**Project**:

Enabling real-time and even predictive out of stock in retail stores in a cost-effective manner

**Introduction**:

Having the products most important to customers on shelf at all time enables customers to get what they want, when they want it.

Availability is a complex issue, as it often involves a long supply chain, backroom store processes (products could be in store, but sitting in the stockroom rather than available to customers on the shelf), and the space given to each product on the shelf in store. In order to focus attention on the most important lines, use the term Diamond Lines – these lines are marked on the shelf in store and in the stock room with a diamond symbol. Store staff are trained to ensure that these products are available on the shelf at all times, and their location on the stock room is made clear so that it is easy for store staff to find them to replenish the shelf.

In order to maintain the focus on diamond lines, it is important that we keep the number of diamond lines relatively small, and that we have a way of identifying which lines are most important for customers. In order to do that, we make use Price Sensitivity segmentation. This segmentation that classifies customer’s according to their behaviour on price, is then used to determine the Product Appeal of each product to customers – i.e. which products appeal to Price Sensitive customers, which appeal to Midmarket customers, which appeal to Upmarket customers, and which ones have a Broad Appeal to all customer segments.

Once these Diamond Lines are identified, the sales pattern for each product is mapped out, to establish where and when it is normally bought by customers – the “where” relates to each store, and the “when” relates to what time of day and day of week. Any departures from the normal sales pattern, where unexpectedly long gaps of no sales are seen in a given store for a given product are flagged as Out of Stock. The amount of time that zero sales needs to be observed for us to be reasonably sure the product is really out of stock, rather than just a natural period where no sales would be expected, is calculated using a statistical probability algorithm.

We can train our model based on historic data and predict for the future transaction. Once we have predict any future out of stock periods, a report is created to summarise the amount of time each product will be out of stock and expressed as a percentage of all store opening time. Summaries are provided to highlight the products and stores with low availability. The retailers operations teams can then invest their resources accordingly on the areas of the supply chain that will have the most impact on customers, and therefore most impact for the long term business.

**Causes**:

There are 5 Major causes of OOS

1. Inaccurate data
2. **Failure to re-order in a timely manner**
3. Poor management of people, processes, and technology
4. Poor communication or relationships with your suppliers
5. Not enough working capital

**Workaround**:

There are 5 Major causes of OOS

1. Inaccurate data
   1. Use a modern inventory system

It’s best to use a point-of-sale or inventory system that automatically modifies inventory levels as you ring up sales, so you won’t have to worry about manually updating your database. Such solutions are also beneficial if you have several locations because they allow you to manage multiple stores from one place.

* 1. Stay organized and vigilant

This is where your diligence and organizational skills will come in. Get to the root of your inventory discrepancies. Is it an issue with your vendors? Are you dealing with theft? Whatever the case, find the reasons why the numbers aren’t adding up and take the necessary steps to stop them.

* 1. **Consider RFID (Radio Frequency Identification)**

People manually counting items in the supply chain take too much time; it is too expensive and is also fraught with error

* 1. Conduct regular stock counts

Avoiding stockouts requires you to have near real-time information on what you have (or don’t have) on hand. You won’t be able to do that if you’re only counting your merchandise once or twice a year

1. **Failure to re-order in a timely manner**
   1. **Find OOS (out of stock) patterns**

Tends to form patterns such as day of week

* 1. Implement demand forecasting

Close attention to the speed at which products are selling

* 1. Pay attention to consumer trends

Looking at sales reports allowed us to identify that trend

* 1. Set re-order points

1. Poor management of people, processes, and technology
   1. People
   2. Processes
   3. Technology
2. Poor communication or relationships with your suppliers
   1. Get all order and deadlines on paper
   2. plan if product is selling faster than expected
3. Not enough working capital
   1. **Liquidate surplus stock**
   2. **Collect on unpaid invoices**
   3. **Increase sales**

**Methodology**:

There are 6 Major steps to predict any real time out of stock product:

1. Diamond line product selection
2. Calculating Out of Stocks
3. Prediction of Out of stock for real time/future transactions
4. On shelf availability report
5. Integration with the retailer’s business
6. Supplier engagement in managing availability

Technology:

There is lots of automation and AI technologies available to help to solve these issues:

1. Computer Vision
2. Weight sensors
3. RFID

We can use Python and other open source python libraries.

**Approach**:

We will try to start with Computer vision and build a robust solution to identify the product availability in real time and use the historic information to forecast the out of stock probabilities and expected inventory required in stock to resolve this issue.

These are the steps to proceed:

1. Analysis on historic data and prepare the diamond line for the fast-moving products to limit the focus to the selected products/categories.
2. Collect the real-time feed of shelf using CCTV camera and cluster products based on their density/shelf/tray/size/colour and estimate their real-time availability.
3. Add weight sensors/RFID data to the above result to increase the accuracy of the above result.
4. Prepare rate of sale measure at different levels and calculate zero sales probability of a product within the store at that time.
5. Create logistic regression model and train the model with the above KPI’s.
6. Predict and forecast the future sale of the product and manage inventory stock accordingly.
7. Evaluate hourly/daily/weekly/yearly historic transaction and computer vision data to prepare the threshold for each cluster to raise the flag for unavailability/OOS to the inventory team.
8. Record the action of the inventory team by re-evaluating the computer vision data for the shelf for that cluster.
9. Prepare daily/weekly/monthly report which help to manage the store workforce and inventory well.

**Evaluation**:

Computer vision can be done with the webcam cameras and achieve similar performance to 720p IP cameras

Weight sensors on smart shelf will be achievable by using flex boards and 2, 3 and 5 KG pressure sensors at the scaling cost of $6. Sensors output is converted by SparkFun HX711 load cell amplifier to digital signals.

We can use SparkFun RFID modules with antennas and multiple UHF passive RFID tags, which help to read upto 150 tags per second.

**References**:

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* <https://tech.instacart.com/predicting-real-time-availability-of-200-million-grocery-items-in-us-canada-stores-61f43a16eafe>
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