Zidio Internship

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E-Commerce Customer Segmentation Project

Raychal Nadar

Group 1

Batch 4

I. Abstract

This report presents a comprehensive data science project focused on customer segmentation within the e-commerce sector. The primary objective of the project is to identify distinct customer groups based on purchasing behavior and demographic characteristics to enable more targeted marketing strategies and personalized customer experiences. To achieve this, we utilized a dataset comprising number of orders, searches corresponding to each brand and customer information. The data underwent rigorous preprocessing, including cleaning, and normalization, to ensure its suitability for analysis. Exploratory Data Analysis (EDA) was conducted to uncover initial insights and guide the segmentation process. We applied clustering algorithms, specifically K-means, to segment the customers into meaningful groups. The performance and validity of the model were assessed using silhouette scores and visual inspection methods. Our analysis revealed distinct customer segments, each with unique purchasing patterns and demographic profiles. The results demonstrate the effectiveness of data-driven customer segmentation in enhancing marketing efforts and improving customer retention. By tailoring marketing strategies to each segment, e-commerce businesses can achieve higher engagement rates and better meet the needs of their diverse customer base. The findings also provide a foundation for future research and potential refinement of segmentation strategies. In conclusion, this project highlights the value of customer segmentation in the e-commerce industry and offers actionable insights for leveraging data science techniques to drive business growth.

II. Table of Contents

Sections	Sub-Sections
Introduction	Background information, Problem statement, Objectives and goals, Importance and relevance of the project
Literature Review	Summary of existing research and studies related to the project, Identification of gaps that the project aims to fill
Data Description	Data sources, Data collection methods, Description of datasets (e.g., features, size, format)
Data Preprocessing	Data cleaning, Handling missing values, Data normalization, Feature engineering
Exploratory Data Analysis (EDA)	Descriptive statistics, Data visualization and Identification of patterns, trends, and insights
Methodology	Description of the models and algorithms used, Rationale for choosing specific methods, Assumptions, limitations, practical considerations
Model Training and Evaluation	Model training process, Evaluation metrics, Model performance results
Results	Key findings from the analysis with supporting graphs and interpretation of results
Discussion	Implications of findings, Limitations of the study, Comparison with existing research
Conclusion	Summary of the project, Key takeaways, Recommendations for future work
References	-
Appendices	Appendix A, Appendix B
Acknowledgements	-

III. Introduction

A. Background information

In the rapidly evolving e-commerce landscape, businesses are constantly seeking ways to enhance customer experience and optimize marketing efforts. One effective approach is customer segmentation, which involves dividing a broad customer base into smaller, homogenous groups based on shared characteristics. This enables businesses to tailor their marketing strategies, improve customer satisfaction, and increase overall profitability. With the advent of big data and advanced analytics, e-commerce platforms have access to vast amounts of customer data, providing an unprecedented opportunity to implement sophisticated segmentation techniques.

B. Problem statement

Despite the availability of rich customer data, many e-commerce businesses struggle to effectively utilize this information for personalized marketing. Traditional one-size-fits-all marketing strategies often fail to resonate with diverse customer groups, leading to suboptimal engagement and conversion rates. The challenge lies in identifying meaningful customer segments and understanding their unique needs and behaviors. Without proper segmentation, businesses risk inefficient resource allocation and missed opportunities for growth.

C. Objectives and goals

The primary objective of this project is to develop a robust customer segmentation model for an e-commerce platform. Specific goals include:

i. **Data Preparation and Exploration:** Collect and preprocess customer data to ensure its quality and relevance.

ii. **Segmentation Analysis:** Apply clustering algorithms to identify distinct customer segments based on purchasing behavior and demographic attributes.

iii. **Model Evaluation:** Assess the performance of the segmentation models using appropriate metrics and validation techniques.

iv. **Actionable Insights:** Derive insights from the identified segments to inform targeted marketing strategies and personalized customer interactions.

D. Importance and relevance of the project

Effective customer segmentation is crucial for e-commerce businesses aiming to thrive in a competitive market. By understanding the unique characteristics and preferences of different customer groups, businesses can enhance customer experience by personalizing interactions and offers to meet the specific needs of each segment, leading to higher customer satisfaction and loyalty. Additionally, segmentation allows businesses to optimize marketing efforts by designing targeted campaigns that resonate with each segment, resulting in improved engagement and conversion rates. It also increases efficiency by enabling more effective resource allocation, focusing on high-value segments, and reducing wastage on less responsive groups. Moreover, segmentation can drive growth by leveraging insights to identify new market opportunities and develop products or services that cater to the evolving needs of customers.

IV. Literature Review

A. Summary of existing research and studies related to the project

Customer segmentation has been extensively studied in the context of e-commerce, with numerous methodologies and algorithms proposed for effectively dividing customer bases into meaningful groups. Traditional segmentation methods often relied on demographic data, such as age, gender, and location. However, recent advancements in data science and machine learning have enabled more sophisticated approaches that incorporate behavioral data, such as purchase history, browsing patterns, and customer engagement metrics. Studies have demonstrated the efficacy of clustering algorithms like K-means, hierarchical clustering, and DBSCAN in identifying distinct customer segments. These techniques have been applied across various industries, including retail, finance, and travel, showing significant improvements in targeted marketing and customer retention. For instance, a study by Tsai and Chiu (2004) employed K-means clustering to segment online shoppers based on purchasing behavior, resulting in more tailored marketing strategies and increased sales. Another research by Wu and Li (2013) utilized hierarchical clustering to segment customers of an online retailer, revealing insights into customer loyalty and spending patterns. Moreover, the integration of machine learning models with traditional RFM (Recency, Frequency, Monetary) analysis has been explored to enhance segmentation accuracy. For example, Khajvand et al. (2011) combined RFM variables with K-means clustering to identify high-value customer segments, demonstrating the potential for increased profitability through targeted promotions.

B. Identification of gaps that the project aims to fill

Despite the progress in customer segmentation research, several gaps remain that this project aims to address:

i. **Integration of Multiple Data Sources:** Many studies focus on a single type of data, such as transactional or demographic data. This project aims to integrate multiple data sources, including behavioral, demographic, and psychographic data, to provide a more comprehensive segmentation model.

ii. **Actionability of Insights:** Many segmentation studies focus on the technical aspects of clustering without providing actionable business insights. This project emphasizes translating

segmentation results into practical marketing strategies and business actions that e-commerce platforms can implement.

By addressing these gaps, this project aims to enhance the effectiveness of customer segmentation in e-commerce, enabling more personalized marketing efforts and better customer experiences.

V. Data Description

A. Data sources

The data for this project was sourced from a leading e-commerce platform, comprising comprehensive information about customer purchases, searches and demographics.

B. Data collection methods

Provided in our case

C. Description of datasets (e.g., features, size, format)

i. **Features**: Customer ID, Gender, Orders, Searches Corresponding to 35 different brands.

ii. **Brands**: Jordan, Gatorade, Samsung, Asus, Udis, Mondelez International, Wrangler, Vans, Fila, Brooks, H&M, Dairy Queen, Fendi, Hewlett Packard, Pladis, Asics, Siemens, J.M. Smucker, Pop Chips, Juniper, Huawei, Compaq, IBM, Burberry, Mi,LG, Dior, Scabal, Tommy Hilfiger, Hollister, Forever 21, Colavita, Microsoft, Jiffy mix, Kraft

iii. **Size**: 30,000 records

iv. **Format**: Excel

VI. Data Preprocessing

A. Data cleaning

Data cleaning is the initial and crucial step to ensure the quality and reliability of the dataset. The cleaning process involved removing the duplicate records to avoid redundancy and ensure each entry was unique.

B. Handling missing values

Handling missing values is essential to maintain the integrity of the dataset. Gender Column had 2724 null values and thereafter got imputed with its mode value (i.e. ‘F’) as it is categorical in nature.

C. Data normalization

Data transformation and normalization ensure that the dataset is suitable for analysis and modeling. Numerical features are normalized to a common scale (e.g., MinMaxScaler normalization) to ensure that features with larger scales did not dominate the analysis.

D. Feature engineering

Feature engineering involved creating new features from the existing data to enhance the segmentation model’s performance and provide deeper insights. New features added are Total Searches and cluster Labels(added after model’s prediction).

VII. Exploratory Data Analysis

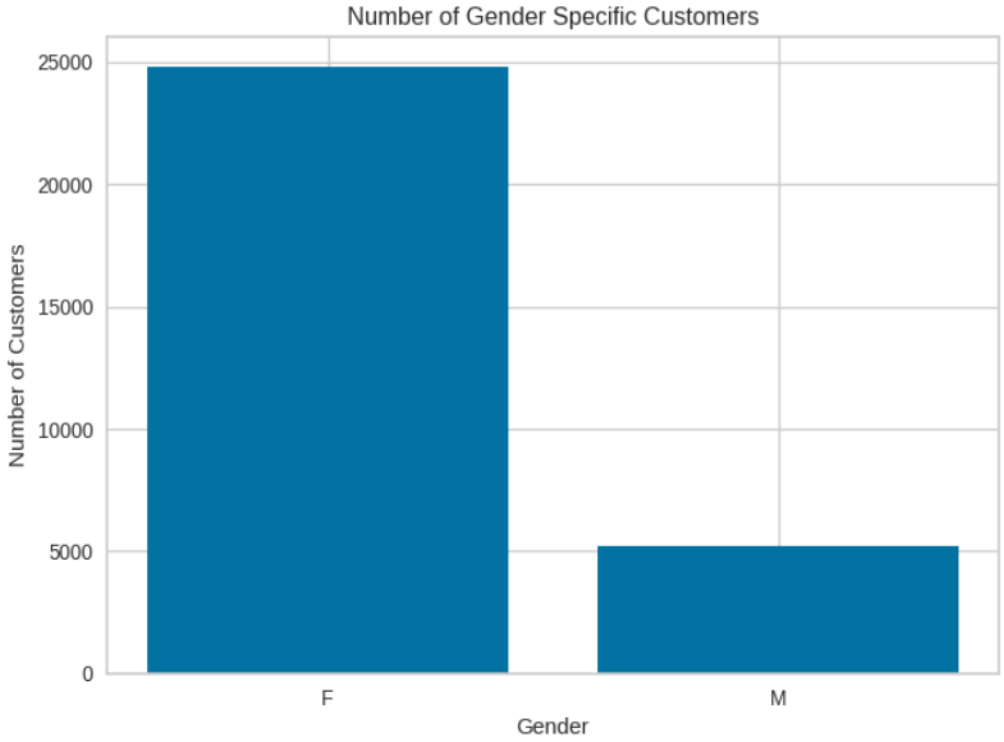
A. Descriptive statistics

Descriptive statistics provide a summary of the key characteristics of the dataset, giving an initial understanding of the data distribution and central tendencies.

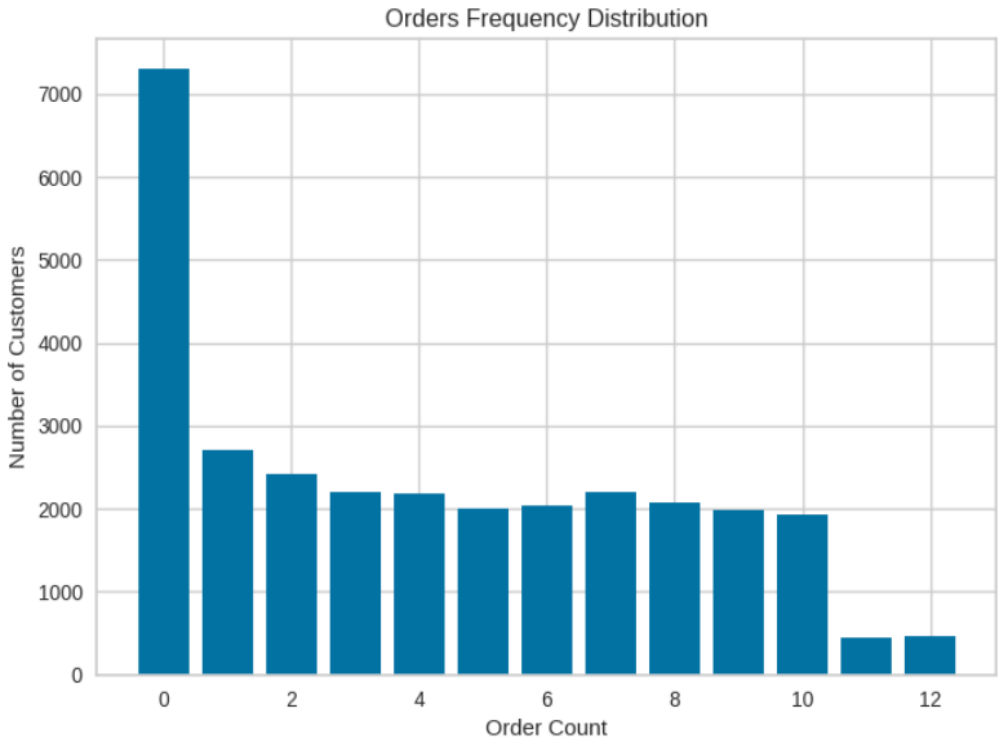
Column	Descriptive Statistics
Cust_ID	• Categorical Data • Unique identifier • 30,000 data points
Gender	• Categorical Data • 24778 females • 5222 males • 30,000 data points
Orders	• Numerical Data • Range is from 0-12 (inclusive) • 30,000 data points • Mean is 4.169800 • std is 3.590311 • 25^{th} percentile is 1 • 50^{th} percentile is 4 • 75^{th} percentile is 7
Searches wrt to Brands	• Numerical Data • 30,000 data points • Mean is between 0.0319-0.7548 • Std is between 0.264-1.346 • Min is 0 • 25^{th} percentile is 0 • 50^{th} percentile is 0 • 75^{th} percentile is between 0-1 • Max is between 8-114
Total_Searches	• Numerical Data • 30,000 data points • Mean is 6.871433 • Std is 6.782249 • Min is 0 • 25^{th} percentile is 3

	• 50th percentile is 5 • 75th percentile is 9 • Max is 160
Cluster_Labels	• Categorical Data • 30,000 data points • (more information done after model's prediction)

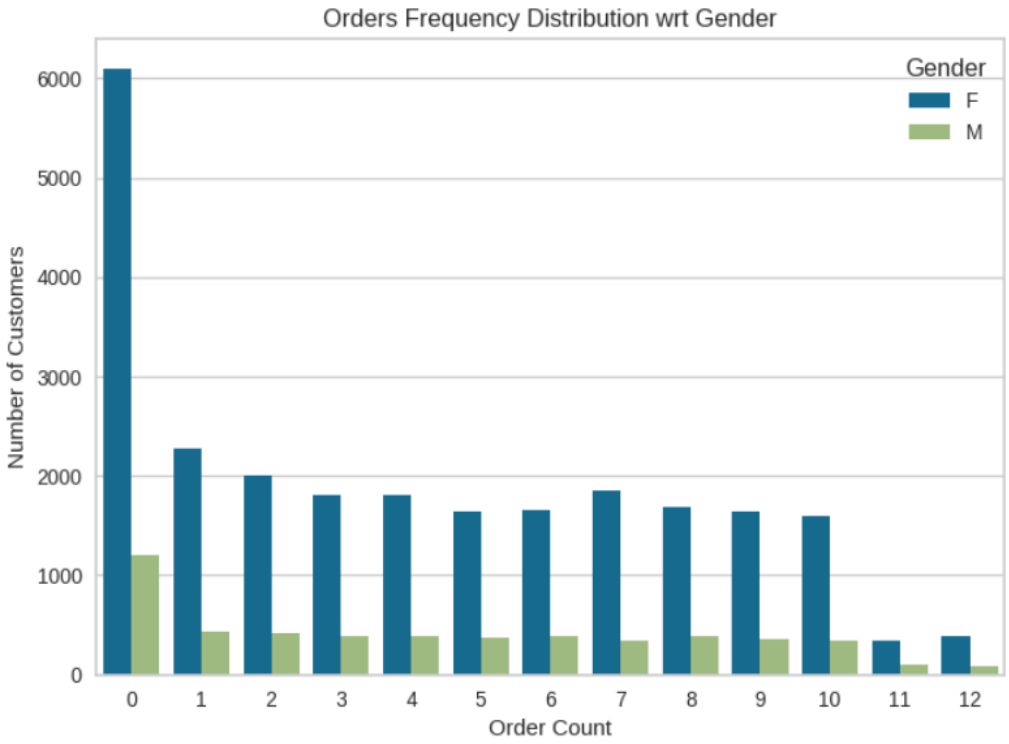
B. Data visualization and Identification of patterns, trends, and insights



The above graph shows the proportion of the majority and minority gender category where female is dominant and male is minor.

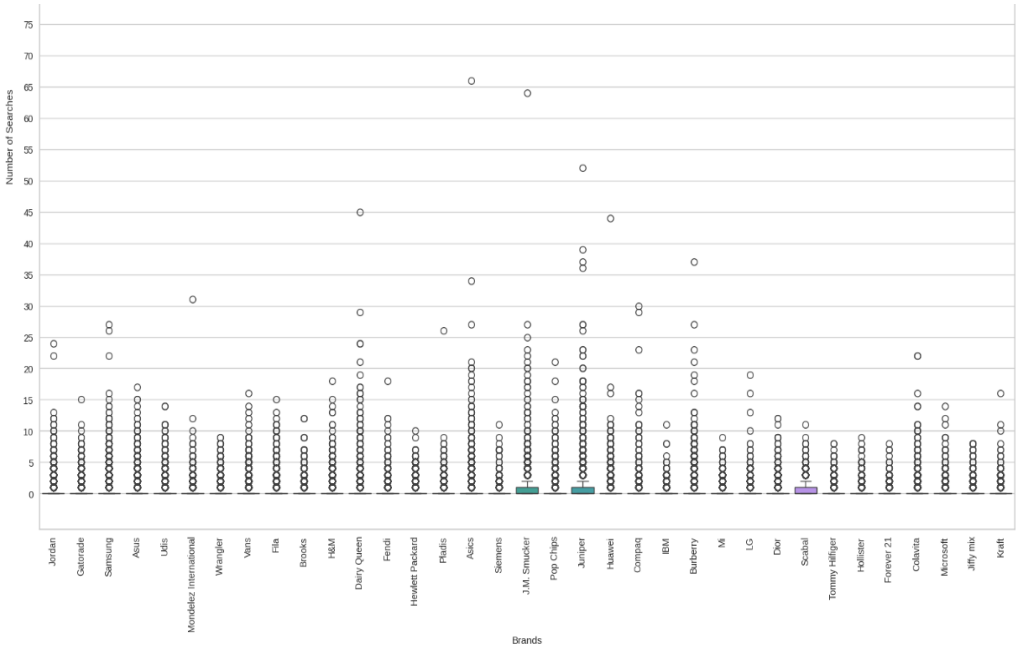


The above graph shows the frequency distribution of the orders placed by customers where around 7200 customers didn't purchase anything. Around 2000-3000 customers have placed orders in the range of 1-10, respectively. Around 500 customers placed 11 and 12 number of orders, respectively.

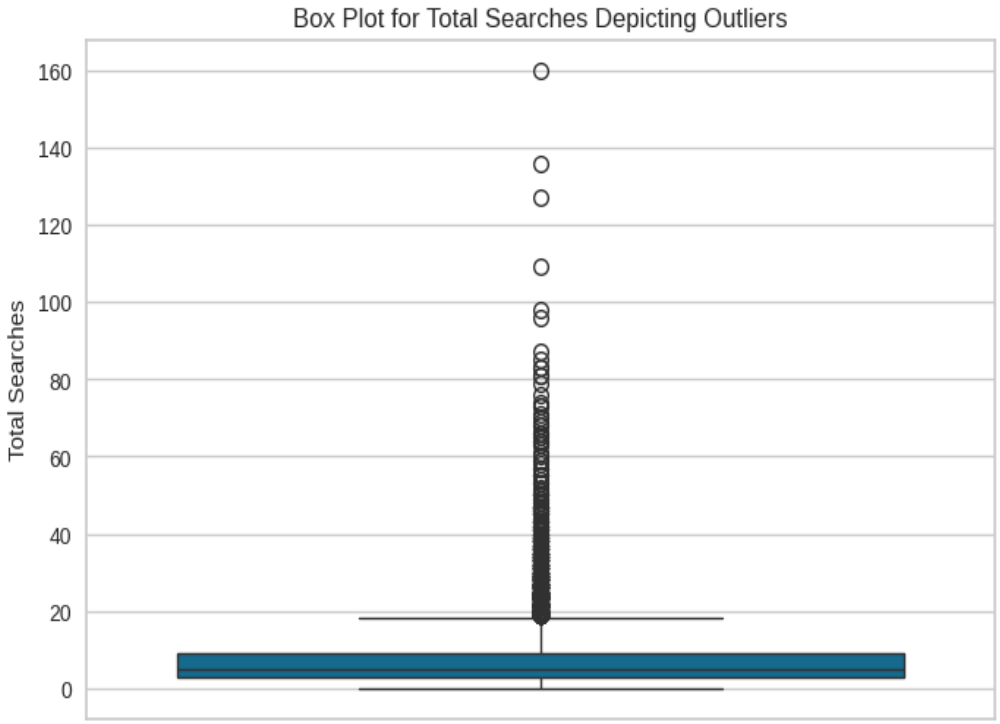


This graph shows the detailed view of the previous graph showcasing orders frequency distribution wrt Gender. Here, around 6000 females

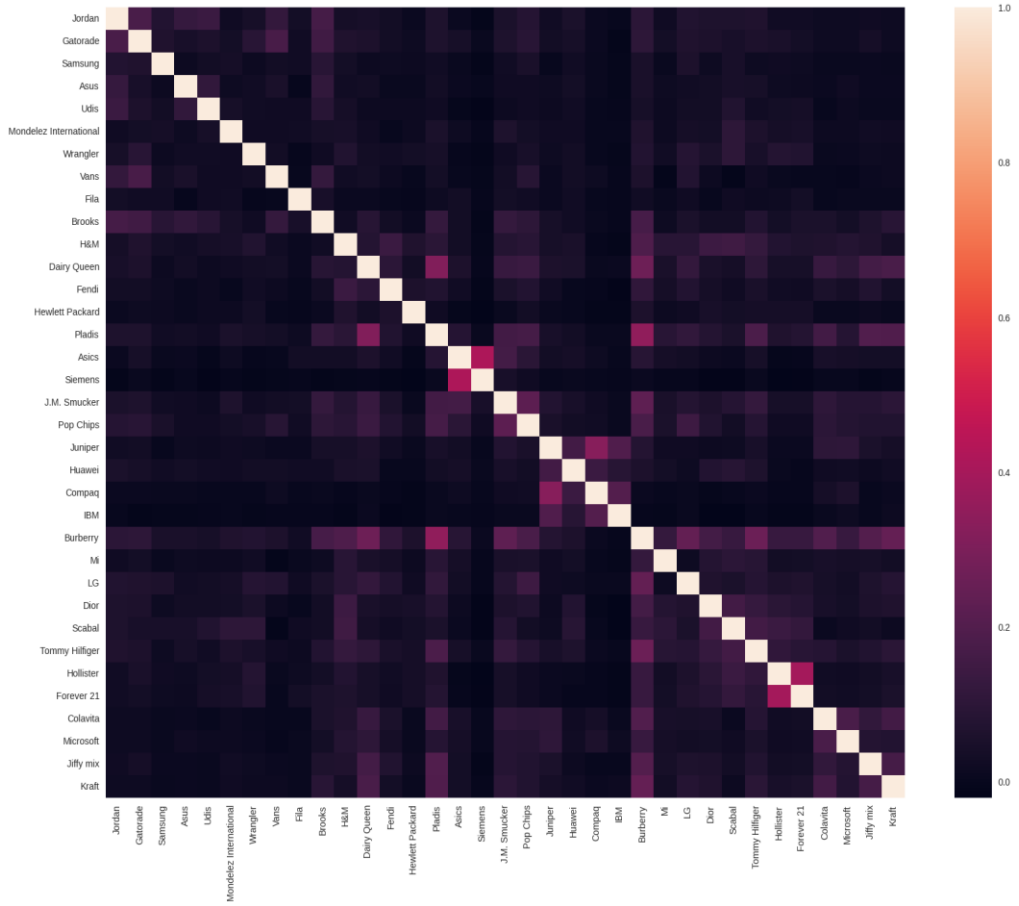
and 1200 males didn't order anything. Around, 400 males and 2000 females placed orders in the range of 1-10, respectively. Also, around 100 males and 200 females placed orders in the range of 11-12, respectively.



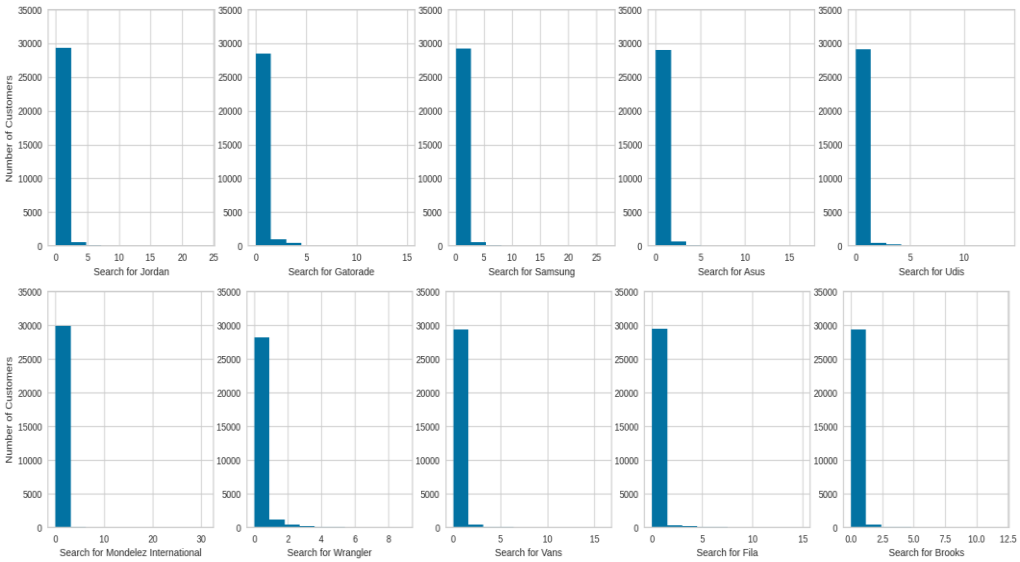
This graph depicts the outliers in all the brand columns wrt to searches using box-plot.

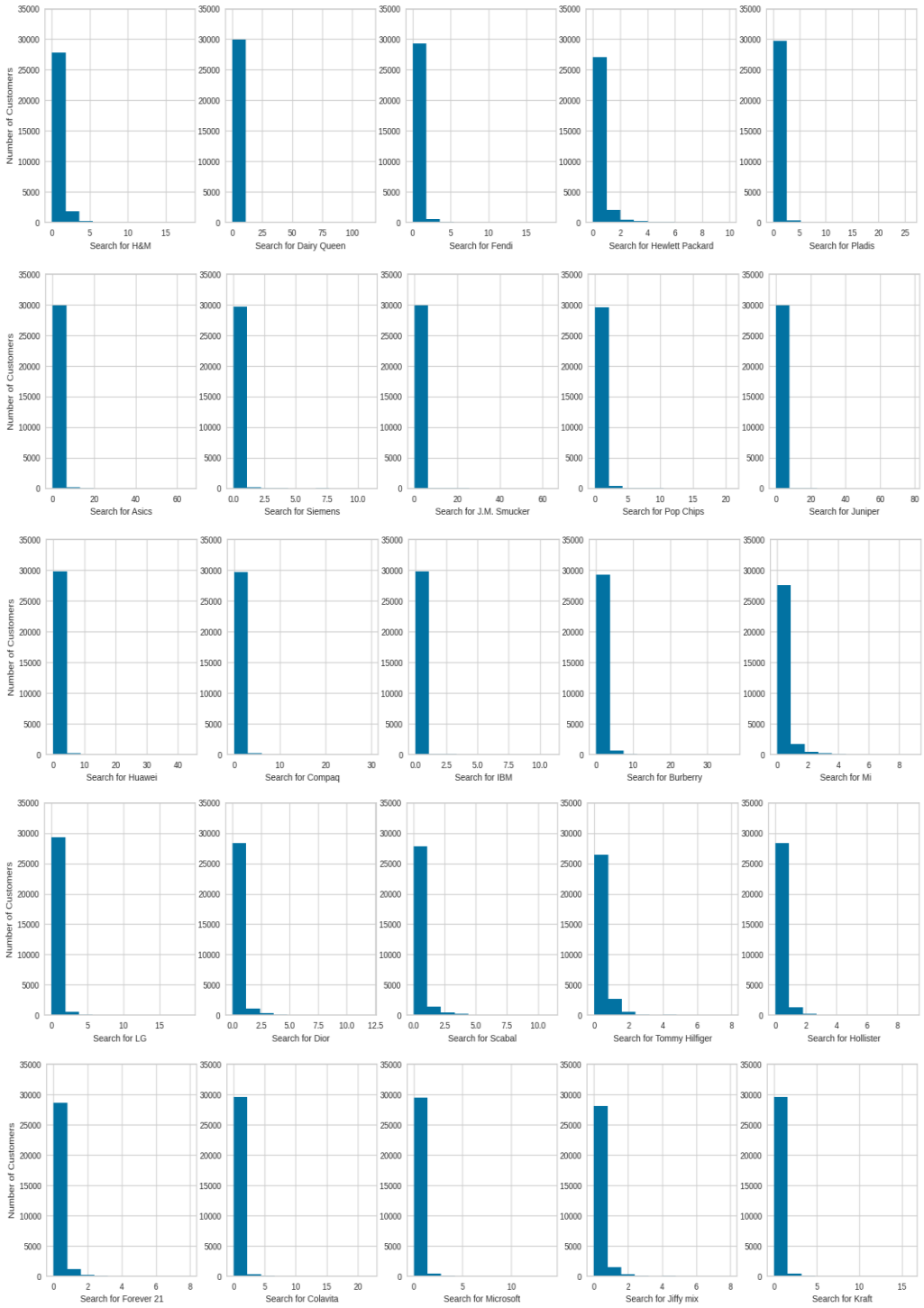


This graph depicts the outliers of Total_Searches columns using box-plot.



This graph depicts the correlation among brands. Lighter the color(value near to 1) are highly correlated whereas darker colors(values near to 0) have no correlation. High(positive) correlation means if one value increases other also increases. Conversely, low(negative) correlation means if one value increases, other decreases.





The above graph depicts the frequency distribution of searches of all brands.

For 0 searches, the no. of customers range from 16480 - 29384

For 1 searches, the no. of customers range from 424 - 8467

For 2 searches, the no. of customers range from 77 - 3062

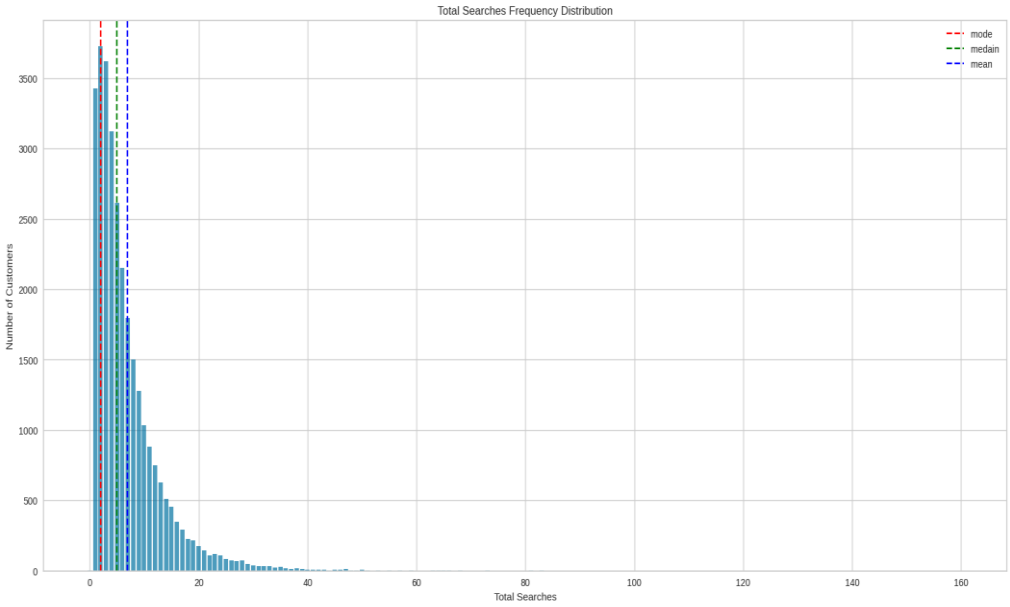
For 3 searches, the no. of customers range from 47 - 1069

For 4 searches, the no. of customers range from 7 - 498

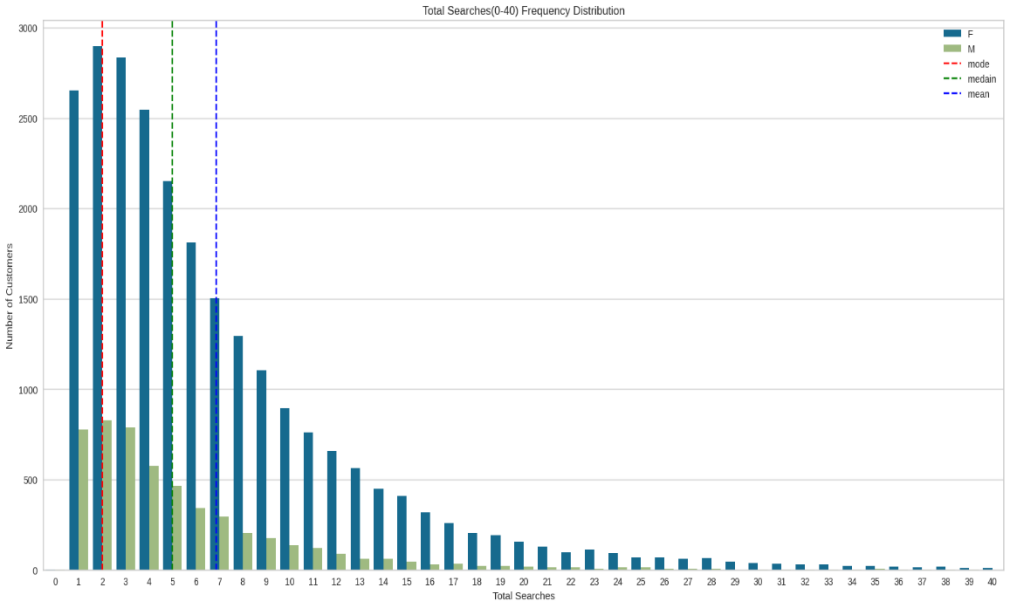
For 5 searches, the no. of customers range from 4 - 200

For 6 searches, the no. of customers range from 1 - 117

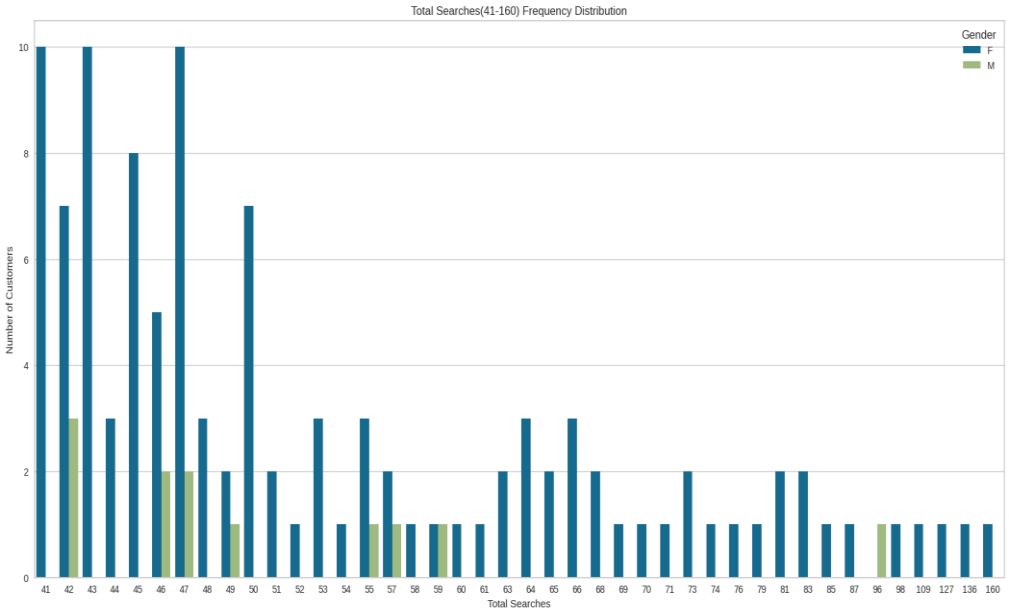
For 7 searches, the no. of customers range from 0 - 54
For 8 searches, the no. of customers range from 0 - 36
For 9 searches, the no. of customers range from 0 - 24
For 10 searches, the no. of customers range from 0 – 16



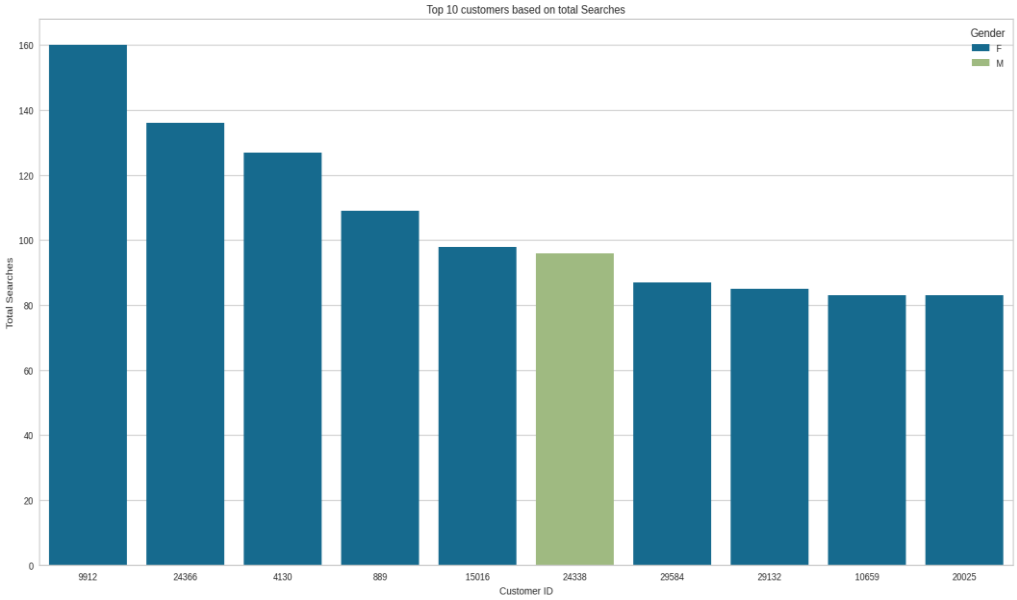
This graph depicts that total_searches column is rightly-skewed where mean>median>mode. The significant total_searches range from 1-20, after which it becomes insignificant(no. of customers decreases).



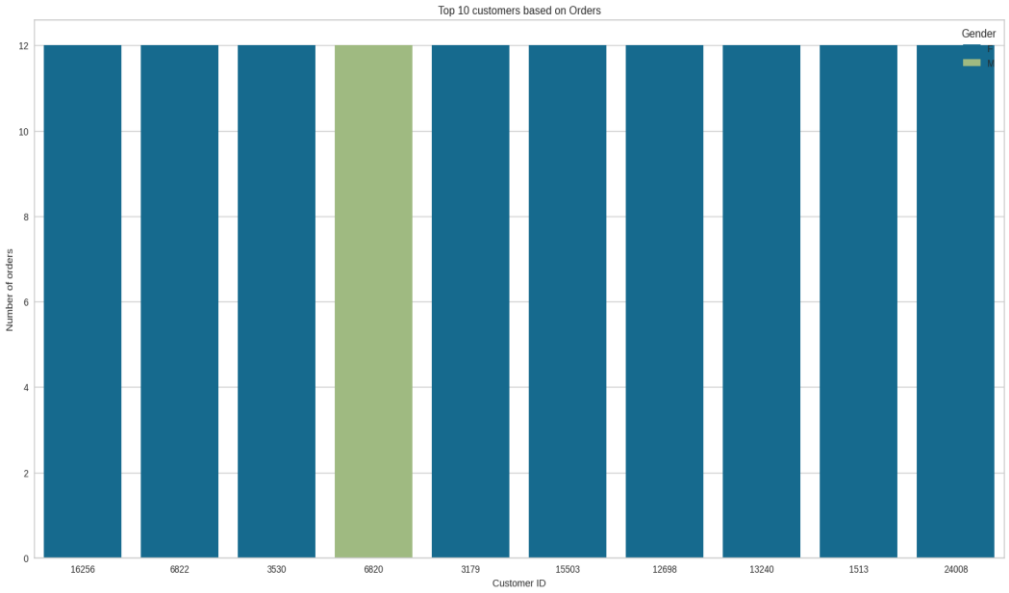
Above is the graph depicting significant total_searches wrt Gender. It can be seen that majority customers have searched between 1-6 total_searches. It can also be seen that the bars wrt Gender is also rightly-skewed. 2700 customers have searched only 2 times. Also, it can be seen that all customers have searched for brands but not compulsorily purchased it.



This graph depicts the insignificant total_searches. The no. of customers decreases if total searches increases. It can be seen that majority are females and males are very less in count as not all bars are accompanied by Gender. It can be seen that there are customers who search for about 160 times!



This grpah shows the potential high valued customers based on Total_Searches.



In an attempt to showcase the potential high valued customers based on Orders, it can be seen that there are many customers who have purchased orders in high amounts.

By leveraging these patterns and insights, the e-commerce platform can better understand its customer base, tailor marketing strategies, and enhance overall customer experience. This foundational analysis sets the stage for more advanced customer segmentation and targeted marketing initiatives.

VIII. Methodology

A. Description of the models and algorithms used

K-means clustering begins by randomly selecting (k) initial centroids from the dataset, which serve as the starting centers of the clusters. Each data point is then assigned to the nearest centroid based on a chosen distance metric, typically Euclidean distance. This assignment forms (k) clusters initially. The algorithm iteratively updates the centroids by computing the mean of all data points assigned to each cluster. This process continues iteratively until the centroids stabilize and no longer change significantly between iterations, or until a predefined number of iterations is reached. The goal of K-means is to minimize the variance within each cluster while maximizing the variance between clusters, ultimately partitioning the dataset into distinct and non-overlapping groups based on their similarities in feature space.

B. Rationale for choosing specific methods

K-means clustering was chosen for this project due to its simplicity and interpretability, making it straightforward to implement and communicate results to stakeholders. Its computational efficiency allows it to handle large datasets common in e-commerce, scaling well with both data points and features. K-means is effective in identifying distinct customer groups by clustering data points based on similarities, essential for targeted marketing and enhancing customer experiences. Moreover, its flexibility in adapting to different data types and distance metrics enables customization to meet specific segmentation requirements, making it a versatile choice for this analysis.

C. Assumptions

i. **Homogeneity Within Clusters**: The algorithm assumes that data points within a cluster are similar to each other.

ii. **Number of Clusters**: K-means requires the number of clusters k to be specified in advance, which necessitates domain knowledge or empirical methods (like the Elbow Method) to determine the optimal k.

iii. **Spherical Clusters**: The algorithm assumes clusters to be spherical and evenly sized, which may not always be the case in real-world data.

D. Limitations

i. **Sensitivity to Initialization:** The algorithm's performance depends on the initial placement of centroids. Poor initialization can lead to suboptimal clustering results. Techniques like k-means++ initialization can mitigate this issue.

ii. **Fixed Number of Clusters:** Choosing the correct number of clusters (k) is crucial but not straightforward. An incorrect choice can lead to poor clustering outcomes.

iii. **Non-Spherical Clusters:** K-means struggles with identifying clusters that are not spherical or have varying sizes and densities. This can be addressed by considering other clustering algorithms like DBSCAN or hierarchical clustering for more complex data structures.

iv. **Outliers**: K-means is sensitive to outliers, which can distort the cluster centroids and lead to inaccurate clustering results. Preprocessing steps to remove or mitigate the impact of outliers are necessary.

E. Practical Considerations:

i. **Distance Metric:** While Euclidean distance is commonly used, it may not be suitable for all types of data. Alternative distance metrics should be considered based on the specific characteristics of the dataset.

ii. **Feature Scaling:** Features need to be scaled to ensure that they contribute equally to the distance calculations, preventing features with larger scales from dominating the clustering process.

iii. **Interpreting Clusters:** The resulting clusters need to be interpreted in the context of the business problem, ensuring that they provide actionable insights for marketing and customer engagement strategies.

IX. Model Training and Evaluation

A. Model training process

Relevant features for clustering were selected, i.e. all. The features were standardized using techniques like Min-Max scaling to ensure equal contribution to distance calculations. Missing values were handled by imputing with appropriate methods, here mode imputation for categorical data. The Elbow Method was used to plot the sum of squared distances (inertia) against the number of clusters, identifying the 'elbow point' where the rate of decrease sharply slows. Silhouette Analysis was then performed to calculate silhouette scores for different values of k, choosing the k with the highest average silhouette score for optimal clustering. The K-means algorithm was then run, iterating between assignment and update steps until the centroids stabilized or a maximum number of iterations was reached.

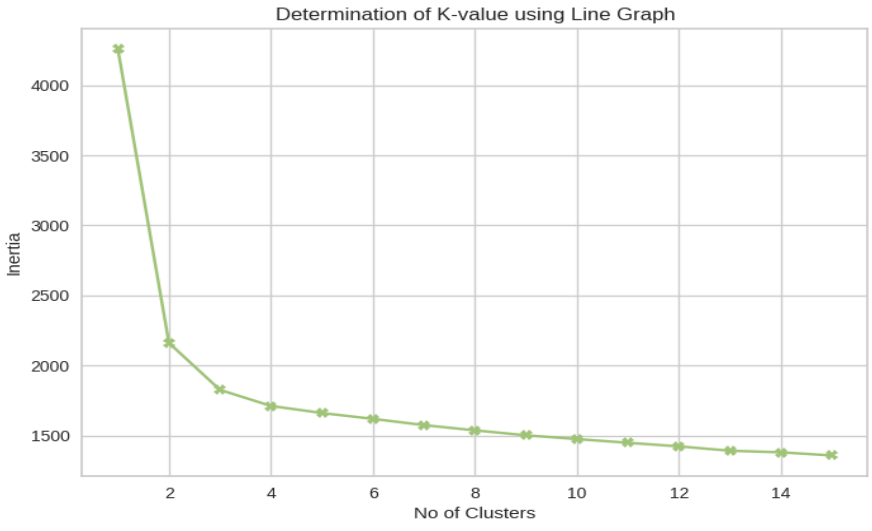
B. Evaluation metrics

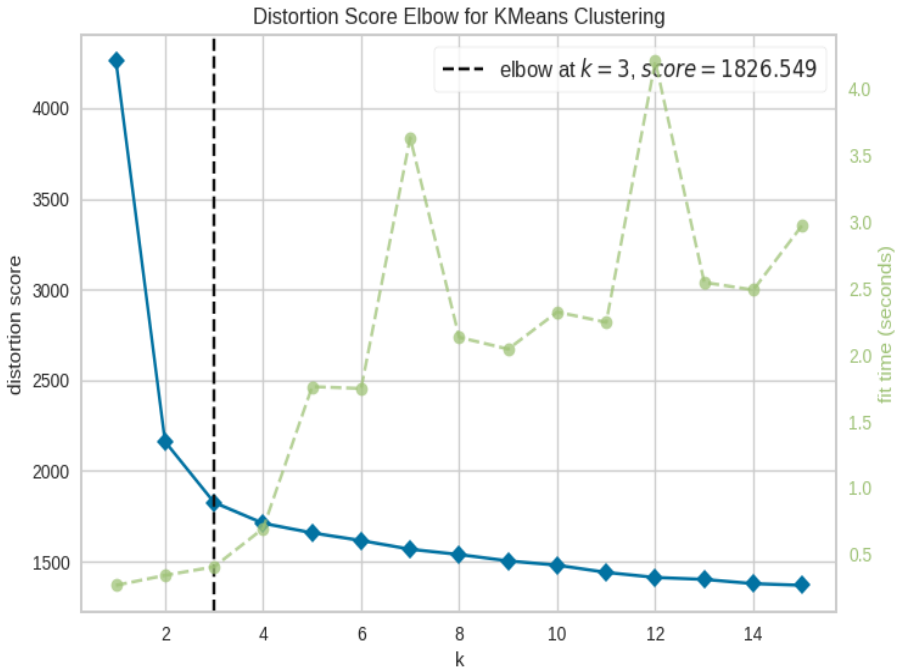
i. **Inertia (Within-Cluster Sum of Squares):** Measures the compactness of clusters, with lower values indicating tighter clusters.

ii. **Silhouette Score:** Measures the cohesion and separation of clusters. Values range from -1 to 1, with higher values indicating better-defined clusters. Calculated as the mean silhouette coefficient of all data points.

C. Model performance results

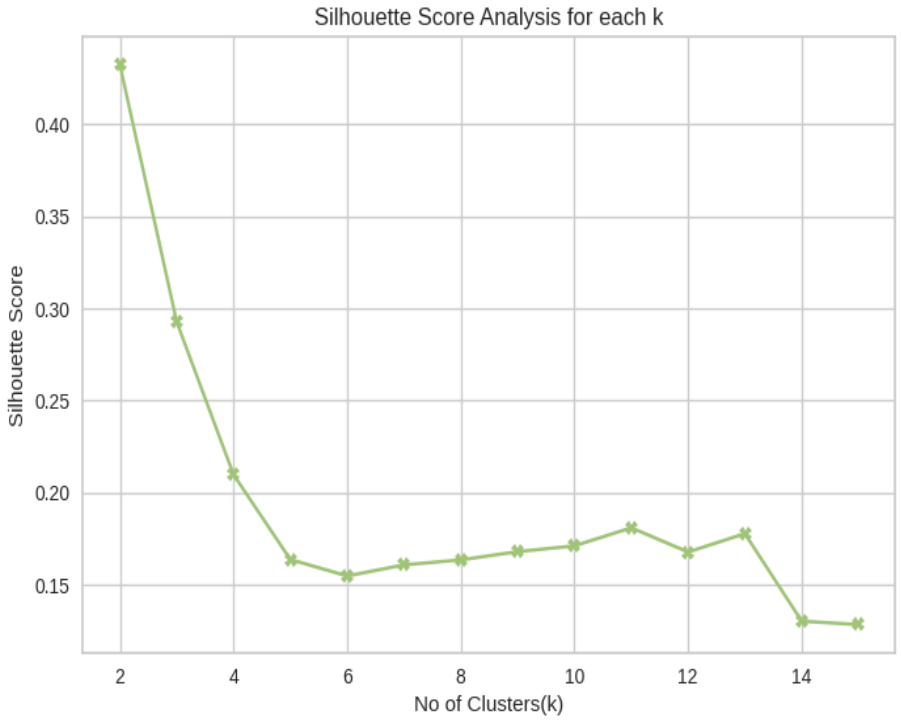
i. **Inertia:** The chosen inertia value is 1826.5486 (for k=3) as the rate of decrease sharply slows. This is shown in the below graph.





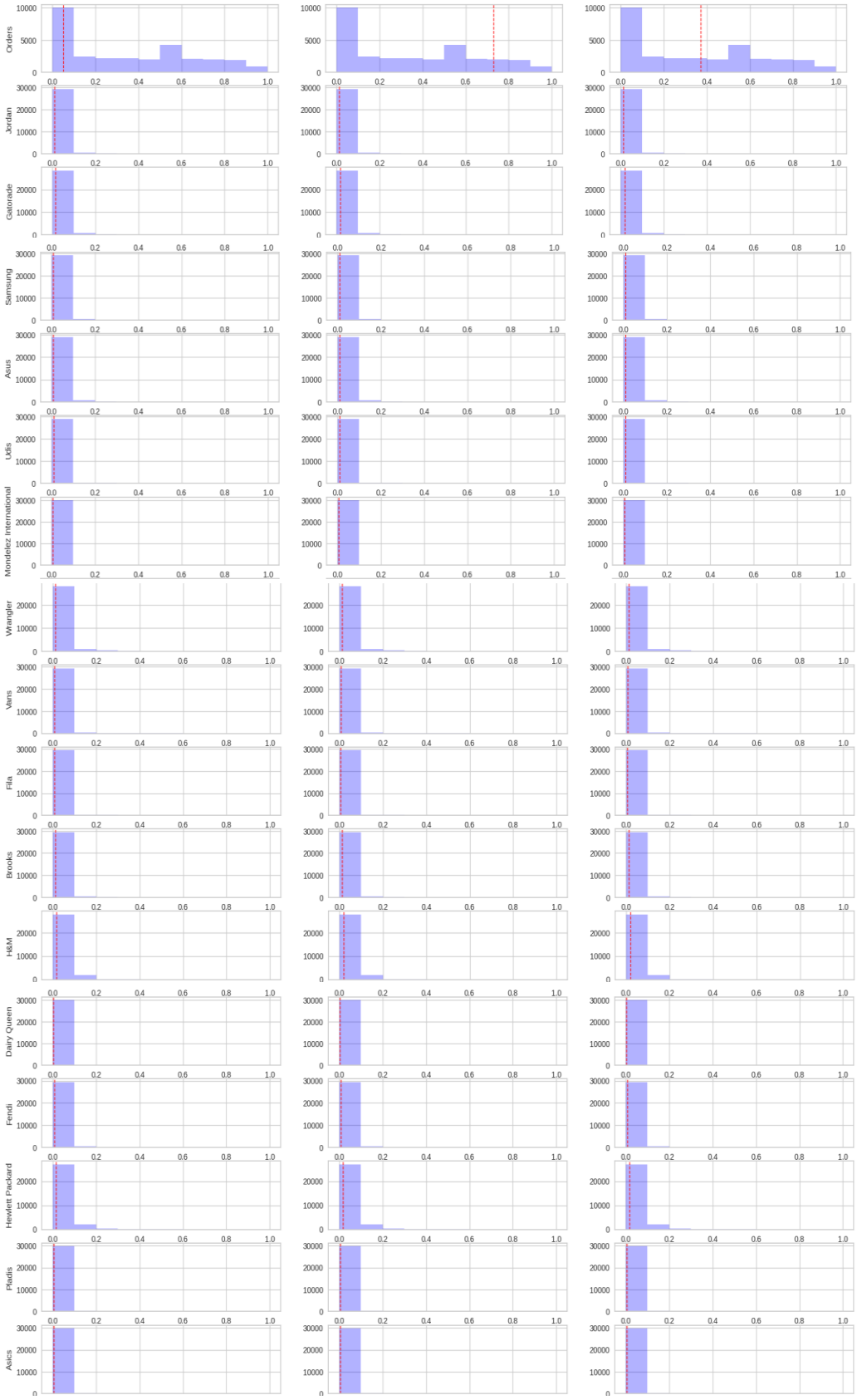
Above graph shows the detailed elbow graph with the k-value and the corresponding inertia score using KElbowVisualizer. It also depicts the model fit time(in seconds) for each k-value.

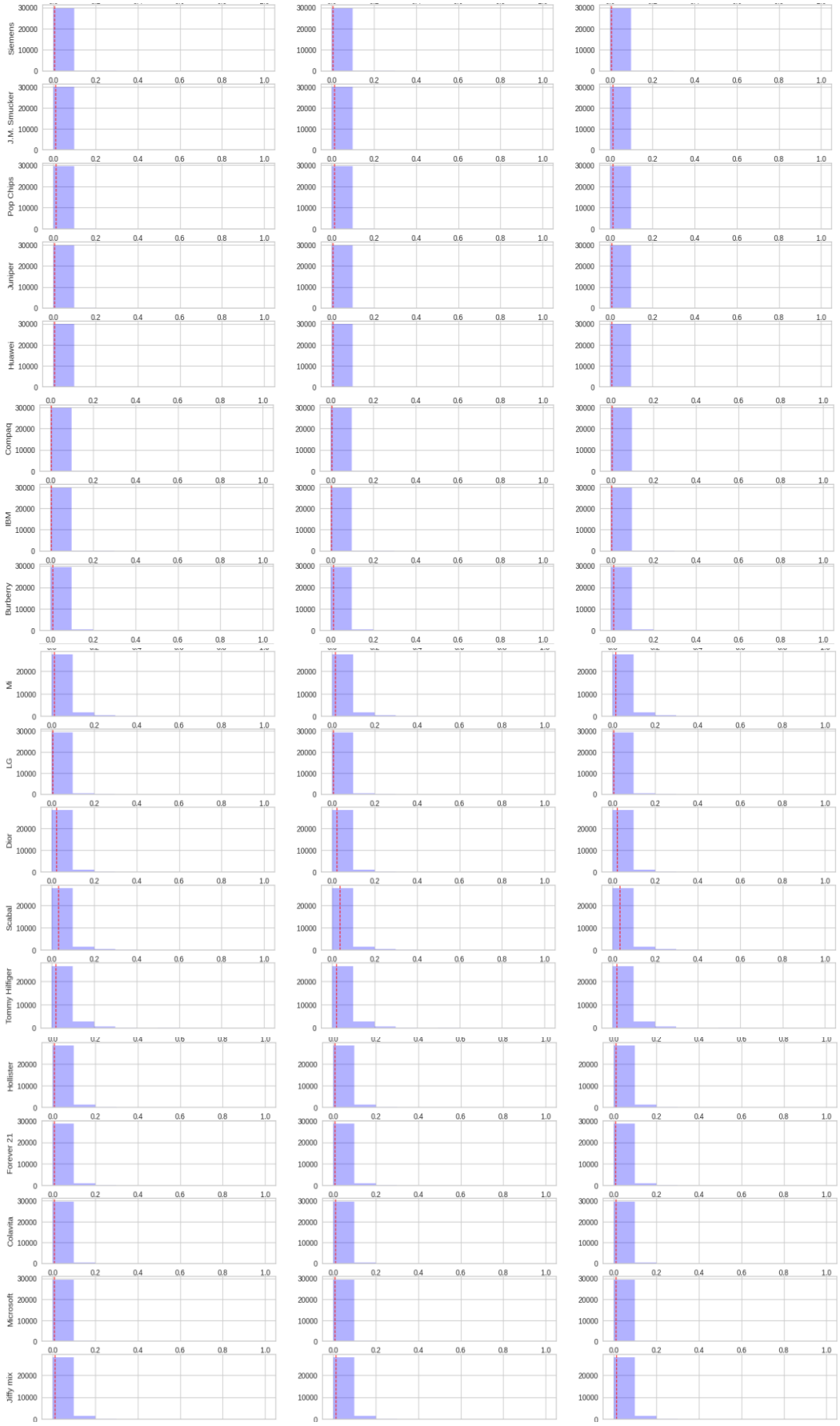
ii. **Silhouette Score:** The average silhouette score for the chosen k=3 is 0. 29268, suggesting that the clusters were reasonably well-separated and cohesive. Below is the graph for silhouette score analysis



X. Results

A. Key findings from the analysis and models with supporting graphs and interpretation




Siemens
J.M. Smucker
Pop Chips
Juniper
Huawei
Compaq
IBM
Burberry
Mi
LG
Dior
Scabal
Tommy Hilfiger
Hollister
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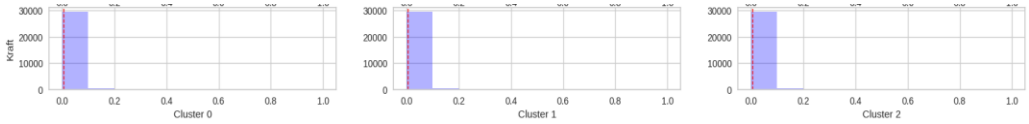


Fig 1

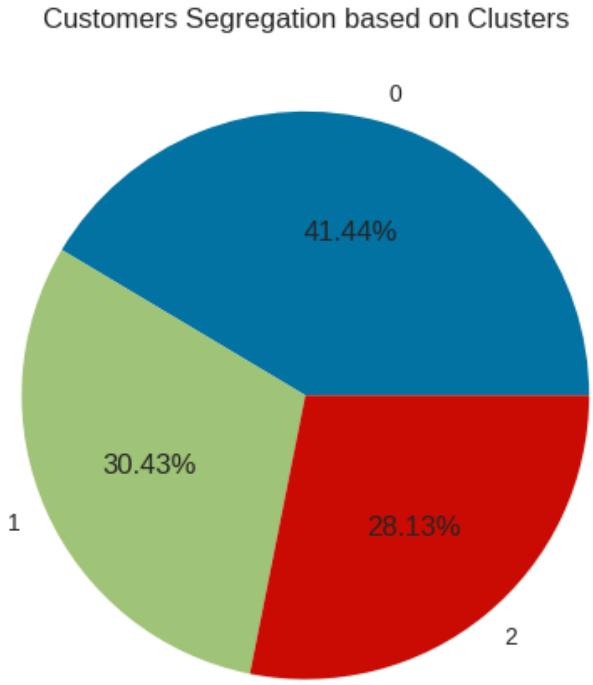


Fig 2

Fig 3

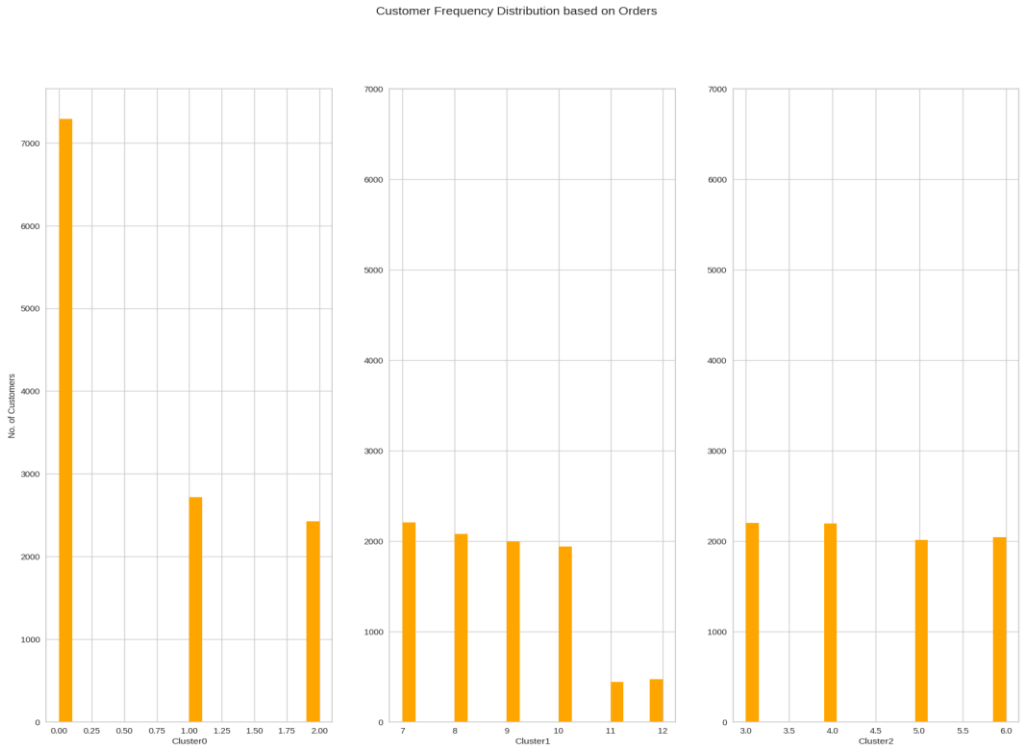
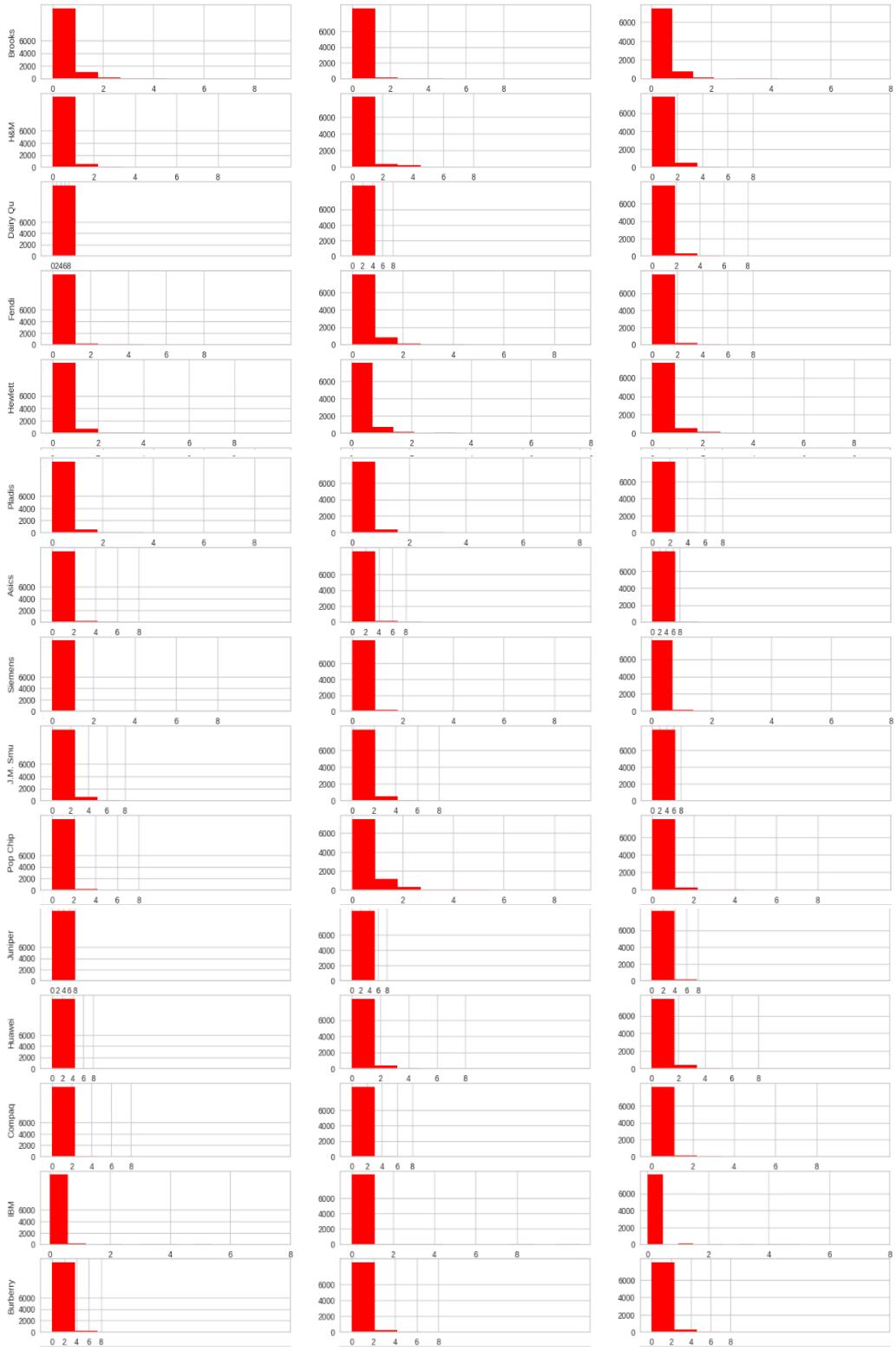

Customer Frequency Distribution based on Orders
No. of Customers
Cluster0
Cluster1
Cluster2

Fig 4

Jordan
Gatorade
Samsung
Asus
Udis
Mondelez
Wrangler
Vans
Fila


Brooks
H&M
Dairy Qu
Fendi
Hewlett
Phadis
Asics
Siemens
J.M. Smu
Pop Chip
Juniper
Huawei
Compaq
IBM
Burberry

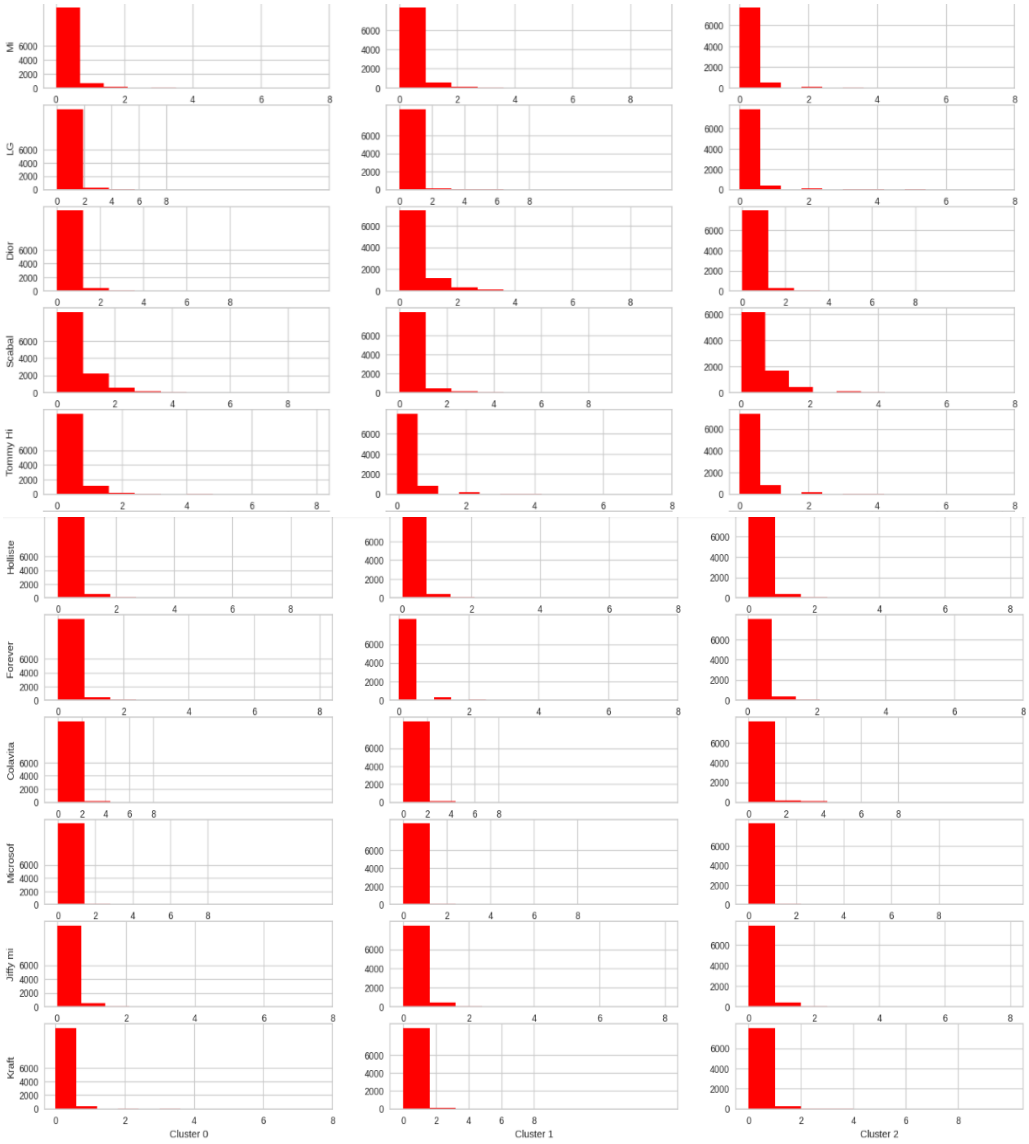

Mi
LG
Dior
Scabal
Tommy Hi
Hellliste
Forever
Colavita
Microsof
Jiffy mi
Kraft
Cluster 0
Cluster 1
Cluster 2

Fig 5

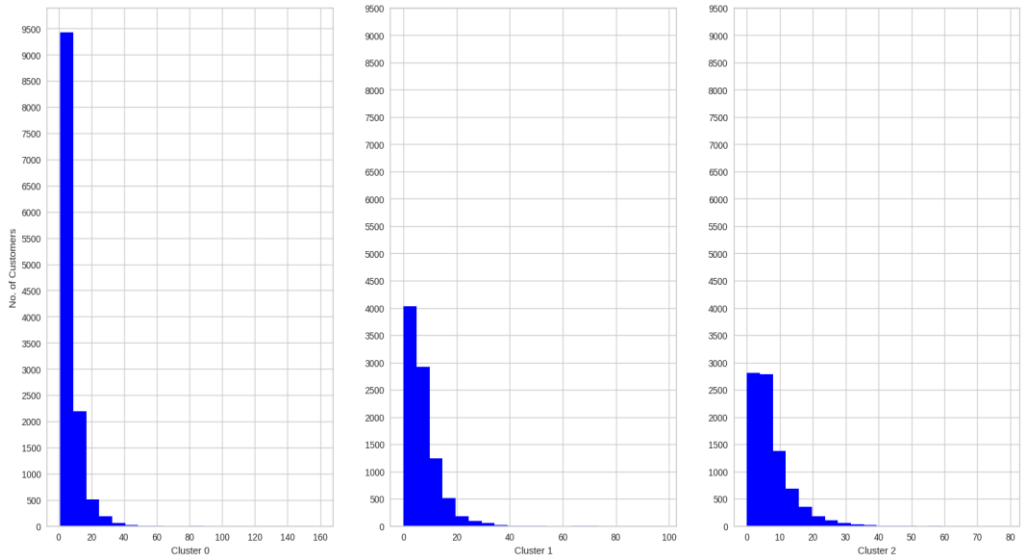

No. of Customers
Cluster 0
Cluster 1
Cluster 2

Fig 6

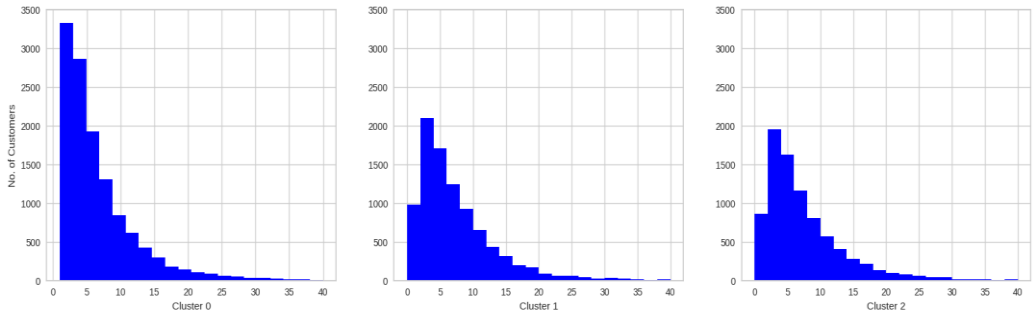


Fig 7

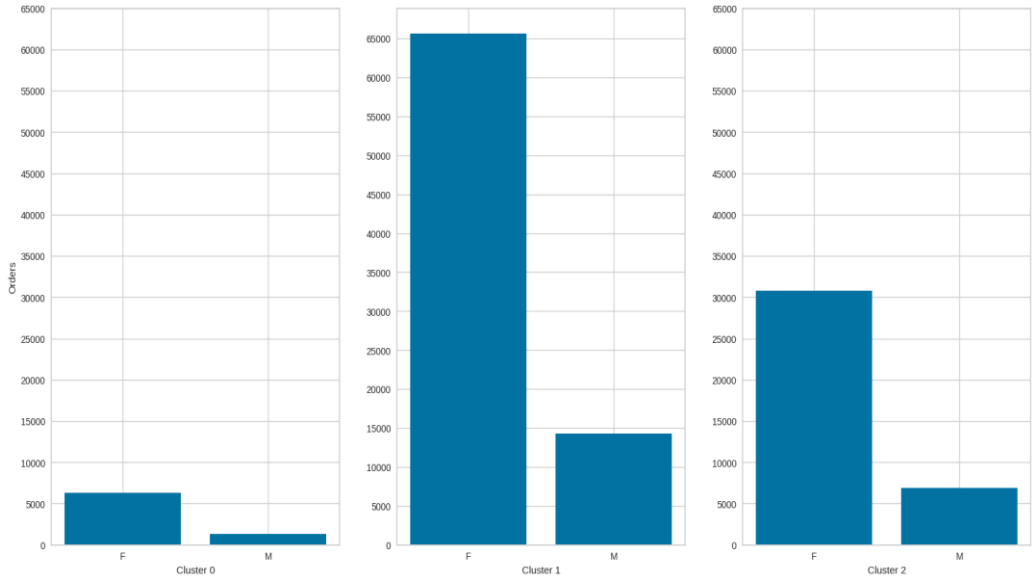


Fig 8

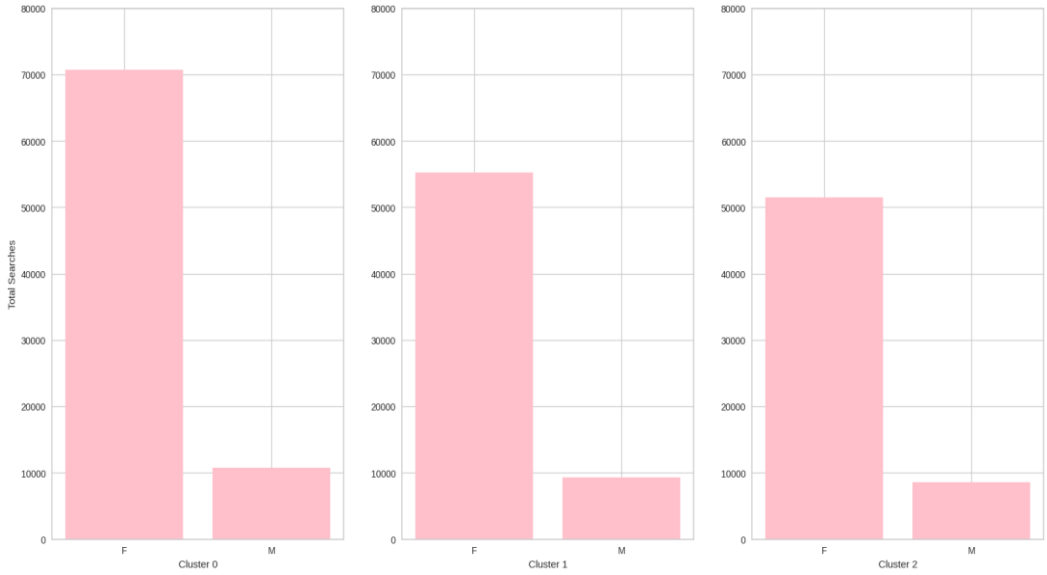


Fig 9

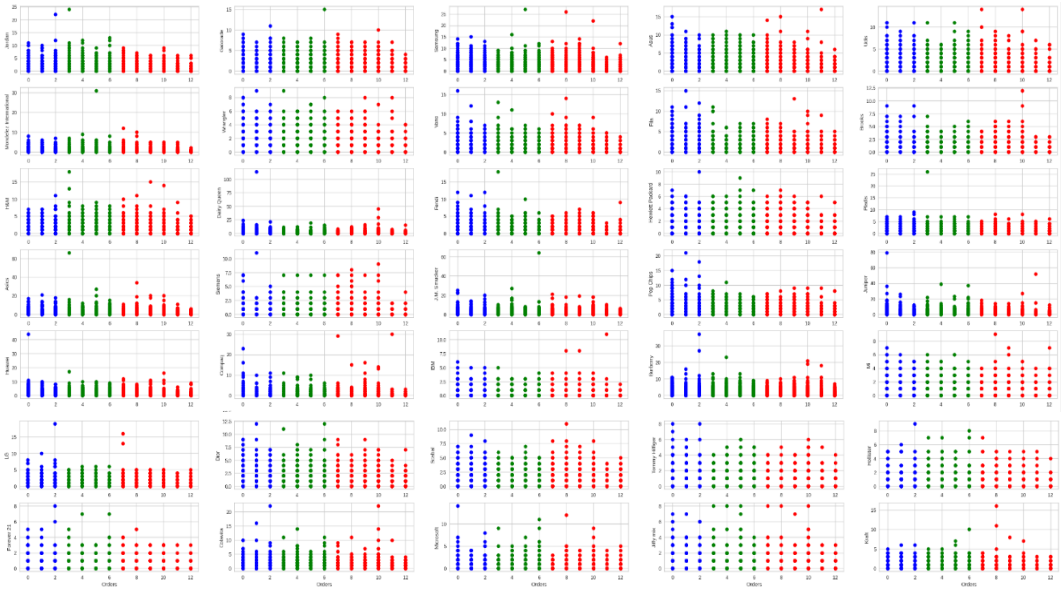


Fig 10

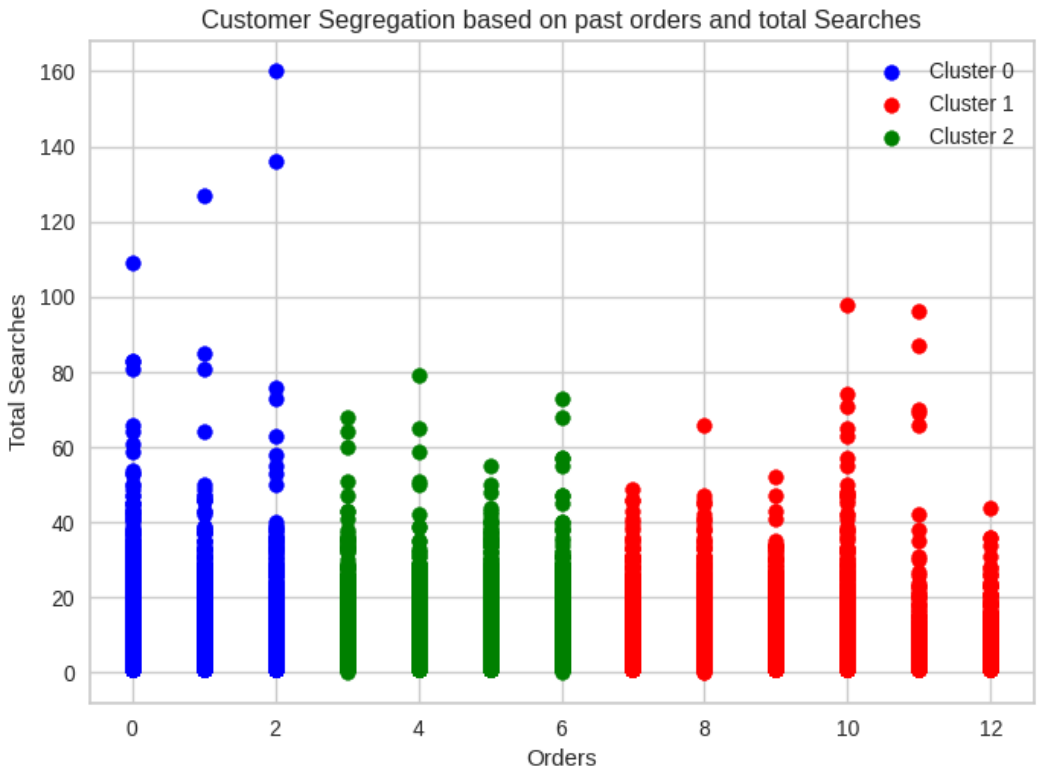

Customer Segregation based on past orders and total Searches
Cluster 0
Cluster 1
Cluster 2
Total Searches
Orders
0
20
40
60
80
100
120
140
160
0
2
4
6
8
10
12

Fig 11

Parameters	Cluster Labels	Description
Centroid among the numerical scaled data distribution from Orders column to Kraft Column (Fig 1)	0	0.05067568, 0.01029266, 0.01460746, 0.00751049, 0.00863521, 0.00980764, 0.0042606 , 0.01146682, 0.00662102, 0.00678893, 0.01128807, 0.01650311, 0.00193332, 0.00729301, 0.01576577, 0.00408375, 0.00401213, 0.00401457, 0.01108028, 0.01121147, 0.00590962, 0.00552277, 0.00389586, 0.00301275, 0.01102647, 0.0128432 , 0.00577881, 0.02228121, 0.03194834, 0.01989825, 0.00831188, 0.00712878, 0.00857757, 0.00769328, 0.01035634, 0.00461511
	1	0.72930361, 0.01144829, 0.01822232, 0.008606 , 0.01017554, 0.01063447, 0.00458002, 0.01190476, 0.00729212, 0.00590126, 0.01248904, 0.01982301, 0.00175861, 0.00832603, 0.01675066, 0.00394391, 0.00479709, 0.00485021, 0.01240346, 0.01255165, 0.00578135, 0.0059059 , 0.00411554, 0.00256952, 0.01176363, 0.01404713, 0.00532774, 0.02305178, 0.03522628, 0.02022623, 0.00845993, 0.00694292, 0.00891861, 0.00856079, 0.01144829, 0.00416301
	2	0.37173183, 0.01206556, 0.0185703 , 0.00897841, 0.01000836, 0.01049425, 0.00479667, 0.01246709, 0.00711641, 0.00595577, 0.01137441, 0.01906266, 0.00177725, 0.00818852, 0.01592417, 0.00422439, 0.00507145, 0.00437312, 0.01218528, 0.01187091, 0.00622713, 0.00632001, 0.00388231, 0.00311288, 0.01215576, 0.0138099 , 0.00490771, 0.02256122, 0.03442482, 0.01944609, 0.0092812 , 0.00746445, 0.00877316, 0.00895396, 0.01147808, 0.00445053
No. of Customers (Fig 2)	0	• 12432 customers • 41.44% of the entire population
	1	• 9128 customers • 30.43% of the entire population
	2	• 8440 customers • 28.13% of the entire population
No. of	0	• Males are 2070 in count

Customers wrt to Gender (Fig 3)		• Females are 10362 in count
	1	• Males are 1620 in count • Females are 7508 in count
	2	• Males are 1532 in count • Females are 6908 in count
No. of Customers based on orders purchased (Fig 4)	0	• No. of orders is in the range of 0-2 • 7294 customers didn't order anything • 2716 customers placed only 1 order • 2422 customers placed 2 orders
	1	• No. of orders is in the range of 7-12 • 2207 customers placed 7 orders • 2080 customers placed 8 orders • 1993 customers placed 9 orders • 1938 customers placed 10 orders • 441 customers placed 11 orders • 469 customers placed 12 orders
	2	• No. of orders is in the range of 3-6 • 2199 customers placed 3 orders • 2192 customers placed 4 orders • 2010 customers placed 5 orders • 2039 customers placed 6 orders
Searches done for each brand (Fig 5)	0	• 12.806% customers searched for 1 times for Jordan brand • 13.94% customers searched for 2 times for Jordan brand • 12.605% customers searched for 3 times for Jordan brand • 10.409% customers searched for 4 times for Jordan brand • 8.937% customers searched for 5 times for Jordan brand • 6.548% customers searched for 6 times for Jordan brand • 5.864% customers searched for 7 times for Jordan brand • 4.681% customers searched for 8 times for Jordan brand

		• 3.797% customers searched for 9 times for Jordan brand • 3.0% customers searched for 10 times for Jordan brand • 12.806% customers searched for 1 times for Gatorade brand • 13.94% customers searched for 2 times for Gatorade brand • 12.605% customers searched for 3 times for Gatorade brand • 10.409% customers searched for 4 times for Gatorade brand • 8.937% customers searched for 5 times for Gatorade brand • 6.548% customers searched for 6 times for Gatorade brand • 5.864% customers searched for 7 times for Gatorade brand • 4.681% customers searched for 8 times for Gatorade brand • 3.797% customers searched for 9 times for Gatorade brand • 3.0% customers searched for 10 times for Gatorade brand • 12.806% customers searched for 1 times for Samsung brand • 13.94% customers searched for 2 times for Samsung brand • 12.605% customers searched for 3 times for Samsung brand • 10.409% customers searched for 4 times for Samsung brand • 8.937% customers searched for 5 times for Samsung brand • 6.548% customers searched for 6 times for Samsung brand • 5.864% customers searched for 7 times for Samsung brand • 4.681% customers searched for 8 times for Samsung brand • 3.797% customers searched for 9 times for

		Samsung brand • 3.0% customers searched for 10 times for Samsung brand • 12.806% customers searched for 1 times for Asus brand • 13.94% customers searched for 2 times for Asus brand • 12.605% customers searched for 3 times for Asus brand • 10.409% customers searched for 4 times for Asus brand • 8.937% customers searched for 5 times for Asus brand • 6.548% customers searched for 6 times for Asus brand • 5.864% customers searched for 7 times for Asus brand • 4.681% customers searched for 8 times for Asus brand • 3.797% customers searched for 9 times for Asus brand • 3.0% customers searched for 10 times for Asus brand • 12.806% customers searched for 1 times for Udis brand • 13.94% customers searched for 2 times for Udis brand • 12.605% customers searched for 3 times for Udis brand • 10.409% customers searched for 4 times for Udis brand • 8.937% customers searched for 5 times for Udis brand • 6.548% customers searched for 6 times for Udis brand • 5.864% customers searched for 7 times for Udis brand • 4.681% customers searched for 8 times for Udis brand • 3.797% customers searched for 9 times for Udis brand

		• 3.0% customers searched for 10 times for Udis brand • 12.806% customers searched for 1 times for Mondelez International brand • 13.94% customers searched for 2 times for Mondelez International brand • 12.605% customers searched for 3 times for Mondelez International brand • 10.409% customers searched for 4 times for Mondelez International brand • 8.937% customers searched for 5 times for Mondelez International brand • 6.548% customers searched for 6 times for Mondelez International brand • 5.864% customers searched for 7 times for Mondelez International brand • 4.681% customers searched for 8 times for Mondelez International brand • 3.797% customers searched for 9 times for Mondelez International brand • 3.0% customers searched for 10 times for Mondelez International brand • 12.806% customers searched for 1 times for Wrangler brand • 13.94% customers searched for 2 times for Wrangler brand • 12.605% customers searched for 3 times for Wrangler brand • 10.409% customers searched for 4 times for Wrangler brand • 8.937% customers searched for 5 times for Wrangler brand • 6.548% customers searched for 6 times for Wrangler brand • 5.864% customers searched for 7 times for Wrangler brand • 4.681% customers searched for 8 times for Wrangler brand • 3.797% customers searched for 9 times for Wrangler brand • 3.0% customers searched for 10 times for

		Wrangler brand • 12.806% customers searched for 1 times for Vans brand • 13.94% customers searched for 2 times for Vans brand • 12.605% customers searched for 3 times for Vans brand • 10.409% customers searched for 4 times for Vans brand • 8.937% customers searched for 5 times for Vans brand • 6.548% customers searched for 6 times for Vans brand • 5.864% customers searched for 7 times for Vans brand • 4.681% customers searched for 8 times for Vans brand • 3.797% customers searched for 9 times for Vans brand • 3.0% customers searched for 10 times for Vans brand • 12.806% customers searched for 1 times for Fila brand • 13.94% customers searched for 2 times for Fila brand • 12.605% customers searched for 3 times for Fila brand • 10.409% customers searched for 4 times for Fila brand • 8.937% customers searched for 5 times for Fila brand • 6.548% customers searched for 6 times for Fila brand • 5.864% customers searched for 7 times for Fila brand • 4.681% customers searched for 8 times for Fila brand • 3.797% customers searched for 9 times for Fila brand • 3.0% customers searched for 10 times for Fila brand

		• 12.806% customers searched for 1 times for Brooks brand • 13.94% customers searched for 2 times for Brooks brand • 12.605% customers searched for 3 times for Brooks brand • 10.409% customers searched for 4 times for Brooks brand • 8.937% customers searched for 5 times for Brooks brand • 6.548% customers searched for 6 times for Brooks brand • 5.864% customers searched for 7 times for Brooks brand • 4.681% customers searched for 8 times for Brooks brand • 3.797% customers searched for 9 times for Brooks brand • 3.0% customers searched for 10 times for Brooks brand • 12.806% customers searched for 1 times for H&M brand • 13.94% customers searched for 2 times for H&M brand • 12.605% customers searched for 3 times for H&M brand • 10.409% customers searched for 4 times for H&M brand • 8.937% customers searched for 5 times for H&M brand • 6.548% customers searched for 6 times for H&M brand • 5.864% customers searched for 7 times for H&M brand • 4.681% customers searched for 8 times for H&M brand • 3.797% customers searched for 9 times for H&M brand • 3.0% customers searched for 10 times for H&M brand • 12.806% customers searched for 1 times for

		Dairy Queen brand • 13.94% customers searched for 2 times for Dairy Queen brand • 12.605% customers searched for 3 times for Dairy Queen brand • 10.409% customers searched for 4 times for Dairy Queen brand • 8.937% customers searched for 5 times for Dairy Queen brand • 6.548% customers searched for 6 times for Dairy Queen brand • 5.864% customers searched for 7 times for Dairy Queen brand • 4.681% customers searched for 8 times for Dairy Queen brand • 3.797% customers searched for 9 times for Dairy Queen brand • 3.0% customers searched for 10 times for Dairy Queen brand • 12.806% customers searched for 1 times for Fendi brand • 13.94% customers searched for 2 times for Fendi brand • 12.605% customers searched for 3 times for Fendi brand • 10.409% customers searched for 4 times for Fendi brand • 8.937% customers searched for 5 times for Fendi brand • 6.548% customers searched for 6 times for Fendi brand • 5.864% customers searched for 7 times for Fendi brand • 4.681% customers searched for 8 times for Fendi brand • 3.797% customers searched for 9 times for Fendi brand • 3.0% customers searched for 10 times for Fendi brand • 12.806% customers searched for 1 times for Hewlett Packard brand

		• 13.94% customers searched for 2 times for Hewlett Packard brand • 12.605% customers searched for 3 times for Hewlett Packard brand • 10.409% customers searched for 4 times for Hewlett Packard brand • 8.937% customers searched for 5 times for Hewlett Packard brand • 6.548% customers searched for 6 times for Hewlett Packard brand • 5.864% customers searched for 7 times for Hewlett Packard brand • 4.681% customers searched for 8 times for Hewlett Packard brand • 3.797% customers searched for 9 times for Hewlett Packard brand • 3.0% customers searched for 10 times for Hewlett Packard brand • 12.806% customers searched for 1 times for Pladis brand • 13.94% customers searched for 2 times for Pladis brand • 12.605% customers searched for 3 times for Pladis brand • 10.409% customers searched for 4 times for Pladis brand • 8.937% customers searched for 5 times for Pladis brand • 6.548% customers searched for 6 times for Pladis brand • 5.864% customers searched for 7 times for Pladis brand • 4.681% customers searched for 8 times for Pladis brand • 3.797% customers searched for 9 times for Pladis brand • 3.0% customers searched for 10 times for Pladis brand • 12.806% customers searched for 1 times for Asics brand • 13.94% customers searched for 2 times for Asics

		brand • 12.605% customers searched for 3 times for Asics brand • 10.409% customers searched for 4 times for Asics brand • 8.937% customers searched for 5 times for Asics brand • 6.548% customers searched for 6 times for Asics brand • 5.864% customers searched for 7 times for Asics brand • 4.681% customers searched for 8 times for Asics brand • 3.797% customers searched for 9 times for Asics brand • 3.0% customers searched for 10 times for Asics brand • 12.806% customers searched for 1 times for Siemens brand • 13.94% customers searched for 2 times for Siemens brand • 12.605% customers searched for 3 times for Siemens brand • 10.409% customers searched for 4 times for Siemens brand • 8.937% customers searched for 5 times for Siemens brand • 6.548% customers searched for 6 times for Siemens brand • 5.864% customers searched for 7 times for Siemens brand • 4.681% customers searched for 8 times for Siemens brand • 3.797% customers searched for 9 times for Siemens brand • 3.0% customers searched for 10 times for Siemens brand • 12.806% customers searched for 1 times for J.M. Smucker brand • 13.94% customers searched for 2 times for J.M. Smucker brand

		• 12.605% customers searched for 3 times for J.M. Smucker brand • 10.409% customers searched for 4 times for J.M. Smucker brand • 8.937% customers searched for 5 times for J.M. Smucker brand • 6.548% customers searched for 6 times for J.M. Smucker brand • 5.864% customers searched for 7 times for J.M. Smucker brand • 4.681% customers searched for 8 times for J.M. Smucker brand • 3.797% customers searched for 9 times for J.M. Smucker brand • 3.0% customers searched for 10 times for J.M. Smucker brand • 12.806% customers searched for 1 times for Pop Chips brand • 13.94% customers searched for 2 times for Pop Chips brand • 12.605% customers searched for 3 times for Pop Chips brand • 10.409% customers searched for 4 times for Pop Chips brand • 8.937% customers searched for 5 times for Pop Chips brand • 6.548% customers searched for 6 times for Pop Chips brand • 5.864% customers searched for 7 times for Pop Chips brand • 4.681% customers searched for 8 times for Pop Chips brand • 3.797% customers searched for 9 times for Pop Chips brand • 3.0% customers searched for 10 times for Pop Chips brand • 12.806% customers searched for 1 times for Juniper brand • 13.94% customers searched for 2 times for Juniper brand • 12.605% customers searched for 3 times for

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		• 10.409% customers searched for 4 times for Compaq brand • 8.937% customers searched for 5 times for Compaq brand • 6.548% customers searched for 6 times for Compaq brand • 5.864% customers searched for 7 times for Compaq brand • 4.681% customers searched for 8 times for Compaq brand • 3.797% customers searched for 9 times for Compaq brand • 3.0% customers searched for 10 times for Compaq brand • 12.806% customers searched for 1 times for IBM brand • 13.94% customers searched for 2 times for IBM brand • 12.605% customers searched for 3 times for IBM brand • 10.409% customers searched for 4 times for IBM brand • 8.937% customers searched for 5 times for IBM brand • 6.548% customers searched for 6 times for IBM brand • 5.864% customers searched for 7 times for IBM brand • 4.681% customers searched for 8 times for IBM brand • 3.797% customers searched for 9 times for IBM brand • 3.0% customers searched for 10 times for IBM brand • 12.806% customers searched for 1 times for Burberry brand • 13.94% customers searched for 2 times for Burberry brand • 12.605% customers searched for 3 times for Burberry brand • 10.409% customers searched for 4 times for

		Burberry brand • 8.937% customers searched for 5 times for Burberry brand • 6.548% customers searched for 6 times for Burberry brand • 5.864% customers searched for 7 times for Burberry brand • 4.681% customers searched for 8 times for Burberry brand • 3.797% customers searched for 9 times for Burberry brand • 3.0% customers searched for 10 times for Burberry brand • 12.806% customers searched for 1 times for Mi brand • 13.94% customers searched for 2 times for Mi brand • 12.605% customers searched for 3 times for Mi brand • 10.409% customers searched for 4 times for Mi brand • 8.937% customers searched for 5 times for Mi brand • 6.548% customers searched for 6 times for Mi brand • 5.864% customers searched for 7 times for Mi brand • 4.681% customers searched for 8 times for Mi brand • 3.797% customers searched for 9 times for Mi brand • 3.0% customers searched for 10 times for Mi brand • 12.806% customers searched for 1 times for LG brand • 13.94% customers searched for 2 times for LG brand • 12.605% customers searched for 3 times for LG brand • 10.409% customers searched for 4 times for LG brand

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		• 6.548% customers searched for 6 times for Hollister brand • 5.864% customers searched for 7 times for Hollister brand • 4.681% customers searched for 8 times for Hollister brand • 3.797% customers searched for 9 times for Hollister brand • 3.0% customers searched for 10 times for Hollister brand • 12.806% customers searched for 1 times for Forever 21 brand • 13.94% customers searched for 2 times for Forever 21 brand • 12.605% customers searched for 3 times for Forever 21 brand • 10.409% customers searched for 4 times for Forever 21 brand • 8.937% customers searched for 5 times for Forever 21 brand • 6.548% customers searched for 6 times for Forever 21 brand • 5.864% customers searched for 7 times for Forever 21 brand • 4.681% customers searched for 8 times for Forever 21 brand • 3.797% customers searched for 9 times for Forever 21 brand • 3.0% customers searched for 10 times for Forever 21 brand • 12.806% customers searched for 1 times for Colavita brand • 13.94% customers searched for 2 times for Colavita brand • 12.605% customers searched for 3 times for Colavita brand • 10.409% customers searched for 4 times for Colavita brand • 8.937% customers searched for 5 times for Colavita brand • 6.548% customers searched for 6 times for

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		• 5.864% customers searched for 7 times for Jiffy mix brand • 4.681% customers searched for 8 times for Jiffy mix brand • 3.797% customers searched for 9 times for Jiffy mix brand • 3.0% customers searched for 10 times for Jiffy mix brand • 12.806% customers searched for 1 times for Kraft brand • 13.94% customers searched for 2 times for Kraft brand • 12.605% customers searched for 3 times for Kraft brand • 10.409% customers searched for 4 times for Kraft brand • 8.937% customers searched for 5 times for Kraft brand • 6.548% customers searched for 6 times for Kraft brand • 5.864% customers searched for 7 times for Kraft brand • 4.681% customers searched for 8 times for Kraft brand • 3.797% customers searched for 9 times for Kraft brand • 3.0% customers searched for 10 times for Kraft brand
	1	• 10.736% customers searched for 1 times for Jordan brand • 11.131% customers searched for 2 times for Jordan brand • 11.799% customers searched for 3 times for Jordan brand • 10.495% customers searched for 4 times for Jordan brand • 8.249% customers searched for 5 times for Jordan brand • 7.406% customers searched for 6 times for Jordan brand

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No. of customers based on total Searches	0	• Rightly-skewed • Majority customers of around 9500 have searched for 1-10 times • Significant searches is between 1-40

(Fig 6)	1	• Rightly-skewed • Majority customers of around 4000 have searched for 1-10 times • Significant searches is between 1-40
	2	• Rightly-skewed • Majority customers of around 2700 have searched for 1-10 times • Significant searches is between 1-40
No. of customers based on total Searches- Zoomed view (Fig 7)	0	• 7297 customers have searched between 1-5 total searches • 2970 customers have searched between 6-10 total searches • 1223 customers have searched between 11-15 total searches • 444 customers have searched between 16-20 total searches • 229 customers have searched between 21-25 total searches • 118 customers have searched between 26-30 total searches • 66 customers have searched between 31-35 total searches • 32 customers have searched between 36-40 total searches
	1	• 4784 customers have searched between 1-5 total searches • 2517 customers have searched between 6-10 total searches • 1052 customers have searched between 11-15 total searches • 415 customers have searched between 16-20 total searches • 155 customers have searched between 21-25 total searches • 88 customers have searched between 26-30 total searches • 52 customers have searched between 31-35 total searches • 21 customers have searched between 36-40 total

		searches
	2	• 4432 customers have searched between 1-5 total searches • 2282 customers have searched between 6-10 total searches • 949 customers have searched between 11-15 total searches • 399 customers have searched between 16-20 total searches • 187 customers have searched between 21-25 total searches • 97 customers have searched between 26-30 total searches • 38 customers have searched between 31-35 total searches • 25 customers have searched between 36-40 total searches
No. of orders placed wrt Gender (Fig 8)	0	• 6269 orders has been placed by females • 1291 orders has been placed by males
	1	• 65606 orders has been placed by females • 14279 orders has been placed by males
	2	• 30755 orders has been placed by females • 6894 orders has been placed by males
No. of total Searches done wrt Gender (Fig 9)	0	• 70690 searches has been done by the females • 10787 searches has been done by the males
	1	• 55251 searches has been done by the females • 9322 searches has been done by the males
	2	• 51550 searches has been done by the females • 8543 searches has been done by the males
Relation between searches(brand respective) and orders placed by the	0	• Maximum of 22 searches has been done for brand Jordan • Maximum of 11 searches has been done for brand Gatorade • Maximum of 15 searches has been done for brand Samsung

customers (Fig 10)		• Maximum of 15 searches has been done for brand Asus • Maximum of 11 searches has been done for brand Udis • Maximum of 8 searches has been done for brand Mondelez International • Maximum of 9 searches has been done for brand Wrangler • Maximum of 16 searches has been done for brand Vans • Maximum of 15 searches has been done for brand Fila • Maximum of 9 searches has been done for brand Brooks • Maximum of 11 searches has been done for brand H&M • Maximum of 114 searches has been done for brand Dairy Queen • Maximum of 12 searches has been done for brand Fendi • Maximum of 10 searches has been done for brand Hewlett Packard • Maximum of 9 searches has been done for brand Pladis • Maximum of 21 searches has been done for brand Asics • Maximum of 11 searches has been done for brand Siemens • Maximum of 25 searches has been done for brand J.M. Smucker • Maximum of 21 searches has been done for brand Pop Chips • Maximum of 79 searches has been done for brand Juniper • Maximum of 44 searches has been done for brand Huawei • Maximum of 23 searches has been done for brand Compaq • Maximum of 6 searches has been done for brand IBM • Maximum of 37 searches has been done for

		brand Burberry • Maximum of 7 searches has been done for brand Mi • Maximum of 19 searches has been done for brand LG • Maximum of 12 searches has been done for brand Dior • Maximum of 9 searches has been done for brand Scabal • Maximum of 8 searches has been done for brand Tommy Hilfiger • Maximum of 9 searches has been done for brand Hollister • Maximum of 8 searches has been done for brand Forever 21 • Maximum of 22 searches has been done for brand Colavita • Maximum of 14 searches has been done for brand Microsoft • Maximum of 7 searches has been done for brand Jiffy mix • Maximum of 6 searches has been done for brand Kraft
	1	• Maximum of 9 searches has been done for brand Jordan • Maximum of 10 searches has been done for brand Gatorade • Maximum of 26 searches has been done for brand Samsung • Maximum of 17 searches has been done for brand Asus • Maximum of 14 searches has been done for brand Udis • Maximum of 12 searches has been done for brand Mondelez International • Maximum of 8 searches has been done for brand Wrangler • Maximum of 14 searches has been done for brand Vans • Maximum of 13 searches has been done for

		brand Fila • Maximum of 12 searches has been done for brand Brooks • Maximum of 15 searches has been done for brand H&M • Maximum of 45 searches has been done for brand Dairy Queen • Maximum of 9 searches has been done for brand Fendi • Maximum of 7 searches has been done for brand Hewlett Packard • Maximum of 8 searches has been done for brand Pladis • Maximum of 34 searches has been done for brand Asics • Maximum of 9 searches has been done for brand Siemens • Maximum of 21 searches has been done for brand J.M. Smucker • Maximum of 9 searches has been done for brand Pop Chips • Maximum of 52 searches has been done for brand Juniper • Maximum of 16 searches has been done for brand Huawei • Maximum of 30 searches has been done for brand Compaq • Maximum of 11 searches has been done for brand IBM • Maximum of 21 searches has been done for brand Burberry • Maximum of 9 searches has been done for brand Mi • Maximum of 16 searches has been done for brand LG • Maximum of 9 searches has been done for brand Dior • Maximum of 11 searches has been done for brand Scabal • Maximum of 6 searches has been done for brand Tommy Hilfiger

		• Maximum of 7 searches has been done for brand Hollister • Maximum of 5 searches has been done for brand Forever 21 • Maximum of 22 searches has been done for brand Colavita • Maximum of 12 searches has been done for brand Microsoft • Maximum of 8 searches has been done for brand Jiffy mix • Maximum of 16 searches has been done for brand Kraft
	2	• Maximum of 24 searches has been done for brand Jordan • Maximum of 15 searches has been done for brand Gatorade • Maximum of 27 searches has been done for brand Samsung • Maximum of 11 searches has been done for brand Asus • Maximum of 11 searches has been done for brand Udis • Maximum of 31 searches has been done for brand Mondelez International • Maximum of 9 searches has been done for brand Wrangler • Maximum of 13 searches has been done for brand Vans • Maximum of 11 searches has been done for brand Fila • Maximum of 7 searches has been done for brand Brooks • Maximum of 18 searches has been done for brand H&M • Maximum of 19 searches has been done for brand Dairy Queen • Maximum of 18 searches has been done for brand Fendi • Maximum of 9 searches has been done for brand Hewlett Packard

		• Maximum of 26 searches has been done for brand Pladis • Maximum of 66 searches has been done for brand Asics • Maximum of 7 searches has been done for brand Siemens • Maximum of 64 searches has been done for brand J.M. Smucker • Maximum of 11 searches has been done for brand Pop Chips • Maximum of 39 searches has been done for brand Juniper • Maximum of 17 searches has been done for brand Huawei • Maximum of 11 searches has been done for brand Compaq • Maximum of 5 searches has been done for brand IBM • Maximum of 23 searches has been done for brand Burberry • Maximum of 6 searches has been done for brand Mi • Maximum of 6 searches has been done for brand LG • Maximum of 12 searches has been done for brand Dior • Maximum of 7 searches has been done for brand Scabal • Maximum of 6 searches has been done for brand Tommy Hilfiger • Maximum of 8 searches has been done for brand Hollister • Maximum of 7 searches has been done for brand Forever 21 • Maximum of 14 searches has been done for brand Colavita • Maximum of 11 searches has been done for brand Microsoft • Maximum of 8 searches has been done for brand Jiffy mix • Maximum of 10 searches has been done for

		brand Kraft
Relation between total searches and orders placed by the customers (Fig 11)	0	• Maximum of 160 total searches has been done
	1	• Maximum of 98 total searches has been done
	2	• Maximum of 79 total searches has been done

XI. Discussion

A. Implications of findings

i. **Enhanced Personalization:** The identification of distinct customer segments enables more personalized marketing efforts. Tailoring communication and offers to the specific needs and preferences of each segment can significantly enhance customer satisfaction and loyalty.

ii. **Optimized Resource Allocation**: By understanding which segments contribute most to revenue and engagement, the business can allocate marketing and operational resources more effectively. High-value segments can be prioritized for special promotions and loyalty programs, ensuring maximum return on investment.

iii. **Improved Customer Retention:** Insights into customer behavior and preferences can inform strategies to improve retention, especially for high-value and high-engagement segments. Personalized retention strategies can help reduce churn rates.

iv. **Strategic Product Development:** Understanding customer preferences can guide product development and inventory management. Ensuring popular products are available and developing new products that meet the needs of valuable segments can drive sales.

v. **Targeted Marketing Campaigns:** With detailed knowledge of customer segments, targeted marketing campaigns can be designed to resonate more effectively with each group, improving engagement and conversion rates.

B. Limitations of the study

i. **Choice of Features:** The analysis was based on selected features such as demographic data and behavioral metrics. Important factors might have been overlooked, and incorporating additional features could provide a more comprehensive segmentation.

ii. **Assumptions of K-means:** K-means assumes spherical clusters of similar size, which may not reflect the true

structure of the data. This could lead to suboptimal clustering results in cases where the actual clusters are not spherical or vary significantly in size.

iii. **Sensitivity to Initialization:** The K-means algorithm is sensitive to the initial placement of centroids resulting in different clustering outcomes.

iv. **Determining Optimal k:** Choosing the optimal number of clusters is subjective and can impact the results. Methods like the Elbow Method and Silhouette Analysis provide guidance, but the final decision still involves some degree of judgment.

v. **Data Quality:** The accuracy and reliability of the segmentation depend on the quality of the data. Missing values, outliers, and data inconsistencies could affect the results. Although data cleaning steps were taken, residual issues might still impact the analysis.

C. Comparison with existing research

Similar to other studies, this analysis highlights the importance of customer segmentation in enhancing marketing effectiveness and customer satisfaction. Many e-commerce studies use K-means clustering for segmentation due to their simplicity and effectiveness. This study incorporates a broader range of features, including demographic and behavioral metrics, providing a more holistic view of customer segments compared to traditional RFM analysis alone. This approach aligns with recent trends in research that advocate for multi-dimensional segmentation. The use of K-means clustering is consistent with established methodologies in existing research. The choice of k-means++ initialization and the combination of the Elbow Method and Silhouette Analysis for determining k reflect best practices in the field. While many studies acknowledge the limitations of K-means, such as sensitivity to initialization and assumptions of cluster shape, this study attempts to mitigate these issues through careful initialization and validation. However, like existing research, it also acknowledges the need for potential alternative clustering methods for more complex data structures. This study contributes to the ongoing discussion in the field by providing practical insights specific to e-commerce customer segmentation, emphasizing the actionable nature of the findings.

XII. Conclusion

A. Summary of the project

This project focused on e-commerce customer segmentation using K-means clustering. By analyzing customer data, along with demographic and behavioral metrics, the study aimed to identify distinct customer segments to enhance marketing strategies and customer engagement. The methodology involved data preparation, determining the optimal number of clusters, initializing and running the K-means algorithm, and evaluating the model's performance. Key findings highlighted the identification of three customer segments, each with unique characteristics and behaviors, providing actionable insights for personalized marketing and resource allocation.

B. Key takeaways

i. Effective Customer Segmentation
ii. Enhanced Personalization
iii. Optimized Resource Allocation
iv. Strategic Product Development
v. Improved Marketing Strategies

C. Recommendations for future work

Future studies should consider incorporating additional features such as social media engagement, customer feedback, and detailed purchase history to enhance the segmentation process. These features can provide a more comprehensive understanding of customer behavior and preferences, leading to more precise and actionable segments. Investigating the use of alternative clustering algorithms, such as DBSCAN or hierarchical clustering, can address the limitations of K-means and improve the quality of segmentation, especially for more complex data structures. Implementing real-time customer segmentation using streaming data would enable businesses to gain immediate insights and respond promptly to changing customer behaviors, ensuring that marketing strategies remain relevant and effective. Establishing a feedback loop with customers to validate the segmentation and refine the clusters based on real-world interactions and feedback can further enhance the accuracy and relevance of the segments, leading to more targeted and successful marketing efforts.

By addressing these recommendations, future work can build on the findings of this project to create more accurate, dynamic, and actionable customer segments, further enhancing the strategic capabilities of e-commerce businesses.

XIII. References

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XIV. Appendices

A. Appendix A - Pseudo Code for K-Means

1. Initialize centroids:

- Select k initial centroids from the dataset using k-means++.

2. Repeat until convergence or max_iterations:

2.1. Assignment Step:

- For each data point xi in the dataset:

- Compute the distance from xi to each centroid.

- Assign xi to the nearest centroid.

2.2. Update Step:

- For each cluster j:

- Calculate the new centroid as the mean of all data points assigned to cluster j.

2.3. Check for convergence:

- If the centroids have not changed significantly, or max_iterations is reached, exit the loop.

3. Output:

- Final centroids.

- Cluster assignments for each data point.

B. Appendix B – Keywords

i. wrt stands for with respect to
ii. std stands for standard deviation
iii. min stands for minimum
iv. max stands for maximum
v. No. stands for number
vi. > is greater than mathematical symbol
vii. 50^{th} percentile is also termed as median
viii. Fig stands for Figure
ix. Churn rates means the percentage of customers who stop using a company's products or services within a given time period.

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