# FSN Analysis using K Means Clustering

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**ABSTRACT**

Inventory management is responsible for planning, controlling and movement of stock within and outside the organization. It plays a huge role in determining the financial and operational health of any organization, considering its significant share in OPEX. Proper inventory control helps in maintaining right amount of stock of materials, etc. thereby making effective use of working Capital.
There are several inventory analysis techniques such as ABC, XYZ, VED, FSN, HML etc. used by the companies. In this study, focus is on FSN Analysis. This paper goes through the FSN (Fast, Slow, and Non-moving) inventory analysis technique using machine learning algorithm (K-Means clustering) of an online food delivery business..

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## Introduction

A good inventory management will help the firm to make the most of the demand by fulfilling orders on time in full, at the same time it will help in minimizing the impact of production failures and fixed capacity issues in matching up the supply with demand.
Organization can take advantage of high volume to get discounts, but in turn pay for holding the inventory. So, a trade-off has is must between holding a stock vs. purchasing it when the order is placed from the customer end.
There are different types of inventories, mainly classified into raw material, work in progress and finished goods. The focus is on finished goods in this study. Inventory analysis is done on finished food items for an online food delivery business owing cloud kitchens. One of the warehouse has been chosen for doing pilot run and implementing FSN analysis coupling with machine learning algorithm (K Means clustering)
With advent of analytics, using machine learning to come up with classification can help in reducing bias to some extent as well generalizing the classification parameters. This study will help the readers to understand the use of K means clustering to do FSN analysis based on consumption rate. It will help to take identify the products lying in different segments, (Fast, slow and Non-moving) and take better business decisions on keeping and discarding finished item stocks. This study is not limited to online food delivery but can be applied on any business and conduct Inventory Analysis based on FSN analysis.

## Research Gap

Ref [2] shows not all materials are required in same quantity in manufacturing industry and so as in online food delivery business, as demand for different food item varies. Hence some material would be required more and for some requirement would be less. In order to identify this, FSN analysis is one of the technique to divide the inventory into three segments:

1 Fast moving
2 Slow moving
3 Non-moving

As per Ref [3]:
1 F-class item: It is generally used item and used in large amount. It is generally 10-15% of total item
2 S-class Item: Slow moving (S) is generally 30-35% of total item.
3 N-class item: It is generally 60-65% of total item.
While classifying the items into any of the segment (Either Fast, slow or non-moving) a general percentage limit, (10-15% of total items) for fast moving, 30-35% for slow moving and rest for Non-moving is observed. Classification of FSN can be done using consumption rate, average stay. For perishable inventory where shelf life is for few days ranging from 1 day to 3 days,(for food items ), it gets difficult and cumbersome to identify correct average stay in warehouse, and hence inventory classifications becomes difficult . In such cases, machine learning can play a vital role in coming up with classification. The same, has been discussed and implemented on one warehouse of a online food delivery business.

## Objectives of the Study

To segregate finished food items into three segments using FSN analysis based on consumption rate using K mean clustering.
To understand K mean clustering
This will help in taking better business decisions with respect to stocking particular material based on consumption patterns

## Literature Review

Multiple research papers have been published based on inventory analysis using different techniques. After going through some of the research study done on inventory analysis, few of them mentioned in the references 1,2,4 , it can be concluded that generally the segmentation of inventory using any technique, be it ABC or FSN etc., items contributing between 70% –80% of cumulative usage can be considered as A or F category, next few items which

together with A or F category items segregated earlier contribute between 80% – 90% of cumulative usage can be considered B or S category, and left over items can be taken as C or N category. This upper and lower limit of item cumulative usage can differ from business to business. To come up with automatic segmentation in FSN analysis, application of K mean clustering is employed to show formation of three different clusters, fast moving ,slow moving and non-moving. Clusters are formed based on algorithm unlike based on theoretically assumed percentage limit.

K mean clustering is a way of forming clusters by breaking the data into groups based on patterns in data. This study shall help the organization to avoid segmentation of items based on assumption.

Here, on the basis consumption rate of food items clusters will be formed based on underlying patterns.

## Methodology

The online food delivery business has multiple warehouses in different regions. One of the warehouse was taken into consideration for study purpose. Warehouse has finished food items having a shelf life of 1 day. Knowing the shelf life of 1 day, taking average stay in doing FSN analysis is not possible. Therefore consumption rate of food items were taken as a parameter for conducting FSN analysis.

Secondary data for 18 days was collected for a warehouse from Information Management System team of the organization. Data had features like component ID, date of offtake and Offtake. After data collection, data was cleaned using Python and feature engineering was done as to calculate consumption rate of different items for a period of 18 days.

Post data collection and cleaning, data was modelled using K means clustering.

K means clustering is a method to form cluster of similar items based on underlying patterns. Where, K refers to number of clusters to be formed. Properties of clusters are stated below for better understanding

1 All data points in a cluster should be similar to each other.

2 The data points in one cluster should be as different as possible with other clusters

The main objective of the K-Means algorithm is to minimize the sum of distances between the points and their respective cluster centroid.

Using Elbow method, value of K was identified as 3. The three clusters can be categorized into fast, slow and non-moving items.

After confirming the value of K as 3, K means clustering model was applied to the data and respective clusters were formed using machine learning. Python was used to create a visualization of clusters.

## Analysis

Total of 64 items were found in the warehouse selected for study. The minimum mean offtake was of 0.00 and maximum mean offtake was found to 4.33 ~ 5 units.

Consumption rate of the item = (Total offtake for n days / n); where n is the number of days for which consumption rate has to be calculated. Here n =18.

Value of K was identified as 3 using Elbow method.

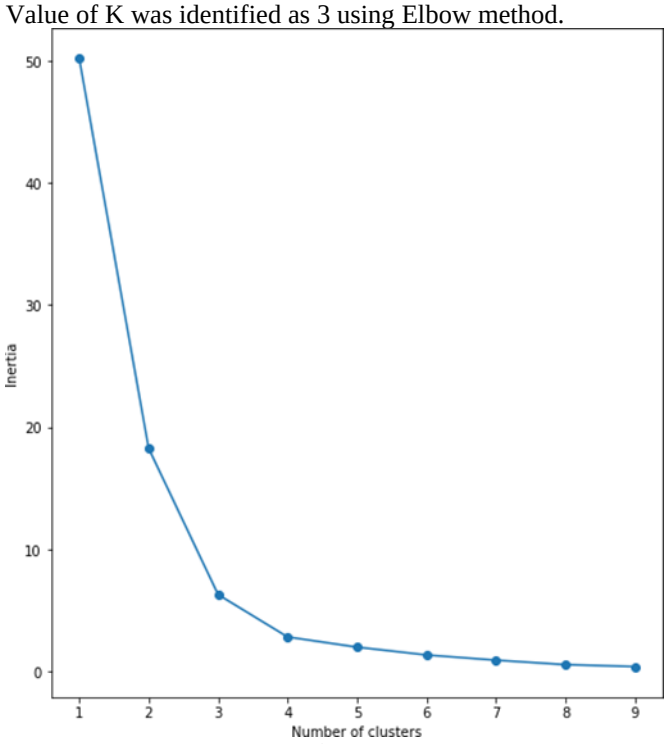



**Fig.1**

Where Inertia is nothing but sum of the distances of all the points within a cluster from the centroid of the cluster. Lesser the inertia, better the clustering

On applying K means clustering model on data, items were clustered into 3 clusters

1 Cluster 0 : Slow moving

2 Cluster 1: Non moving

3 Cluster 2: Fast Moving

Few components details cluster wise along with mean offtake is referenced in figure.

| | component | mean_offtake | cluster |
|---|---|---|---|
| 0 | FG0152 | 1.000000 | 0 |
| 1 | FG0204 | 1.000000 | 0 |
| 2 | FG0213 | 1.277778 | 0 |
| 3 | FG0264 | 0.333333 | 1 |
| 4 | FG0806 | 3.388889 | 2 |
| 5 | FG0886 | 0.111111 | 1 |
| 6 | FG0887 | 1.444444 | 0 |
| 7 | FG1228 | 0.187500 | 1 |
| 8 | FG1944 | 1.294118 | 0 |
| 9 | FG1952 | 1.722222 | 0 |
| 10 | FG1956 | 0.333333 | 1 |
| 11 | FG1960 | 1.117647 | 0 |
| 12 | FG1966 | 0.500000 | 1 |
| 13 | FG1970 | 1.722222 | 0 |
| 14 | FG1974 | 0.750000 | 0 |
| 15 | FG1975 | 3.111111 | 2 |
| 16 | FG1976 | 0.294118 | 1 |
| 17 | FG1980 | 0.823529 | 0 |
| 18 | FG1987 | 1.444444 | 0 |
| 19 | FG1989 | 0.615385 | 1 |
| 20 | FG2001 | 0.833333 | 0 |
| 21 | FG2007 | 0.600000 | 1 |
| 22 | FG2026 | 0.833333 | 0 |
| 23 | FG2273 | 0.666667 | 1 |
| 24 | FG2274 | 0.666667 | 1 |
| 25 | FG2291 | 0.875000 | 0 |
| 26 | FG2299 | 1.363636 | 0 |
| 27 | FG2305 | 1.555556 | 0 |
| 28 | FG2317 | 0.294118 | 1 |

**Fig.2**

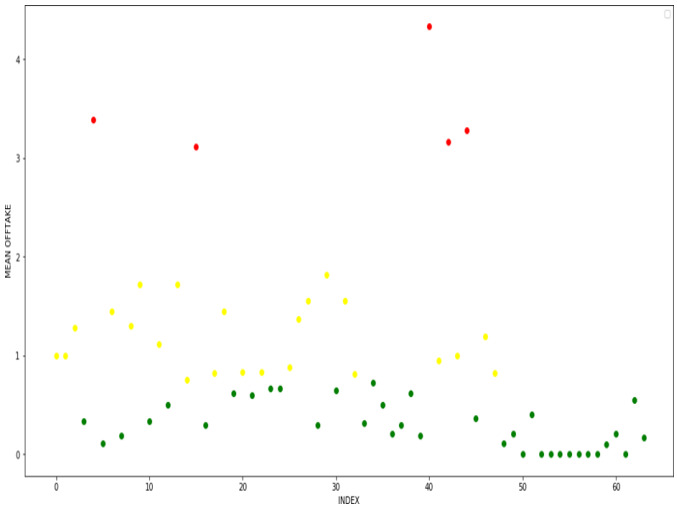
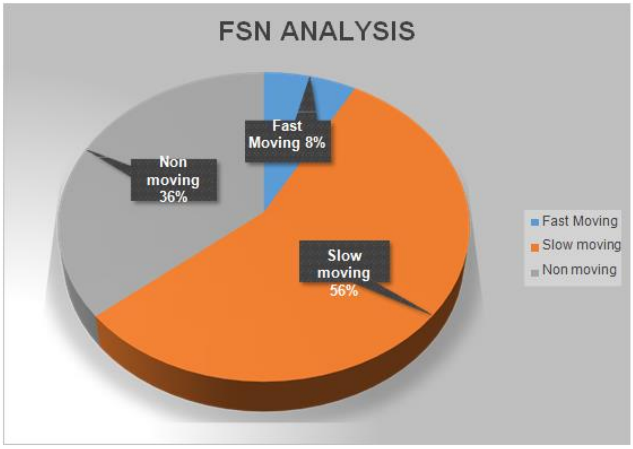



**Fig.3**

Fig 3. Represents scatter plot of clusters where x axis are the index, items assigned to a number. Y axis is Mean offtake. Red points are the fast moving items, yellow items depicts slow moving items and green points depicts non-moving items.

## Findings

- K value of 3 confirms that three clusters can be formed which can be categorized as fast moving, slow moving and non-moving.
- Cluster 2 which represents fast moving clusters has 5 items out of 64 items which is 8% of total items
- Cluster 0 represents slow moving and has 23 items which constitutes 36% of total items
- Cluster 1 represents non-moving items and has 36 items which constitutes 56 % of total items.




## Conclusion

For inventory having shelf life of very few days, calculating average stay gets difficult and human judgment plays a crucial role in doing FSN analysis in traditional way. Using machine learning in inventory analysis is a desire as per current business environment. This will help in reducing the human judgment error at the same time is time saving in coming up with such inventory analysis. The concept of K means clustering is not limited to FSN analysis, but has a wide scope of application.

## References

[1] Ref[1] STUDY OF FSN ANALYSIS FOR INVENTORY MANAGEMENT IN KORADI

[2] THERMAL POWER STATION (KTPS), MAHARASHTRA Sonali S.Wasnik1 1Maharashtra State Power Generation Company Ltd. Koradi, Nagpur-441111, India Chitra Gidwani2 2Dept. of Business Management, Jhulelal Institute of Technology, Nagpur-441111, India

[3] Ref [2] T.V.S.R.K.Prasad, Dr. Srinivas Kolla, Multi Criteria ABC analysis using artificial – intelligence-based classification techniques – case study of a pharmaceutical company, IJIRMPS,Volume 2, Issue 3, December 2014, p 35-4

[4] Ref 3 : FSN Analysis for Inventory Management – Case Study of Sponge Iron Plant Yogesh Kumar1

[5] , Rupesh Kumar Khaparde 2 , Komal Dewangan3 , Gautam Kumar Dewangan4 , Jalam Singh Dhiwar5 , Devprakash Sahu6 1, 2, 3, 4, 5, 6 Students, Department of Mechanical Engineering, CSVTU Bhilai India

[6] Ref[4] An Inventory Control using ABC Analysis and FSN Analysis Mr. Rohan Nadkarni1 , Dr. Asita Ghewari 2 1,2Operations Management, Sinhgad Institute of Management, S.T.E.S. Campus, Vadgaon Budruk, Pune-411041, Maharashtra, INDIA

[7] Ref[5] https://www.analyticsvidhya.com/blog/2019/08/comprehensive-guide-k-means-clustering/