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Design and Development of An Inventory Management Mobile Application

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Abstract
Inventory management plays a crucial role in meeting customer demands and maximizing profits for businesses. However, many organizations still rely on manual, time-consuming methods for recording and managing inventory data, leading to inefficiencies, data loss, and human errors. This study addresses these challenges through the design and development of a mobile application specifically tailored for inventory management using smartphones. The rapid application development methodology is employed to ensure an agile and iterative approach when developing the application. Functional requirements for the mobile application are gathered through a comprehensive analysis of existing manual inventory management processes and analyzing documents and apps from the Internet that are related to inventory management. The rapid application development methodology enables quick iterations, allowing for the rapid development of a prototype based on the gathered requirements. This prototype is then subjected to field testing, where its usability is evaluated. The results of the evaluation show that the overwhelming majority of the respondents agree with the fact that the prototype is useful, easy to use, and well-designed, expressing overall satisfaction. However, a small portion of respondents have concerns regarding error recovery and aspects of the prototype's design, leading to lower satisfaction ratings in these areas. These findings highlight areas for improvement and provide insights for future iterations and enhancements. This study significantly contributes to the field of inventory management by introducing a mobile application designed to streamline processes, reduce errors, and enhance efficiency. By leveraging mobile technology, the application offers businesses an effective tool to improve inventory control, optimize operations, and ultimately maximize profitability.

Keywords: *inventory, mobile, efficiency, management.*

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I. INTRODUCTION

Inventory management, which is a very important part of the supply chain, involves the tracking of inventory from manufacturers to warehouses and to its point of sale. However, organizations often face challenges such as inaccurate demand forecasting, overstocking, stockouts, and poor supply chain coordination. Effective inventory management is a vital component of successful business operations, ensuring optimal stock levels, minimizing costs, and maximizing customer satisfaction.

Nowadays, there are several companies that still use the traditional method of managing inventory manually by hand. Traditional manual inventory management methods are often time-consuming, error-prone, and lack real-time visibility. These methods involve recording stock levels, tracking inventory movement and reconciling data manually which are very time-consuming, prone to errors and delays which leads to inaccurate inventory information. The lack of real-time visibility into inventory levels also makes it really hard to respond quickly to changes in demand or supply, which results in stockouts or excess inventory.

Traditional manual inventory management methods also has a high risk of data loss as misplacing or damaging the logbook or spreadsheet that holds the data will lead to loss of critical inventory data which will end up in irreversible data loss if there is no proper backup. Human errors are also common when managing inventory manually with things such as inaccurate data entry, miscalculations and misinterpretations causing differences between the recorded and actual inventory levels. These errors may lead to orders not being able to be fulfilled due to insufficient stock.

In order to solve this problem, a system is required that is able to manage inventory effectively. Therefore, this study aims to develop an inventory management mobile application which is able to increase efficiency of inventory management processes, prevent inventory data loss, minimize human error and prevent stock-outs. The target users of the application are small to medium sized businesses and the scope includes being able to manage data of inventory, manage data of sales and purchases and notifying the user when inventory is running low.

II. RELATED WORKS

2.1 Case Study on Inventory Management Improvement

This paper presents a case study for a microchip assembling company on inventory management improvement. The paper analyzes the existing inventory management situation, proposes improvements to decrease inventory levels and holding costs, and compares it with real-time data. The proposed improvements include using inventory management to avoid overstocks and applying an agent system to make inventory management processes automatic and react to deviations in the demand of inventory. According to the experiments done in the paper, the conclusion has been made that better results can be achieved if timely reactions are made when there are changes in the environment. In order to achieve this, a human or decision support system is required to compare the demand that is forecasted beforehand with the real time demands and make corrections in orders or have an agent system to automate those processes.

2.2 Performance Improvement of Inventory Management System Processes by an Automated Warehouse Management System

This paper conducts research on how an automated warehouse management system impacts the performance of a supply chain which is provided little resources and efforts but was given an inventory system that is able to carry out process more efficiently and reliably. The study explores the impact of the system on supply chain performance, providing less resource effort, more efficient, and reliable inventory management system. The paper discusses the steps taken to optimize the process, including conducting a time and motion study, optimizing the facility layout, and implementing software to handle transactions and enhance workflow. Results of the study is able to give a conclusion that inventory management system that is automated is required and important to replace an inventory management system that is manual. The primary aim of replacing the manual management system with an automated one is to be able to have better control over the movement and storage of inventory along with having quicker handling times and better security. The automated system is able to organize data according to their serial number and carry out the FIFO concept which enables data to be handed to dealers quickly and accurately with little errors. This implementation of the new system was able to make the inventory management process more reliable and efficient by simplifying the processes that had to be done by the operators, suppliers and dealers.

2.3 Evaluation of the Role of Inventory Management in Logistics Chain of an Organization

This study focuses on defining the part that an inventory management plays in logistics of an organization. The paper reviews development in logistics, characteristics of different inventory operations being used in logistics, the applications of logistics in various fields, and its relationship with inventory systems. Results of the study concludes that inventory management and logistics have an interdependent relationship. This means that logistics management requires inventory management in order to carry out its activities efficiently and having a successful logistics system may have a positive impact on warehouse environment and its activities. Inventory is an important part of having good logistics system and without it a good logistics strategy is unable to show its full potential and capacity.

III. METHODOLOGY

The methodology that is going to be used to develop this project is the Rapid Application Development Methodology. This methodology is split into four different phases which are the requirements planning phase, user design phase, rapid construction phase and lastly, the cutover phase.

The requirements planning phase involves gathering the functional requirements of the inventory management application. The UML, also known as Unified Modelling Language diagrams such as use case, activity and class diagrams were then produced. During the user design and rapid construction phase, users are closely involved and give feedback on the prototypes that were produced to improve the application. Lastly, an evaluation is carried out in the cutover phase to evaluate the usability of the application.

IV. IMPLEMENTATION

This section is about the implementation of the application following the phases of rapid application development. The section is divided into two which are; (1) gathering the requirements of the mobile application and (2) the prototype development of the mobile application;

4.1 Requirements Gathering

Requirements were gathered through comprehensive analysis of existing manual inventory management processes and going through documents and apps found on the Internet which are related to inventory management. In comprehensive analysis of existing manual inventory management process, the sequence of activities that are performed in the manual inventory management process were observed and documented which

includes tasks such as performing individual counts, recording stock levels and recording stock purchases and sales. Each step was analyzed to understand the purpose, the information recorded and whether there was any challenges or inefficiencies encountered. This allows for identification of areas where the application is able to provide significant improvements when compared to the traditional inventory management process.

Documents were found using the keyword "inventory management" on the Google search engine. The results were then analyzed and relevant requirements were used. Table 1 contains a list of 6 requirements along with their priorities that were gathered from the processes described above. They include register account, login account, store inventory data, store inventory sales and purchases, search inventory details and generate report.

Table 1. List of Requirements

ID	**Description**	**Importance**
IMS_01	Register Account	
IMS_01_01	User will enter their email and password	Mandatory
IMS_01_02	User will fill in personal details such as name and contact number	Mandatory
IMS_01_03	System will ask for confirmation that the information entered is correct	Mandatory
IMS_01_04	System will display error if any of the fields is filled incorrectly	Mandatory
IMS_02	Login Account	
IMS_02_01	User will enter login information which is the username and password	Mandatory
IMS_02_02	System will display error if login information is wrong	Mandatory
IMS_02_03	User can use the forgot password function to reset password	Mandatory
IMS_03	Store Inventory Data	
IMS_03_01	User will enter the details of inventory	Mandatory
IMS_03_02	User will edit the details of inventory	Mandatory
IMS_03_03	System will display list of inventories	Mandatory
IMS_03_04	System will notify user if inventory level drops below the level that is specified by user	Mandatory
IMS_04	Store Inventory Purchases and Sales	
IMS_04_01	User will enter the details of inventory purchases and sales	Mandatory
IMS_04_02	System will display list of inventories	Mandatory
IMS_04_03	System will automatically add or deduct the inventory amount from currently available inventory when inventory is purchased or sold	Mandatory
IMS_05	Search Inventory Details	
IMS_05_01	User enters the ID of the inventory they want to search for	Mandatory
IMS_05_02	System will display the details of inventory that is chosen by the user	Mandatory
IMS_06	Generate Report	
IMS_06_01	System will generate a report showing the profits earned in the selected time slot	Mandatory
IMS_06_02	System will generate a report showing the amount of inventory purchased and sold in the selected time slot	Mandatory

Requirements shown in Table 1 were converted into computer system functionality. The following stage entails utilizing Unified Modelling Language to visualize and model the application's requirements. Use case, activity, and class diagrams were the models that were used, and they were all drawn using Draw.io. The use case diagram and interactions between the use cases and actors for the mobile app's inventory management are shown in Figure 1. The use cases include "Register Account", "Login Account" which includes "Verifying username and password" and allows user to reset their password using "Forget Password", "Store Inventory Data" which includes allowing user to "Add Inventory" and "Edit Inventory", "Store Inventory Purchases and Sales" which includes "Deduct from current inventory" and allows user to "Add Purchase or Sales", "Search Inventory Details" and "Generate Report".

Figure 1. Use Case Diagram

The use case diagram demonstrates the application's dynamic behavior. Activity diagrams of Figures 2 to 7 depicts the actions involved in utilizing the mobile application for managing inventory.

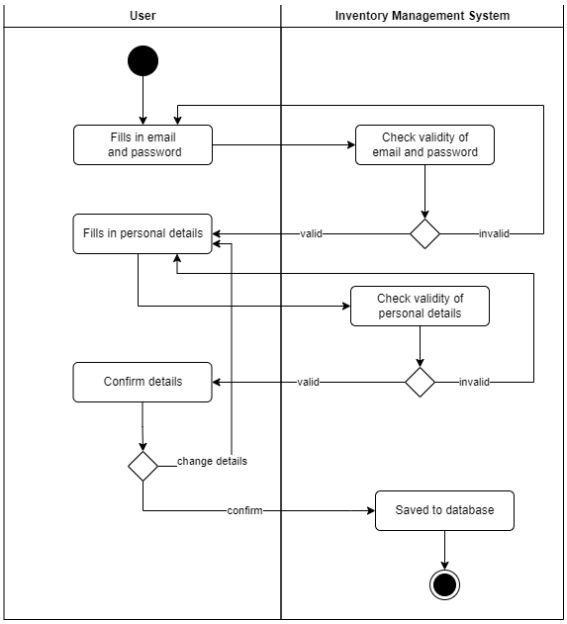

Figure 2. Activity Diagram for Register User

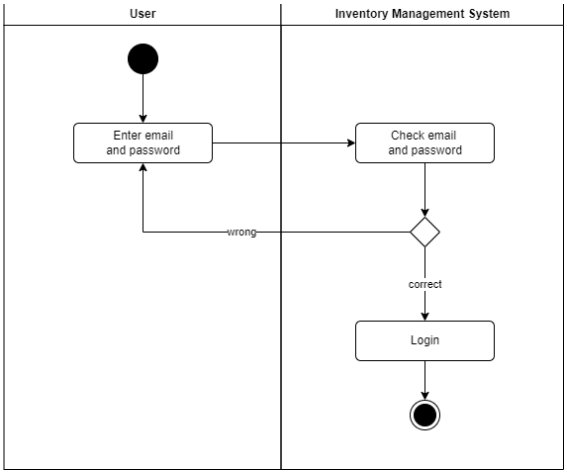

Figure 3. Activity Diagram for Login User

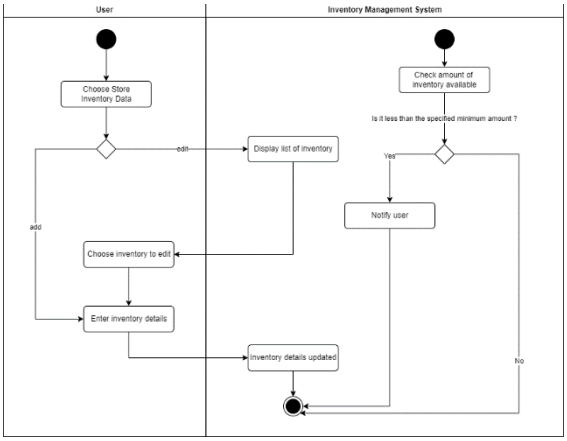

Figure 4. Activity Diagram for Store Inventory Data Function

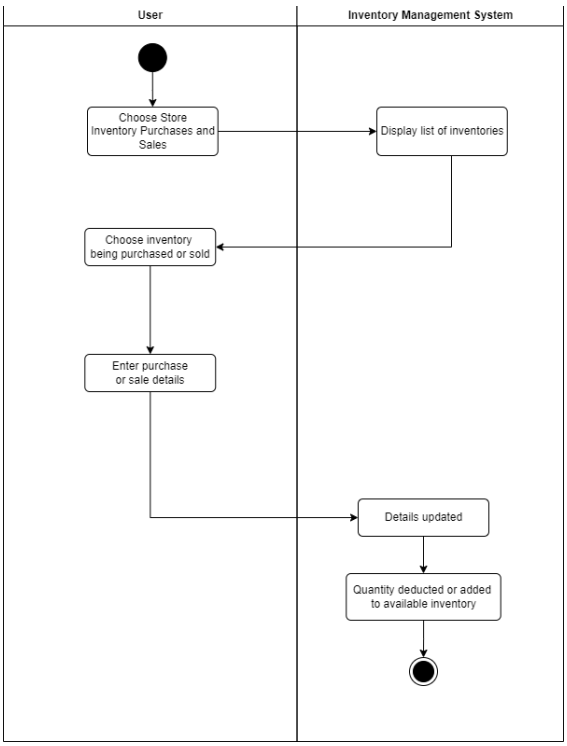

Figure 5. Activity Diagram for Store Purchases and Sales Function

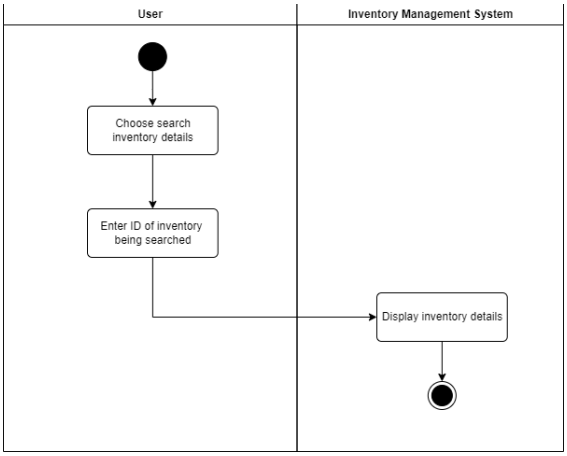

Figure 6. Activity Diagram for Search Inventory Details Function

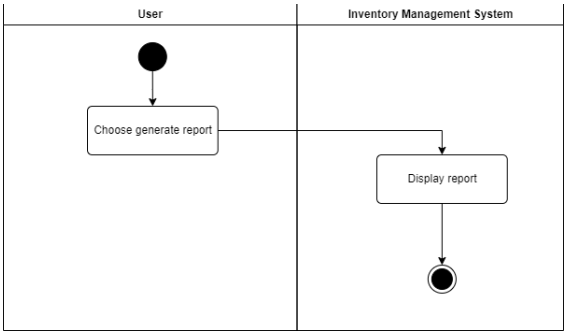

Figure 7. Activity Diagram for Generate Report Function

Figure 8's class diagram illustrates how the structural elements of the mobile inventory management application are organized. The primary classes are User, Product, PurchaseOrder, SalesOrder, Sales, Customer, and Supplier, and it displays the attributes and operations of the application.

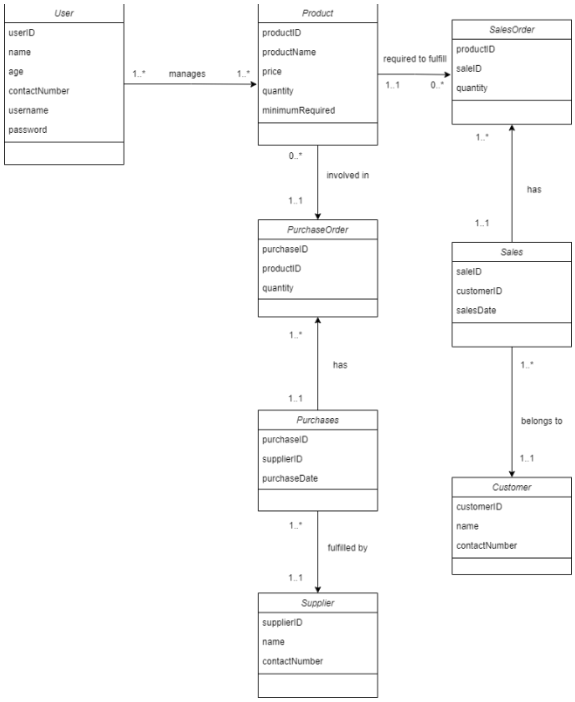

Figure 8. Class Diagram

4.2 Prototype Development

From the requirements acquired, a prototype of the inventory management mobile app was created. Software prototyping is the practice of displaying software requirements in real-time so that user feedback based on their interaction with the prototype can be received. The primary integrated development environment (IDE) tool was Flutter, while JomHosting served as the web hosting company for databases and data storage. Screenshots of the prototype's interface are shown in Figures 9, 10, and 11.

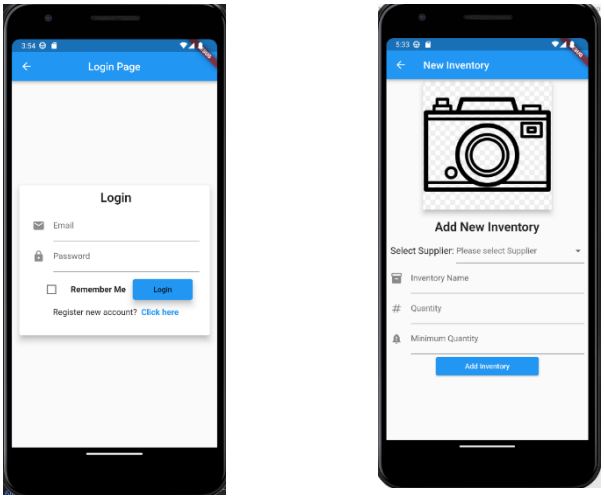

Figure 9. Login Screen (Left) and Insert Inventory (Right)

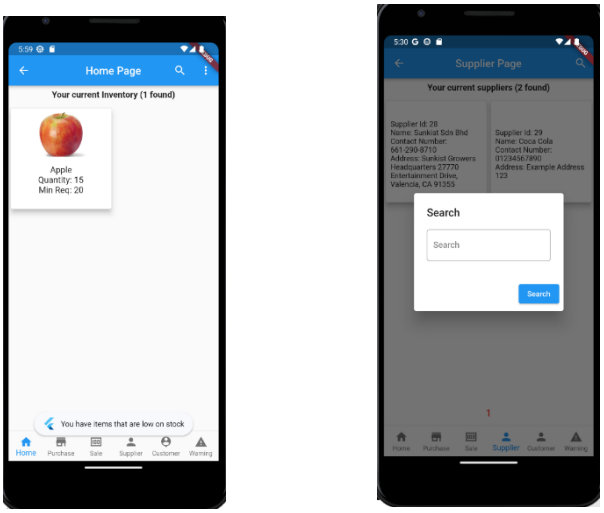

Figure 10. Warning Notification (Left) and Search (Right)

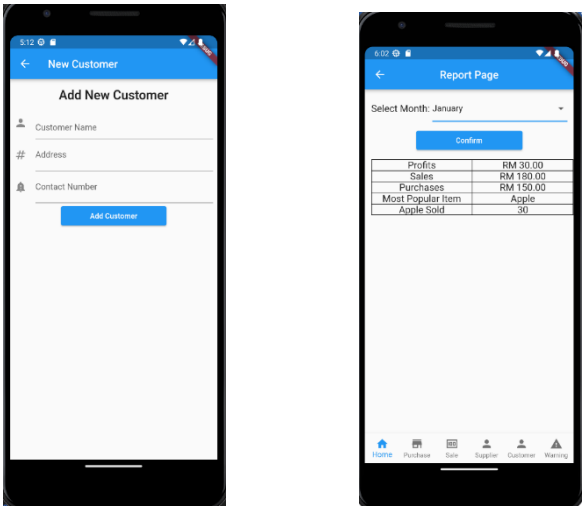

Figure 11. Add Customer (Left) and Generate Report (Right)

V. RESULTS AND ANALYSIS

5.1 Type of Evaluation

A usability evaluation of 30 respondents was done, of which 24 were Universiti Utara Malaysia students and 6 weren't. A group of volunteers who volunteered to take part in the study were used to choose the respondents. The post-task questionnaire and the prototype application were the tools that were employed and the USE questionnaire served as the basis for the post-task questionnaire, which has 19 questions divided into 5 sections. Section A asked questions about the respondents' demographics, Section B about the application's usefulness, Section C about the application's usability, Section D about the application's design, and Section E about the respondents' satisfaction with the application after using it. From Section B to Section D, the questions were graded on a five-point Likert scale, with 1 denoting Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree, and 5 Strongly Agree. For the evaluation, the respondents followed these steps: the provided apk must be downloaded and installed for non-face to face sessions, the prototype must be used and the post-task survey must be completed.

5.2 Demographic Data

According to an analysis of the respondents' demographic data, 63.3% of them were men and 36.7% were women. 73.3% of the respondents were Chinese, 16.7% were Malay while 10% were Indian. In terms of age, 86.7% of the respondents belong to the 18-30 age group while only 13.3% belong to the 30+ age group.

5.3 Usability Evaluation of the Prototype

Based on the replies in Sections B through E of the post-task questionnaire, an analysis was done. These parts gauge how respondents feel about the prototype's utility, usability, design, and satisfaction. Table 2,3,4 and 5 shows the frequency of the responses. Overall, majority of the respondents responded positively with Agree or Strongly Agree to all questions. However, there were some respondents that had a neutral opinion when asked whether they were able to recover from mistakes easily when using the system, whether the user interface was visually appealing or whether the user interface made it easy to understand how to interact with it.

Questions	1	2	3	4	5	Average
The system makes it easier for me to manage inventory	0 (0.00)	0 (0.00)	0 (0.00)	13 (43.33)	17 (56.67)	4.57
The system helps me save more time when managing inventory	0 (0.00)	0 (0.00)	0 (0.00)	14 (46.67)	16 (53.33)	4.53
The system helps me track and update inventory levels quickly and accurately	0 (0.00)	0 (0.00)	0 (0.00)	9 (30.00)	21 (70.00)	4.7
The system provides all necessary features and functionality to manage inventory effectively	0 (0.00)	0 (0.00)	0 (0.00)	16 (53.33)	14 (46.67)	4.47

Table 2. Responses for Section Usefulness

Questions	1	2	3	4	5	Average
The system is easy to use	0 (0.00)	0 (0.00)	0 (0.00)	16 (53.33)	14 (46.67)	4.47
I am able to quickly learn how to navigate through the system and perform tasks quickly	0 (0.00)	0 (0.00)	0 (0.00)	17 (56.67)	13 (43.33)	4.43
I can recover from mistakes quickly and easily when using the system	0 (0.00)	0 (0.00)	7 (23.33)	12 (40.00)	11 (36.67)	4.13
I don't notice any inconsistencies when using the system	0 (0.00)	0 (0.00)	0 (0.00)	12 (40.00)	18 (60.00)	4.6

Table 3. Responses for Section Ease of Use

Questions	1	2	3	4	5	Average
The user interface of the system is visually appealing	0 (0.00)	0 (0.00)	7 (23.33)	14 (46.67)	9 (30.00)	4.07
The color scheme and typography used in the mobile application enhance readability and usability	0 (0.00)	0 (0.00)	0 (0.00)	17 (56.67)	13 (43.33)	4.43
The layout and organization of the UI elements are logical and intuitive	0 (0.00)	0 (0.00)	0 (0.00)	15 (50.00)	15 (50.00)	4.5
The UI of the system makes it easy to understand how to interact with it	0 (0.00)	0 (0.00)	5 (16.67)	14 (46.67)	11 (36.67)	4.2

Table 4. Responses for Section Design

Questions	1	2	3	4	5	Average
I am satisfied with the system	0 (0.00)	0 (0.00)	0 (0.00)	16 (53.33)	14 (46.67)	4.47
The system works the way that I expect it to	0 (0.00)	0 (0.00)	0 (0.00)	17 (56.67)	13 (43.33)	4.43
I would recommend this system to a friend	0 (0.00)	0 (0.00)	5 (16.67)	13 (43.33)	12 (40.00)	4.23
I am likely to continue using this system in the future if working in a relevant field	0 (0.00)	0 (0.00)	7 (23.33)	12 (40.00)	11 (36.67)	4.13

Table 5. Responses for Section Satisfaction

VI. DISCUSSION

The vast majority of respondents gave incredibly positive answers to the questions on usefulness. In this case, the system was ready to be implemented.

The vast majority of respondents gave incredibly positive answers to the questions about usability. However, there were some participants that had a neutral opinion when asked whether they were able to recover from mistakes easily when using the system. Improvements could be made on this by displaying clearer error messages and adding visual elements to increase clarity and prevent mistakes from happening.

The vast majority of respondents gave incredibly positive answers to the questions about design. However, there was a small portion of participants that had a neutral opinion when asked whether user interface was visually appealing or whether that the user interface of the system makes it easy to understand how to interact with it. Improvements could be made on this by adding relevant images to make the user interface more attractive and adding visual elements to increase clarity on what everything does.

The vast majority of respondents gave incredibly positive answers to the questions about satisfaction. However, there were some participants that had a neutral opinion when asked whether they would recommend

this system to a friend or are likely to continue using this system in the future if working in a relevant field. I believe if the improvements listed above to the design and ease of use were made the satisfaction level of the system will increase.

VII. CONCLUSION

This paper addresses the challenges faced by businesses who are still relying on the traditional inventory management processes such as inefficiency, data loss and human errors. The application developed makes managing inventory more efficient by providing real-time access to inventory data, and having automated processes to reduce human errors when performing calculations, and stored in a database which reduces the risks of data loss.

The significance of application is in its potential to increase a business' profits and customer satisfaction by being able to maintain accurate inventory records, reducing stockouts and minimize overstocking. This leads to increased customer satisfaction as they are able to get their goods on time, reduced costs and increased profits from less overstocking and no stockouts.

For future work, additional features like having advanced analytics to forecast real-time demands and inventory optimization can be added. This involves the use of machine learning algorithms and predictive models that are able to make forecasts about demands and give suggestions on how to plan your inventory purchases.

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