SELF CHECKOUT SYSTEM

Capstone Project Report

MID SEMESTER EVALUATION

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Computer Science and Engineering Department
Thapar Institute of Engineering and Technology, Patiala
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ABSTRACT

In today's world, there is a dire need to revolutionize how we shop in our daily lives, majorly how we shop at super markets, where we have to stand in long queues just to checkout.

The traditional ways of shopping not only suffers from long waiting queues at the checkout counter but also, some poor user experiences like customers cannot see their bill in real time because of which people might overshoot their budget which alleviates wastage of time on removing redundant items at the checkout counter, furthermore there is no privacy in current ways of shopping and no personalised suggestions based on shopping.

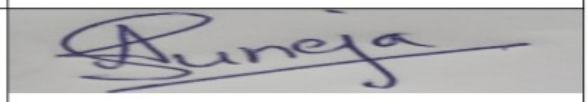
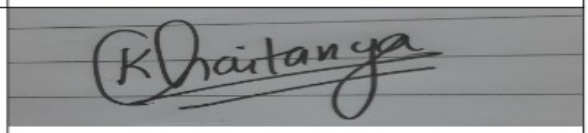
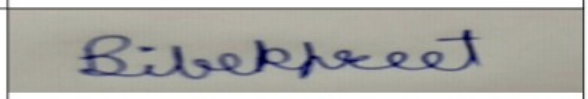
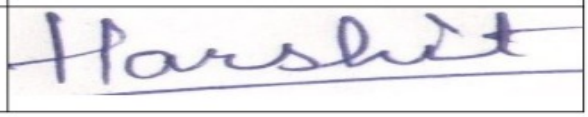
Our solution to this problem is the self checkout system where there is real time bill generation so that no one overshoots their budget,full privacy enabling customers to buy whatever they want without the judgement of others and no long queues.

We are going to make a mobile application which will scan the products before you put it into the cart and you will be seeing a real time bill as you keep on shopping and the trolley will keep on checking for fraudulent cases.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled SELF CHECKOUT SYSTEM is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Sharad Saxena during 6th and 7th semester (2021).

Date: 28 Aug, 2021

Project Title: Self -Checkout System		
Roll No	**Name**	**Signatures**
101803268	Ajat Suneja	
101803269	Chaitanya Kaushal	
101803272	Bibekpreet Singh	
101803276	Harshit Bansal	

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ACKNOWLEDGEMENT

We would like to express our thanks to our mentor(s) Dr. Sharad Saxena. He has been of great help in our venture, and an indispensable resource of technical knowledge. He is truly an amazing mentor to have.

We are also thankful to CSED, Head, Computer Science and Engineering Department, entire faculty and staff of Computer Science and Engineering Department, and also our friends who devoted their valuable time and helped us in all possible ways towards successful completion of this project. We thank all those who have contributed either directly or indirectly towards this project.

Lastly, we would also like to thank our families for their unyielding love and encouragement. They always wanted the best for us and we admire their determination and sacrifice.

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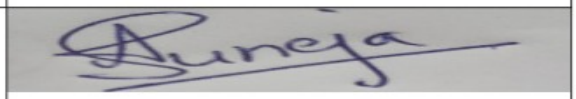
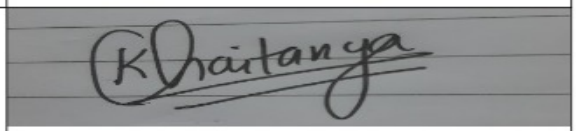
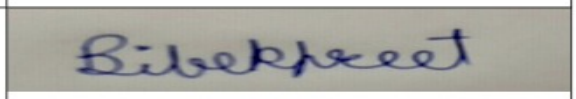
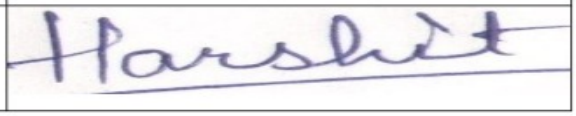
101803268	Ajat Suneja	
101803269	Chaitanya Kaushal	
101803272	Bibekpreet Singh	
101803276	Harshit Bansal	

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LIST OF ABBREVIATIONS

VER	Version
RFID	Radio Frequency Identification
LED	Light- emitting diode
LCD	Liquid Crystal Display
GPS	Global Positioning System
GUI	Graphical User Interface
IOT	Internet of Things
RF	Radio Frequency
CASE	Computer- aided Software Engineering
EEPROM	Electronically Erasable Programmable Read Only Memory
IEEE	Institute of Electrical and Electronics Engineers

INTRODUCTION

1.1 Project Overview

A stitch in time saves nine. Time is the most valuable resource which needs to be saved. Shopping at market stores expends ample amount of time at the billing counters by standing in long queues. Thus, self-checkout systems are the need of the hour. In a traditional retail store, much of the employer's cost goes on providing staff to run checkouts. Self service checkout transfers the workload to the customer. Some stores see this opportunity to reduce labor costs and it is often more cost-effective to transfer those staff to other duties, particularly customer service.

Shopping at market stores expends a lot of time at the billing counters by standing in long queues which leads to poor user experience. The employees at the billing counters do the payment work which could otherwise be handled by the customers themselves are more convenient and in trend. Moreover, a customer does not know what the current bill amount is for the items in the trolley. Thus, the problem statement is to simplify the shopping process and scrutinize ways to tackle and optimise ways for the above-stated problems.

The main objective of the Shopping Cart System is to manage the details of Cart, Orders, Payment, Customer, Category. It manages all the information about Cart Products Category, Cart. The project is totally built at the administrative end and thus only the administrator is guaranteed the access. The purpose of the project is to build an application program to reduce the manual work for managing the Cart, Orders, Products, Payment. It tracks all the details about the Payment, Customer, Category.

The aim of the project is to implement a self-checkout system which accomplishes the following goals:

- Removal of waiting queues, thus, saving time.
- Handling of fraudulent cases efficiently.
- Real-time bill generation.
- Implementation of online payment options.

This record explores and demonstrates how the tech set of rules model became used in assessment of a commercial enterprise opportunity from a generated era idea proposed for commercialisation functions. The concept technology became conducted using the double diamond approach in guiding the team toward identifying a technological concept for this challenge. There are four fundamental strategies within the double diamond approach known as ideation, necessities, iterative layout and idea implementation. Those strategies have been utilised with the aid of the group to put into effect a fantastic technology concept, a good way to be centered toward all of the big united kingdom retail shops. The double diamond approach aided the team in growing many ideas to narrow it down to the smart trolley idea based totally on remarks from a targeted organization within the crew. A precise idea came up from the ideas technology listing which became chosen for this venture.

This report discussed the choice of the smart trolley concept through the technique of the use of an algorithm to assess the unique business benefits in comparison to its hazards. To come up with creative and modern ideas, the crew turned it into two sub teams to generate ideas. Every subgroup became responsible to supply ideas which turned into later controlled by means of verifying with the requirements set for this project. As a team, all thoughts had been exploited and explored carefully to fit the scope of implementing a technology that is useful inside the global enterprise.

The smart trolley concept stood out from many thoughts offered by the crew primarily based on how the concept would be advanced into an exciting technology product which is handy, clean to apply and efficient, such as it being an add-on provider for the existing self-checkout gadget. As the idea became based on generation, it changed into critical to get the perception of consumers for which the idea became designed. The motive for this became to analyse the position of assumptions, perceptions and expectancies from the shops and its each day clients toward the proposed smart trolley concept for United kingdom supermarket outlets and perhaps to different European countries. The group had a splendid response from major retail shops such as Tesco, Asda and Sainsbury after a central institution from the group had made contact.

The smart trolley idea is based on the most popular automated self-checkout machine in a

maximum of United kingdom retail shops. The concept is designed into a smaller version of the automatic self-checkout system on a buying trolley with a consumer interface screen which lets in customers to make a fee for objects scanned and placed in the trolley before leaving the doorway of the store. That is to release strain at the tills in the course of height hours. The clever trolley comes with all the traditional offerings such as scanning an object to take a look at for price and info, also there are other additional functions that could be covered in the layout which includes locating an object in the shop via typing in the item's call in the search discipline on the consumer interface display screen so one can routinely show the object's place in the shop. The smart trolley is designed with security measures to prevent it being wheeled out from the store's premises and additionally to protect purchaser's card information as it's far designed to accept simplest card fee for items sold in the shop.

Features of buying cart device are as follows:

- Affords the looking facilities based on various factors which include cart, payment, patron, category.
- It tracks all of the data of orders, merchandise, customers and many others.
- Control the records of orders.
- Indicates the data and outline of the cart, charge.
- All the fields inclusive of cart, payment, class are proven and do no longer take invalid values.
- It generates reports on cart, orders, and products.
- Provide filter reports on payment, purchaser, class.
- You could easily export pdf for the cart, merchandise, and customer.
- Utility additionally presents excel export for orders, fee, class.
- You can additionally export the record into csv layout for cart, orders, category.
- To grow performance of dealing with the cart, orders.
- It offers tracking the information and transactions of clients.
- Modifying, including and updating of facts is progressed which results in right aid management of cart records.
- Control the information of clients.
- Integration of all records of class.

1.2 Need Analysis

The problems listed below contribute to poor user experience and thus, arises a much needed solution to make things simpler and easy to use.

- Real-Time Bill Generation: The existing systems do not provide information on what the current bill is. In some cases, the customer might exceed his/her budget and would only be able to know about it at the time of checkout. This leads to poor user experience.
- Long Waiting Queues: The existing systems are unable to tackle this problem. Consider a queue of say three people where the first one has A products in his cart and the second person has B products but the third has only a single item in his cart. In this case, he must wait for a long time till his turn comes.
- Cost to the company: In a traditional retail store, much of the employer's cost goes on providing staff to run checkouts. It is often more cost-effective to transfer those staff to other duties, particularly customer service which promises good user experience.
- Ease-of-use: has been described as the diploma to which a person believes that the usage of a specific device is free of effort. Ease-of-use for that reason relates to the efforts a purchaser needs to make on the way to efficiently use the new provider process and enjoy its anticipated advantage. Self checkout System effort perceptions may be inspired by means of e.g., the bodily vicinity, operating hours, and overall availability of the Self checkout System.
- Ease-of-use reflects the quantity to which clients assume Self checkout System to be smooth to research and use, and is definitely linked to clients willingness to reuse Self checkout System.
- Reliability: It is an important measurement of carrier best, which includes technology-based total offerings. Reliability entails consistency of performance and dependability, or the potential to perform the promised provider dependably and as it should be, as a result lowering perceived risk . consult with reliability as the volume to which the sst constantly and as it should be performs the anticipated project. Reliability accordingly refers to the correct technical functioning of a Self checkout System and the accuracy of carrier shipping. The risks of malfunctioning the Self checkout System include dissatisfaction and lack of income.

1.3 Research Gaps

Title	Research Gap	References
A Proposed Technique for Implementing Smart Cart Based on Artificial Intelligence	1) Usage of RFID tags for identification 2) Adding extra workload of putting RFID tags on products 3) Extra cost 4) Every cart has an LCD display adding further cost and removing the possibility of more personalised shopping.	[1] A. Kumar, A. Gupta, S. Balamurugan, S. Balaji and R. Marimuthu, "Smart Shopping Cart," 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS), Vellore, India, 2017, pp. 1-4, doi: 10.1109/ICMDCS.2017.8211723.
The RFID Based Smart Shopping Cart	1) Usage of RFID tags adding further cost and work to the setup.	[4] Ms. Rupali Sawant, Kripa Krishnan, Shweta Bhokre, Priyanka Bhosale "The RFID Based Smart Shopping Cart", International Journal of Engineering Research and General Science Volume 3, Issue 2 pp 275-280, March-April, 2015.
IoT Applications on Secure Smart Shopping	1) RFID, LCD and RFID tagged shelves and payment gateway. 2) Smart shelves are redundant as inventory can be managed on purchase information directly.	[6] R. Li, T. Song, N. Capurso, J. Yu and X. Cheng, "IoT Applications on Secure Smart Shopping," 2016 International Conference on Identification, Information and Knowledge in the Internet of Things (IIKI), Beijing, China, 2016, pp. 238-243, doi: 10.1109/IIKI.2016.25.
Interactive Intelligent Shopping Cart Using RFID And ZIGBEE Modules	1) RFID tags are again used along with LCDs adding further cost and work. 2) Adding LCDs to the carts itself adds a risk factor and less customer personalization.	[7] S. Dhauta and S. Kapoor, "Interactive intelligent shopping cart using RFID and ZIGBEE modules," 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Palladam, 2017, pp. 764-769, doi: 10.1109/I-SMAC.2017.8058282.
An IOT Based Smart Shopping Cart for Smart Shopping	1) It uses RFID, LCD and android application altogether but the mobile app has no real use. 2) Mobile app is only for making a list from the database.	[8] Karjol, Srinidhi & Holla, Anusha & c b, Abhilash. (2018). An IOT Based Smart Shopping Cart for Smart Shopping. 10.1007/978-981-10-9059-2_33.

TABLE 1: Research Gaps

1.4 Problem Definition and Scope

Shopping at market stores expends a lot of time at the billing counters by standing in long queues which leads to poor user experience. The employees at the billing counters do the payment work which could otherwise be handled by the customers themselves are more convenient and in trend. Moreover, a customer does not know what the current bill amount is for the items in the trolley. Thus, the problem statement is to simplify the shopping process and scrutinize ways to tackle and optimise ways for the above-stated problems.

The planned realistic booking out tram device intends to assist looking out in-character that is in a function to decrease the extensive amount of it sluggish spent in searching out nevertheless on time required in bcating the desired product comfortably. The purchaser merely should type the call of the products he wants to e book on the automaton device, and so the cart will robotically guide him/her to the product/s locations.

Smart carts could be interfaced with wi-fi technology to make them completely transportable within the close to future. Fee of bills victimization mobile can be enforced. A coffee value mobile scanner may be manufacturing unit-made and used which may additionally experiment a couple of tags (products) at the identical time for faster system and lesser assets. Computerized scanning & accessibility of products could be introduced. Pay programming features are going to be the maximum current fashion in coming years because of the improvement inside the e-trade enterprise.

We also are planning to feature a webcam for detecting the character's face so that the trolley knows its owner. If a GPS is mounted in the system then the proprietor also can understand in which his/her trolley is presently. An interactive lcd, which can display the location of the objects a client wants to shop for, and other information of the scanned product, may be the concept of appending alongside too.

The machine which could experiment a couple of tags at a time with 100% accuracy continues to be underneath development. As soon as it's far available, this generation can gain new heights with least time consumption and higher security.

1.5 Assumptions and Constraints

Sr. No.	Assumptions and Constraints
1	Users should have a Smart Phone with internet connection all the time.
2	No two products have similar weight.
3	Shop has a dedicated server.

TABLE 2: Assumptions and Constraints

1.6 Standards

Phase or Activity Group	**Number**	**Standard Title**
Requirements Specifications	IEEE 830	Recommended practice for Software requirements specifications
	IEEE1233	Guide for developing system requirements specifications
Design	IEEE 1016	Software design descriptions
	IEEE 1062	Software acquisitions
Implements ,acquisitions and tools	IEEE 1462	Guidelines for evaluations and selection of CASE tools
ESP 12E Module	IEEE 802.11	Microcontroller module for the Internet of Things (IOT)
Testing	IEEE 829	Software test documentation
	IEEE 1008	Software unit testing
	IEEE 1012	Software verification and validation

TABLE 3: Standards

1.7 Objectives

- Scanned items are added to the database and displayed in the mobile application with its price and information.
- Item is removed by scanning it after pressing the delete button.
- Our system is able to detect fraudulent cases.

- Unscanned items added in the trolley are detected.
- Unscanned items removed from the trolley are detected.
- Scanning item A but putting item B instead of A is detected for unequal weights of A and B.

- The shopping time is reduced by removal of queues.

1.8 Methodology

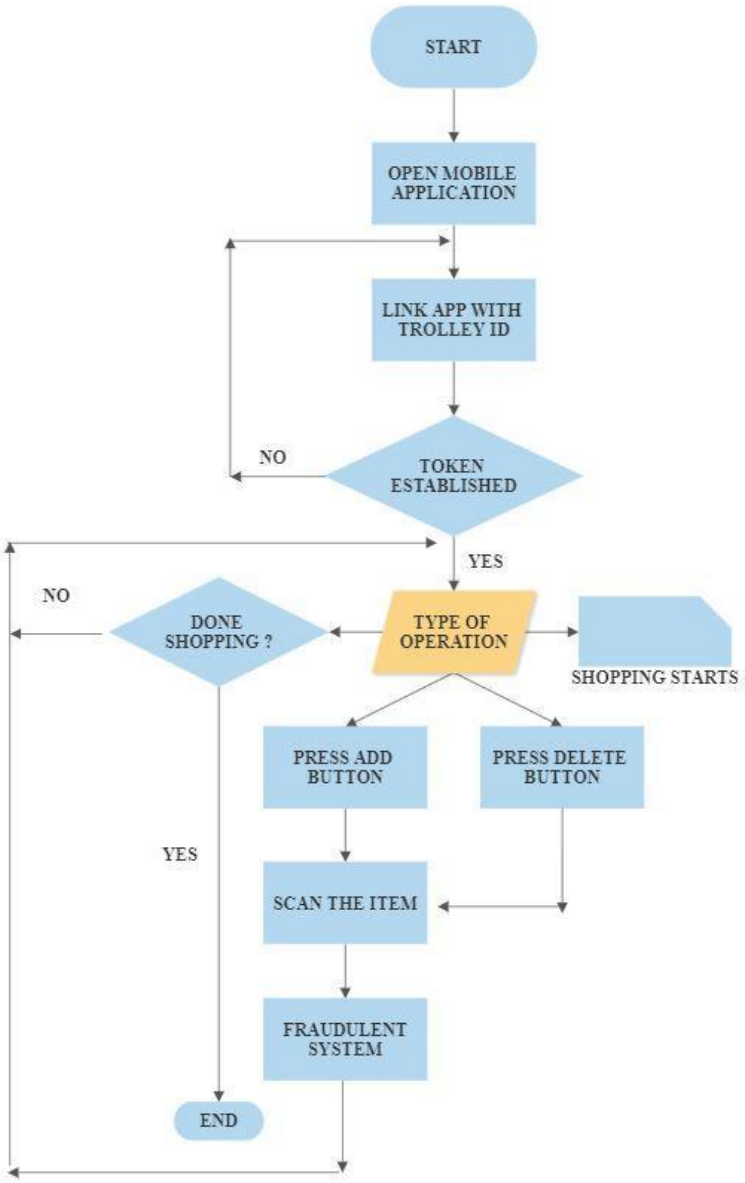


FIGURE 1: Product Overview

- Customer enters the mall with the mobile application installed.
- Customer gets a trolley from the trolley stack and enters the trolley number in the application to connect with the trolley database.
- On successful connection the user is directed towards the items list, otherwise the user has to enter the correct trolley number.
- Now the customer proceeds towards shopping and if he wants to add the item in the cart he should press the add button and scan the product barcode and put the product in the cart.
- On successful scan the product is added to the list and the weight of the product is measured with the weight sensors and is transmitted to the database by the arduino installed on the trolley.
- If the weight on cart and product weight is not within specified range the cart LED is turned red implying there is a problem otherwise the addition of the product is successful and the LED turns green.
- If the customer wants to remove the item from the list then he would press the delete button in the application and scan the product to be removed.
- On removing the product from the cart the new weight is transferred to the database and is checked against the weight of the product, if the weight matches the LED turns green otherwise it turns red.
- When the customer is done with his shopping, if the cart LED is green then he would be able to proceed with the bill payment through the application and for that purpose he would have to enter the checkout zone where the guard would only allow those people to enter whose cart LEDs are green and then while the customer is paying the bill the guard would empty the cart products in a bag and on successful payment he would hand over the bag to the customer.

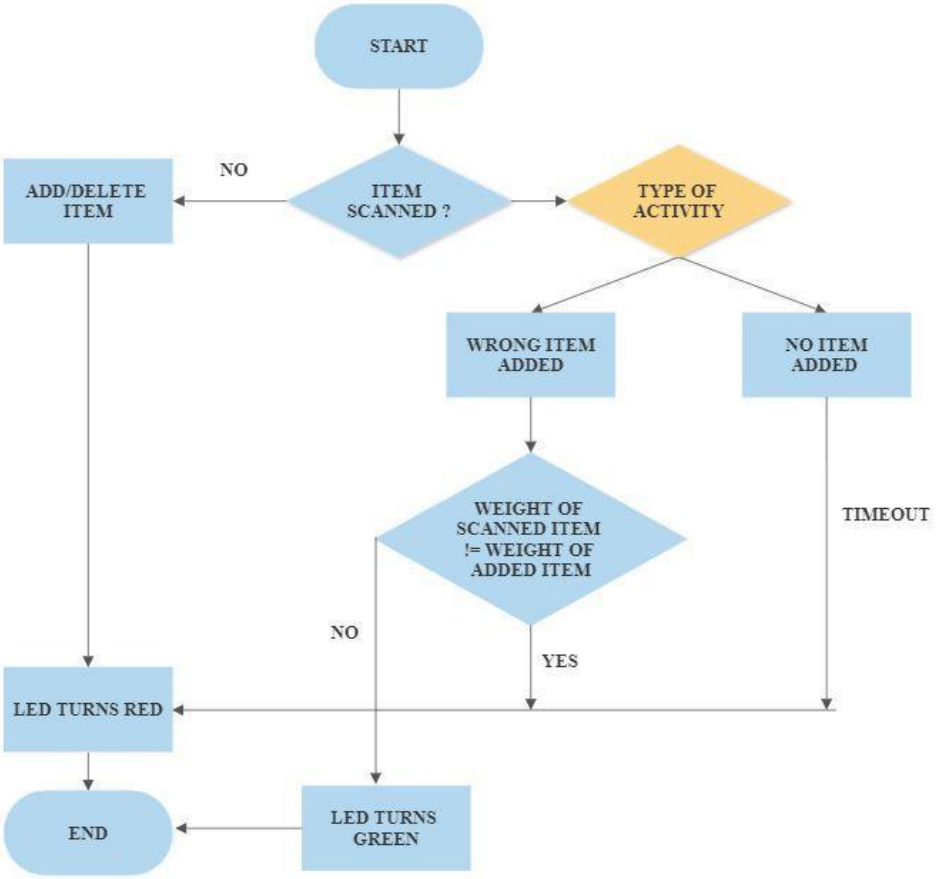


FIGURE 2: Fraud Testing

1.9 Project Outcomes

- The proposed system implements self-checkout with online bill payment options.
- The mobile application is fully-functional and the hardware is working.
- The proposed system is able to detect fraudulent cases.
    - unscanned items added in the trolley are detected.
    - unscanned items removed from the trolley are detected.
    - scanning item A but putting item B instead of A is detected for unequal weights of A and B.

1.10 Novelty of Work

The following modifications have been made to the existing research work which improvises on both user-experience and security.

- The proposed system is fully automated with the mobile application. Instead of the display screen, the product list and the bill amount is displayed on the mobile application itself. In addition, the barcode is scanned with the mobile's camera.
- The proposed system discards the smart shelves and utilisation of RFIDs. It follows basic insert and delete operations as is followed in the traditional systems. So, no extra cost is incurred for RFIDs.
- The proposed system adopts the method of the system. However, instead of barcodes, the mobile application is used and no payment counter is utilised.

REQUIREMENT ANALYSIS

2.1 Literature Survey

2.1.1 Theory Associated With Problem Area

In most of the cities there are supermarkets and shops where the customer carries a trolley to shop. When the customer is done shopping they go to the billing counter for payment and completion of shopping.

Disadvantages

- The customers have to stand in long queues to get their bill done.
- The customers have no way to know about their bill in real time.

2.1.2 Existing Systems and Solutions

2.1.2.1 Amazon Go

Amazon in the USA opened a store which is known as Amazon Go, where the customer just has to enter the store, grab the product they want and walk out. The system despite being able to handle the queues and self checkout system there are technical and economical faults.

Disadvantages

- High Deployment Cost.
- Implementation of an honour system in which they expect customers to be honest with shopping.

2.1.2.2 Kroger and Caper Cart

Microsoft and Kroger designed and implemented the Caper smart carts that scans items placed in the cart. Caper also installed sensors under the shelf. The Bingo Box in China unmanned store is working on a seamless shopper experience. The Bingo Box uses cameras and RFID tags for every item on shelves. The 7-11 also opened its unstaffed store relying on artificial intelligence and IoT technologies to serve customers but still face a technical issue due to errors and malfunctioning. The Automated shopping cart is also a

similar innovation which was designed to help customers track their shopping experience using the sensor fusion technology.

Disadvantages

- These systems depend on sensors and RFID tags on every item which increases the cost and lowers the profit margin.
- RFID readers cannot sometimes read tags due to some signal blockages and improper packaging.

2.1.3 Research Findings for Existing Literature

S. No.	Roll Number	Name	Paper Title	Tools/ Technology	Findings	Citation
1	101803268	Ajat Suneja	A Proposed Technique for Implementing Smart Cart Based on Artificial Intelligence	RFID tag, reader, Raspberry Pi, LCD display	used RFID to track the products that are bought and display on trolley screen only	[1] A. Kumar, A. Gupta, S. Balamurugan, S. Balaji and R. Marimuthu, "Smart Shopping Cart," 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS), Vellore, India, 2017, pp. 1-4, doi: 10.1109/ICMDCS.2017.8211723.
2	101803268	Ajat Suneja	Smart Shopping Cart	Raspberry Pi, Ultrasonic Distance Sensor, Weight Sensor, PiCamera	Deep learning is used for real time detection of objects while placing them in a cart.	[2] V. V., P. K. P. and C. R. S., "Smart Shopping Cart," 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET), Kottayam, India, 2018, pp. 1-4, doi: 10.1109/ICCSDET.2018.8821103.
3	101803269	Chaitanya Kaushal	Smart Shopping	Raspberry Pi,	use of artificial	[3] M. A. Sarwar, Y. Daraghmi, K. Liu, H. Chi,

			Carts Based on Mobile Computing and Deep Learning Cloud Services	PiCamera, artificial Intelligence	intelligence and deep learning for detection of products.	T. -. İk and Y. Li, "Smart Shopping Carts Based on Mobile Computing and Deep Learning Cloud Services," 2020 IEEE Wireless Communications and Networking Conference (WCNC), Seoul, Korea (South), 2020,pp.1-6,doi:10.1109WCNC45663.2020.9120574.
4	101803269	Chaitanya Kaushal	The RFID Based Smart Shopping Cart	RFID tags ,readers , microcontroller , LCD display	using RFID for tracking the products bought and displaying on trolley connected LCD	[4] Ms. Rupali Sawant, Kripa Krishnan, Shweta Bhokre, Priyanka Bhosale “The RFID Based Smart Shopping Cart”, International Journal of Engineering Research and General Science Volume 3, Issue 2 pp 275-280, March-April, 2015.
5	101803272	Bibekpreet Singh	Smart shopping cart with automatic billing system through RFID and ZigBee	RFID tags, reader, ZigBee, EEPROM, micro controller	data read by RFID is written by EEPROM and is sent to database with ZigBee	[5] P. Chandrasekar and T. Sangeetha, "Smart shopping cart with automatic billing system through RFID and ZigBee," International Conference on Info Communication and Embedded Systems (ICICES2014), Chennai, India, 2014, pp. 1-4, doi: 10.1109/ICICES.2014.7033996.
6	101803272	Bibekpreet Singh	IoT Applications on Secure Smart Shopping	RFID tags, reader, ZigBee, micro controller, LCD	RFID tags apart from products are also placed on shelves for inventory management and also at payment	[6] R. Li, T. Song, N. Capurso, J. Yu and X. Cheng, "IoT Applications on Secure Smart Shopping," 2016 International Conference on Identification, Information and Knowledge in the Internet of Things (IIKI), Beijing,

					gateways for payment verification.	China, 2016, pp. 238-243, doi: 10.1109/IIKI.2016.25.
7	101803276	Harshit Bansal	Interactive intelligent shopping cart using RFID and ZIGBEE modules	RFID tags, reader, ZigBee, micro controller, LCD	Using RFID for tracking the products bought and displaying on trolley connected LCD	[7] S. Dhauta and S. Kapoor, "Interactive intelligent shopping cart using RFID and ZIGBEE modules," 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Palladam, 2017, pp. 764-769, doi: 10.1109/I-SMAC.2017.8058282.
8	101803276	Harshit Bansal	An IOT Based Smart Shopping Cart for Smart Shopping	RFID tags, reader, LCD, micro controller, android application	RFID tags are used for product tracking and shown on LCD, and mobile applications are connected to store databases for list creation and can be shared with others as well.	[8] Karjol, Srinidhi & Holla, Anusha & c b, Abhilash. (2018). An IOT Based Smart Shopping Cart for Smart Shopping. 10.1007/978-981-10-9059-2_33.

TABLE 4: Research Findings for existing Literature

2.1.4 Problem Identified

The problems listed below contribute to poor user experience and thus, arises a much needed solution to make things simpler and easy to use.

- Real-Time Bill Generation: The existing systems do not provide information on what the current bill is. In some cases, the customer might exceed his/her budget and would only be able to know about it at the time of checkout. This leads to poor user experience.
- Long Waiting Queues: The existing systems are unable to tackle this problem. Consider a queue of say three people where the first one has A products in his cart and the second person has B products but the third has only a single item in his cart. In this case, he must wait for a long time till his turn comes.
- Cost to the company: In a traditional retail store, much of the employer's cost goes on providing staff to run checkouts. It is often more cost-effective to transfer those staff to other duties, particularly customer service which promises good user experience.

2.1.5 Survey of Tools and Technologies Used

Software :-

- React Native - For the creation of mobile applications.
- Firebase - This is for databases as well as authentication.
- Arduino Programming - For the connection of all hardware and database with trolley.

Hardware :-

- Arduino Uno - Microcontroller which will connect all the hardware components.
- Weight Sensor - For measuring the weight of the products.
- Battery - To keep arduino active.
- Wifi Chip - to connect arduino to database.

2.2 Software Requirement Specification

2.2.1 Introduction

2.2.1.1 Purpose

- To develop a self-checkout system where a user buys items and checks out without waiting in long queues.

- To reduce total time for the entire shopping process including but not limited to adding and removing items from trolleys and making a final checkout.
- To build a fraudulent system which tackles checks against
  1. Unscanned items added or removed from the trolley,
  2. Wrong items added or removed from the trolley on a successful scan of different items with an assumption that items of different categories have different weights.

2.2.1.2 Intended Audience and Reading Suggestions

- The proposed system is intended for all the places that use shopping carts and where people have to stand in lines for checking out.
- The audience includes shoppers, shopping mall, grocery store owners and other commercial places where buying and selling activities are held.

2.2.1.3 Project Scope

- Our system must detect fraudulent cases.
  - Unscanned items added in the trolley are detected.
  - Unscanned items removed from the trolley are detected.
  - Scanning item A but putting item B instead of A is detected for unequal weights of A and B.
- The shopping time is reduced by removal of queues.
- Our system is able to provide real - time bills.

2.2.2 Overall Description

2.2.2.1 Product Prospective

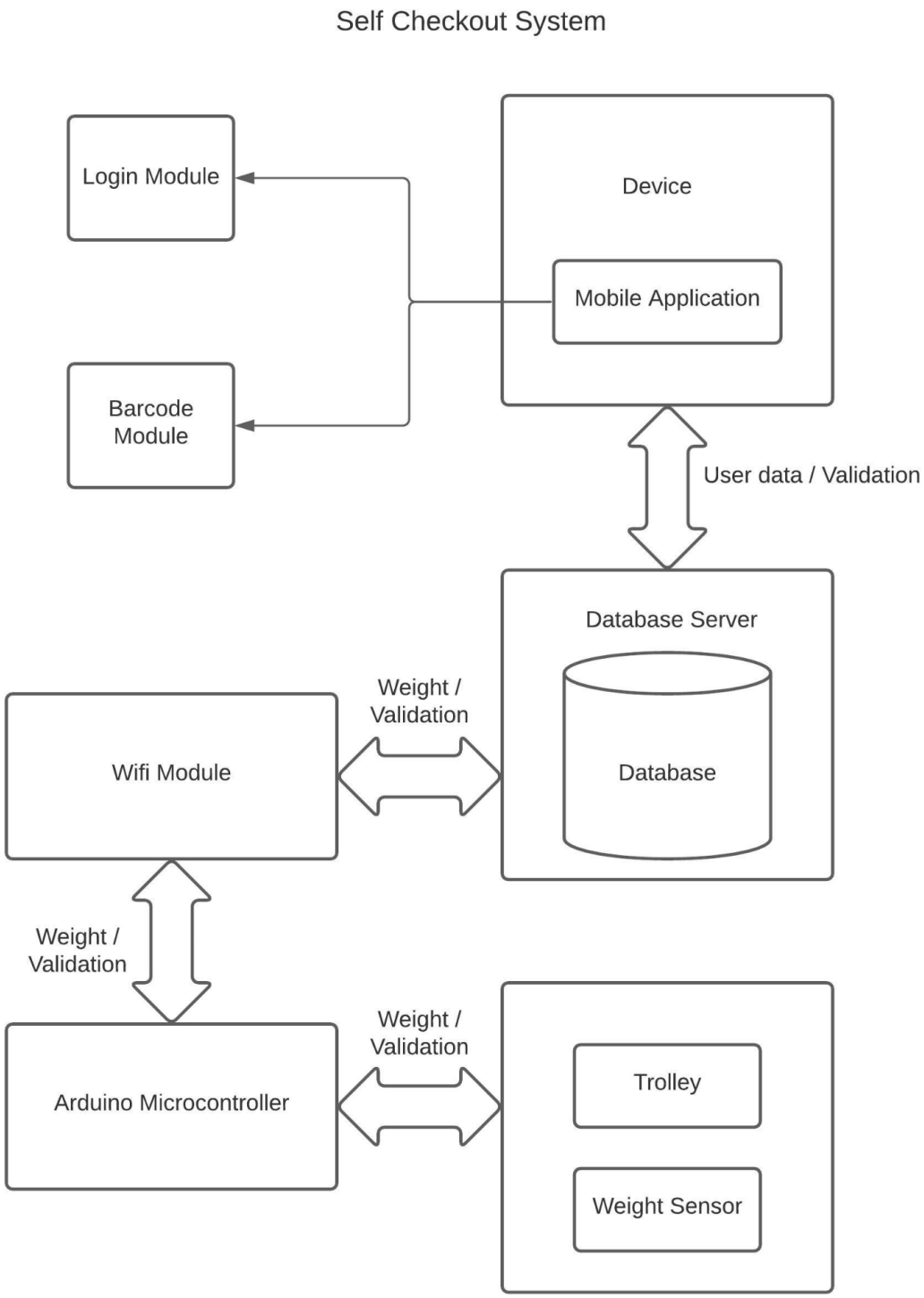


FIGURE 3: Product Perspective

2.2.2.2 Product Features

- The proposed system implements self-checkout with online bill payment options.
- The mobile application is fully-functional and the hardware is working.
- The proposed system is able to detect fraudulent cases.
    - Unscanned items added in the trolley are detected.
    - Unscanned items removed from the trolley are detected.
    - Scanning item A but putting item B instead of A is detected for unequal weights of A and B.

2.2.3 External Interface Requirements

2.2.3.1 User Interfaces

- The mobile application has the following screens
    - For Admin
        - Product List Screen showing list of all products available at the store whose quantity can be added.
        - Product Create Screen where admin can insert attributes of a new product that is to be added in the store.
    - For User
        - Product List Screen showing list of all products available at the store for purchasing purposes.
        - Discounts Screen showing available offers.
        - Orders Screen which shows the history of all transactions made till now.
        - Checkout Screen which performs the payment action.
    - The Authentication Screen.
- A side drawer is available for all user screens which helps in navigation and logout.
- Important buttons for various screens
    - Logout Button
    - Authentication (Signup and Signin Buttons)

- Checkout Button
- Add and delete buttons for admin product screen

2.2.3.2 Hardware Interfaces

- Arduino would be connected to the ESP 12E to connect to the internet which in turn would connect arduino to Firebase for data access.
- HX711 and Load cell would continuously provide the current weight data of the trolley to the arduino by which the arduino would decide about the fraudulent checks and would display the results using LEDs.

2.2.3.3 Software Interfaces

- **React Native ver. 0.65 -** It is used to develop the application and its libraries are used to scan the barcode, for payment gateway, for connection with the Firebase to Login, Register and share cart and product data with Firebase.
- **Expo ver 41.0.0 -** It is for the testing and build release of the application.
- **Firebase**
  - **Realtime Database**
    - All the application data will be stored in the realtime database.
  - **Firebase Authentication**
    - This will authenticate the users securely.

2.2.4 Non - Functional Requirements

2.2.4.1 Performance Requirements

- 10 seconds are given to place or remove the product from the trolley after scan.
- Self-checkout system has been realized in a user-understandable GUI i.e. a mobile application. Thus, the system has usability.
- The camera efficiently scans the barcode.
- With any change in database, the corresponding change is reflected on the device affected by it.

- Database is updated automatically after scanning of products.

2.2.4.2 Safety Requirements

- No personal detail of the user is shared with anyone
- User password is stored in encrypted form only.
- Every user is assigned only one trolley.

2.2.4.3 Security Requirements

- A session is created for the user when he logs in. Thus, the system has security.
- On detection of weight change, the trolley performs fraudulent checks.

2.3 Cost Analysis

Sr. No.	Product Name	Quantity	Price/ unit(in Rs.)
1	Arduino Uno	1	700
2	Load Cell + HX711	2 + 1	800
3	Wifi Module (ESP 12E)	1	300
4	Supporting Material (Trolley, Wires, Resistor, Bulbs)		400
Miscellaneous			1000
Total Cost (Tentative)			3200

TABLE 5: Cost Analysis

2.4 Risk Analysis

- Failure in fraudulent checks like same weight yet differently priced products can incur losses to the company.
- Damage to the hardware like weight sensors and arduino can incur losses to the company.
- Loss in number of customers whose mobiles are not able to detect barcodes.

METHODOLOGY ADOPTED

3.1 Investigative Technique

- **Comparative Technique**

  Why Comparative?
  Our project is the result of a comparative study of the traditional checkout systems that are already in place today. There is a need to introduce a better way to implement the checkout system and thus we came to our solution which is to create a self checkout system.

- **Problems with traditional systems**

  - Shopping at market stores expends a lot of time at the billing counters by standing in long queues which leads to poor user experience.
  - The employees at the billing counters do the payment work which could otherwise be handled by the customers themselves are more convenient and in trend.
  - Customer does not know what the current bill amount is for the items in the trolley. Thus,there is a need to simplify the shopping process and scrutinize ways to tackle and optimise ways for the above-stated problems.

- **Some already implemented solutions internationally**
  - Amazon in the USA opened a store which is known as Amazon Go, where the customer just has to enter the store, grab the product they want and walk out. The system despite being able to handle the queues and self checkout system there are technical and economical faults.
  - The Bingo Box in China unmanned store is working on a seamless shopper experience. The Bingo Box uses cameras and RFID tags for every item on shelves.
  - Microsoft and Kroger designed and implemented the Caper smart carts that scans items placed in the cart. Caper also installed sensors under the shelf.

- **Research based solutions**

  However, there has been research going on regarding solutions to the problem. Several research papers were published which revolved around the same ideas as the actual implemented solutions i.e. using RFIDs for each shelf and making use of proximity sensors.

- **Problems with Current Solutions**

  However, be it research based approach or company's implemented approach, all of them have at least one of following downfalls.

  - High Deployment Cost.
  - Implementation of an honour system in which they expect customers to be honest with shopping.
  - These systems depend on sensors and RFID tags on every item which increases the cost and lowers the profit margin.
  - RFID readers cannot sometimes read tags due to some signal blockages and improper packaging.

- **Why our solution is better**

  The problems listed below contribute to poor user experience and thus, arises a much needed solution to make things simpler and easy to use.

  - Real-Time Bill Generation: The existing systems do not provide information on what the current bill is. In some cases, the customer might exceed his/her budget and would only be able to know about it at the time of checkout. This leads to poor user experience.
  - Long Waiting Queues: The existing systems are unable to tackle this problem. Consider a queue of say three people where the first one has A products in his cart and the second person has B products but the third has only a single item in his cart. In this case, he must wait for a long time till his turn comes.
  - Cost to the company: In a traditional retail store, much of the employer's cost goes on providing staff to run checkouts. It is often more cost-effective to transfer those staff to other duties, particularly customer service which promises good user experience.

3.2 Proposed Solution

The proposed system is primarily divided into three aspects namely, workflow, implementation and fraudulent system which are explained below.

- **Workflow**
  - Customer enters the mall with the mobile application installed.

- Customer gets a trolley from the trolley stack and enters the trolley number in the mobile application to select an unassigned trolley.
- Now the customer proceeds towards shopping.
- The customer can add and remove items from the trolley by scanning them first with the mobile's camera.
- After each add or remove a fraudulent check is made in the trolley to verify the product added.
- After doing the shopping, customers can simply make payment via the mobile application and checkout from the store without having to wait in long queues for their turn to come.

- **Implementation**
  - A customer can select a trolley from the mobile application which is communicating with the trolley database server through network protocols. The trolley database would contain status information for each trolley in the shop regarding whether it was assigned or unassigned.
  - On entering a valid trolley number, the trolley is assigned to the customer. If the check fails, the process has to be repeated again till a valid trolley number is entered.
  - The customer can invest in two activities: adding an item to the cart or removing an item from the cart.
  - The trolley has an LED bulb equipped. The green color of the bulb would imply nothing is wrong while doing transactions until now. However, a red color would imply that a fraudulent check must have failed i.e. the user would have used dishonest means while shopping for items. For instance, removing or adding an item into a cart without a scan or adding wrong items by scanning some other items.
  - Adding an item to the cart first involves scanning its barcode with the mobile's camera which is used by the application as a barcode scanner. On a successful scan, the mobile application sends the scanned item information like its name, id , weight and price to the server. Now a window of 10 seconds is given to the user for putting the item into the cart. If it is not done within the time slot, then the transaction would be canceled for the current item. Once the item is added, the weight sensors which are present at the base of the cart would detect an increase in the net weight of itself and would reflect

the delta reading (difference between current and past weights of the trolley) to the server. If the delta reading matches with the weight of the scanned item that was sent via the mobile application then, it would be regarded as a successful transaction and the LED would remain green. However, if they do not match, then the LED would start blinking red representing a false transaction.

- The delta reading matching is done considering some specified error values.
- Similarly, for removing an item , the same scanning procedure would be repeated and same checks for delta readings are performed.
- Once, the shopper is done with the shopping, the security guard at the exit point of the store would see the color of LED light. If it is green, the shopper is permitted to checkout via the mobile applications and if it is red, he would be denied and have to correct the wrong transactions.

- **Fraudulent System**
  - Frauds are detected by the trolley and conveyed to the Database.
  - It is detected by comparing the current weight of the trolley and the supposed weight from the database and after comparing the two weights red/green LED would lit up to convey an error/no error respectively.
  - If fraud is detected then the mobile application would also cease adding or deleting any other product to/from the list until the fraud is rectified.
  - At the time of the checkout if the LED is red, the customer would not be allowed to make payment and exit the shopping center with products.
  - If the LED is green only then the customer would be able to make payment and can leave the shopping center after payment verification.

3.3 Work Breakdown Structure

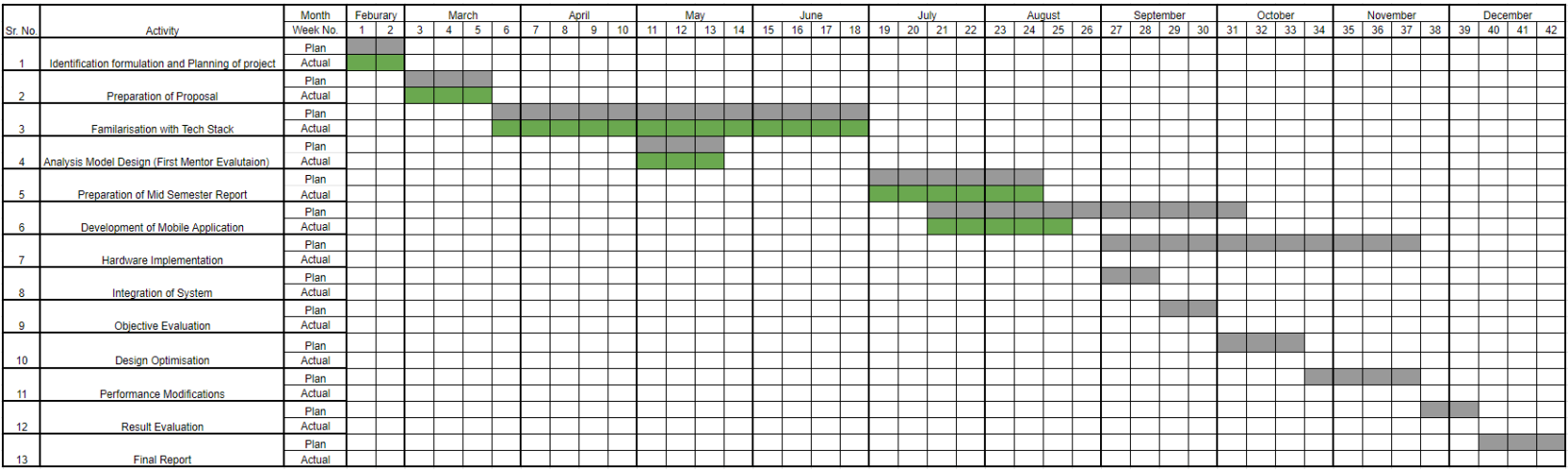


FIGURE 4: Work Breakdown Structure

3.4 Tools and Technology

3.4.1 Software

- React Native for mobile application.
- React Native Libraries for payment and barcode scan.
- Arduino Programming for weight detection and fraudulent checks.
- Firebase as database for real time data storing.

3.4.2 Hardware

- Arduino for connecting all the hardware components and syncing with the database.
- ESP 12E (Wifi Module) to connect the arduino with the internet.
- Load Cell and HX711 for measuring the weight.

4.1 System Architecture

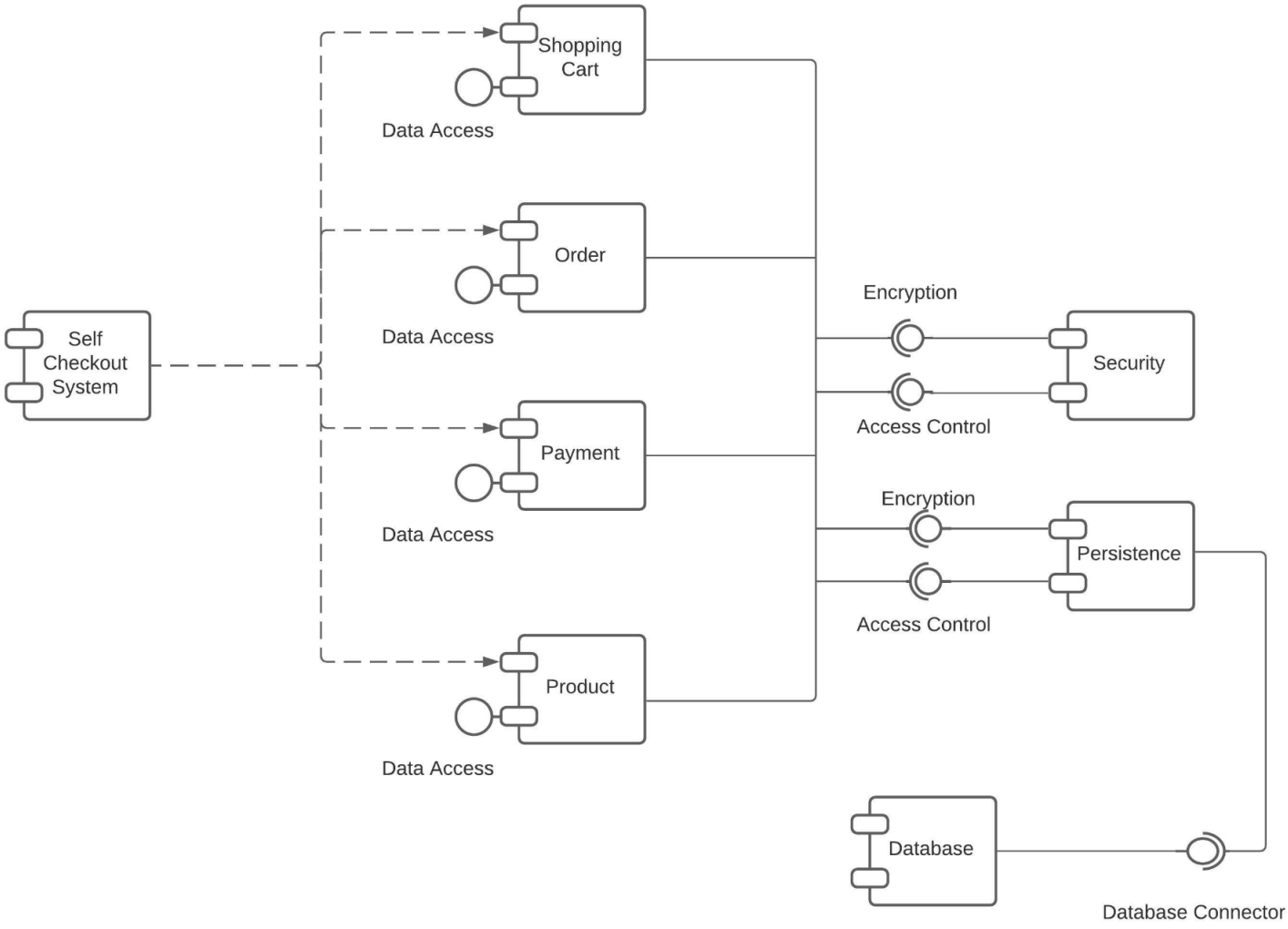


FIGURE 5: Component Diagram

4.2 Design Level Diagram

- **Class Diagram**

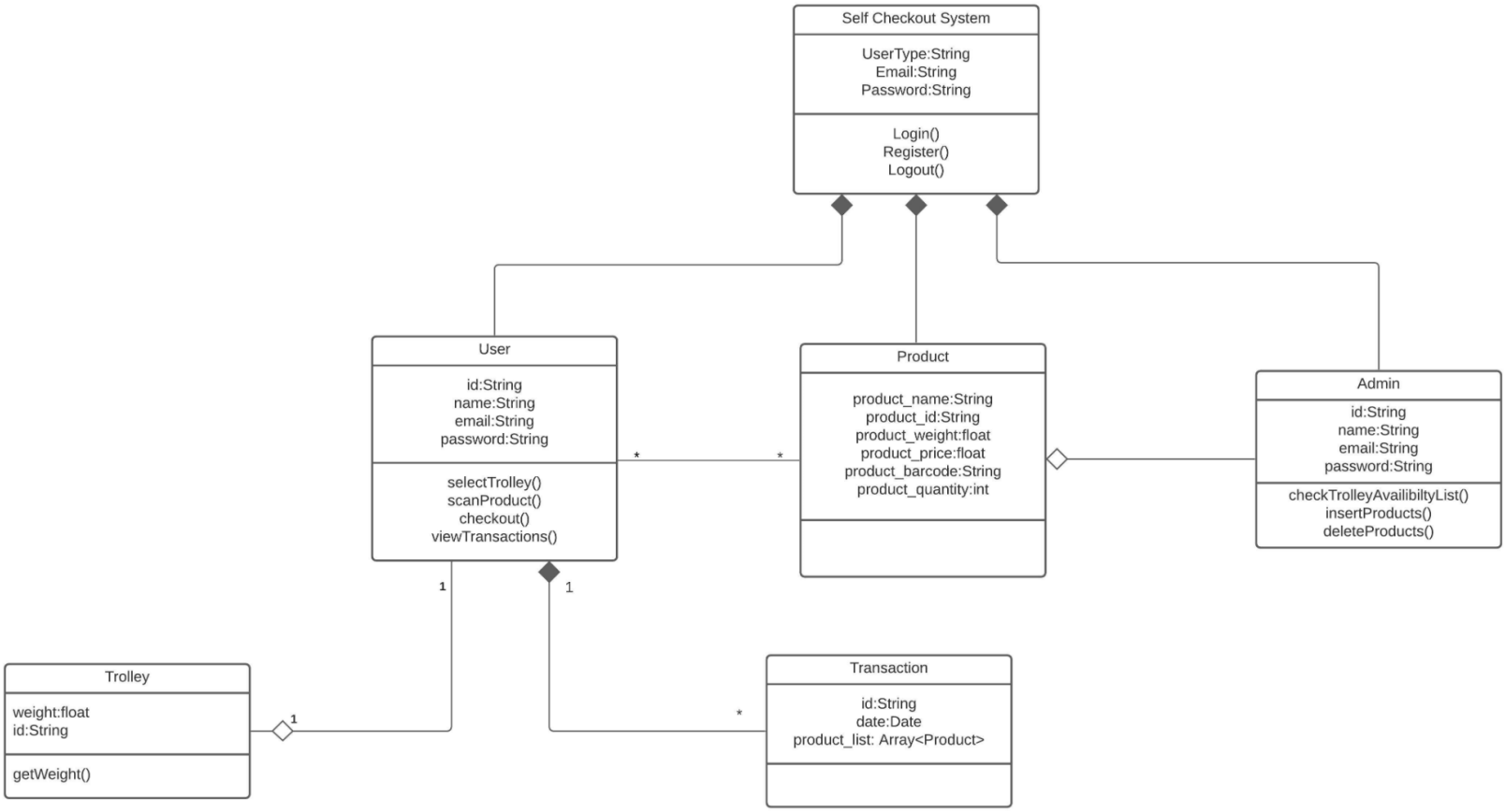


FIGURE 6: Class Diagram

- **Use Case Diagram**

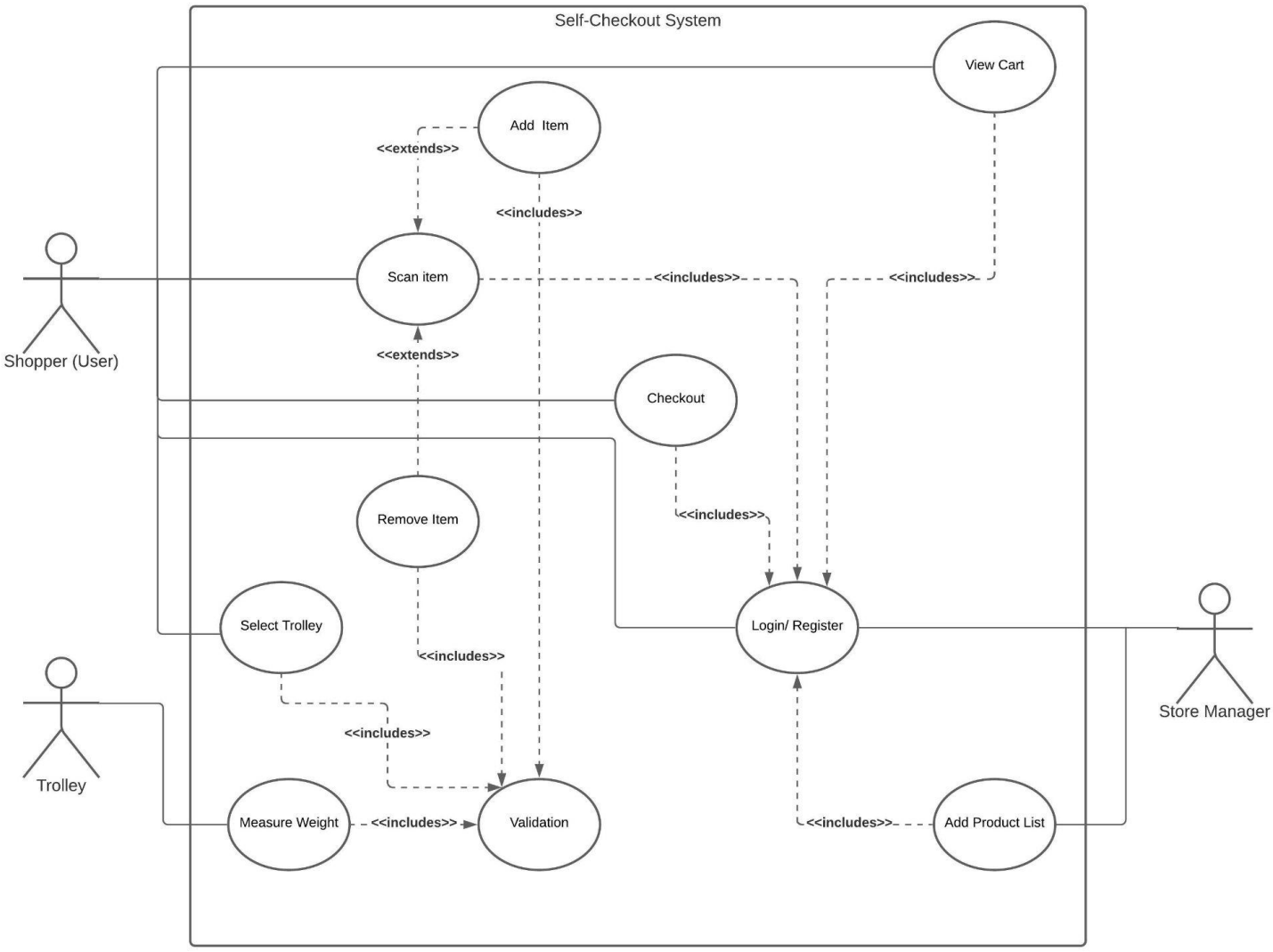


FIGURE 7: Use Case Diagram

- **State Chart Diagram**

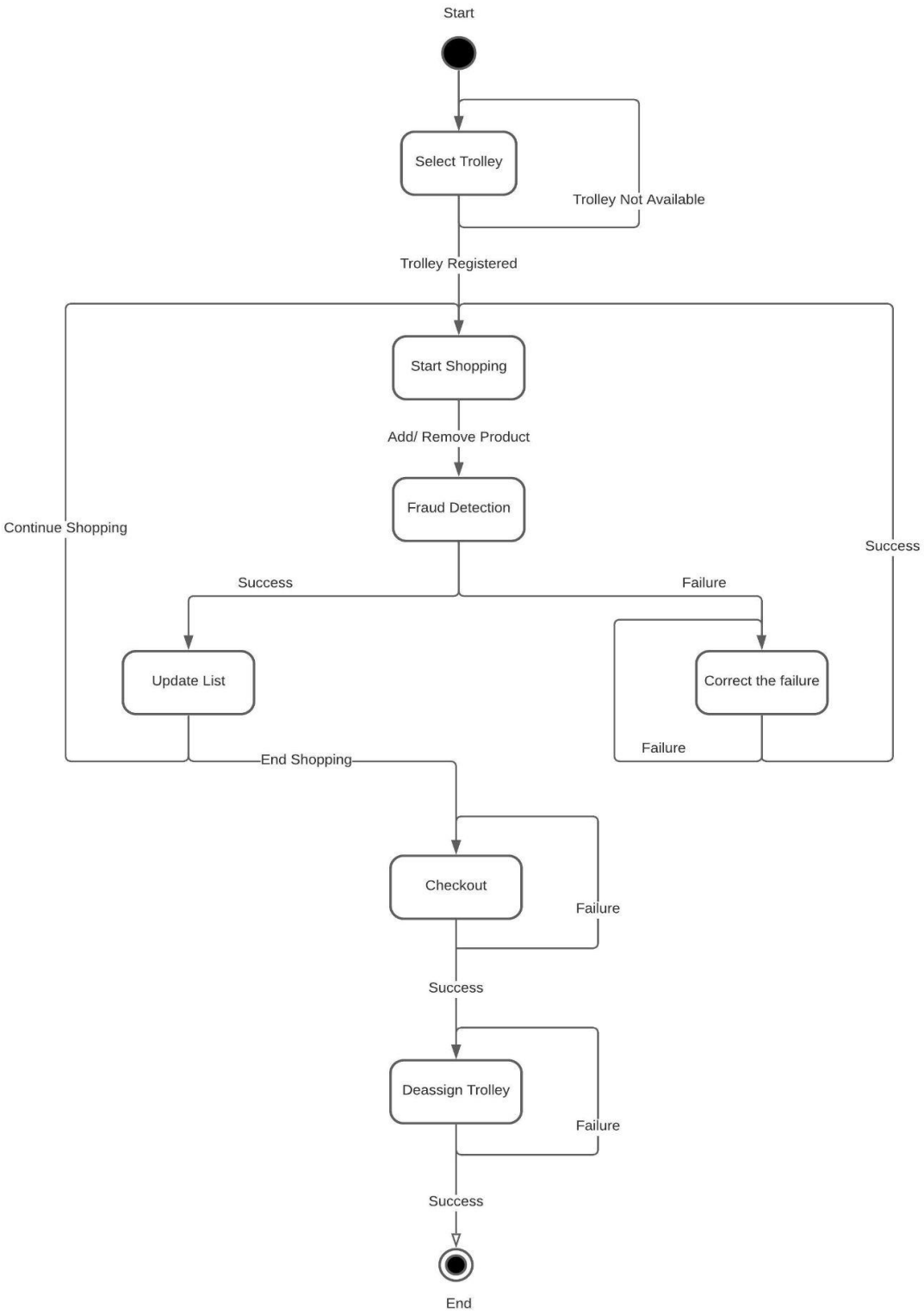


FIGURE 8: State Chart Diagram

- **Activity Diagram**

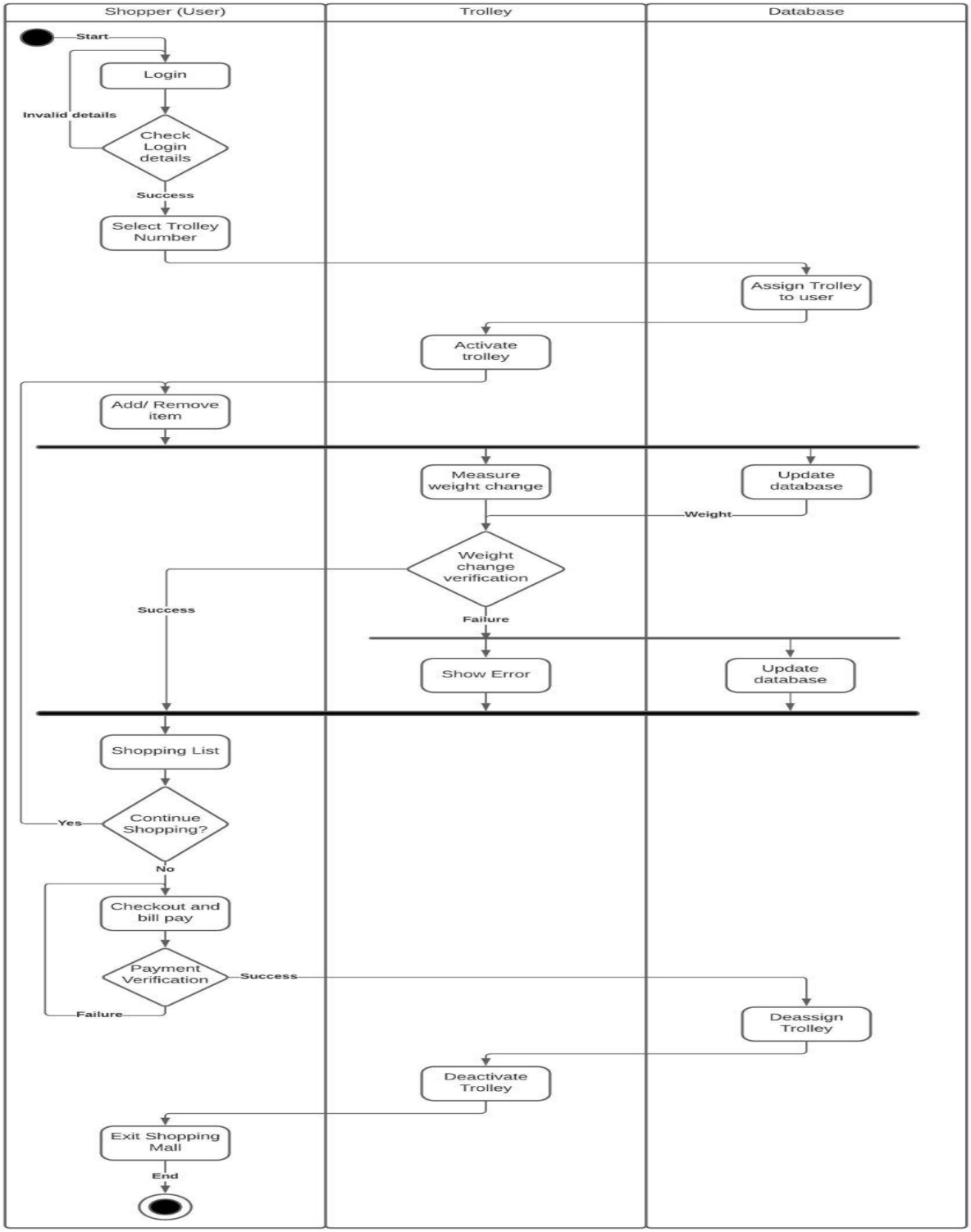


FIGURE 9: Activity Diagram

- **Sequence Diagram**

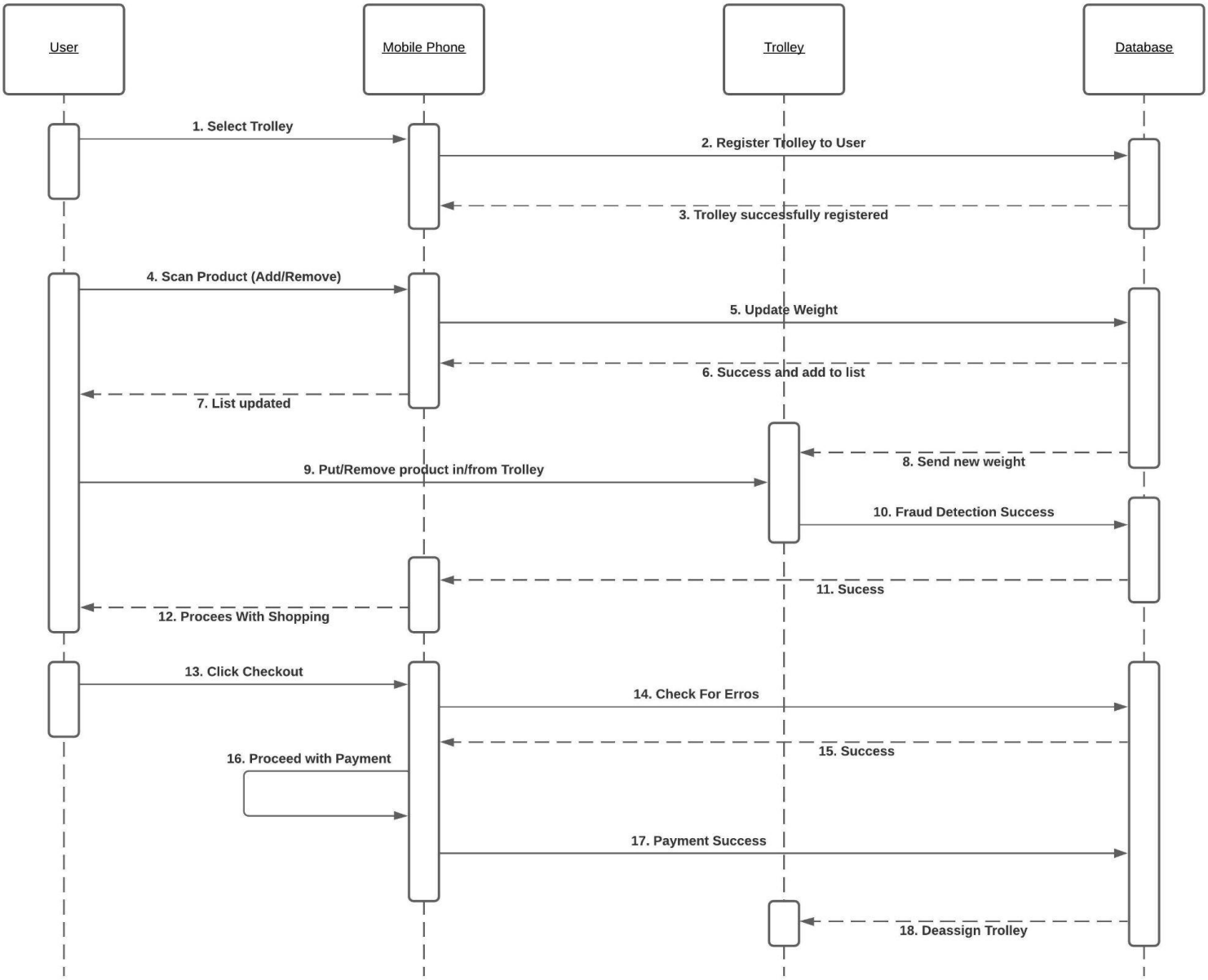


FIGURE 10: Sequence Diagram

4.3 User Interface Diagrams

- **ER diagram**

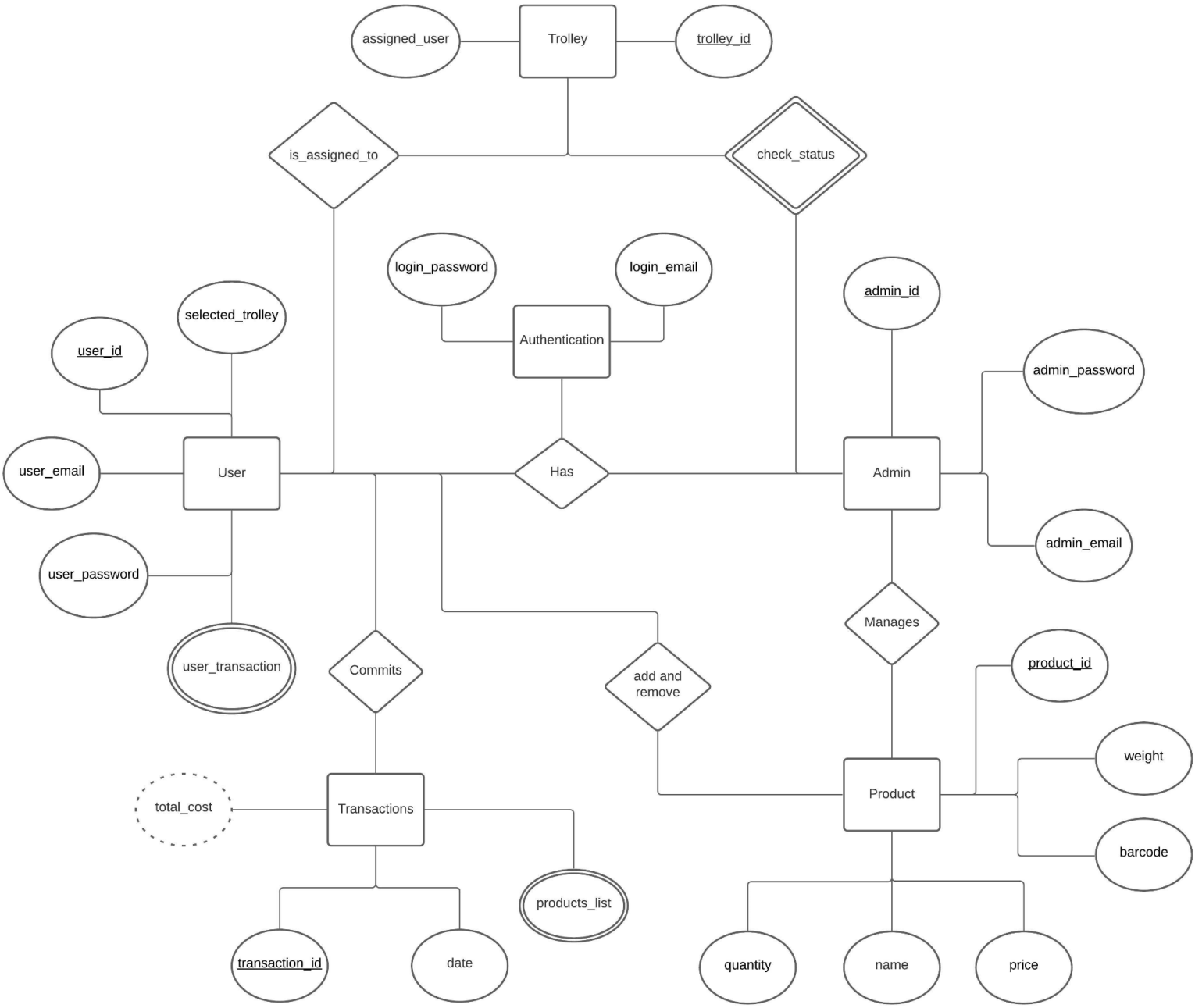


FIGURE 11: ER Diagram

- **Data Flow Diagram**

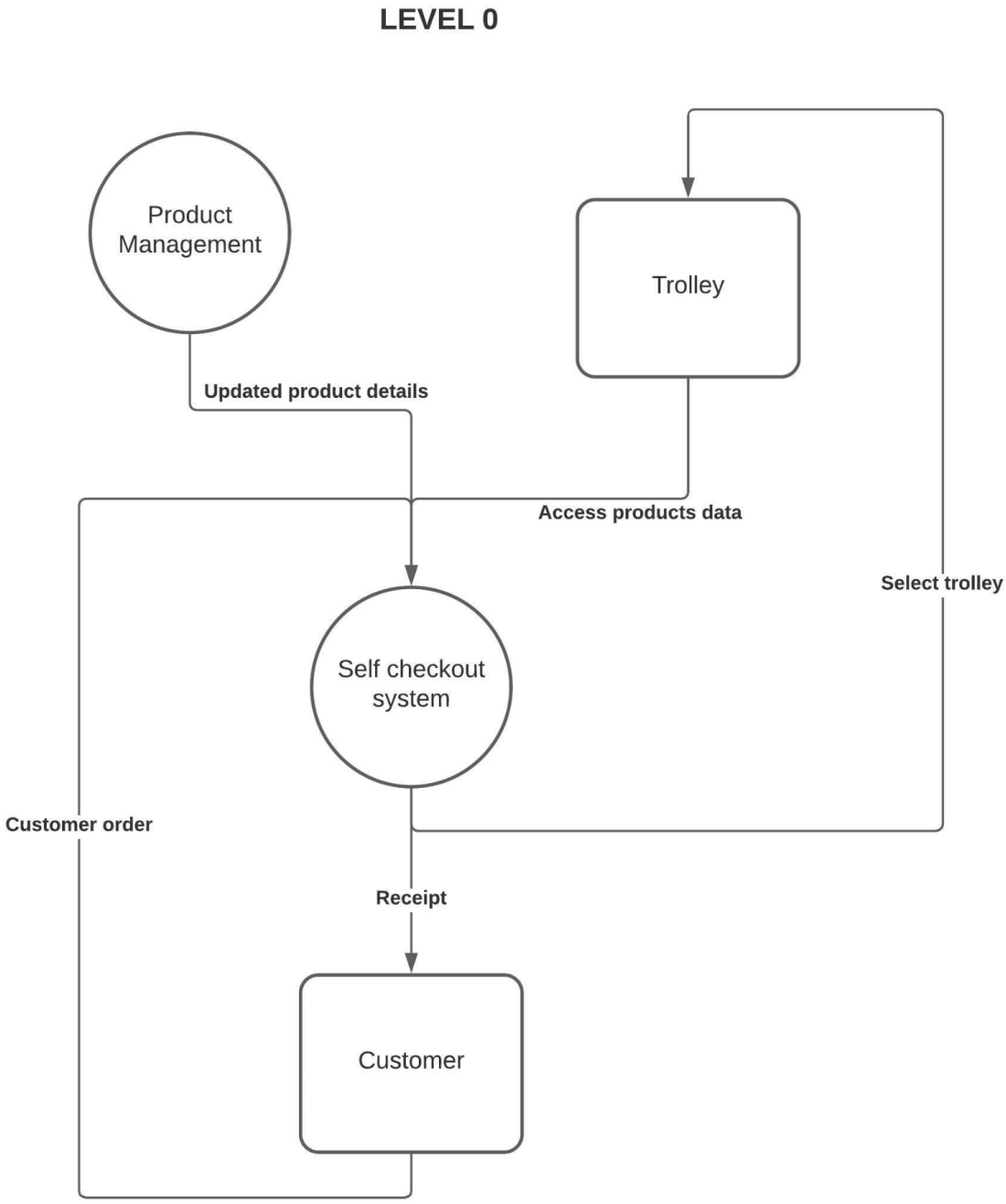


FIGURE 12: DFD Level 0

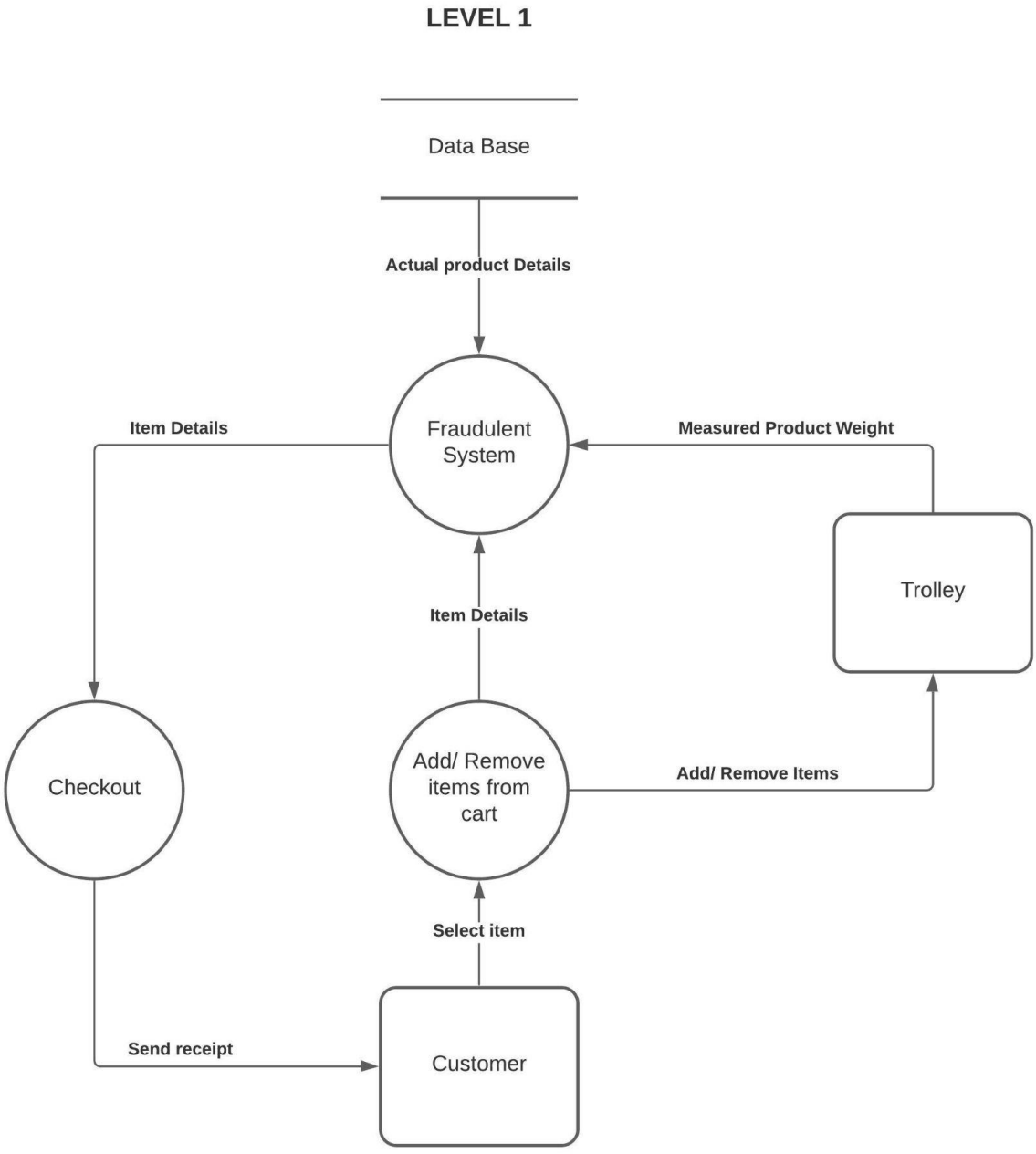


FIGURE 13: DFD Level 1

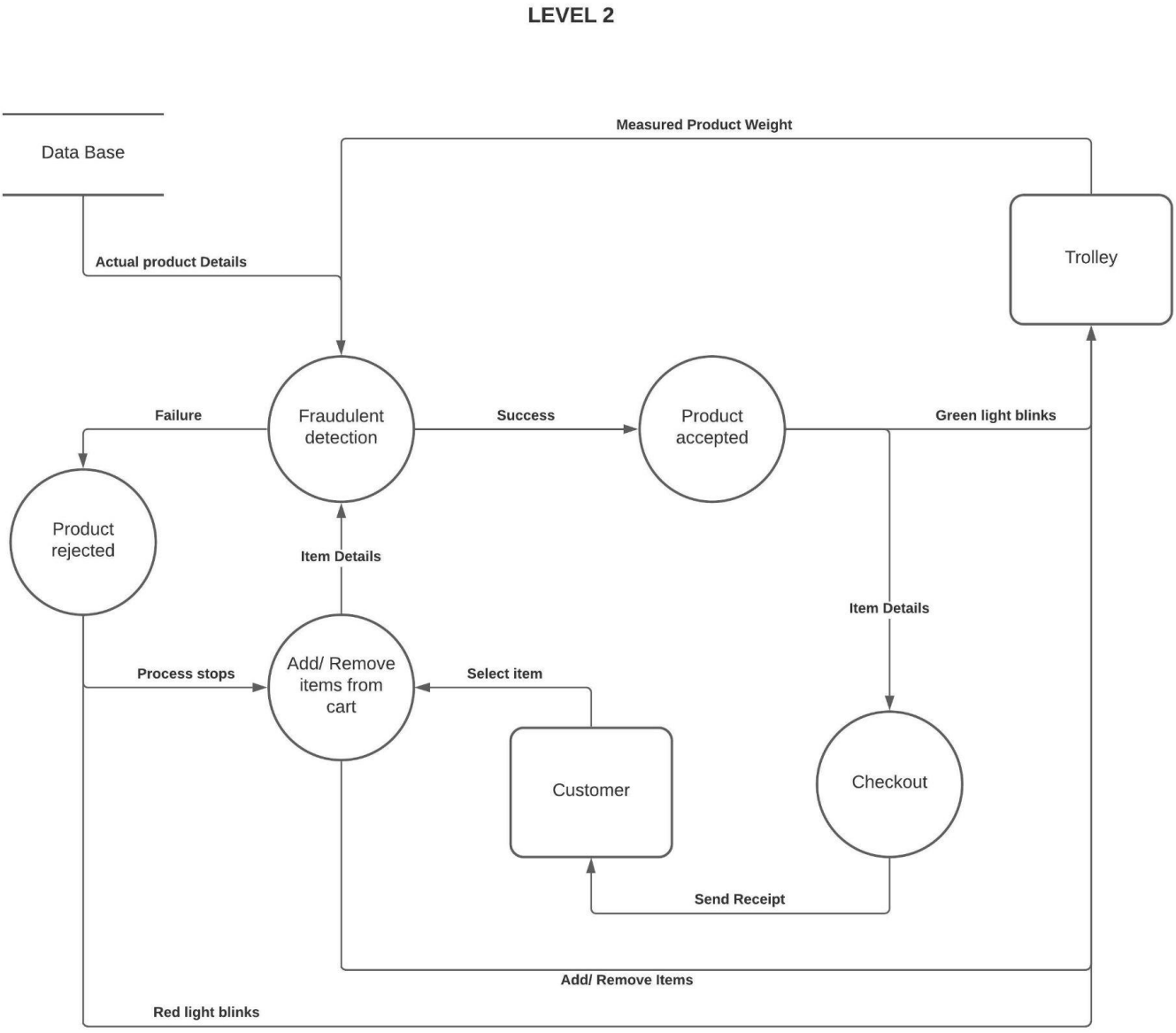
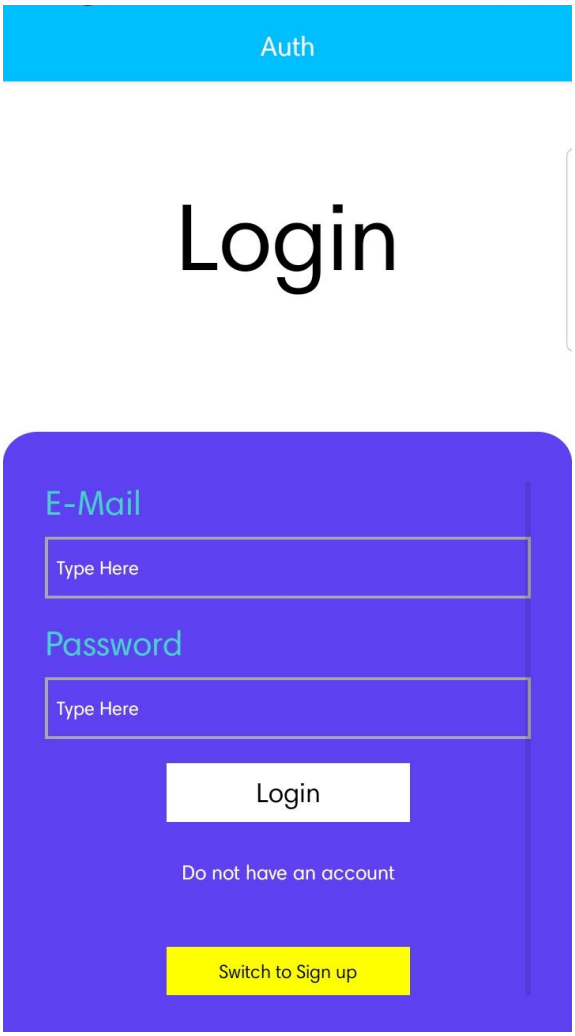


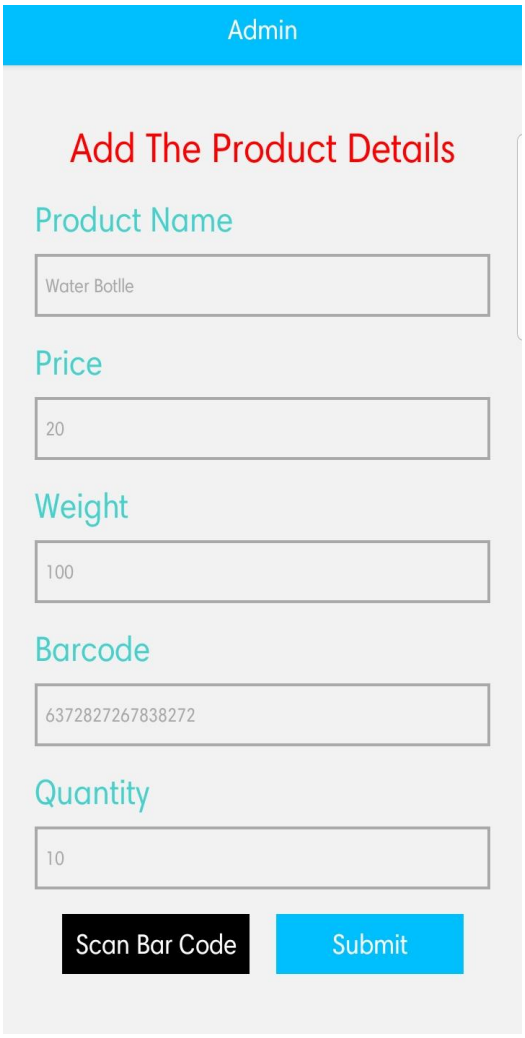
FIGURE 14: DFD Level 2

4.4 Snapshots of Working Prototype

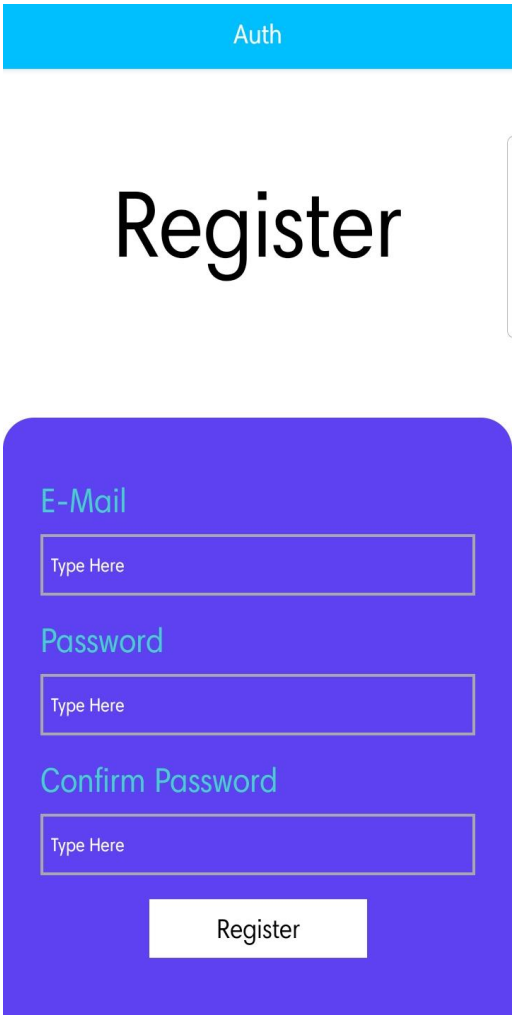
Login Screen



Admin Add Product

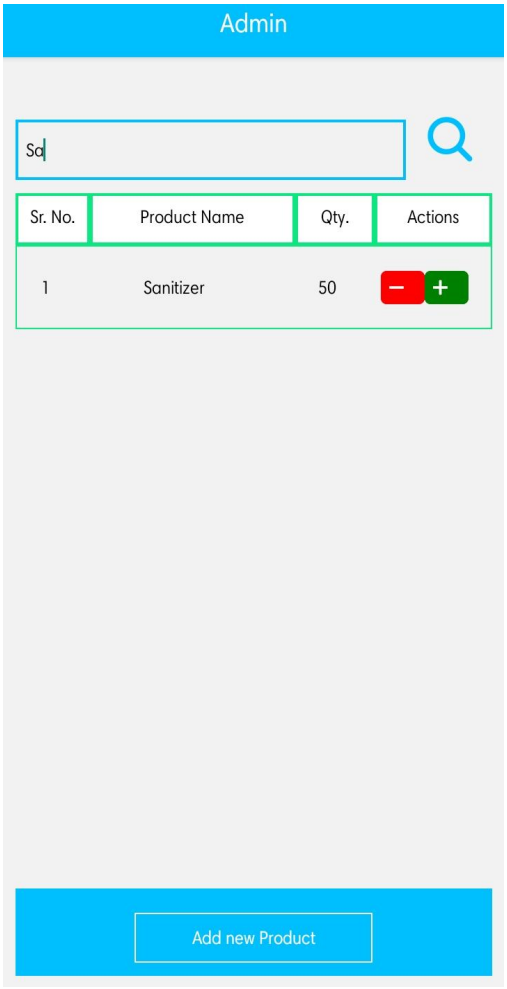


Register Screen

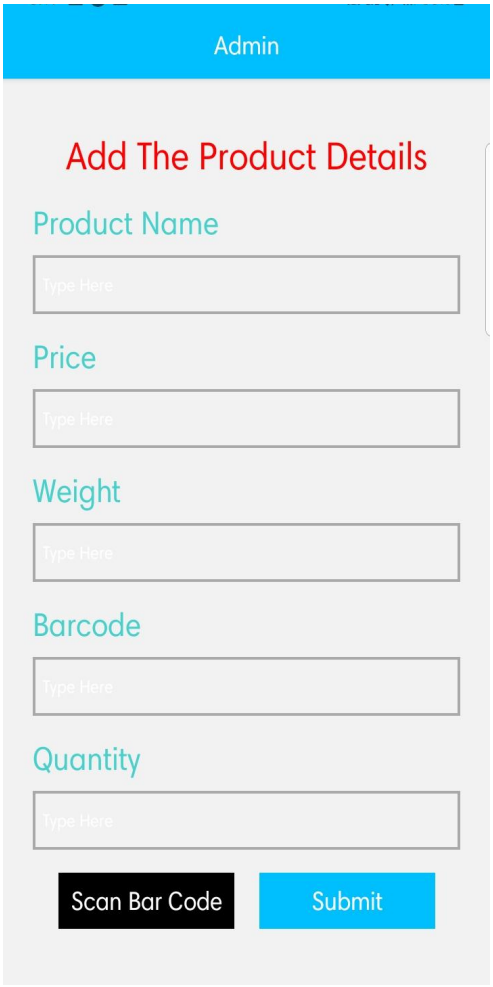


Admin Inventory

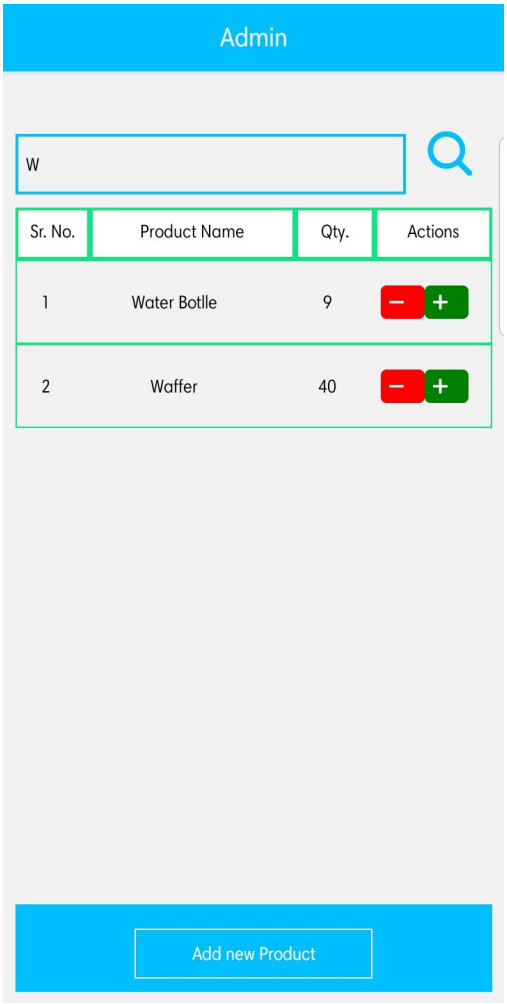
Search functionality



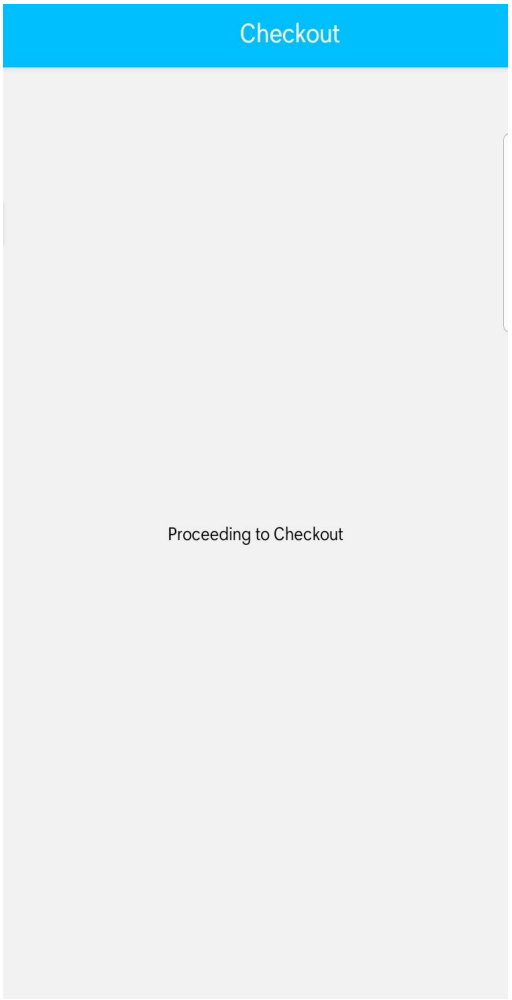
Add new Product in Store



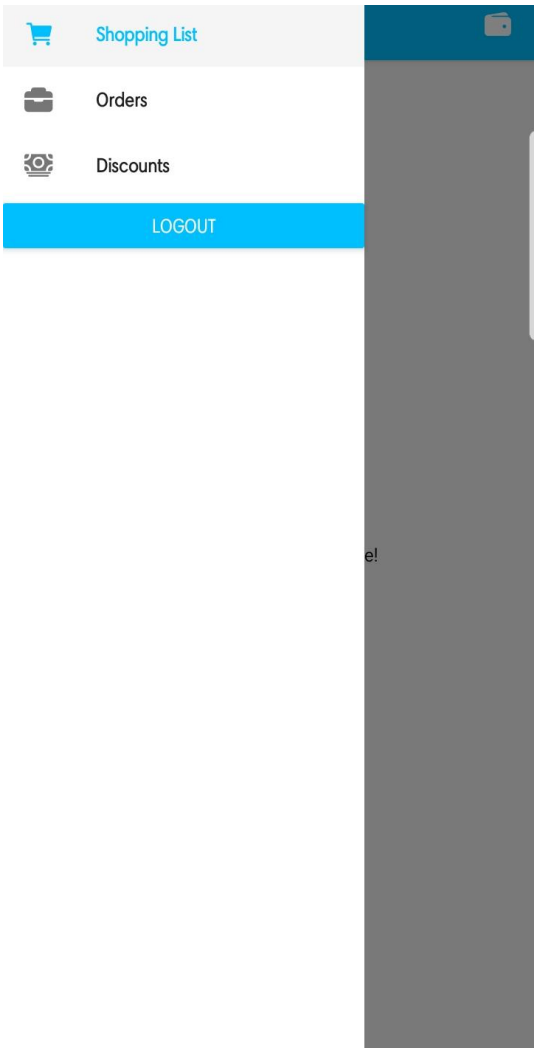
Search



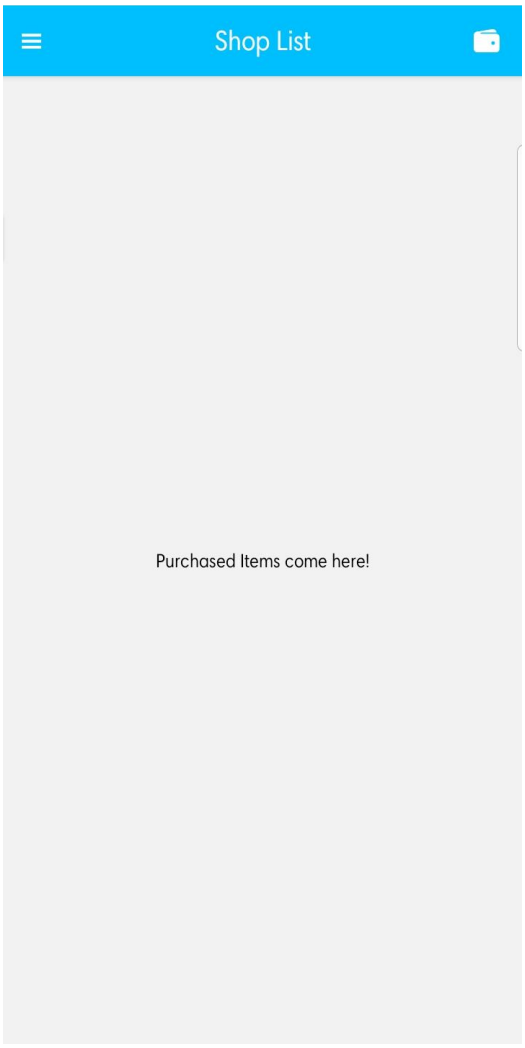
User Checkout Page



User Page Navigation



User Product List



CONCLUSIONS AND FUTURE SCOPE

5.1 Work Accomplished

- Mobile application Login and Register is done.
- Admin page has been created along with the functionality to add products.
- Admin page has a list of all the available products that are stored in the datastore along with the details of the products.
- Admin can directly increase or decrease the quantity of the product from this page.
- User page has been created with the list page as the starting point.

5.2 Conclusions

Till now we have successfully created the barebone structure for the mobile application along with some important functionalities. We have also decided the database schema that we are going to create along with the proper details of the database.

5.3 Economic/ Social Benefits

- Real time bill generation.
- Customers get full privacy and no judgement.
- Customers do not need to stand in long queues, thus saving time.
- Cost effective.
- Customers will have a good grip over the budget.

5.4 Future Work Plan

- Mobile applications will be further improved to add more features.
- Hardware implementation will be started.
- Hardware programming will also be done.
- Discounts algorithm may be deduced.

REFERENCES

1. A. Kumar, A. Gupta, S. Balamurugan, S. Balaji and R. Marimuthu, "Smart Shopping Cart," 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS), Vellore, India, 2017, pp. 1-4, doi: 10.1109/ICMDCS.2017.8211723.

2. V. V., P. K. P. and C. R. S., "Smart Shopping Cart," 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET), Kottayam, India, 2018, pp. 1-4, doi: 10.1109/ICCSDET.2018.8821103.

3. M. A. Sarwar, Y. Daraghmi, K. Liu, H. Chi, T. -. İk and Y. Li, "Smart Shopping Carts Based on Mobile Computing and Deep Learning Cloud Services," 2020 IEEE Wireless Communications and Networking Conference (WCNC), Seoul, Korea (South), 2020, pp. 1-6, doi: 10.1109/WCNC45663.2020.9120574.

4. Ms. Rupali Sawant, Kripa Krishnan, Shweta Bhokre, Priyanka Bhosale “The RFID Based Smart Shopping Cart”, International Journal of Engineering Research and General Science Volume 3, Issue 2 pp 275-280, March-April, 2015.

5. P. Chandrasekar and T. Sangeetha, "Smart shopping cart with automatic billing system through RFID and ZigBee," International Conference on Information Communication and Embedded Systems (ICICES2014), Chennai, India, 2014, pp. 1-4, doi: 10.1109/ICICES.2014.7033996.

6. R. Li, T. Song, N. Capurso, J. Yu and X. Cheng, "IoT Applications on Secure Smart Shopping," 2016 International Conference on Identification, Information and Knowledge in the Internet of Things (IIKI), Beijing, China, 2016, pp. 238-243, doi: 10.1109/IIKI.2016.25.

7. S. Dhauta and S. Kapoor, "Interactive intelligent shopping cart using RFID and ZIGBEE modules," 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Palladam, 2017, pp. 764-769, doi: 10.1109/I-SMAC.2017.8058282.

8. Karjol, Srinidhi & Holla, Anusha & c b, Abhilash. (2018). An IOT Based Smart Shopping Cart for Smart Shopping. 10.1007/978-981-10-9059-2_33.