Optimization of shopping product strategy using automatic billing and machine learning enabled smart trolley

S Vidhya Kamala Lakshmi1*, R V Elatchiya1, S Balamurugan2 and Vignesh Shanmugam3
1Student, PSG College of Technology, Coimbatore, Tamil Nadu, India
2Assistant Professor, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India
3Automobile Engineer, Hyundai Engineering Company, Tamil Nadu, India

*Corresponding author’s e-mail: vidyakamala081999@gmail.com

Abstract. This paper is about a smart trolley (Fute cart – fute means smart, cart means trolley) which can provide fast and comfortable shopping experience to shopping customer. The trolley has attached barcode scanner to scan the products dropped, load cell to detect the weight of the products dropped and raspberry pi to integrate all these components using python. Fute cart is designed in such a way that it undergoes machine learning process with the history of data available. So with these data, it is possible to form relation between a product sale and its relative position in the shop. Also from the history of data, it is possible to categorise the products as complementary, mutually exclusive and dependent products based on the sequence based prediction. This kind of strategic arrangement and prediction increased the profit rate of the surveyed shop by 21%. The trolley also has theft detection system. Fute cart serves to be beneficial for both the customers and shopkeepers. It gives fast and informative shopping experience to the customers. Also for the shopkeeper, it reduces the cost of appointing an operator and it provides theft detection service and customer attractive product arrangement ideas.

1. Introduction
In this fast moving world people don’t want to waste their time in waiting. According to a study people mostly lose their time for waiting in a grocery or shopping mall for billing. To overcome this difficulty fute cart would serve better. In fute cart, scanning and billing of the product and also some additional utilisations can be done as soon as the product is put into the cart. Preliminarily, the idea is to build a module which will automatically start billing when the product is dropped into it. Fute cart also serves best to both the customers and shopkeepers. This kind of smart trolley undergoes machine learning with instantly available purchased data list and produces ‘Shopping Sequence Based Prediction’ results. Using this list it can categorise the products and provide apt positional recommendations every week to the shopkeeper thus increasing the sales profit of the shop. For the customers, fute cart makes the shopping process easy and quick as the customers need not depend on...
the billing operator, instead here the customer becomes his own billing operator. So adding / removing of products is possible at any instant of time.

2. Literature Survey

2.1. Rfid Based Trolley System
In [1], [2] and [3] the main idea proposed is to use RFID technology for the smart trolley. For each trolley there will be a RFID reader attached to it and for every product the RFID tags has to be attached. So as and when the products are dropped, the RFID reader will read it and the products are billed automatically. These papers aims at saving the time wasted in billing counters.

2.2. Shopping Bot
In [4], the proposed methodology is self-moving trolley which can trace the human actions. The trolley has attached motors to the wheels. These motor are controlled by the controller. The distance between the trolley and the customer is checked periodically. If the distance increases beyond a certain limit, the trolley is trained to move in such direction that the distance decreases.

2.3. Machine Learning Enabled Smart Trolley
Using machine learning techniques, the trolley is made to predict the shortest path to pick up an object from the shelf [5]. This prevents the time wasted in searching for a product in the supermarket. The trolley displays the shortest path and also gives messages through voice to find the shortest path. Here to find the optimal path, Q-learning algorithm is used.

2.4. Sales Improving Trolley System
In [6], the trolley undergoes Machine learning to find the preferences of the customers. The trolley also displays the recommended products for the customers. The trolley is said to have anti-theft system to prevent the theft by the customers. It uses zigbee and RFID technology to implement this (table 2).

| Existing system                  | Need for improvement                                                                 | Proposed alternate methodology                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Normal billing system            | Wasting timing in waiting has to be reduced                                         | Billing while shopping itself                                                                   |
| RFID based smart trolley         | Attaching RFID tag for each and every product in the super market is very difficult and costly too | Barcode scanner is used instead of RFID technology. Almost all the products in the super market will have barcode on its cover. So it is easy to implement barcode scanner based technology. |

3. Special Features of Proposed Methodology
Though there are many smart trolley systems, fute cart serves to be unique due to the following special features [7-9]:

- Fute cart uses easily implementable barcode system instead of RFID tags.
- Fute cart has theft detection system which most of the smart trolley are lagging. It detects the difference in actual weight and estimated weight and predicts the theft made by the customers. Once theft is detected a warning message pops up at LCD screen. If the customer didn’t mind the warning message and continues to shop, then a buzzer sound will ring up to indicate the theft and the indication is sent to the shopkeeper.
• Fute cart is not only useful to the customers but also to the shopkeepers. It undergoes machine learning and provides the positional recommendations to increase the sales for the shopkeeper.
• Fute cart can also replace the traditional billing system operator. So it removes the need for the shopkeeper to spend monthly wages on appointing an operator.
• Fute cart can estimate the number of carry bags during the purchase time itself. There is an ultrasonic sensor to find the capacity status of the trolley and estimates the number of carry bags needed.
• Fute cart displays the total cost of purchase at any instant of time. So if a customer has only a certain amount, he can re-plan his shopping since the customer himself becomes his operator. This is not possible in normal billing system because only when the customer reaches the billing counter, he will know the total amount of purchase.

4. Flow Chart
The following is the flow chart (figure 1) representing this:

![Flow Chart](image)

**Figure 1.** Flow chart for working of fute cart.

5. Sequence Model Prediction and Classification Algorithm
The generated bill is generally considered of no significance once the amount is paid. But the real data is in the bill. The products purchased by the customers can be treated as data for data analysis. The
The purpose of such analysis is to bring some improvement in the sales of the shop. So for that, the trolley is enabled with machine learning process. The trolley is trained with the bill as input data (table 2).

The machine learning model for the trolley is created using a machine learning software. Based on the order of entry of products and the count of each products purchased the trolley will categorise into 3 divisions. The same process can be done using normal billing system but there the order of products brought can’t be determined because the products are dropped in some order into the cart and billed in some other order at the bill counter. So the accuracy of the machine learning process may be very less. But here since the product is billed as and when it is dropped, the order of products brought is easily tracked along with its count. Thus fute cart has the ability called ‘SHOPPING SEQUENCE BASED PREDICTION’ for classifying the products.

Once the bill is generated, the products in the bill are given as input for machine learning process. The trolley undergoes machine learning to classify products into 3 categories.

i. Complementary products – if a product is brought by the customer, then its complementary product will also have the same probability to be brought due to its complementary nature in usage. For example, oil and shampoo are complementary products (figure 2).

ii. Dependent products – if product A is ‘dependent product’ for product B, it means that whenever product B is brought, product A is expected to be brought by the same customer with same probability but when product A is brought it’s can’t be told that surely product B will be brought because product A is only dependent on B and not vice versa (if vice versa is true, the it becomes complementary products). For example candle and matchbox, where if candle is brought, matchbox is expected to be brought with same probability but vice versa is not true (figure 3).

iii. Mutually exclusive products – if product A is brought, then probability of buying product B is negligible. In other words, buying one product excludes the other product from buying. For example, bathing soap and body lotion. People who use soap will not use body lotion.

The following is the sample of the input given to machine learning model in the same order:

| Order of the products purchased | Customer 1 | Customer 2 | Customer 3 |
|--------------------------------|------------|------------|------------|
| Product purchased | count | Product purchased | count | Product purchased | count |
| 1 | Tooth paste ‘X’ | 1 | Tooth brush ‘X’ | 1 | Tooth paste ‘X’ | 1 |
| 2 | Shoes ‘A’ | 1 | Shoes ‘B’ | 2 | Shoe polish ‘A’ | 1 |
| 3 | Tooth brush ‘Y’ | 1 | Tooth paste ‘Y’ | 1 | Tooth brush ‘Y’ | 1 |
| 4 | Shoe polish ‘B’ | 1 | Shoe polish ‘A’ | 2 | Perfume ‘R’ | 2 |
| 5 | Deodorant ‘P’ | 1 | Perfume ‘Q’ | 1 | Milk ‘Z’ | 1 |

All the bills generated in a week are given as input to the ML model one by one in the order they are generated. The above 3 bills are 3 such bills chosen to show the working and the working is explained with these 3 bills here.

When the products are given as input, the ML model will keep a track on the count of products and will form relation among the products based on their arrival order.

Here, from the above 3 bills the following inference can be obtained by data analytics:
i. Whenever toothpaste of 1 brand is brought, then toothbrush of same/another brand is brought by the same customer.

ii. Whenever toothbrush of 1 brand is brought, then toothpaste of same/another brand is brought by the same customer.

iii. Whenever shoes of 1 brand are brought, then shoe polish of same/another brand is brought by the same customer.

iv. Whenever shoe polish of 1 brand is brought, it is not sure that the same customer will buy shoes too. The customer may already have shoes and so would not buy shoes now.

v. Whenever perfume is brought, then deodorant is not brought by the same customer.

vi. Whenever deodorant is brought, then perfume is not brought by the same customer.

The (i) and (ii) inference says that toothbrush and toothpaste are ‘complementary products’. It means both the products may have same probability to be brought by the same customer. So such products has to be placed nearer to each other because even if the customer has no plan to buy product B, the location of product B nearer to product A tempts the customer to buy product B too.

The (iii) and (iv) inference says that shoes are ‘dependent products’ for shoe polish. So whenever shoes are brought a customer there is equal probability to buy shoe polish too. But if a customer buys a shoe polish, probability of buying shoes can’t be predicted. Such products can be placed in opposite racks to increase the sales rate. The (v) and (vi) inference says that perfumes and deodorants are mutually exclusive products. If one product is brought, then it exempts the other product from buying. Such products can be placed far apart in the shop so that it increases the sales rate. In this ways 100s of data are collected in a week and the products are classified and placed accordingly.

Every week, the arrangement of products is changed based on the ML results and the sales are found to increase by 21%.

The machine learning model is first created using a machine learning software. Then the model is made to train with 100s of sample input data (figure 4). Through this process, the model will get trained to classify the products into the above mentioned 3 categories.

Once the model is well trained with sample data in the machine learning software, it displays the category in which the given product falls. Using this classification, the shopkeeper can place products accordingly and increase his profit.
Figure 3. Trained model correctly identifying ‘dependent product’.

Figure 4. Screenshot of the results generated by the ML model after trained with 100 products.

6. Market Analysis

The market for smart trolley is very huge. This smart trolley (fute cart) can be implemented in all the malls and super markets. This product finds good invite in all big shops where there is a lot of crowd. This project is really a unique one. Though there exist many smart trolley concepts, there no defined product like this which has barcode scanning, theft control and carry bag calculation along with machine learning concept of sequenced based prediction. On a general view the online shopping zones can be compared as competitors. However fute cart gives a lively experience to the customer which online shopping zones can't. Here time is saved through smart trolley and several additional features are enabled which are not available in normal billing system. So on comparing with both normal shopping system and online shopping system, fute cart seems to serve as the best.
7. Experimental Setup

The fute cart has an attached barcode scanner which scans the products when dropped into it. There is a LCD screen which displays the details of the products dropped (figure 5). So at any instant of time, the customer can know the total amount of purchased. This feature is not possible in normal billing system. The raspberry pi is the main brain of the fute cart which controls all the functioning of the trolley. An ultrasonic sensor is fixed on the top of the trolley. The ultrasonic sensor keeps tracking the available capacity of the cart. Using this data, the size and number of carry bags needed can be determined at any instant of time. A load cell is placed at the base of the trolley. It measures the instantaneous weight of the products dropped. This weight value is used in the theft detection. The load cell is mounted on a cardboard and the HX711 is present inside it (figure 6). Once the shopping is done, the trolley undergoes machine learning process and categorise the products as complementary, dependent and mutually exclusive products.

8. Analysis and Results
Fute cart is found to be the most efficient method of shopping. The following are the results of this project (figure 7).

1. The LCD screen attached to the trolley displays the user interface when a new customer arrives (figure 8). This GUI is created using python TKINTER.
2. When the customer drops the product it gets scanned and the barcode is displayed on the screen. When the ‘SHOW DETAILS’ button is pressed product name, cost and weight is displayed (figure 9).
3. When ‘ADD’ button is pressed the product is added and total cost id displayed for each time. Also deletion is possible by scanning the products barcode again and pressing the ‘DELETE’ button.
4. Once a product is added/deleted then pressed ‘CONTINUE SHOPPING’ to add next product or press ‘END SHOPPING’ to end the process.
5. Once the shopping is over, the user clicks the ‘PRINT BILL!’ button, then the bill is generated as a word document with all the purchase details (figure 10). This can be printed or processed later.
Figure 7. Image of python coding for the fute cart.

```python
from tkinter import *
import time
import eyed
import random
from datetime import date
import os
import RPi.GPIO as GPIO

# Setting GPIO pins
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
TDI = 30
ECSN = 40
buzzer = 35
I0A1 = 29
I0A2 = 31

# Main program
date=date.today()
name=['dairy milk','milky bar','hakka','mickeys','kinderjoy','prizk']
cost=[5,4,2,3,4,5]
date=[3,4,5,6,3,4]
for i in range(0,6):
    cost=0
    price=0
    total_cost=0
    flag=0
    flag2=0
```

Figure 8. LCD displaying product details through Tkinter GUI.
9. Future Scope
Thus fute cart served to be beneficial to both customers and shopkeepers. This was practically implemented in a shop and the sales profit is found to increase by 21% due to the ‘Shopping Sequenced Based Prediction’ of the fute cart. This project can also be extended much more in a better innovative concept. Further the payment can be made in the trolley itself. Also when theft occurred, the trolley can be made to lock at that location itself [6]. If required this trolley can be converted to more intelligent one by making the trolley to follow the customers instead of customers pushing it while shopping [4]. Another plan of designing a carry bag dispenser and fitting to this cart also exists. So according to the purchase the number of carry bags will be displayed and according to the count and size displayed, the corresponding bag will be dispensed. So hopefully the best outcome can be obtained from fute cart and there is a wide future scope for it.

10. References
[1] Sahare PS, Gade A and Rohankar J 2019 A Review on Automated Billing for Smart Shopping System Using IOT Journal homepage: http://ijeta.org/Journals/RCES 6 1-5
[2] Machhirke K, Goche P, Rathod R, Petkar R and Golait M 2017 A new technology of smart shopping cart using RFID and ZigBee International Journal on Recent and Innovation Trends in Computing and Communication 5 256-9
[3] Thiyagarajan M, Aejaz M and Kumar M 2017 RFID based advanced trolley for super market

[4] Ying W, Qi L, Zhuang L, Baohua L, Kai L and Shuo L 2019 IOP Conf. Ser.: Mater. Sci. Eng. 631 052033

[5] Budakova D and Dakovski L 2019 IOP Conf. Ser.: Mater. Sci. Eng. 618 012036

[6] Yewatkar A, Inamdar F, Singh R and Bandal A 2016 Smart cart with automatic billing, product information, product recommendation using rfid & zigbee with anti-theft Procedia Computer Science 79 793-800

[7] Maini E and Shettar J 2014 Wireless intelligent billing trolley for malls International Journal of Scientific Engineering and Technology 3 1175-8

[8] Raju K, Gopalakrishna K and Ramesha K 2013 Intelligent Shopping Cart International Journal of Engineering Science and Innovative Technology 2

[9] Kamble S, Meshram S, Thokal R and Gakre R 2014 Developing a multitasking shopping trolley based on RFID technology International Journal of Soft Computing and Engineering 3