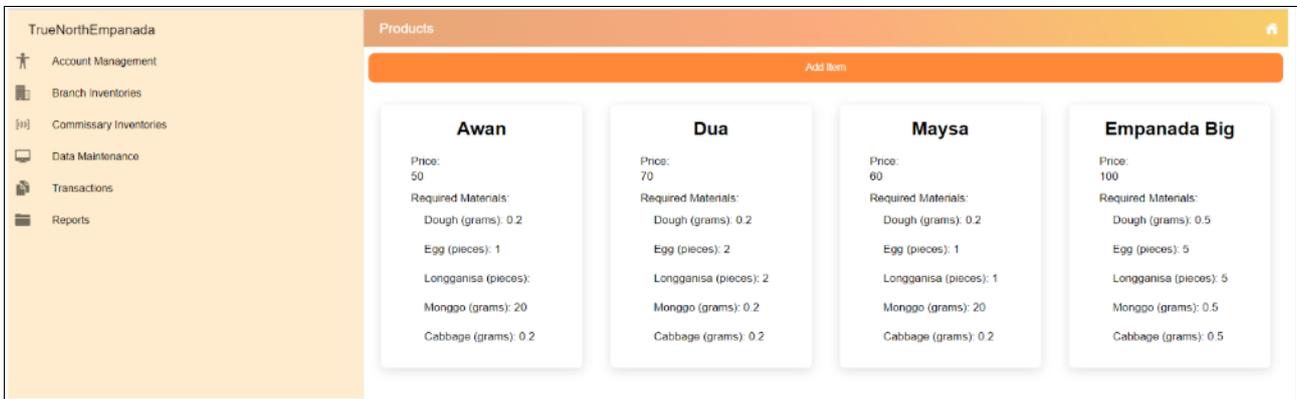


Fig. 10: Products Page

The product maintenance page shown in Figure 10 is where the administrator can edit and organize a product's information.

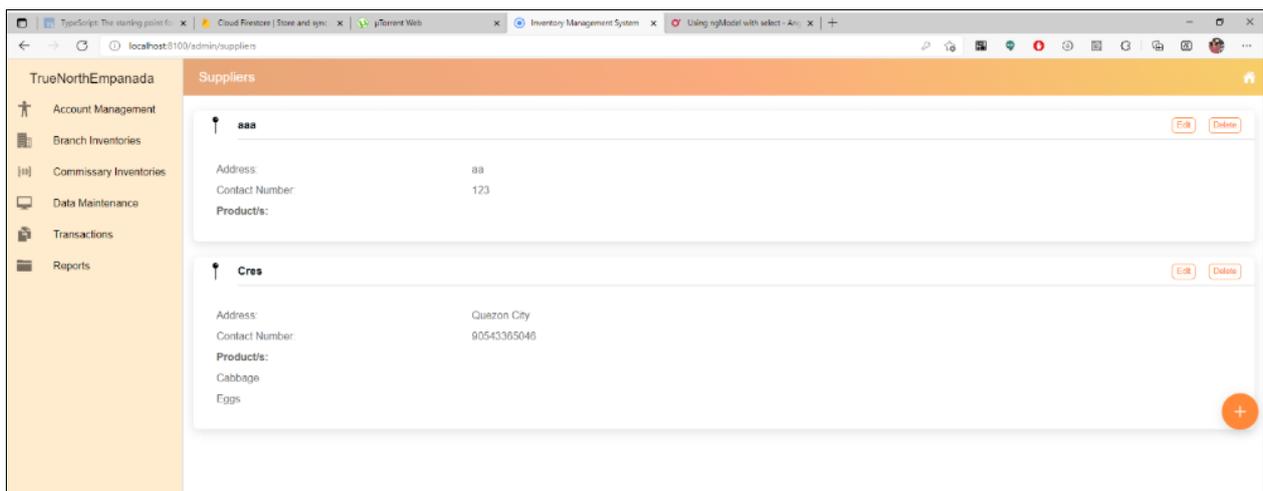


Fig. 11: Suppliers Page

Shown in Figure 11 is the supplier maintenance page where the administrator can maintain and organize the suppliers.

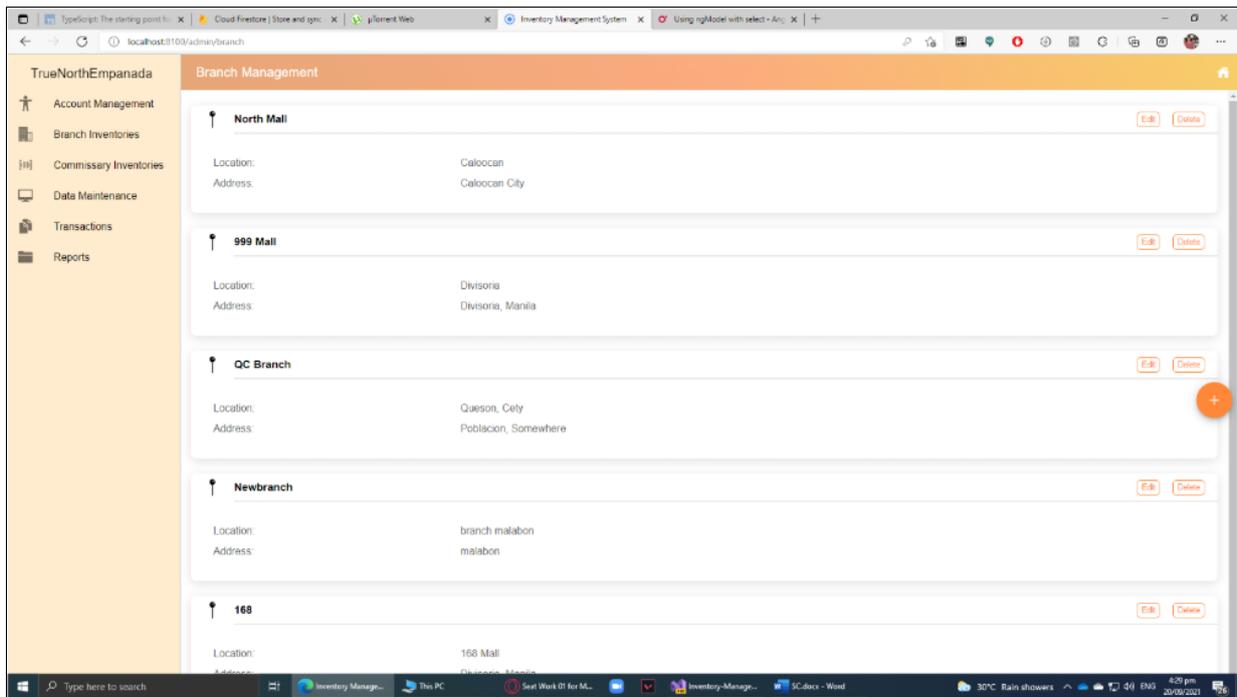


Fig. 12: Branch Management Page

On the branch management page shown in Figure 12, the administrator can organize and maintain different the branches and their information.

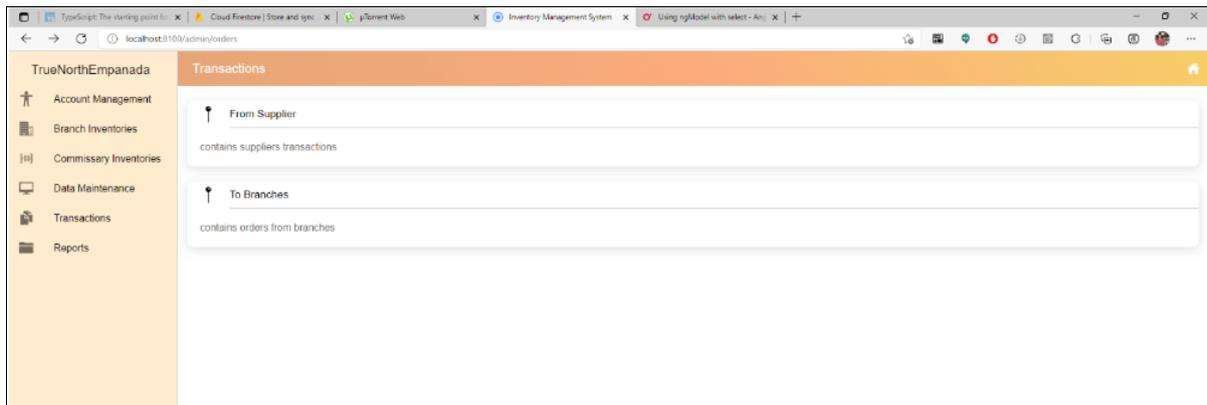


Fig. 13: Transactions Page

Figure 13 shows the transactions page where the transaction history can be checked.

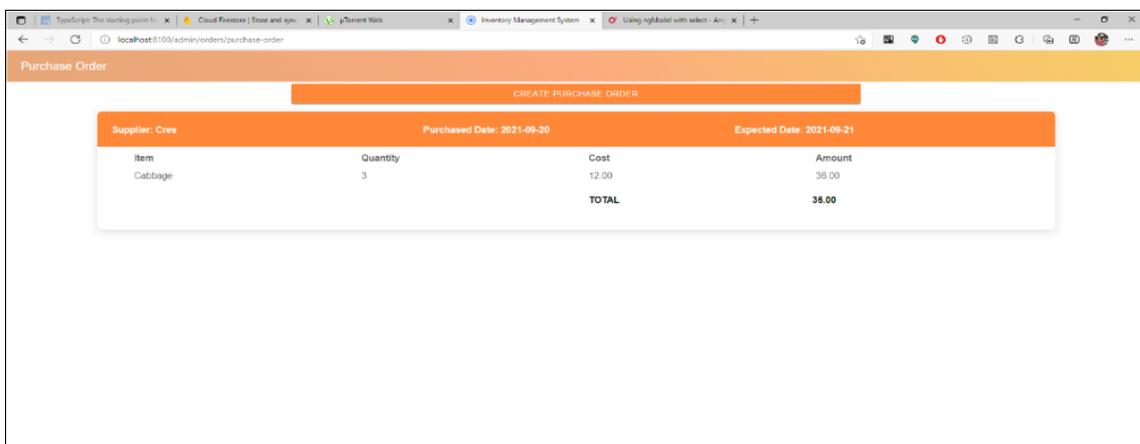


Fig. 14: Purchase Order Page

Figure 14 shows the purchase order page which is used to place order to the supplier. It gives specific information about the purchased order from the supplier such as quantity, date, price, item name, and amount.

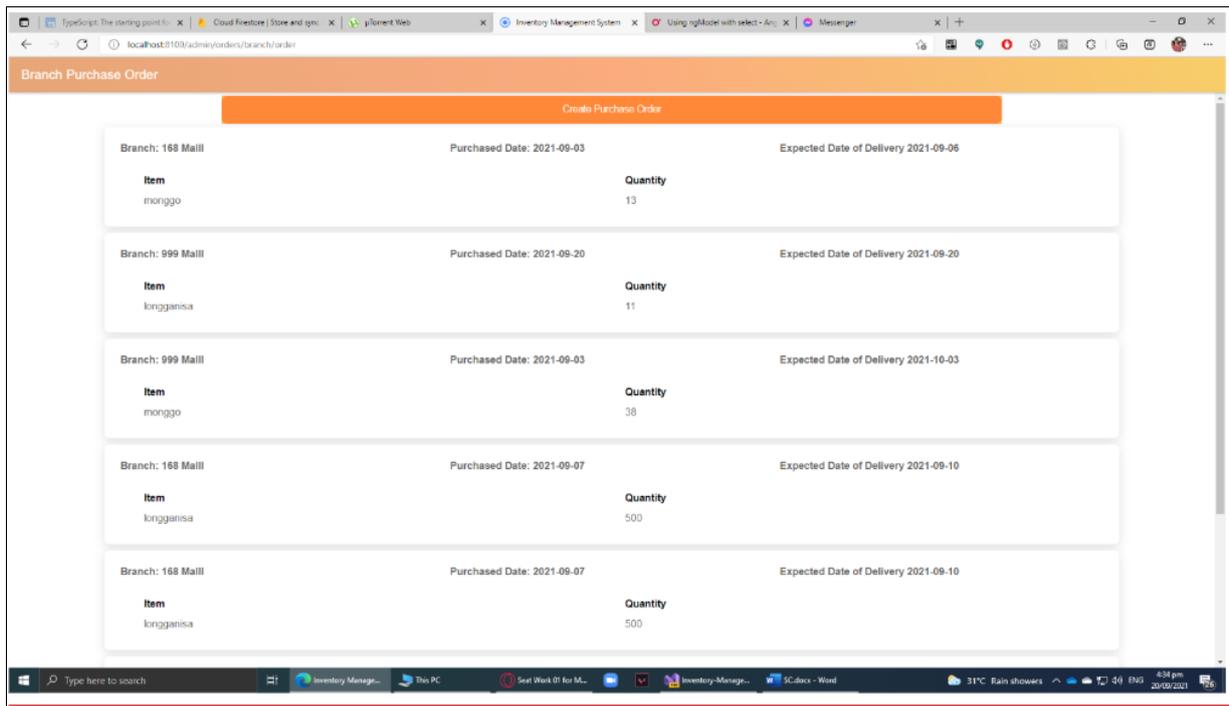


Fig. 15: Branch Purchase Order

The branch purchase order page shown in Figure 15 is a separate page from the supplier. It has the same information as the supplier except that it is for the branches.

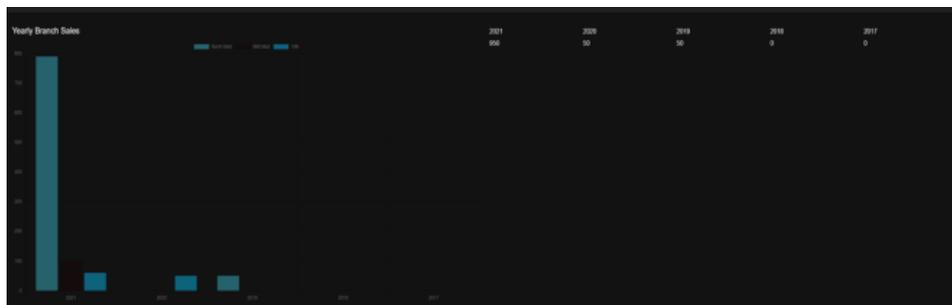


Fig. 16: Reports Page

A sample report that can be generated from the system is shown in Figure 16. The reports show sales information of the selected branch. There is a filter function that can be used to specify the desired period of the sales report. E.g. per year, per month, etc. The report function has a bar graph visualization for easy understanding and monitoring. The function also has a different view just to show data instead of a visualization.

4.2 Initial and Final Functionality Testing

The Initial Functionality Testing and Final Functionality testing for the features and functionalities were done by the researchers. The testing shows the documentation of testing of application's functions. The following functions that were tested are listed below:

Table 1: Initial Testing Results

Initial testing	
Action	Result
Login/Logout	PASS
Admin Home Page	PASS
Accounts Management	PASS
Branch Inventory	PASS
Data Maintenance	PASS
Transactions	FAIL
Reports	FAIL
Commissary Home Page	PASS
POS System	PASS
Bill of Materials	PASS

As shown in Table 1, all failed functions in the initial functionality testing are Transactions and Reports. The Delivery to branches does not work correctly. It does not increment the inventory of the selected branch and material correctly. And it does not decrement the values of the commissary inventory. The report's functionality does not update on some charts and has visual bugs with numbers and graphs.

Table 2: Final Testing Results

Final testing	
Action	Result
Login/Logout	PASS
Admin Home Page	PASS
Accounts Management	PASS
Branch Inventory	PASS
Data Maintenance	PASS
Transactions	PASS
Reports	PASS
Commissary Home Page	PASS
POS System	PASS
Bill of Materials	PASS

In the final testing shown in Table 2, the researchers have successfully fixed the bugs and errors found in the initial functionality testing. Specifically, these are the increment of branch inventory and the decrement of commissary inventory in the Transactions function. The bugs in the reports module were fixed, and all the charts and graphs were rendered successfully.

4.3 Usability Review

The researchers conducted a survey using the PSSUQ (Post-Study System Usability Questionnaire). PSSUQ is a 16-item standardized questionnaire, it is widely used to measure users' perceived satisfaction of a website, software, system, or product at the end of a study. The PSSUQ uses a 1 to 7 rating system, 1 is strongly agreeing and 7 is strongly disagreeing. The questions used are shown below:

1. Overall, I am satisfied with how easy it is to use this system.
2. It was simple to use this system.
3. I was able to complete the tasks and scenarios quickly using this system.
4. I felt comfortable using this system.
5. It was easy to learn to use this system.
6. I believe I could become productive quickly using this system.
7. The system gave error messages that clearly told me how to fix problems.
8. Whenever I made a mistake using the system, I could recover easily and quickly.
9. The information (such as online help, on-screen messages, and other documentation) provided with this system was clear.

10. It was easy to find the information I needed.
11. The information was effective in helping me complete the tasks and scenarios.
12. The organization of information on the system screens was clear.
13. The interface of this system was pleasant.
14. I liked using the interface of this system.
15. This system has all the functions and capabilities I expect it to have.
16. Overall, I am satisfied with this system especially the Bill of Materials feature in the POS.

The overall result is calculated by averaging the scores or getting the mean from the 7 points of the scale. It also has 3 sub-scales, namely system usefulness, information quality, and interface quality. To get the Overall score, the researchers average the scores of questions 1 to 16. To get the System Usefulness (SYSUSE) score, the researchers average the scores of questions 1 to 6. To get Information Quality (INFOQUAL) score, the researchers average the scores of questions 7 to 12. Finally, to get the Interface Quality (INTERQUAL) score, the researchers average the scores of questions 13 to 15. By seeing the scores for each scaling, the researchers will understand what the respondents think about the system.

Table 3: Descriptive Rating Scale

MEAN	DESCRIPTIVE RATING
2.00-1.00	Excellent
3.00-2.01	Good
4.00-3.01	Moderate
5.00-4.01	Poor
6.00-7.00	Very Poor

The following criteria were used to describe the score, (1) Very Poor, (2) Poor, (3) Moderate, (4) Good, and (5) Excellent. The mean was derived by adding together all the scores and then dividing them by the number of the scores. After all, nine respondents answered the usability review to assess the verbal description, as shown in Table 3.

The target respondents are employees from the food retail company who will be using the system. The researchers gathered data from 9 respondents to review, test, and measure the application's usability. The table below shows the grand mean which is the overall review of the respondents' about the system and shows the verbal description of the mean.

Table 4: Usability Categories Grand Mean

USABILITY CATEGORIES GRAND MEAN		
RESPONDENTS	GRAND MEAN	VERBAL DESCRIPTION
RESPONDENT 1	2.437	GOOD
RESPONDENT 2	1.933	EXCELLENT
RESPONDENT 3	1.437	EXCELLENT
RESPONDENT 4	2.437	GOOD
RESPONDENT 5	3.375	MODERATE
RESPONDENT 6	2.687	GOOD
RESPONDENT 7	2.625	GOOD
RESPONDENT 8	2.875	GOOD
RESPONDENT 9	2.937	GOOD

The Usability Review Survey that was conducted was composed of four sections and the average mean of each of these sections were calculated which resulted to the overall score of $M=2.5273$, System Usefulness score of $M=2.4629$, Information Quality score of $M=2.6851$, and Interface Quality score of $M=2.4814$. Based on the results shown in Table 4, the respondents perceived that the developed web-based application is relevant to their business, with a verbal description of “Good” for each functionality of the system.

5. Conclusion and Recommendations

The researchers aimed to develop and improve upon the inventory management system of food retail companies. They have developed a system that can be used to make inventory management easy and fast. Specifically, they have included a Bill of Materials feature in the system’s POS to make the inventory update faster and more accurate. For every product ordered and sold, the bill of materials will be updated. The user will see how much materials are left in the inventory and the admin can see the changes in real time. An end-of-the-day report will not be required anymore to see the decrease in inventory which saves a lot of time.

The results of the Usability Review shows that the respondents perceived that the developed web-based application is relevant to their business, with a verbal description of “Good” for most functionality of the system. The results showed that the respondents agree to the importance of the web-based application to their company and that they are willing to use it in the future. The researchers can therefore conclude that the developed Inventory and Stock Management System can improve the inventory management system of food retail companies and can help decrease the discrepancy between the actual and recorded inventory and thus, reduce inventory cost.

The researchers recommend the use of search and filter features in the system. A search function can make the system more efficient and the filter function can enumerate and separate the searches quickly. An analytical tool can also be included or incorporated with the system. Having a predictive analytical sales tool will significantly benefit for decision making and provide more insights. For further study, the researchers recommend that the web-based inventory management system be made available as an application for computer or smartphone. Making it as an app can be more efficient when the browser version is having problems. Finally, the researchers recommend the use of this system to Food retail companies to improve their inventory monitoring.

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