



King Abdulaziz University Faculty of Computing & Information Technology Department of Computer Science CPCS351 Project, Fall Semester 2023



Pick&Pay

Smart Supermarket System

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Project ID: Group 2

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Phase 1: Project Description

1.1 Introduction

Markets provide the most important needs of people in our time. Perhaps there are several markets in one neighborhood to serve the largest number of customers, to avoid overcrowding and the lack of products from the market. Since the customer may come to buy a specific thing and end up buying products that he does not need. So, what if we turned this process into a smarter and more efficient process? Through digitization, today we can create an integrated system to create an exceptional experience and make the task of shopping more practical and less consuming.

1.2 Project Description

Our project's concept revolves around using technology industries to serve the community. Supermarkets are one of the most visited commercial centers in people's daily lives, where most of their needs like food, drinks, or even personal care products. The idea of our project is based on developing and facilitating the shopping process for customers, in addition to solving some problems that customers were facing in the market. The most common problem is the wasted time for customers who may face some difficulties while shopping. For example, the time spent walking from section to section to search for a specific product or brand, also the consuming time in the cashier line where each item must be accounted one by one. According to this, we have made a supermarket system that enables robots to serve customers by collecting all their needs and purchases. The customer must select all the products he wants through the machine, and then the robot will collect his order and deliver it to him.





1.3 Project Objectives

- Providing order machines (kiosks) to enable customers to enter their desired groceries.
- Providing a robot to collect items for instore customers of supermarkets whether they come on-foot or via drive through.
- Use robots in stock quality / freshness monitoring system.

1.4 Project Team

Student name	ID	Work distribution
Amani .		
Ashwaq	_	All group members participated
Shaden		in all parts.
Hadeel		





Goals and Scope

1.5 Project Goals

Pick & Pay system aims to organize and facilitate the shopping process for customers using modern means, and we expect the following:

- Accelerate checkout and purchase processes.
- Serving the largest number of customers.
- Increasing the individual's economic rate so that he does not buy things he
 does not need.
- Saving the market budget.
- Safer shopping.
- Safer payment.

1.6 Source of Domain Analysis Information

Since our project aims to improve the idea of supermarkets, our sources will include large market companies, store owners, customers, transportation and storage companies, and market staff.

1.7 Scope of the Project

"Pick & Pay" will be a system dedicated to supermarkets with a completely different experience. It will serve customers in their purchasing process without having to deal with any humans. The main task of the system is to display a list of products provided by the market where the customer identifies and chooses his needs, and then the system will collect them through transport robots for the delivery and payment area, so that the customer can receive his items at once and complete the payment process. The system also manages products by



checking their quantities available in stock and their validity (by their expiration dates). This project is expected to be completed by November 2025.

1.7.1 Included

The system provides:

- Security cameras to prevent a steal.
- Stock control to check product availability.
- Provide a check on the expiration date of products.

1.7.2 Excluded

- The system does not provide cash pay.
- The system does not provide disposal of the products that are expired.





Phase 2: Business Requirements Specifications

2.1 Domain Analysis

In recent years, assistive robots that help customers and provide various services to them have proliferated in public places such as airports, shopping centers, and supermarkets. As we know, global companies have recently become almost entirely dependent on robots to manage and organize their stocks and warehouses. Therefore, we have expanded and researched this field, which gave us the idea of creating smart supermarkets that fully utilize technology and machines to keep pace with the modernity and development of Oxagon city, speed up the shopping processes, and make them easier. Also, we were inspired by some ideas from projects that we see in our reality such as selfservice machines, which are found in some of the most famous fast-food restaurants, and we saw how acceptable they were to customers. Smart supermarkets will also help delivery companies' employees in their job, they will facilitate the process of collecting products from different store sections and save more time, and in the future, Pick & Pay project may expand to include a special delivery application to deliver customers' orders to their homes. All these things led to the development of our project idea which we hope will succeed and contribute effectively to a creative and sophisticated environment like Oxagon city.

2.2 Functional Requirements

R1: The system will allow users to register or login into the system.

- **R1.1:** The system will allow users to create an account in the system.
 - **R1.1.1:** The system must ask the user to enter his first & last name.
 - **R1.1.2:** The system must ask the user to enter his phone number.
 - **R1.1.3:** The system must verify the users' numbers by sending a verification code.



- **R1.1.4:** The system will send an OTP code to the user's phone number for verification each time he logs into the system.
- **R1.2:** The system will allow the user to use the system as a guest.
 - **R1.2.1:** The system will let guests make orders without the need to have an account.
- **R2:** The system will automatically log out the customer once he confirms the payment.
- **R3:** The system must display supermarkets' products to users.
 - **R3.1:** The system must show the products in sections (Meat Section, Vegetable Section, etc.).
- **R4:** The system must offer products filtered by type, price, calories, and brand.
- **R5:** The system must provide a searching tool for the user.
- **R6:** The system must display the supermarket's offers to the customers.
- **R7:** The system must allow users to select products.
 - **R7.1:** The system must show the details of the selected products (name, description, ingredients, calories, price).
- **R8:** The system must allow users to (add products to / remove products from) the cart.
- **R9:** The system must offer an option to set a purchase budget during the order process.
 - **R9.1:** The system will suggest less expensive and available alternatives based on similarities in their section, type, composition, and description to products in case the order cost exceeds the specified budget.
- **R10:** The system must generate the order once the user confirms payment.
 - **R10.1:** The payment process is done by (Mada Apple pay Master Card STC pay).
- **R11:** The system must generate an invoice after the customer confirms his order, and a QR code to receive the order from the receiving area.



- **R11.1:** The invoice shows the order details including the order number, date and time, list of chosen products, total price, and the approximate delivery time.
- **R11.2:** The system must offer two options to customers with accounts: send an SMS of the invoice and QR code or print them through the ordering machine.
- **R11.3:** Guests have only one option: printing the invoice and QR code.
- **R12:** The system must issue commands to the robots to start collecting items after the customer confirms his order.
 - **R12.1:** The system must analyze and manage the robot's commands to make the collecting process fast and efficient. For example, a robot should collect all required products from a particular section once without returning to it again.
- **R13:** The system must announce the order number once the order is ready for delivery.
 - **R13.1:** The robot will give the customer his order once the QR code is scanned.
- **R14:** The system allows the robots to wait 10 minutes for the customer to pick up his order in the receiving area. Robots will put the untaken orders in some specified place so the staff can restock them later.
 - **R14.1:** The system must return the amount paid to the customer within the next 24 hours if the customer didn't receive the order.
- **R15:** The system must manage stocks.
 - **R15.1:** The system must update the stock of the products after each order, which is precisely during the order-generating process.
 - **R15.2:** The system must check the validity (Expiration dates) of the products periodically.
- **R16:** The system must provide a comprehensive weekly report.
 - **R16.1:** The system must issue a report on stocks and product information in terms of available quantities and expiration dates.



- **R16.2:** The system must issue a report on generated orders during the week that includes the number of completed orders, canceled orders, a list of orders information, and details including the customer's name, the products purchased by him, order time, and the order's total amount.
- **R17:** The employee must restock store's products at the end of each day.
 - **R17.1:** The employee must return products that have not been received from the incomplete orders area.
 - **R17.2:** The employee must update the stocks in the system after the restocking process.
- **R18:** The guest who have a profile will benefit many facilities such as reward points, which are used in getting special offers or discounts for order based on the number of points collected by the user with each purchase
- **R19:** System must Provide an image and text for each product.

2.3 Non-Functional Requirements

R1: Payment must be made in a secure manner.

R2: The system must operate 24 hours.

R3: Customer can choose the language they want (English - Arabic).



2.4 Techniques for gathering data

We gathered data using a survey sent to the system's users. The results showed that they all have difficulties shopping in the supermarket, like waiting in the payment line and not resisting buying more products they don't need. Also, 90.1% wasted their time searching for products that weren't available in the supermarket. 75.3% Expect an amount different from the actual purchases. 72.7% use electronic payment methods. And there are some suggestions for the system. Check Appendix A for detailed information.

2.5 Use Case Description

	Use Case Documentation				
Use Case ID:	UC-1				
Use Case Name:	Create Account				
Description:	Customer accesses the system and choose between three options either log in, continue as a guest, or create an account using his phone number. Then he can select products and continue the shopping process.				
Primary Actor:	Customer				
Preconditions:	Customer is on the start interface				
Postconditions:	Customer entered the system and ready to select products.				
Main Success Scenario:	 Customer selects "create an account " from the startup page. System asks the customer for his first name, last name, and phone number. Customer enters his phone number and click "Register" button. System checks the validity of the phone number. System sends an SMS verification to the customer's phone number. Customer enters the OTP (One-time Password) code into the system. System registers customer and display a confirmation message. System displays available offers and products menu. 				
Extensions:	5a. Phone number is already registered in the system. 5a1. System displays an error message saying that the phone number is already used for a registered account, and then return the customer to the startup page. 6a. The user did not receive the verification code message. 6a1. System counts down for 60 seconds and then enable the option to resend the verification code. 7a. Customer enters a wrong verification code (OTP). 7a1. System asks user to re-enter the verification code (OTP).				



Use Case Documentation				
Use Case ID:	UC-2			
Use Case Name:	Make Order			
Description:	The customer will place an order, he will have the ability to choose products, add them to the cart and check the available offers.			
Primary Actor:	Customer			
Preconditions:	Customer logged into system.			
Postconditions:	Customer confirms the order.			
Main Success Scenario:	 The customer will select the product on the screen. The system will display the product information. The customer will add the product to the cart. The system will display offers to the customer to use. 			
Extensions:	3a. The customer can remove an existing product in his cart 3a1. A The customer cannot remove the product if his cart is empty			



Use Case Documentation				
Use Case ID:	UC-3			
Use Case Name:	Make Payment			
Description:	The customer makes payment and the system informs him whether the payment is successful or not.			
Primary Actor:	Customer			
Preconditions:	The customer confirmed his order.			
Postconditions:	Payment has done successfully.			
Main Success Scenario:	 The customer chooses the payment method (Apple pay, STC pay, Mada, MasterCard). Customer enters his payment information and selects confirm payment. System informs the customer that the payment is successful. 			
Extensions:	 2a. Wrong payment Information. 2a1. System displays an error message saying wrong input. 2a2. Customer either enters the information again or cancels the order. 2a3. After the third wrong input, the system automatically cancels the order-generating process and logs out the customer. 2b. Payment failed. 2b1. System displays an error message saying "Payment failed, try again later" and. 2b2. System keeps the order not fulfilled and load the main page. 			



Use Case Documentation						
Use Case ID:	UC-4					
Use Case Name:	Manage Stock					
Description:	The system manages the stock (check the validity/update the store).					
Primary Actor:	System					
Preconditions:	The system generated an order.Date to check the products.					
Postconditions:	Stock is updated.Expired products are removed.					
Main Success Scenario:	The system will check the products' validity date The system will remove the expired products from stock.					
Extensions:	None					



2.6 Use Case Diagram for Given Problems

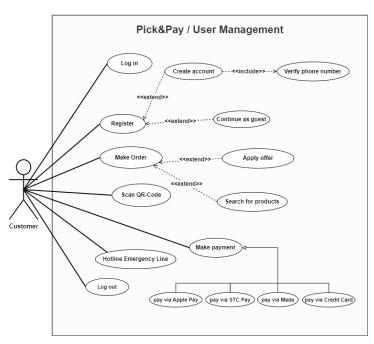


Figure 2: Use case diagram of user management

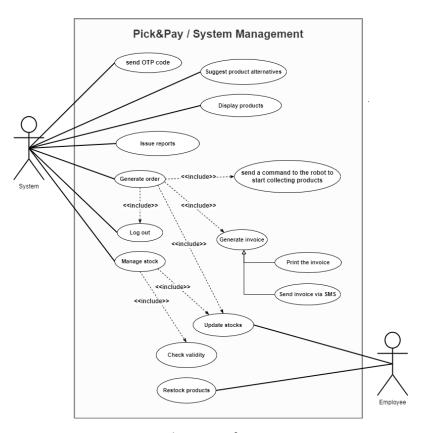


Figure 1: Use case diagram of system management





2.7 Difficulties & Risk Analysis in The Domain

The difficulties we faced while developing this system are:

- Difficult to know how the supermarkets manage their stock.
- Requirements may change during working on the system.
- Difficulty determining the period of the customer's receipt of the order.
- Difficulty determining the tasks of the robots.





Phase 3: Design and Structuring

3.1 Converting use cases to class diagram

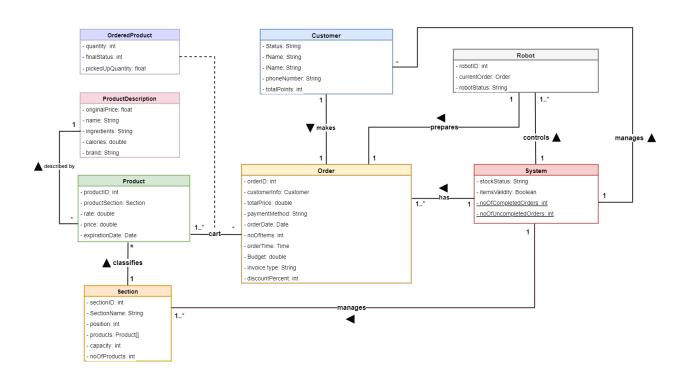


Figure 3: Domain Model of Pick & Pay System



3.2 UML class diagram

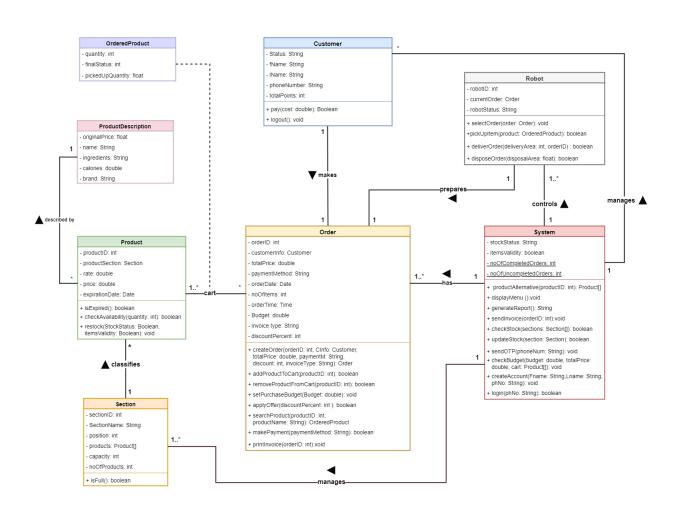


Figure 4: UML Class Diagram of Pick & Pay System



3.2.1 Association Relationships

"هنا الدكتورة ما طلبت مننا تعديلها, فهي تتبع رسمات سابقة قبل التعديل الموجود هنا Follow Old Class Diagram"

- 1. Between Employee class and System class
 - Each Employee has access to a single System
 - System has many Employees.
- 2. Between Customer class and Order class
 - Each Customer can make one Order at a time.
 - Each Order is made/created by one Customer.
- 3. Between Robot class and Order class
 - Each Robot prepares one Order at a time.
 - Each Order is prepared by one Robot.
- 4. Between the System class and Robot class
 - The System controls many Robots.
 - Each Robot is controlled by the System.
- 5. Between the System class and Order class
 - The System generates many Orders.
 - Each Order generated by the System.
- 6. Between the Section class and Products class
 - The Section classifies many products.
 - Products are classified into each Section.

3.2.2 Aggregation Relationships

- 1. Between Product class and Order class
 - A product is a part of an order.
 - Each product is contained in one order and each order can have one to many products.
- 2. Between the System class and Section class
 - The System manages many Sections.
 - Each Section is managed by the System.



3.3 System Architecture

3.3.1 Architectural Design

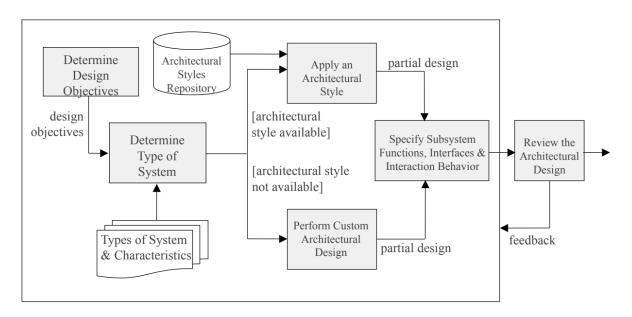


Figure 5: Pick & Pay Architectural Design Process

1. Determine Design Objective

Pick & pay aims to offer a supermarket ordering system that is quick and easy to use and provides services to customers, including ordering machines and robots to collect the order items.

2. Determine Type of System

Pick and pay is an interactive system.

3. Apply an Architectural Style

Pick & pay uses a N-Tier style.



4. Specify Subsystem Functions, Interfaces, and Interaction Behavior

Subsystems are customer, robot, order, and product. All functionalities these subsystems rely on were explained in functional requirements, all interactions were explained in UML diagram.

5. Review The Architectural Design

All requirements, architectural design objectives, and constraints are met. Pick & pay architectural design meets software design principles.

Our choice is N-tier architecture because our system involves user interaction, and the processes start and end with the user.

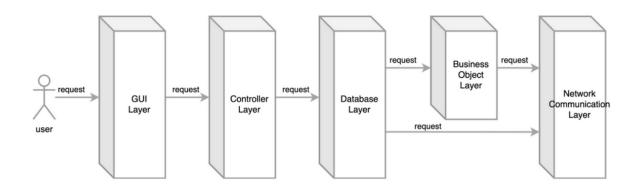


Figure6: Pick & Pay N-Tier Architectural Design



Phase 4: Modelling, Interaction & Behavior

4.1 Interaction Diagram: Sequence Diagrams

4.1.1 Sequence Diagram 1: Create Account – the case of valid OTP code

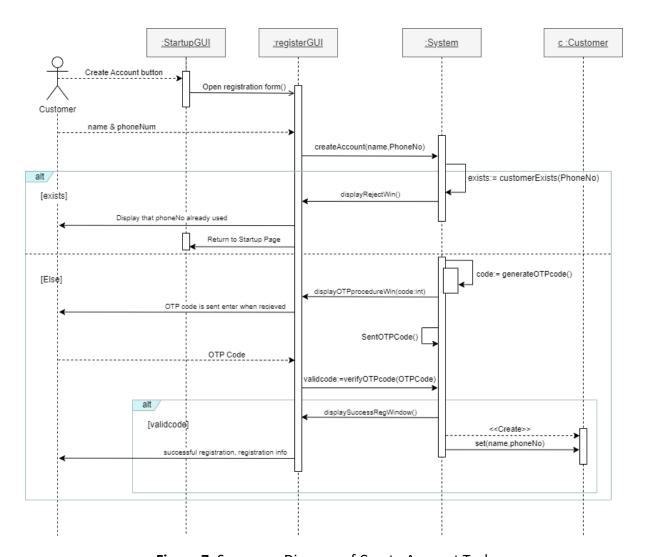


Figure 7: Sequence Diagram of Create Account Task



4.1.2 Sequence Diagram 2: Make Order

"This follows old class diagram"

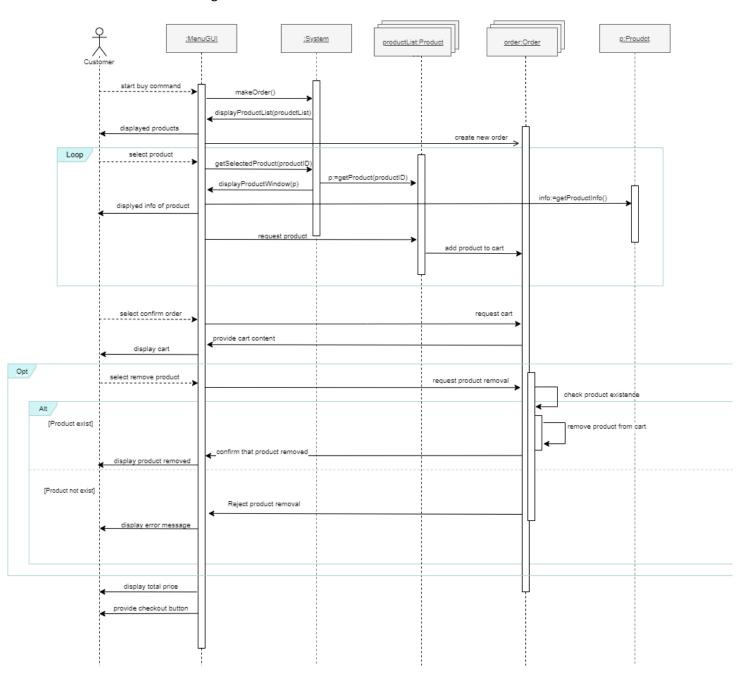


Figure 8: Sequence Diagram of Make Order Task





4.2 Interaction Diagram: State Diagrams

4.2.1 State Diagram 1: Make Order

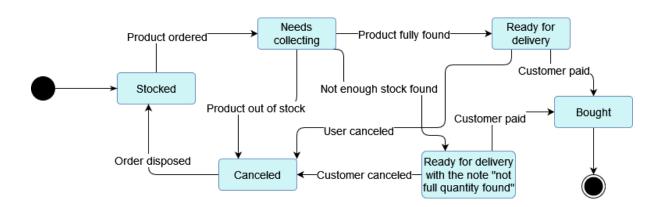


Figure 9: State Diagram of Order Product

4.2.2 State Diagram 2: Order Product

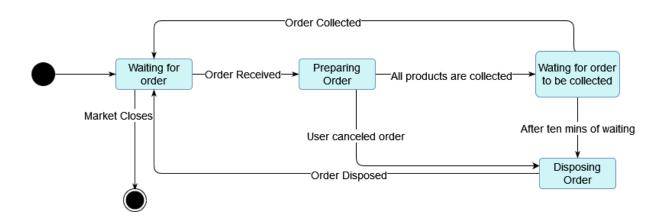


Figure 10: State Diagram of Robot



× Δ × ×

4.3 Interaction Diagram: Activity Diagrams

4.3.1 Activity Diagram 1: Registration

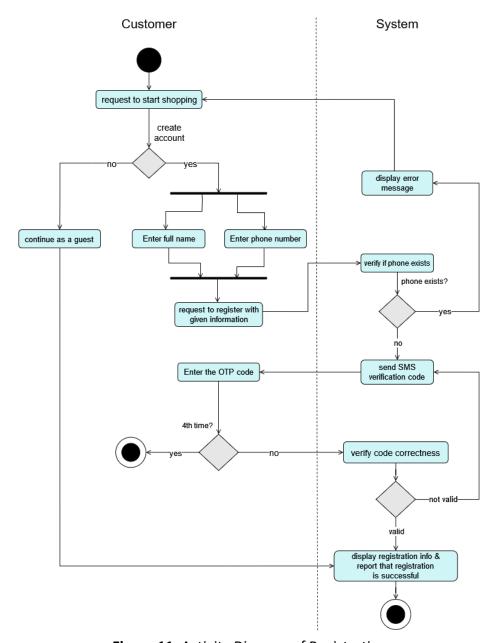


Figure 11: Activity Diagram of Registration



× Δ × × × ×

4.3.2 Activity Diagram 2: Generate Order

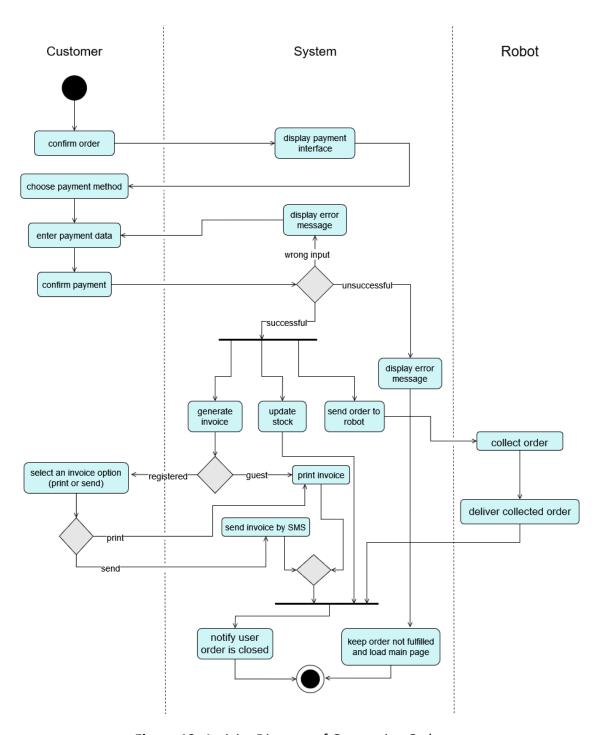


Figure 12: Activity Diagram of Generating Order





4.4 Testing

4.4.1 Testing Objectives

- Identify whether the system meets the requirements.
- Ensure the system and all its features are working fast and efficiently.
- Identify the system issues and fix them.
- Determinate which areas need more development.
- Evaluate system interaction with customers.

4.4.2 Testing Strategy

The primary purpose of testing our system pick & pay is to ensure that the system satisfies all the predefined requirements and functions correctly and smoothly, in addition to detecting any possible errors to fix them.

Therefore, we have selected the following functionalities to be tested:

- Deliver the order.
- Budget selection.
- Generate order.

For the system to be considered successful, the result of the previously selected functionalities is expected to be correct.

4.4.3 Testing Approach

In this test, used the black box testing approach. We selected this method because we will focus on testing the system's behavior.





4.4.4 Test Plans: consists of 3 test cases

Test Case 1 -

• **System:** Pick&Pay supermarket system.

• **Test case name:** Deliver the orders.

• **Description:** Test if the robot delivers the orders well.

• **Pre-condition:** The robot is waiting for an order.

• **Post-condition:** Delivered successfully.

Test ID	Test Scenario	Test Steps	Test Data	Expected result	Actual Result	Pass/fail
1	Deliver the order, and the customer receives it.	 1- Order generated. 2- Send the order to the robot. 3- The robot preparing the order. 4- The robot goes to receiving area 	 Order data location of the receiving area location of the disposing area 	The robot goes back to stock to wait for another order.		
2	Deliver the order, and the customer does not receive it.	 1- Order generated. 2- Send the order to the robot. 3- The robot preparing the order. 4- The robot goes to receiving area 	 Order data location of the receiving area location of the disposing area 	After ten min of waiting for the customer to receive the order, The robot goes to the disposal area and sets the order. Then the robot goes back to stock to wait for another order.		

Table 1: Test Plan of Delivering the orders





- **System:** Pick&Pay supermarket system.
- **Test case name:** Budget selection.
- **Description:** The possibility of specifying the budget by the customer.
- **Test Scenario:** Testing the budget selection mechanism when selected by the customer.

Preconditions:

- Choose the budget selection option.
- Determine the budget value.
- **Postcondition:** The total price of the customer is within the budget.

1						
Test ID	Test Scenario	Test Steps	Test Data	Expected result	Actual Result	Pass/fail
1	Check system behaviour when the customer sets a specific budget.	 Customer logs into the system The customer sets a specific budget The customer Starts adding products to the car Customer does payment 	 Customer ID:54321 Order ID:12345 Specific Budget: 345 SR Total price: 347 SR 	Print msg "You have exceeded the budget; do you want to complete the payment?" • If no: system provides alternatives, then the customer continues to the payment step • If yes: The customer continues to the payment		
2	Check system behaviour when the customer does not set a specific budget.	 Customer logs into the system The customer Starts adding products to the car Customer does payment 	 Customer ID: 54321 Order ID: 12345 Total price: 347 SR 	The customer will continue to the payment step		

Table 2: Test Plan of Selecting a budget

• System: Pick & Pay supermarket system

• **Test case name:** Payment.

• **Description:** Test if the system will generate the customer's order.

Preconditions:

- The customer must be logged into the system whether as a guest or as a registered user.

- The customer made an order and confirmed it.

• **Post-condition:** The customer's order is successfully generated.

Test ID	Test Scenario	Test Steps	Test Data	Expected result	Actual Result	Pass/fail
1	Check system behaviour when the customer enters payment information, and the payment operation is successful	 Customer logs into the system. The customer confirms an order. The customer chooses a payment method and enters the payment information. The customer confirms the payment. The system generates order's invoice The system logs out the customer. 	 Order ID: 27245 Payment data. Invoice number: 102 	Order is generated successfully. Print "your order is generated successfully, thank you for using our system. "Message.		



Check system behaviour when the customer enters payment information, and the payment operation is unsuccessful	information. 4. The customer confirms the	 Order ID: 78654 Payment data. 	The system will not generate the order. Print "Sorry, the payment was unsuccessful. Please try again later." Error message		
--	---	--	--	--	--

Table 3: Test Plan of Generating order

4.5 Test Design Technique

4.5.1 Decision Table Testing

Order Send	F	Т	F	Т
Receiving the Order	F	F	Т	Т
Expected Result	Waiting for order	Disposed the Order	Waiting for order	Delivered successfully

Table 4: Deliver order Decision Table

Phone Number	F	Т	F	Т
Full Name	F	F	Т	T
Expected Result	Error: Please enter Full Name & Phone Number	Error: Please enter Full Name	Error: Please enter Phone Number	Login processed

Table 5: Login Decision Table





4.5.2 Equivalence Partitioning

Phone Number (10 Digits):

Invalid Partition	Valid Partition	Invalid Partition
 0 Digits 1 Digits 9 Digits	• 10 Digits	11 Digits12 Digits13 Digits

 Table 6: Equivalence Partitioning for Register (set Phone Number)



Appendix A

