REPORT

for the project named

RETAIL STORE STOCK INVENTORY ANALYTICS

SUBMITTED BY

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PROJECT REPORT

CONTENTS:

1. INTRODUCTION

1.1 Project Overview

As a retail business owner, one of the worst scenarios that can occur to the stores are product stock-outs, dead stock or excess inventory. In order to overcome such disadvantage this project was developed.

1.2 Purpose

Our project **"Retail Store Stock Inventory Analytics"** is done in order to help stores and ecommerce sellers satisfy the customer, reduce costs and increase profits.

2. LITERATURE SURVEY

2.1 Existing Problem

The maintenance of inventory manually is hard. It's hard to determine the demands and satisfy the customer at same time. The shortage of stock and overflow of stock is the major problem in retail inventory management.

2.2 References

Paper- 1: Combination of Advanced Robotics and Computer vision for Shelf Analytics in a Retail Store.

Year: 2017

Author: Gopichand Agnihotram, Navya Vepakomma, Suyog Trivedi, Sumanta Laha, Nick Isaacs, Srividya Khatravath, Pradeep Naik, Rajesh Kumar.

Description: Large-scale retail store associates are constantly faced with the challenge of managing store operations smoothly and maintaining the products in full stock on the product support devices (retail shelves). Keeping track of the quantities of each individual Stock Keeping Unit (Retail Product), replenishing them when depleted, and identifying and replacing misplaced products are few tasks that require continuous monitoring and large amount of manual effort. The solution being presented here aims at automating the tasks performed by the store

associates which result in reducing the manual effort. The solution proposes the use of a Double Robot to patrol the store over a fixed path and capture images of the retail shelves at real time. These images are processed using developed solution to address various retail store challenges such as stock out problems and misplaced products. An alert generating mechanism has also been incorporated into the solution to alert the store associate via email or a text message, when a product is completely out of stock/misplaced. The solution approaches use classification techniques, deep learning techniques along with computer vision algorithms to automate these processes in retail stores.

References: https://ieeexplore.ieee.org/document/8423894

Paper- 2: Development of Smart Sensor Array Mat for Retail Inventory Management

Year: 2022

Author: Ruiqi Lim, Musafargani Sikkandhar, Ming-Yuan Cheng.

Description: Inventory management of retail market involve manual stock keeping process that is labour intensive and prompt to human error. Hence, results in mismatching of items with the inventory record and loss of sale up to 4%. Thus, there is a need to monitor the movement of the goods on the retail shelves. In this paper, we disclosed the fabrication of large piezo-resistive sensor mat, which is able to display the product base structure shape for tracking the stock inventory in retail store. Each square-shaped sensing pixel is of 5 mm in dimension with the sensing area of 4×4 mm^2. The detected shape of the product is displayed on the graphical user interface (GUI) using the PC. The fabricated sensor mat is characterized for functional resistance range of 10KΩ to 900KΩ with a 98mN resolution. The sensor mat has an uniformity error of 2.2%, and repeatability error of 3.1%. The longevity and durability of the sensor mat is validated for 7 days and through 1000 times drops test respectively. The proposed sensor mat is also demonstrated with five different products for shape detection.

References: https://ieeexplore.ieee.org/document/9816441

Paper- 3: Towards Intelligent Retail: Automated onShelf Availability Estimation Using a Depth Camera

Year: 2020

Author: Annalisa Milella Antonio Petitti ,Roberto Marani Grazia Cicirelli, Tiziana D' orazio

Description: Efficient management of on-shelf availability and inventory is a key issue to achieve customer satisfaction and reduce the risk of profit loss for both retailers and manufacturers. Conventional store audits based on physical inspection of shelves are labor-intensive and do not provide reliable assessment. This paper describes a novel framework for automated shelf monitoring, using a consumer-grade depth sensor. The aim is to develop a low-cost embedded system for early detection of out-of-stock situations with particular regard to perishable goods stored in countertop shelves, refrigerated counters, baskets or crates. The proposed solution exploits 3D point cloud reconstruction and modelling techniques, including surface fitting and occupancy grids, to estimate product availability, based on the comparison between a reference model of the shelf and its current status. No a priori knowledge about the product type is required, while the shelf reference model is automatically learnt based on an initial training stage. The output of the system can be used to generate alerts for store managers, as well as to continuously update product availability estimates for automated stock ordering and replenishment and for e-commerce apps. Experimental tests performed in a real retail environment show that the proposed system is able to estimate the on-shelf availability percentage of different fresh products with a maximum average discrepancy with respect to the actual one of about 5.0%.

References: https://ieeexplore.ieee.org/document/8963979

Paper- 4: Exploiting Egocentric Vision on Shopping Cart for Out-Of-Stock Detection in Retail Environments

Year: 2021

Author: Dario Allegra, Mattia Litrico, Maria Ausilia Napoli Spatafora, Filippo Stanco, Giovanni Maria Farinella

Description: Continuous detection and efficient monitoring of Out-Of-Stock (OOS) of products in retail environments is a key factor to improve stores profits. Traditional methods require labour-intensive human work dedicated to checking for products to refill raising the requirement of automatic solutions to detect OOS. In this work, we focus on the problem of OOS detection from an egocentric perspective proposing a new weak annotation of the EgoCart dataset. We benchmark the considered challenge employing a deep learning approach for the detection of OOS areas. Specifically, we train a Convolutional Neural Network (CNN) to predict attention maps useful to find OOS in retail areas and hence suggest the retail employers where to intervene. We evaluate results with both objective measures and a subjective analysis provided by human which has reviewed the obtained OOS attention maps. The achieved performance demonstrates that the proposed pipeline is promising to help the refilling process in the retail domain

References: https://ieeexplore.ieee.org/document/9607839

Paper- 5: Store-sales Forecasting Model to Determine Inventory Stock Levels using Machine Learning

Year: 2022

Author: Akanksha Akanksha, Devesh Yadav, Deepak Jaiswal, Ashwani Ashwani, Ashutosh Mishra

Description: Predicting sales had been a common practice. Sales prediction plays a crucial role in the business world. It gives accurate and dependable information related to current and previous events, also the events that are expected to occur in the future. However, because traditional sales approach lack insight into customers' buying patterns, they can no more help businesses in keeping up with the pace of a competitive business world. Machine Learning evolvements have resulted in major changes in sales and marketing fields. Many key aspects like consumers' buying

patterns, target audiences, and estimating sales for upcoming years can be determined easily, all thanks to the advancements in machine learning and thus helping the sales team in the companies for making plans for a boost in sales.In the proposed methodology, the study of several forecasting methods used in the forecasting of the future sales of stores keeping previous year's sales in view. We tried linear regression model, Random Forest and XGBoost regressor. But linear model performed poor, so it is not included here. The prediction models implemented herein are random forest regressor and XGBoost regressor. Both of the regression techniques give better accuracy and less RMSE (Root Mean Squared Error) value than linear model. XGBoost perform best in all the three models.

References: https://ieeexplore.ieee.org/document/9850468

2.3 Problem Statement Definition

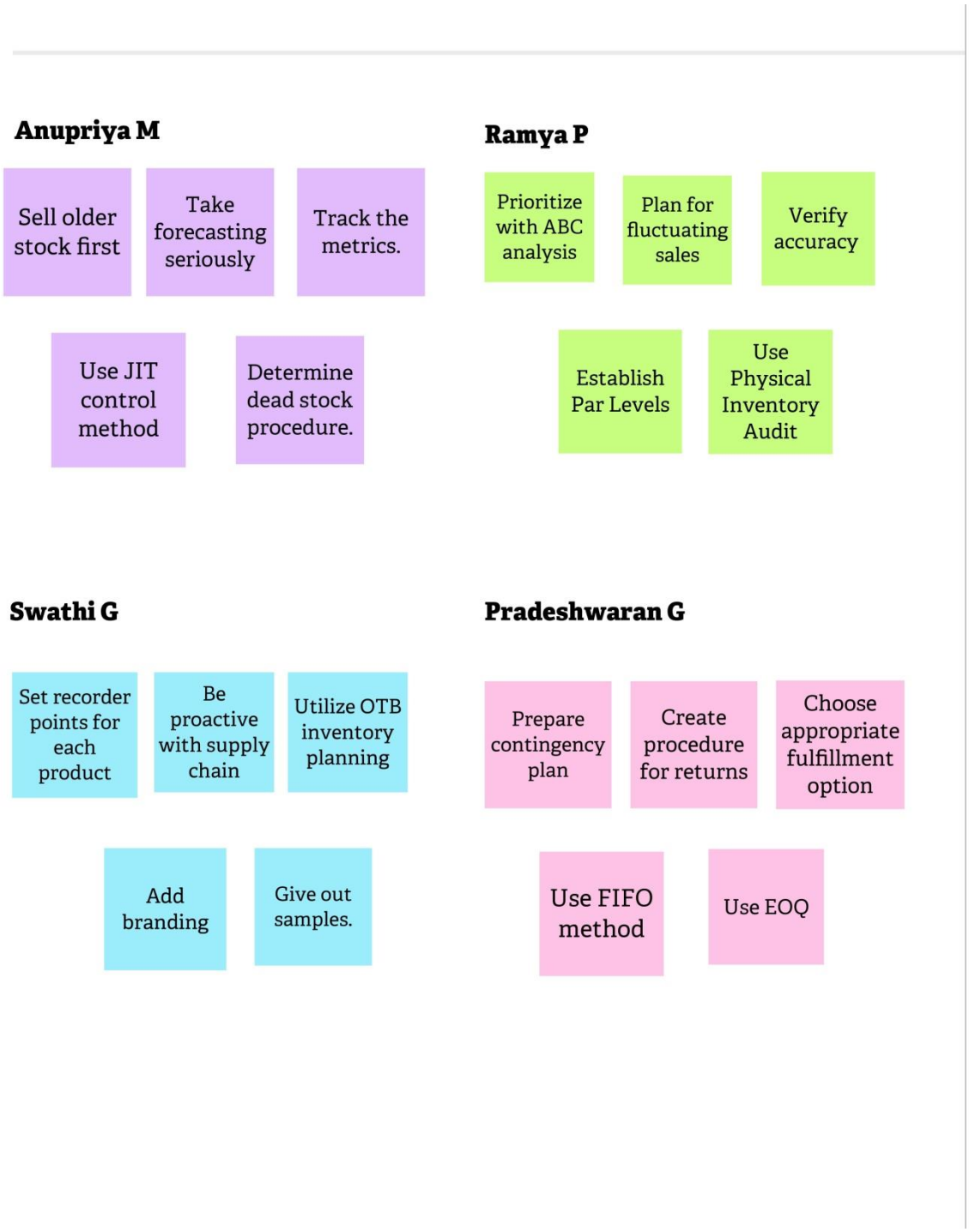
The major problem in retail store stock inventory is to predict the demands of the stocks in accordance with customer. The big problem in inventory is the overflow of stocks. Sometimes the stock remains dead because of the lack of demand for that particular stock. At times there is shortages of stock due to the demand in that certain period. Taking care of inventory manual is very hard. It need a lot of labour.

So this project was developed to meet all the problems mentioned above.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 Ideation & Brainstorming

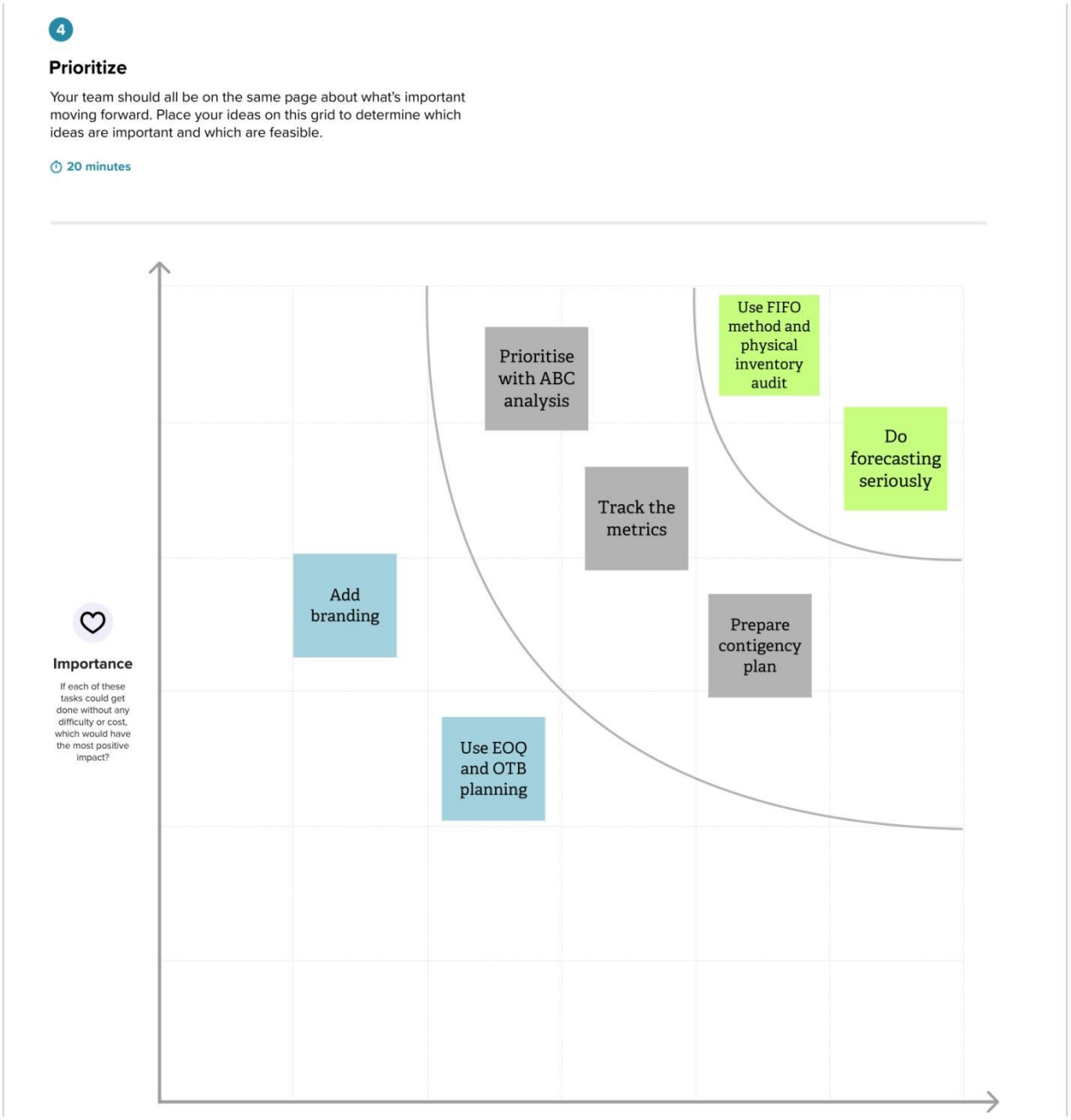


3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes



3.3 Proposed Solution

S. No.	Parameter	Description
1	Problem Statement (Problem to be solved)	Demands are uncertain. Need to avoid shortages and overflow of stock. Manual work should be avoided. Need to satisfy the customer

2	Idea / Solution description	To meet crisis like shortage and overflow of stock FIFO method can be used. In order to avoid manual work online inventory can be maintained using ABC analysis and physical inventory audit. To satisfy customer brand can be added and contingency plan can be made.
3	Novelty / Uniqueness	We use FIFO method to overcome crisis and use ABC analysis as well as physical inventory audit. All these together bring the uniqueness to our project.
4	Social Impact / Customer Satisfaction	To satisfy the customer new brands are added and contingency plans are made from the previous experience.
5	Business Model (Revenue Model)	Introduction of new brands can increase revenue. At times we also get to know which product was sold high by analysis and increase in that particular product can get more revenue.
6	Scalability of the Solution	The solution is capable of changes when it is necessary. Like using ABC analysis shortage and overflow can always be maintained despite the quantity.

3.4 Problem Solution Fit

Define CS, fit into CC	**1. CUSTOMER SEGMENT(S)** **CS** Who is your customer? The one who purchases the product.	**6. CUSTOMER CONSTRAINTS** **CC** What constraints prevent your customer from taking action or limit their choices of solutions? Product quality, quantity. Affordable prices. Reliability.	**5. AVAILABLE SOLUTIONS** **AS** Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? Change of the brands. Rating of the product.	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEM **J&P** Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides. ABC analysis, FIFO method. To have contingency plans.	**9. PROBLEM ROOT CAUSE** **RC** What is the real reason that this problem exists? What is the back story behind the need to do this job? To meet with the crisis like shortages and overflow. To avoid manual work.	**7. BEHAVIOUR** **BE** What does your customer do to address the problem and get the job done? Address about the product quality, quantity, price, guarantee, quality of service. Do contingency plan for job done.	Focus on J&P, tap into BE, understand RC

Identify strong TR & EM	**3. TRIGGERS TR** What triggers customers to act? Satisfaction of the product. Brands of the product. Current running of the product. **4. EMOTIONS: BEFORE / AFTER EM** How do customers feel when they face a problem or a job and afterwards? If the product quality is good it feels happy. If the product quality is bad it feels bad about that product	**10. YOUR SOLUTION SL** If you are working on an existing business, write down your current solution first fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour. To meet crisis like shortage and overflow of stock FIFO method can be used. In order to avoid manual work online inventory can be maintained using ABC analysis and physical inventory audit. To satisfy customer brand can be added and contingency plan can be made	8. **CHANNELS OF BEHAVIOUR CH** **ONLINE** What kind of actions do customers take online? **OFFLINE** What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. See the product quality, review. Deliver on time.	Identify strong TR & EM

4. REQUIREMENT ANALYSIS

4.1 Functional Requirements

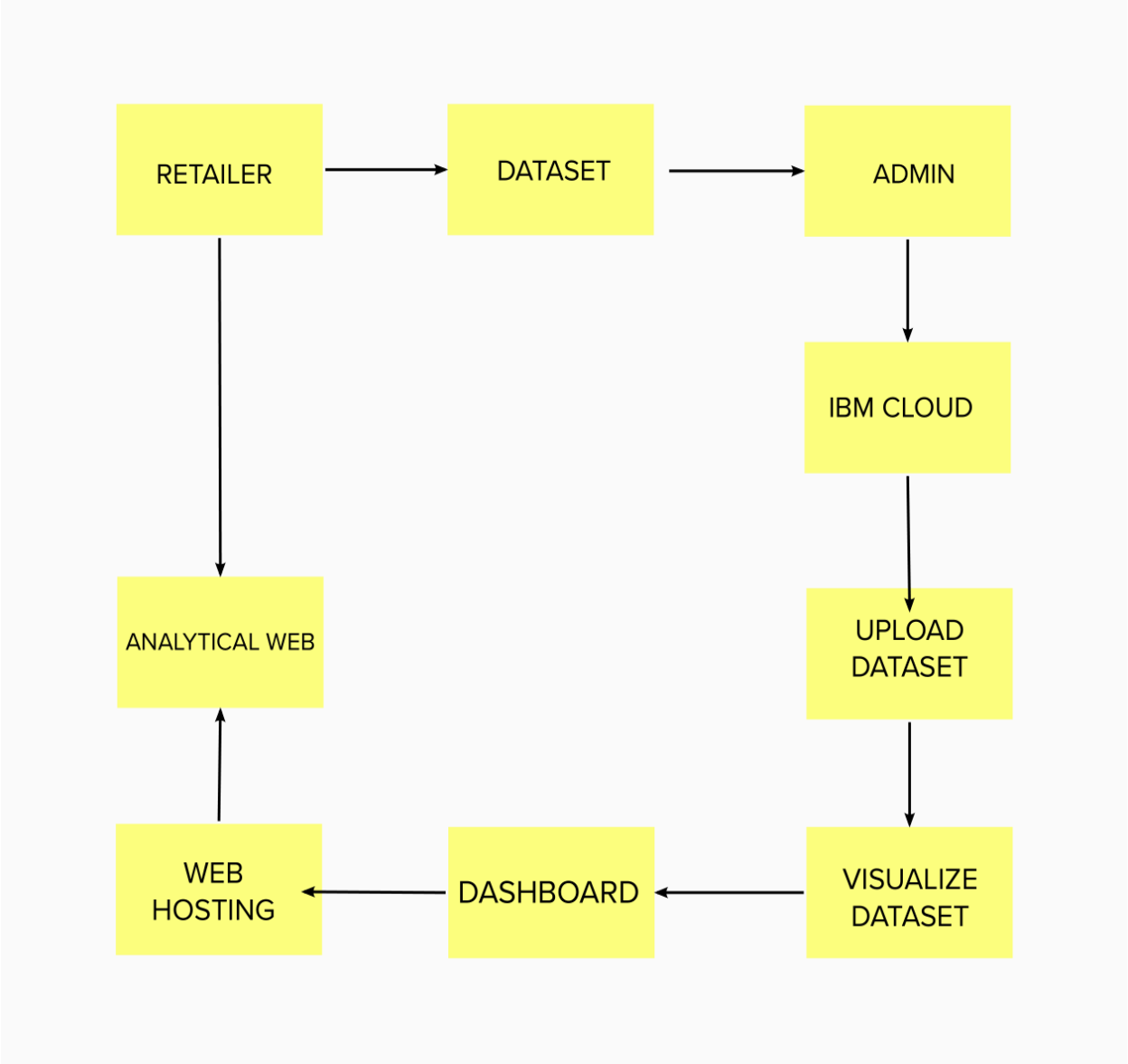
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration to IBM cloud
FR-2	User Confirmation	Confirmation via Email
FR-3	User Login	Login with username Login with password
FR-4	Profile update	Update the user credentials Update the Contact details
FR-5	Uploading Data	Collect the customer details as well as product details Upload the product details into IBM cloud object storage.
FR-6	Recommendation	The user will get the recommendation about the products in the dashboard.

4.2 Non- functional Requirements

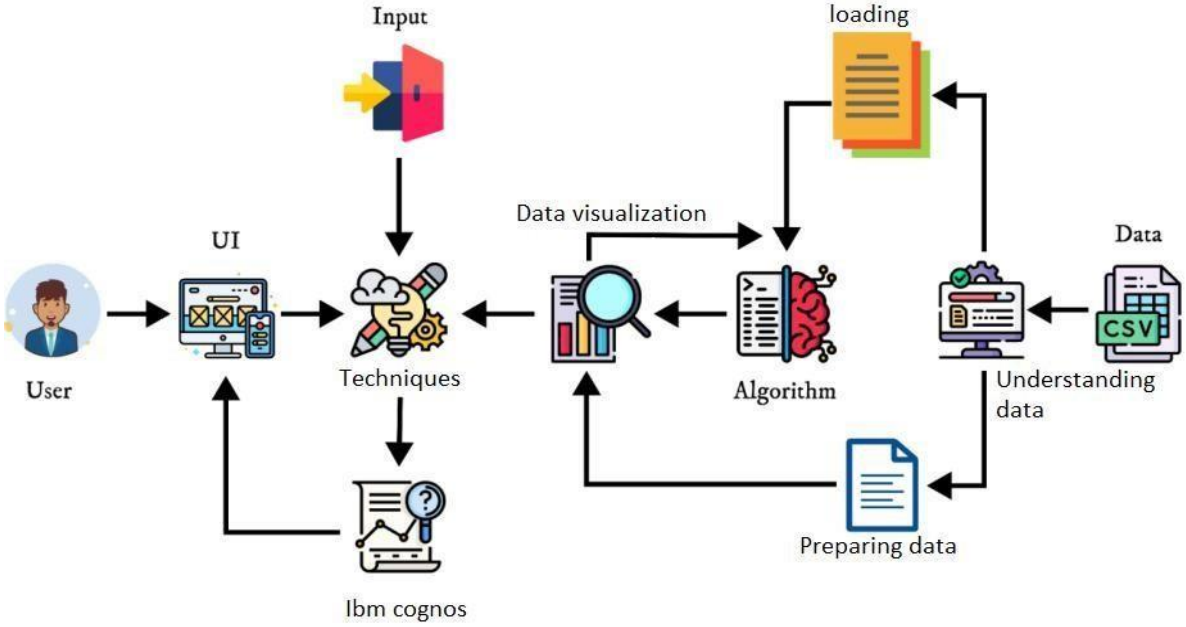
NFR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	They are used to have enough inventory to capture every possible sale while avoiding overstock and minimizing expenses.
NFR-2	**Security**	This can be used only by the users who have their proper login credentials in the IBM cloud
NFR-3	**Reliability**	Avoid over or under stocking Ensure accurate inventory valuation Prevent order delay Reduce dead stock
NFR-4	**Performance**	From this, the model can predict the dead stocks and highly profitable stocks. The accuracy of this model will be ensured by checking multiple times by using random forest algorithms, etc..
NFR-5	**Availability**	It can give retailers real-time visibility into stock levels, avoid stock outs, keep inventory carrying costs low and help meet customer expectations
NFR-6	**Scalability**	More users can be accessed at the same time without any issues. The feedback of the users will be taken and be proceeded further up to the satisfaction of the user.

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Dashboard	USN-1	As a user, I can view the charts and graphs representation of the dataset and the information shown in the dashboard	I can access my account / dashboard	High	Sprint-1
Customer (Web user)	Dashboard	USN-1	As a user, I can view the charts and graphs representation of the dataset and the information shown in the dashboard	I can access my account / dashboard	High	Sprint-1

Administrator	Login	Admin-1	As a admin,I can log in to the IBM account by using authorized user ID and password	I can access my account	High	Sprint-1
	Upload	Admin-2	As a admin,I can log in into my account and use the cloud object storage service of the IBM cloud to store and retrieve my dataset whenever it is needed.	I can access my cloud storage	High	Sprint-1
	Visualize	Admin-3	As a admin,I can visualize my dataset for the specified constraints to satisfy or give solution to our problem statement.	I can visualize my data	High	Sprint-2

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	IBM Cognos account creation	USN-1	The account is created in IBM Cognos Analytics Account for each person in the team.	2	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-1	Data collection	USN-2	The data is collected and the understanding of data is done in order to present to user.	2	High	Anupriya M Ramya P Swathi G Pradeshwaran G

Sprint-2	Data Preparation	USN-3	As a user the accurate data that is prepared can be viewed. The collected data is prepared by restructuring & clean	3	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-2	Data Exploration	USN-4	As a user, the visualized data can be view for better understanding about sales, price, stock and revenue. The data exploration is done.	8	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-3	Build Visualization Charts	USN-5	As a user, I can view the visualization better in the chart form. The visualization chart is build.	8	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-3	Dashboard Creation	USN-6	As a user, I can view the different visualization in dashboard about price, stock, sales and revenue.	8	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-4	Report Creation	USN-7	As a user, I can view the detailed report of the sales, stock, price and revenue. The user gets the detailed report.	8	High	Anupriya M Ramya P Swathi G Pradeshwaran G
Sprint-4	Story Creation	USN-8	As a user, I can view the story to get better understanding of sales, stock, price and revenue. The user can decide by viewing the story.	8	High	Anupriya M Ramya P Swathi G Pradeshwaran G

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	4	6 Days	24 Oct 2022	29 Oct 2022	2	29 Oct 2022
Sprint-2	11	6 Days	31 Oct 2022	05 Nov 2022	11	05 Nov 2022
Sprint-3	16	6 Days	07 Nov 2022	12 Nov 2022	16	07 Nov 2022
Sprint-4	16	6 Days	14 Nov 2022	19 Nov 2022	16	14 Nov 2022

7. CODING & SOLUTIONING

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<meta charset="utf-8">

<meta name="viewport" content="width=device-width, initial-scale=1.0">

<title>demo</title>

</head>

<body bgcolor="#D8F8F7 ">

        <h1 align="center"><b>Retail Store Stock Inventory Management</b>
</h1>

<hr>

        <h2><b>Dashboard </b></h2>
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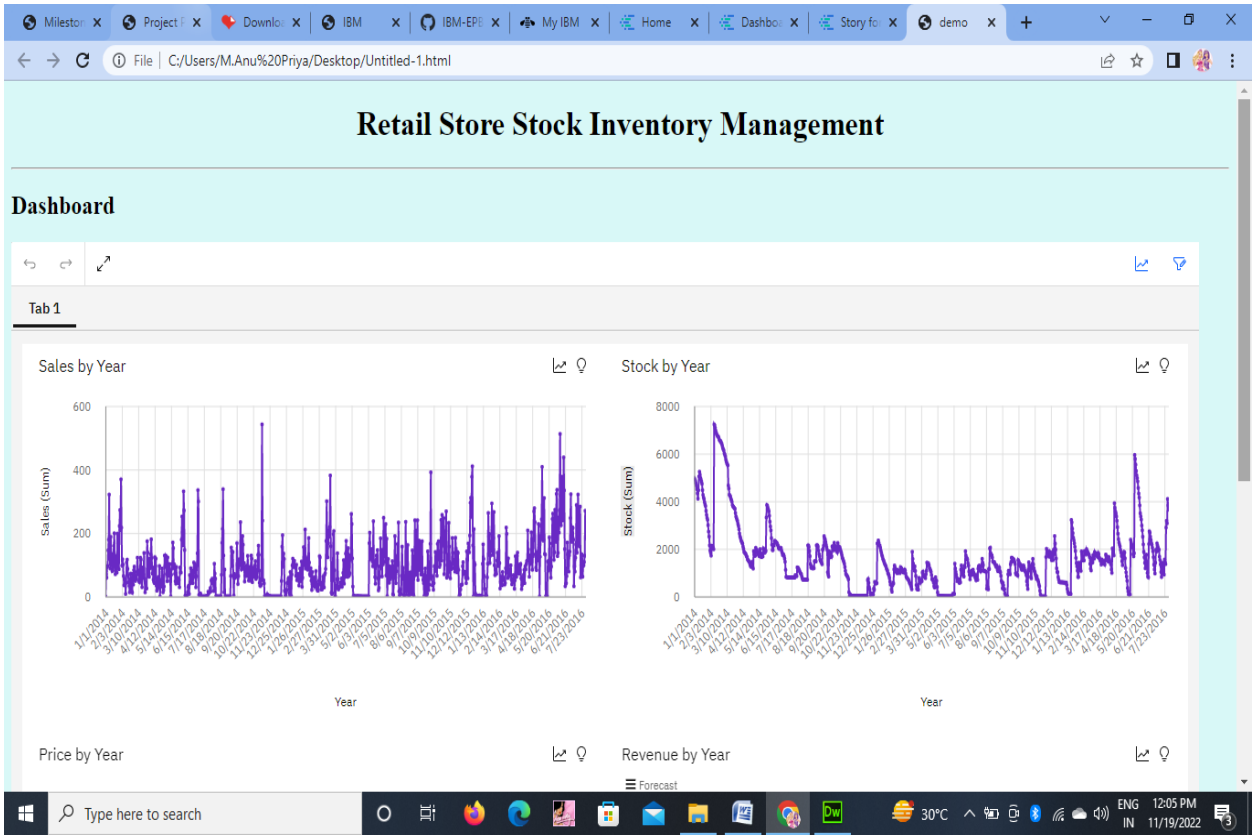
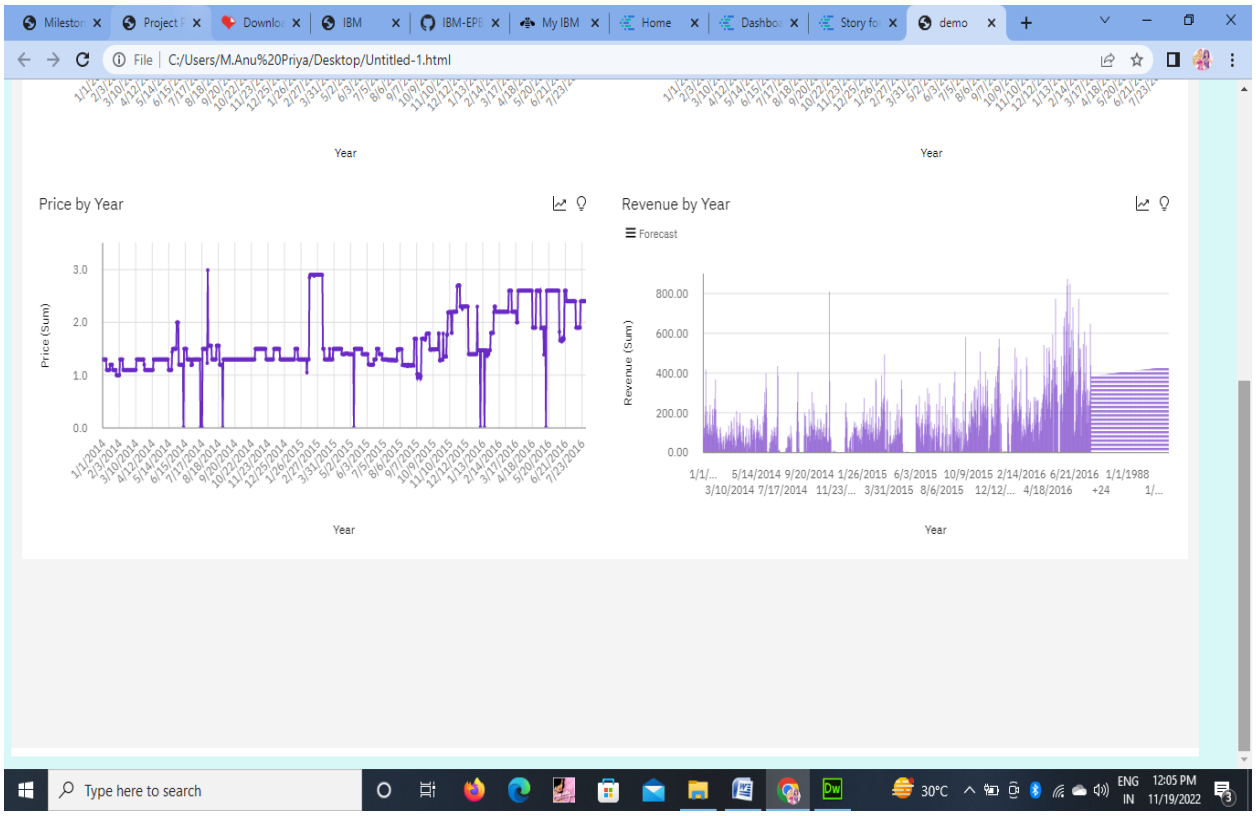
</iframe>

</body>

</html>

8. RESULTING





9. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- It reduces manual labor.
- It helps to predict the demands.
- The correct prediction of demand leads to avoidance of dead stock and helps with the shortages of the stock.

DISADVANTAGES:

- If there occurs any error in prediction it cause loses.

10. CONCLUSION

The project "Retail Store Stock Inventory Analytics" was developed to satisfy the retailer or ecommerce customer and in order to maintain the stock at the demand level. It helps to overcome the crisis like overflow of stock or dead stock

or with nearly expiring items. This analytics helps in prediction, so using prediction the shortage of the stock can't be happen. Since the project is done as web app, it helps to meet with the need of labor for maintaining the inventory.

11. APPENDIX

Story link:

https://us1.ca.analytics.ibm.com/bi/?perspective=story&pathRef=.my_folders%2FStory%2Bfor%2BRetail%2BStore&action=view&sceneId=model000001848e7404a7_00000000&sceneTime=0

Dashboard link:

https://us1.ca.analytics.ibm.com/bi/?perspective=dashboard&pathRef=.my_folders%2FDashboard&action=view&mode=dashboard&subView=model0000018436ed9cae_00000000

Github link:

https://github.com/IBM-EPBL/IBM-Project-54355-1661855691