Experiment No. 5
Apply appropriate Unsupervised Learning Technique on the Wholesale Customers Dataset
Date of Performance: 21-08-2023
Date of Submission: 30-09-2023

Aim: Apply appropriate Unsupervised Learning Technique on the Wholesale Customers Dataset.

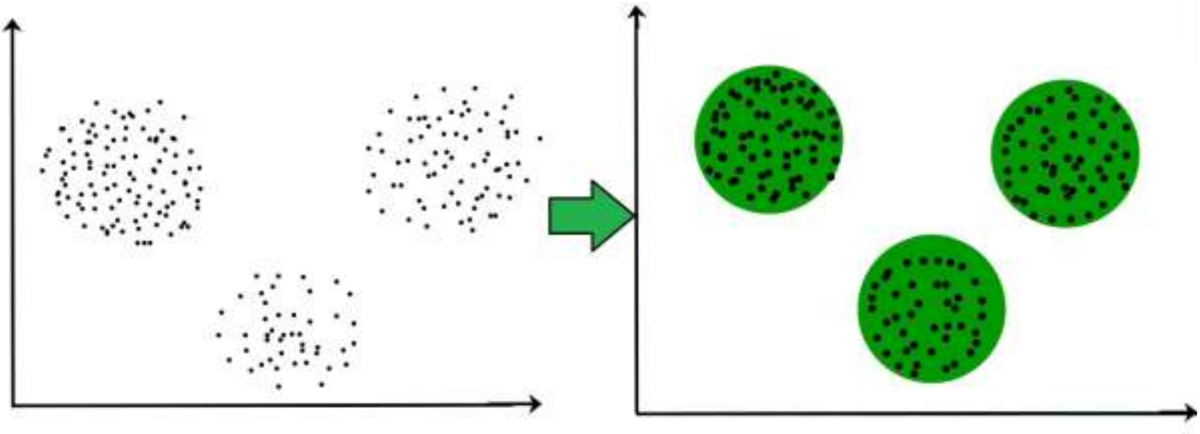
Objective: Able to perform various feature engineering tasks, apply Clustering Algorithm on the given dataset.

Theory:

It is basically a type of unsupervised learning method. An unsupervised learning method is a method in which we draw references from datasets consisting of input data without labeled responses. Generally, it is used as a process to find meaningful structure, explanatory underlying processes, generative features, and groupings inherent in a set of examples.

Clustering is the task of dividing the population or data points into a number of groups such that data points in the same groups are more similar to other data points in the same group and dissimilar to the data points in other groups. It is basically a collection of objects on the basis of similarity and dissimilarity between them.

For example: The data points in the graph below clustered together can be classified into one single group. We can distinguish the clusters, and we can identify that there are 3 clusters in the below picture.



Dataset:

This data set refers to clients of a wholesale distributor. It includes the annual spending in monetary units (m.u.) on diverse product categories. The wholesale distributor operating in different regions of Portugal has information on annual spending of several items in their stores across different regions and channels. The dataset consist of 440 large retailers annual spending on 6 different varieties of product in 3 different regions (lisbon , oporto, other) and across different sales channel (Hotel, channel)

Detailed overview of dataset

Records in the dataset = 440 ROWS

Columns in the dataset = 8 COLUMNS

FRESH: annual spending (m.u.) on fresh products (Continuous)

MILK:- annual spending (m.u.) on milk products (Continuous)

GROCERY:- annual spending (m.u.) on grocery products (Continuous)

FROZEN:- annual spending (m.u.) on frozen products (Continuous)

DETERGENTS_PAPER :- annual spending (m.u.) on detergents and paper products (Continuous)

DELICATESSEN:- annual spending (m.u.)on and delicatessen products (Continuous);

CHANNEL: - sales channel Hotel and Retailer

REGION:- three regions (Lisbon, Oporto, Other)

In [21]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
df = pd.read_csv("customers.csv")
df.sample(5)
```

```
   Channel  Region  Fresh  Milk  Grocery  Frozen  Detergents_Paper  Delicass
en
0        2       3  12669  9656     7561     214              2674        13
38
1        2       3   7057  9810     9568    1762              3293        17
76
2        2       3   6353  8808     7684    2405              3516        78
44
3        1       3  13265  1196     4221    6404               507        17
88
4        2       3  22615  5410     7198    3915              1777        51
85
```

In [7]:
```
print(df.columns)
```

```
Index(['Channel', 'Region', 'Fresh', 'Milk', 'Grocery', 'Frozen',
       'Detergents_Paper', 'Delicassen'],
      dtype='object')
```

In [6]:
```
print(df.dtypes)
```

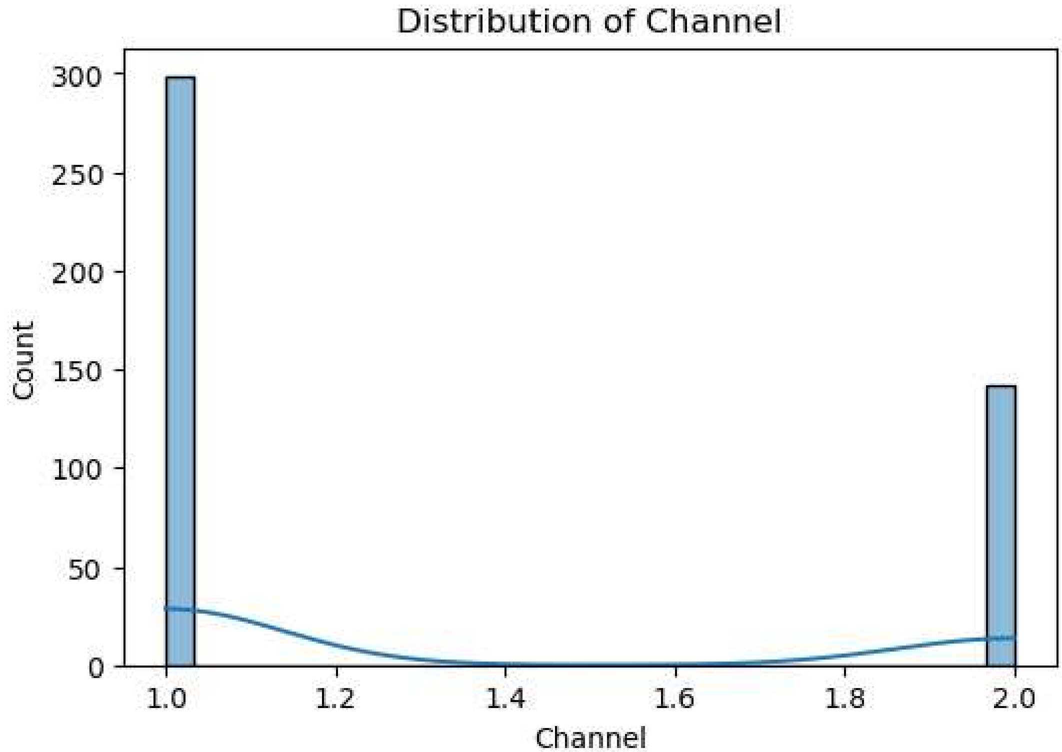
```
Channel             int64
Region              int64
Fresh               int64
Milk                int64
Grocery             int64
Frozen              int64
Detergents_Paper    int64
Delicassen          int64
dtype: object
```

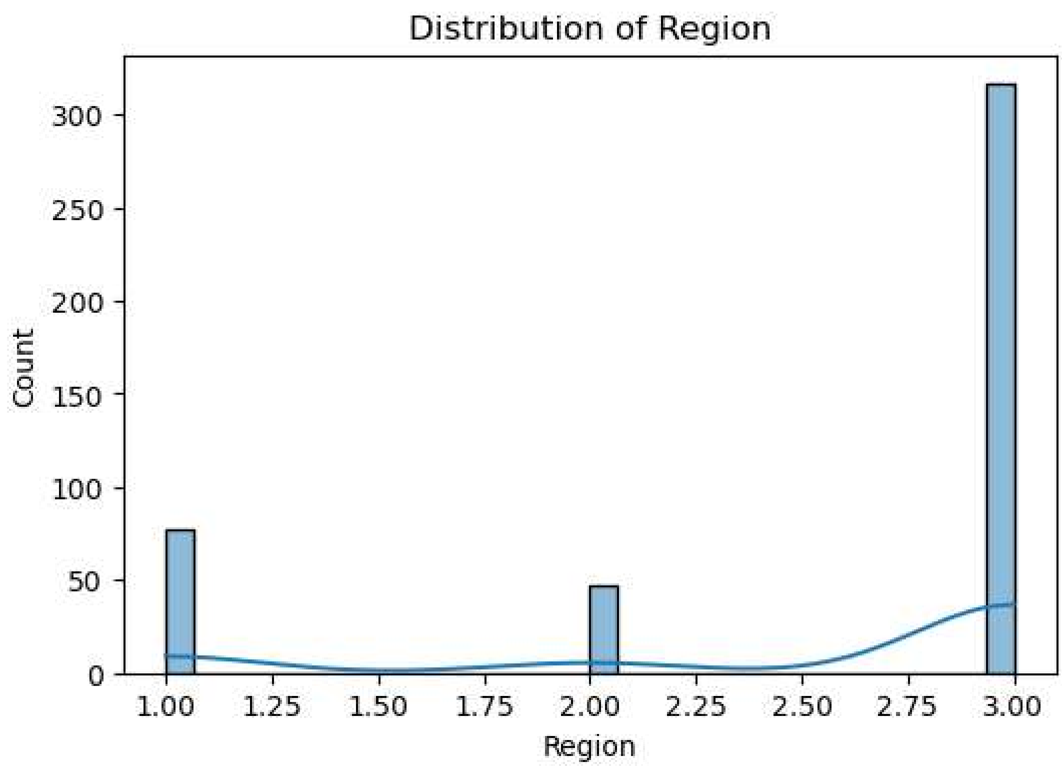
In [5]:
```
print(df.isnull().sum())
```

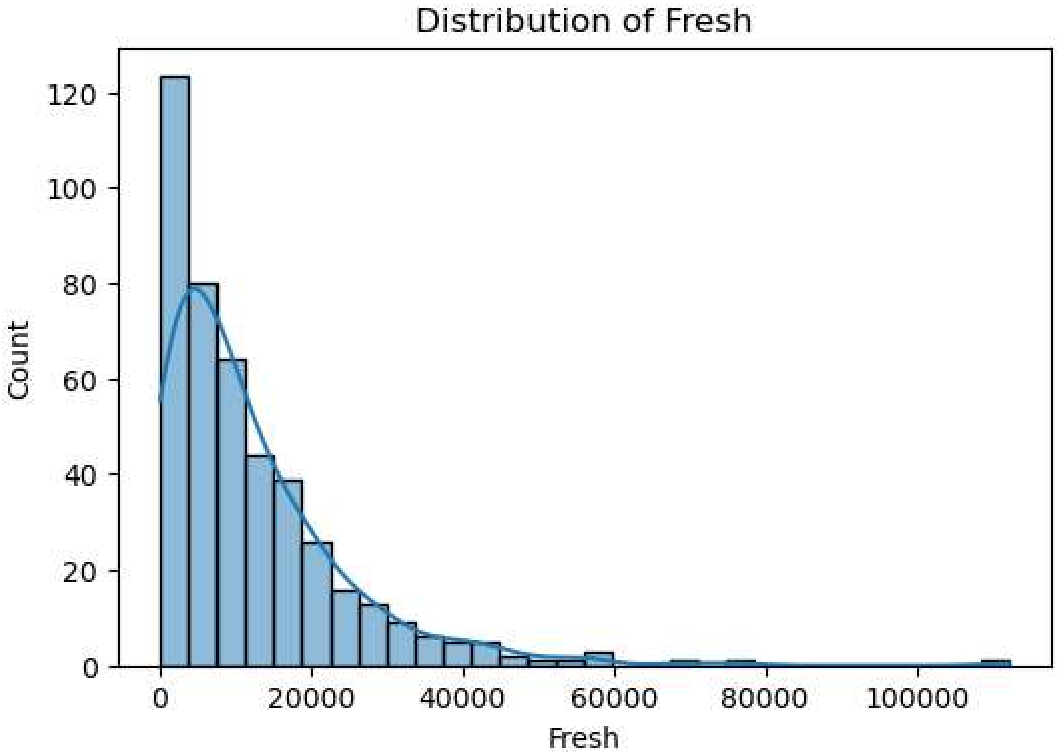
```
Channel             0
Region              0
Fresh               0
Milk                0
Grocery             0
Frozen              0
Detergents_Paper    0
Delicassen          0
dtype: int64
```

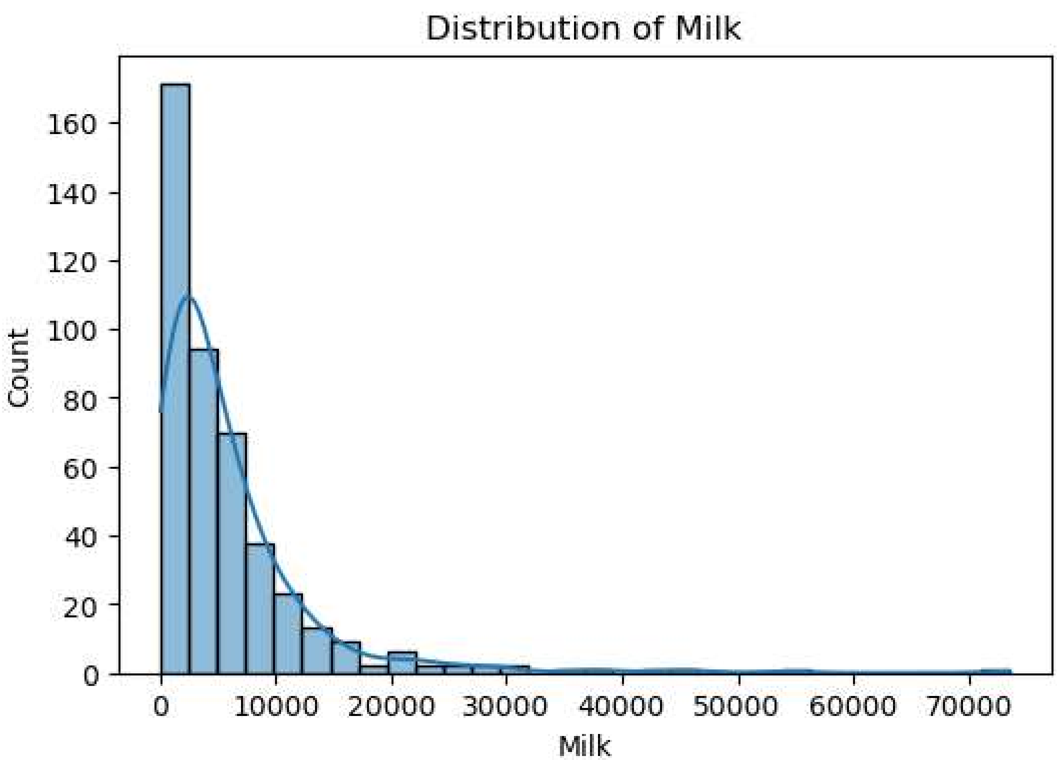
In [9]:
```python
import matplotlib.pyplot as plt
import seaborn as sns

print("Descriptive Statistics:")
print(df.describe())

print("Number of duplicate rows: ", df.duplicated().sum())

for column in df.columns:
    plt.figure(figsize=(6, 4))
    sns.histplot(df[column], bins=30, kde=True)
    plt.title(f'Distribution of {column}')
    plt.show()

plt.figure(figsize=(10, 8))
sns.heatmap(df.corr(), annot=True, cmap='coolwarm', center=0)
plt.title('Correlation Heatmap')
plt.show()
```

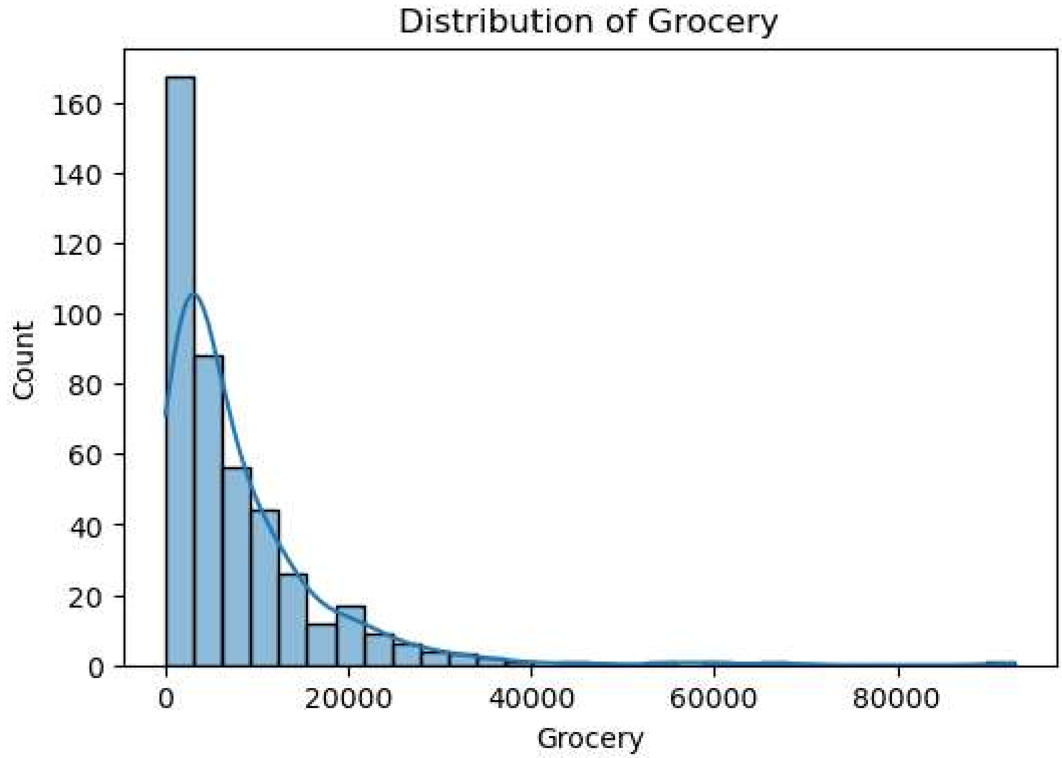
```
Descriptive Statistics:
          Channel      Region          Fresh          Milk       Grocery  \
count  440.000000  440.000000     440.000000    440.000000    440.000000
mean     1.322727    2.543182   12000.297727   5796.265909   7951.277273
std      0.468052    0.774272   12647.328865   7380.377175   9503.162829
min      1.000000    1.000000       3.000000     55.000000      3.000000
25%      1.000000    2.000000    3127.750000   1533.000000   2153.000000
50%      1.000000    3.000000    8504.000000   3627.000000   4755.500000
75%      2.000000    3.000000   16933.750000   7190.250000  10655.750000
max      2.000000    3.000000  112151.000000  73498.000000  92780.000000

             Frozen  Detergents_Paper    Delicassen
count    440.000000        440.000000    440.000000
mean    3071.931818       2881.493182   1524.870455
std     4854.673333       4767.854448   2820.105937
min       25.000000          3.000000      3.000000
25%      742.250000        256.750000    408.250000
50%     1526.000000        816.500000    965.500000
75%     3554.250000       3922.000000   1820.250000
max    60869.000000      40827.000000  47943.000000
Number of duplicate rows:  0
```

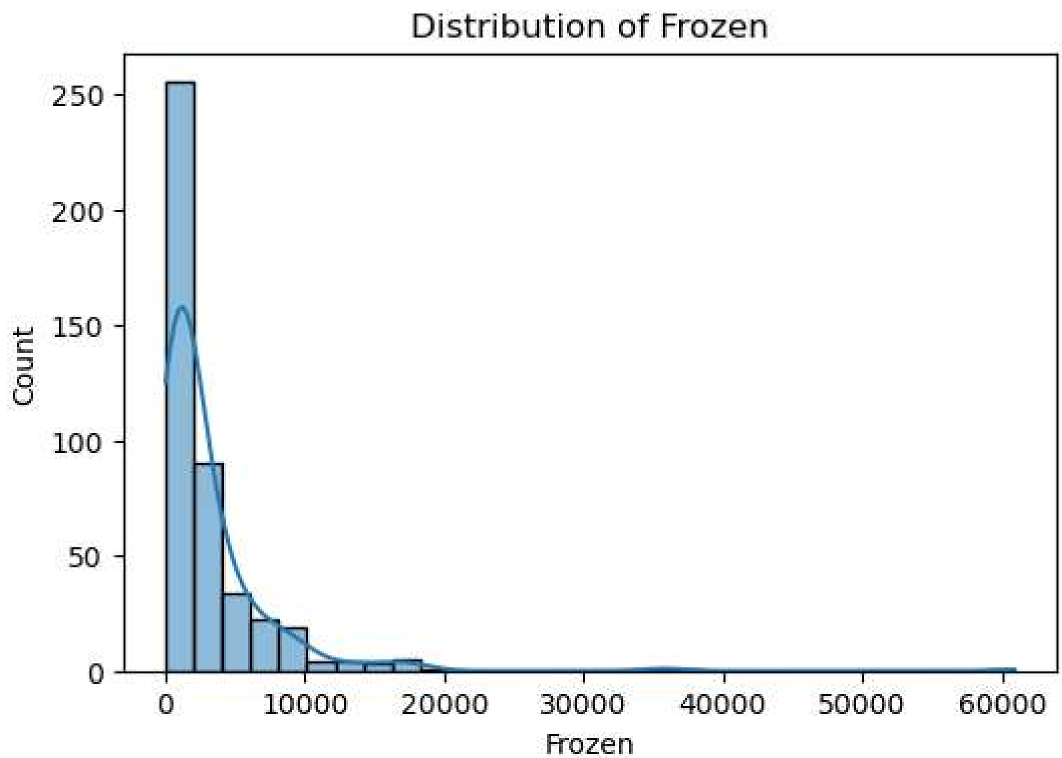

Distribution of Channel
Count
300
250
200
150
100
50
0
1.0
1.2
1.4
1.6
1.8
2.0
Channel

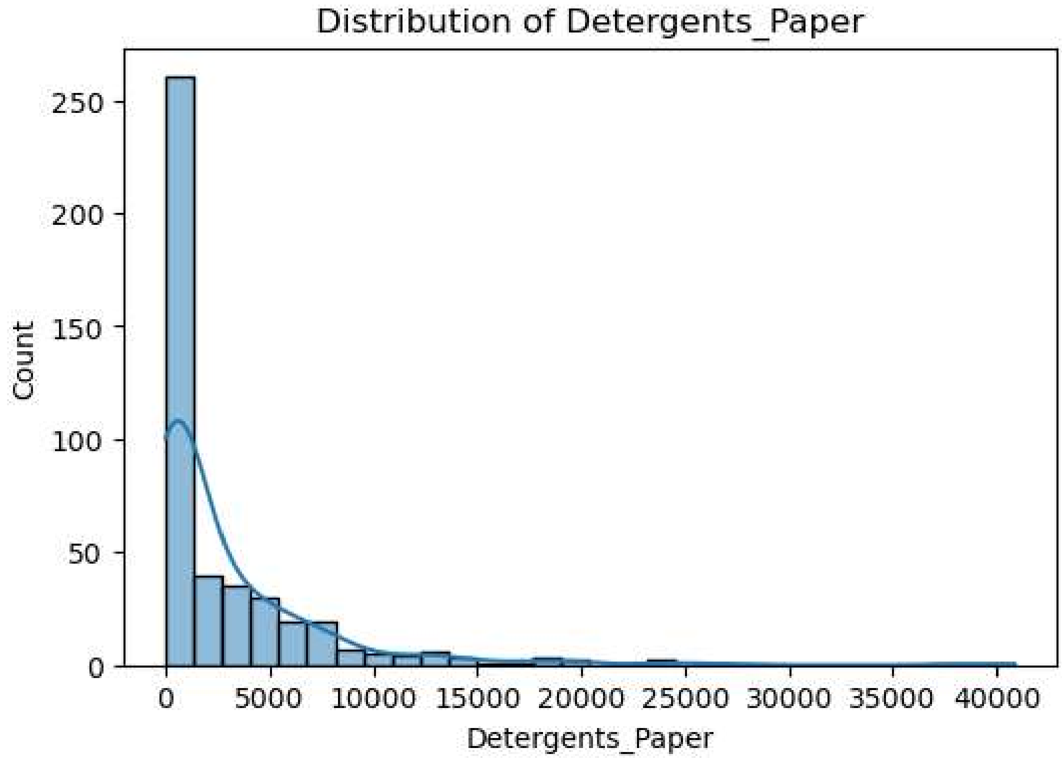

Distribution of Region
Count
300
250
200
150
100
50
0
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
Region

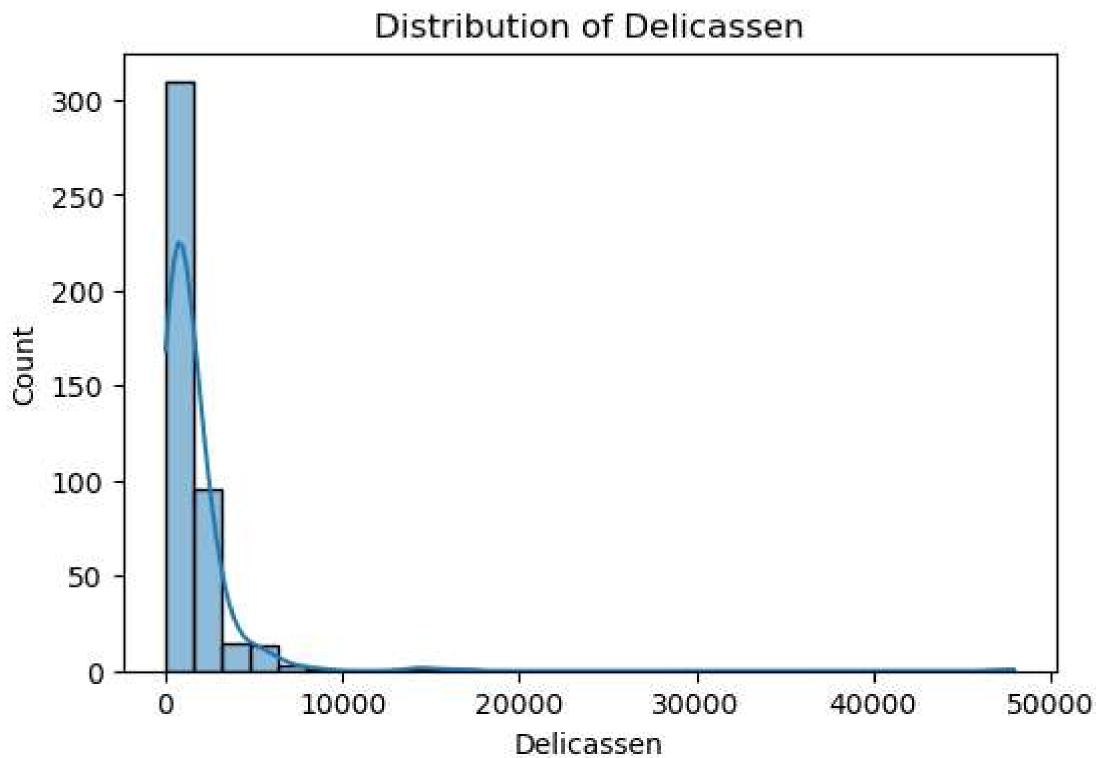

Distribution of Fresh
Count
Fresh
0
20
40
60
80
100
120
0
20000
40000
60000
80000
100000

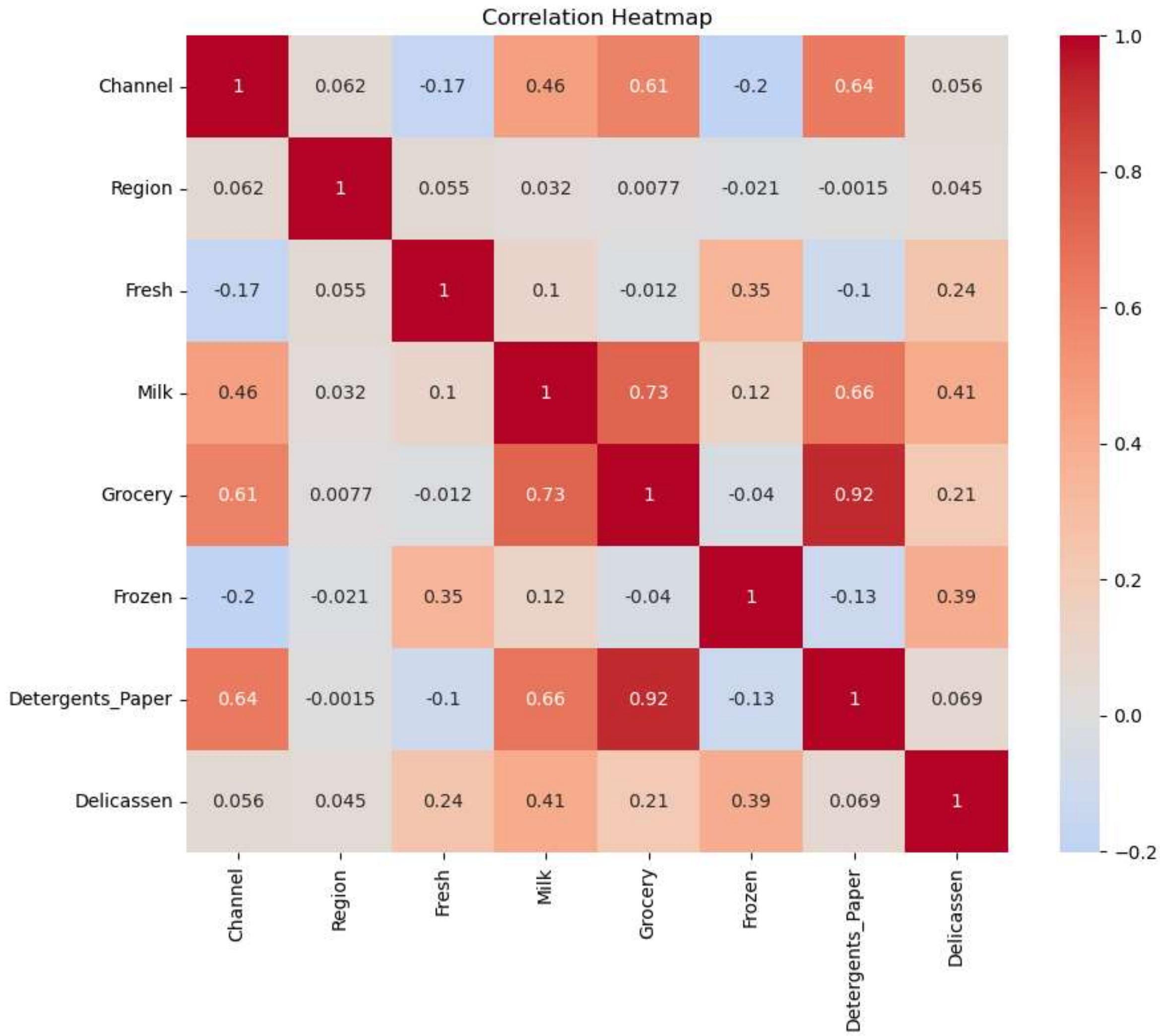

Distribution of Milk
Count
Milk
0
20
40
60
80
100
120
140
160
0
10000
20000
30000
40000
50000
60000
70000


Distribution of Grocery
Count
Grocery
0
20
40
60
80
100
120
140
160
0
20000
40000
60000
80000


Distribution of Frozen
Count
Frozen
0
50
100
150
200
250
0
10000
20000
30000
40000
50000
60000


Distribution of Detergents_Paper
Count
0
50
100
150
200
250
0
5000
10000
15000
20000
25000
30000
35000
40000
Detergents_Paper

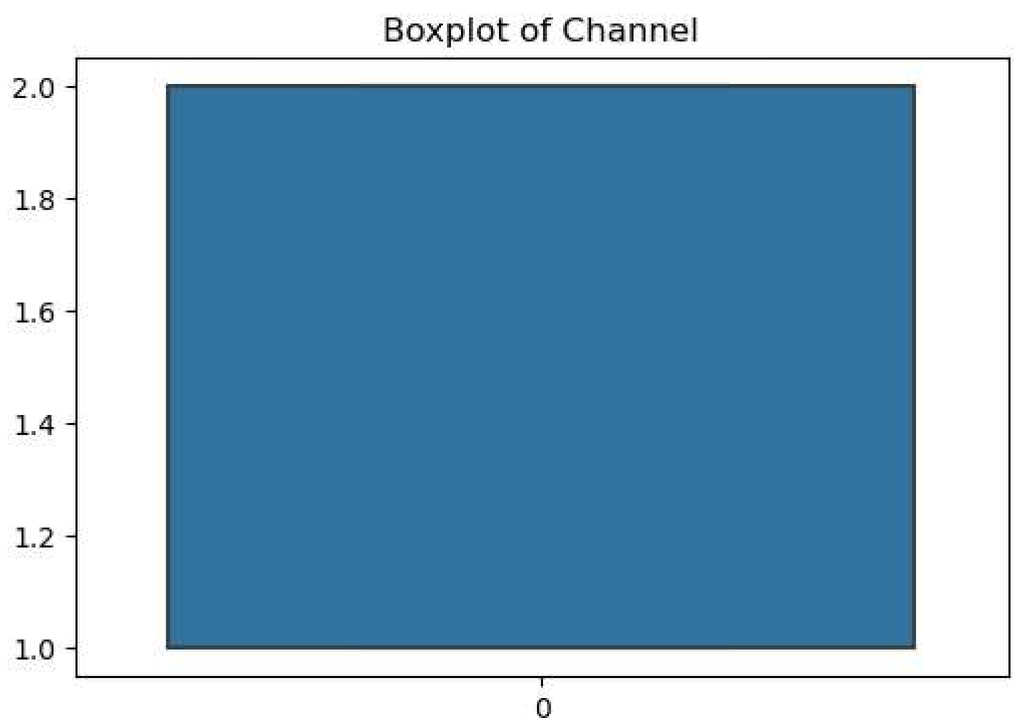

Distribution of Delicassen
Count
0
50
100
150
200
250
300
0
10000
20000
30000
40000
50000
Delicassen

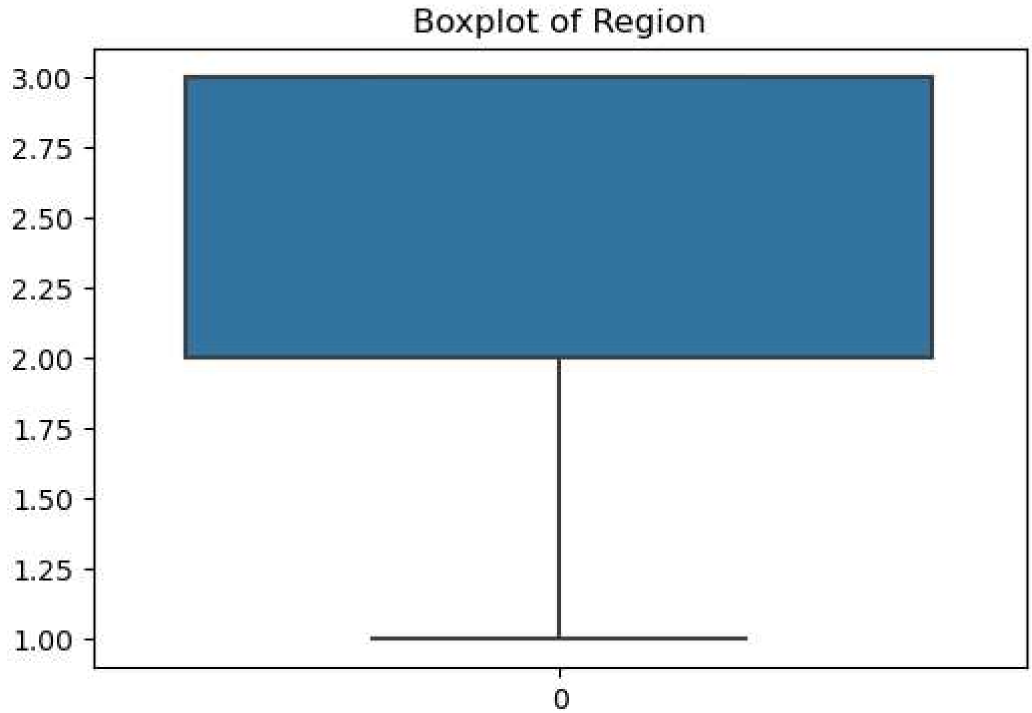


Correlation Heatmap
Channel
Region
Fresh
Milk
Grocery
Frozen
Detergents_Paper
Delicassen
1 0.062 -0.17 0.46 0.61 -0.2 0.64 0.056
0.062 1 0.055 0.032 0.0077 -0.021 -0.0015 0.045
-0.17 0.055 1 0.1 -0.012 0.35 -0.1 0.24
0.46 0.032 0.1 1 0.73 0.12 0.66 0.41
0.61 0.0077 -0.012 0.73 1 -0.04 0.92 0.21
-0.2 -0.021 0.35 0.12 -0.04 1 -0.13 0.39
0.64 -0.0015 -0.1 0.66 0.92 -0.13 1 0.069
0.056 0.045 0.24 0.41 0.21 0.39 0.069 1
1.0
0.8
0.6
0.4
0.2
0.0
−0.2

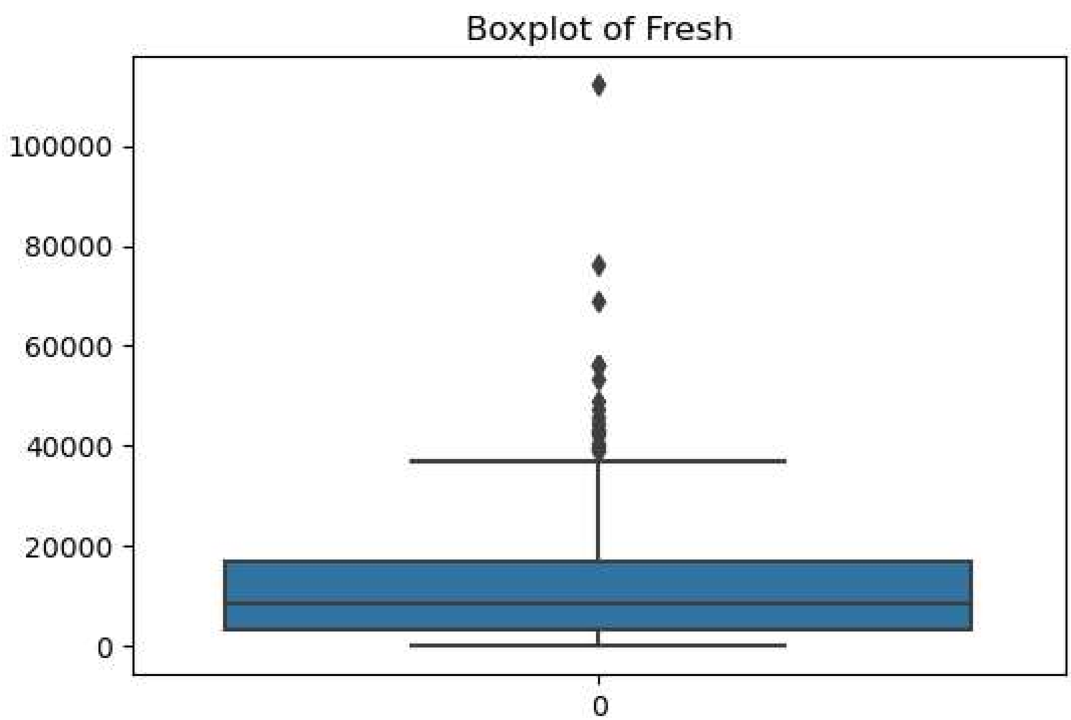
In [10]:

```
import seaborn as sns
import matplotlib.pyplot as plt

for column in df.columns:
    plt.figure(figsize=(6, 4))
    sns.boxplot(df[column])
    plt.title(f'Boxplot of {column}')
    plt.show()

def detect_outliers(dataframe, column):
    Q1 = dataframe[column].quantile(0.25)
    Q3 = dataframe[column].quantile(0.75)
    IQR = Q3 - Q1
    outliers = dataframe[(dataframe[column] < Q1 - 1.5*IQR) | (dataframe[colun
    return outliers

for column in df.columns:
    outliers = detect_outliers(df, column)
    print(f'Number of outliers in {column}: {len(outliers)}')
```

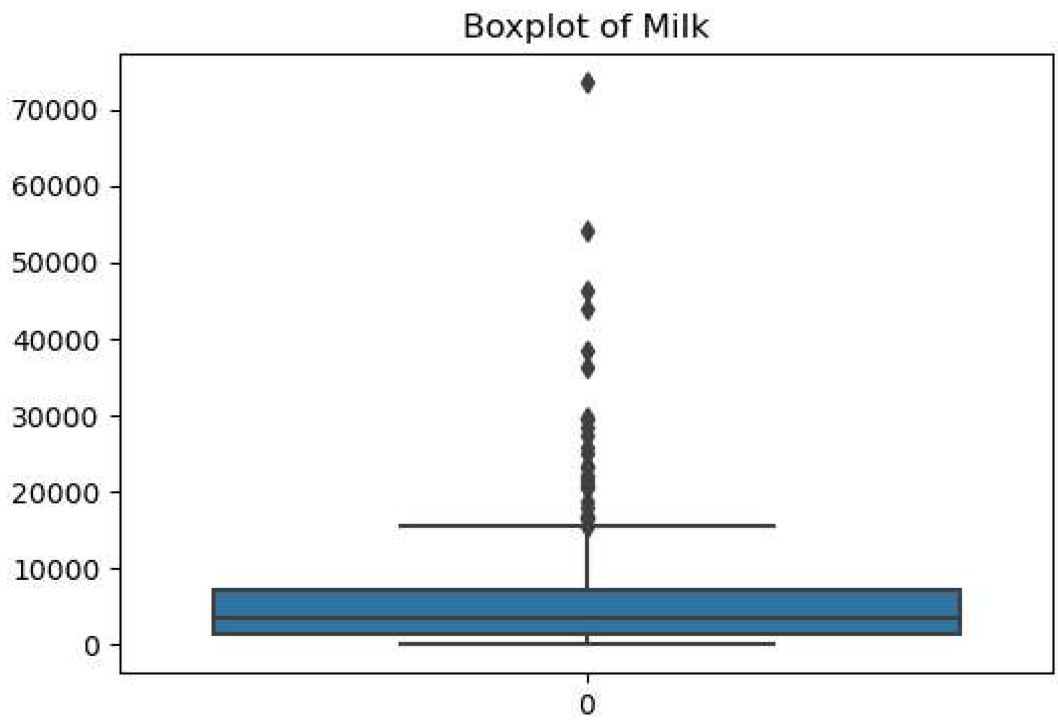




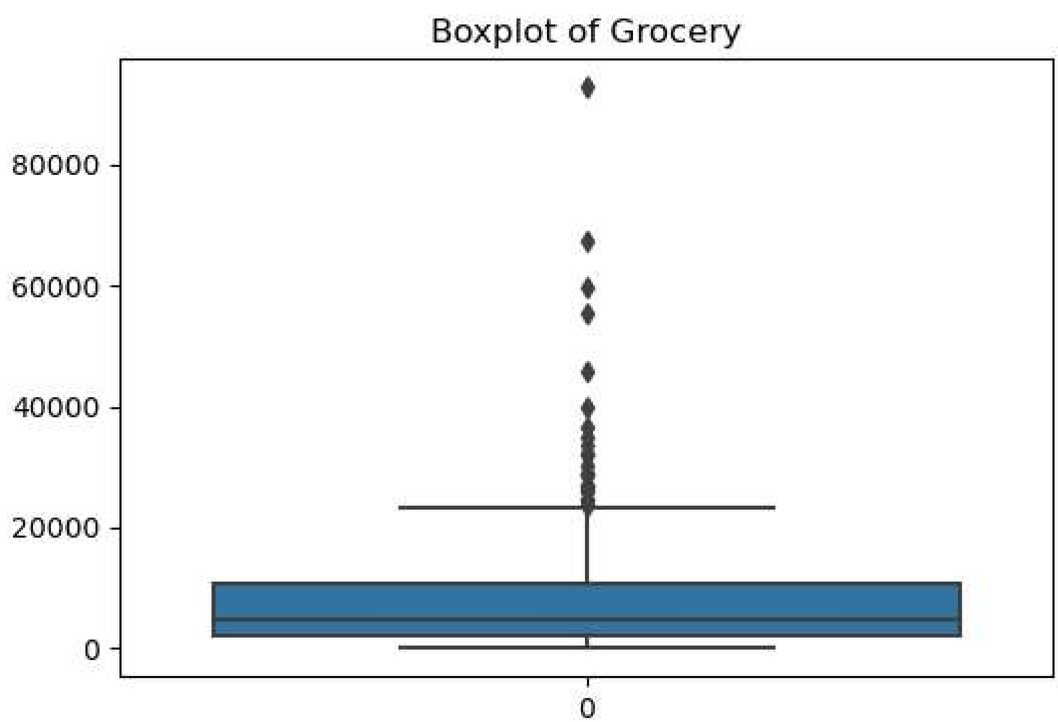
Boxplot of Region
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0



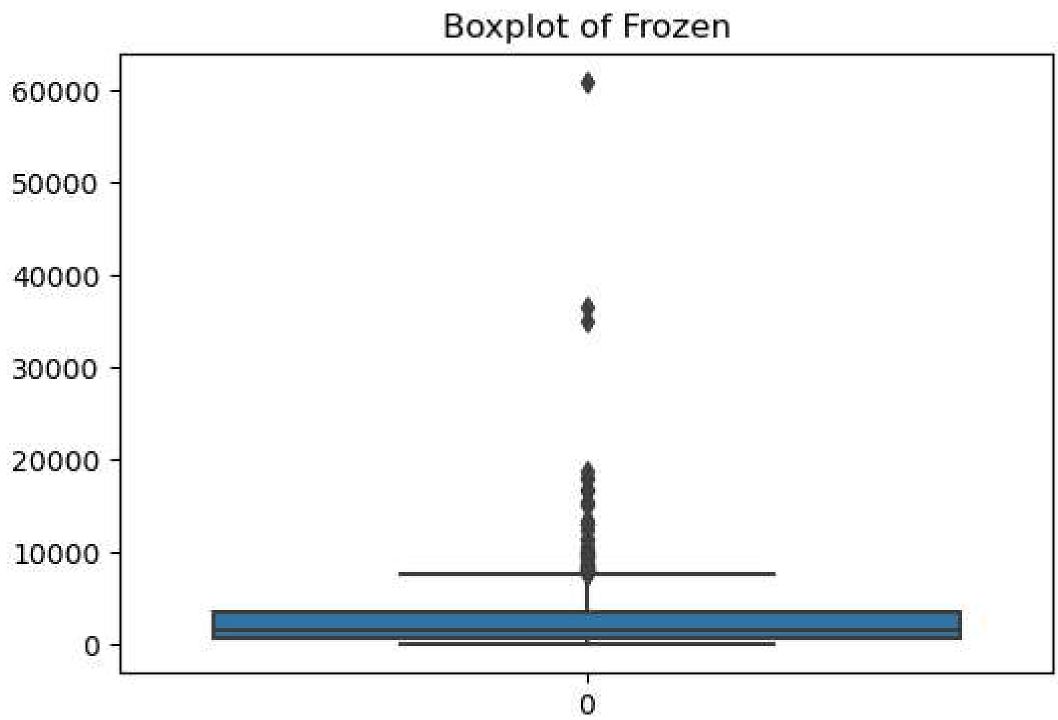
Boxplot of Fresh
100000
80000
60000
40000
20000
0
0

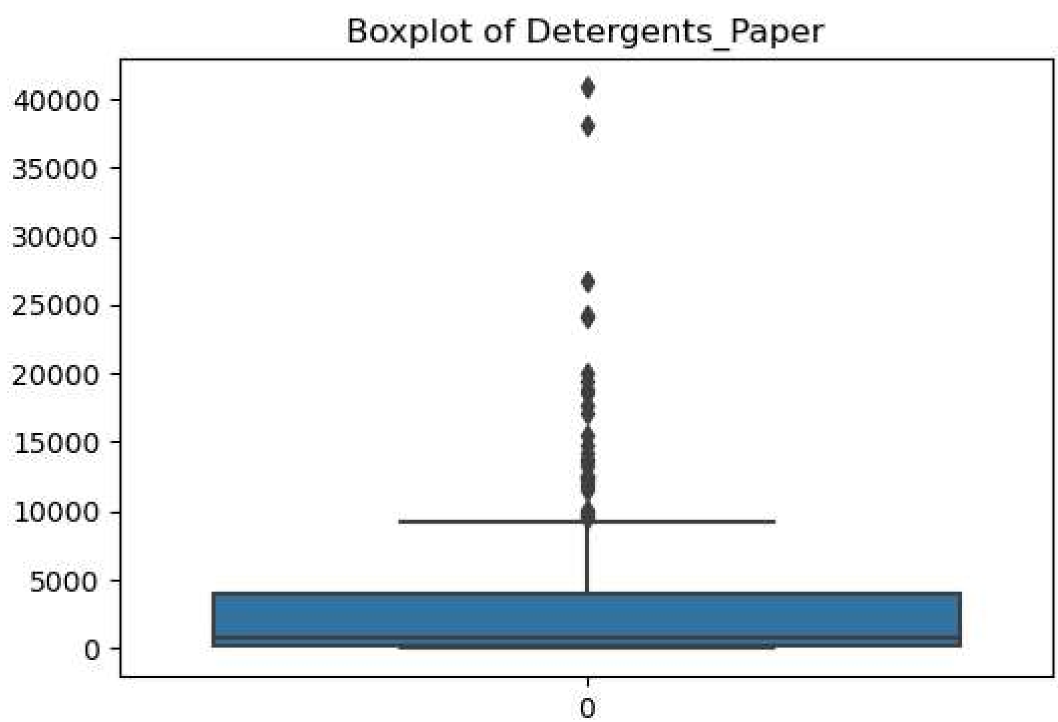


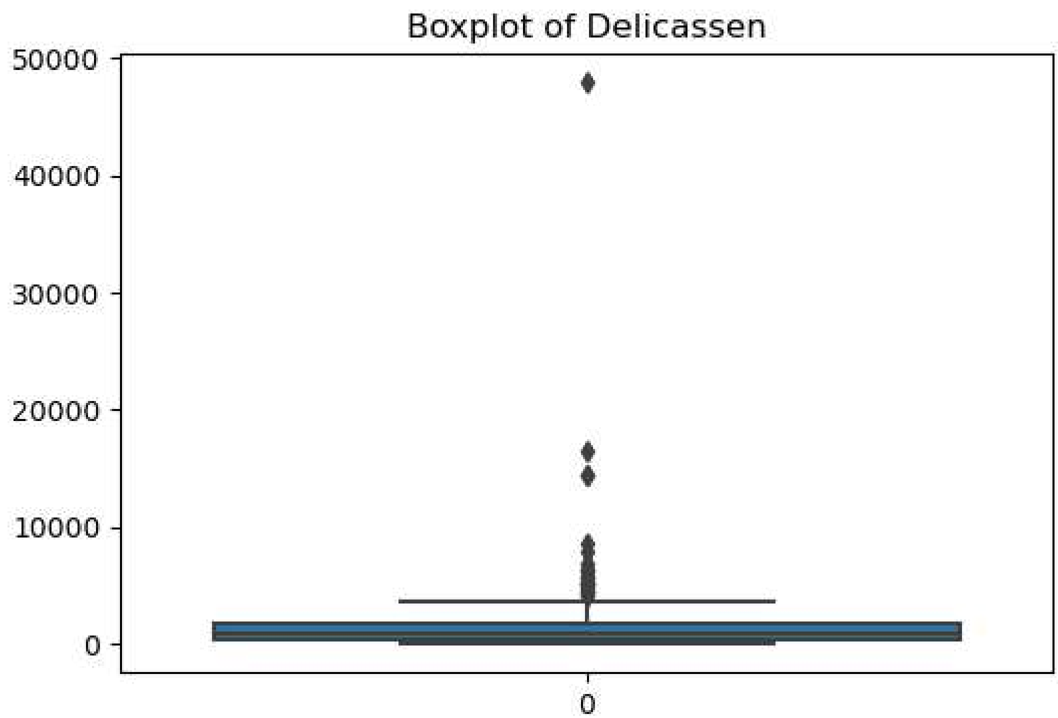
Boxplot of Milk
70000
60000
50000
40000
30000
20000
10000
0
0



Boxplot of Grocery
80000
60000
40000
20000
0
0


Boxplot of Frozen
60000
50000
40000
30000
20000
10000
0
0


Boxplot of Detergents_Paper
40000
35000
30000
25000
20000
15000
10000
5000
0
0

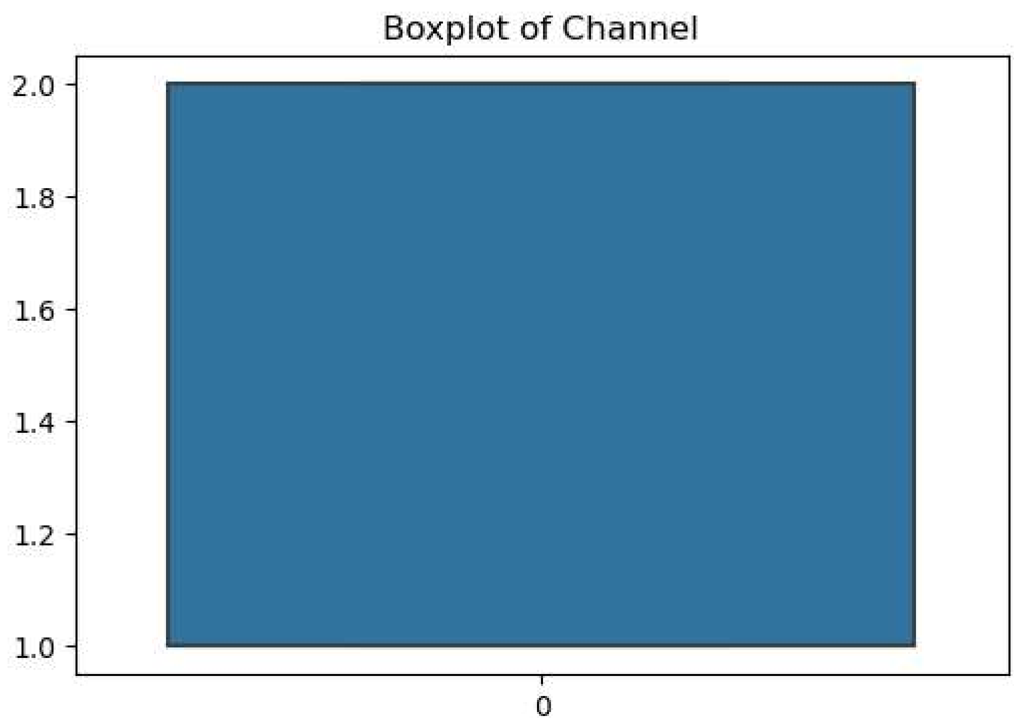


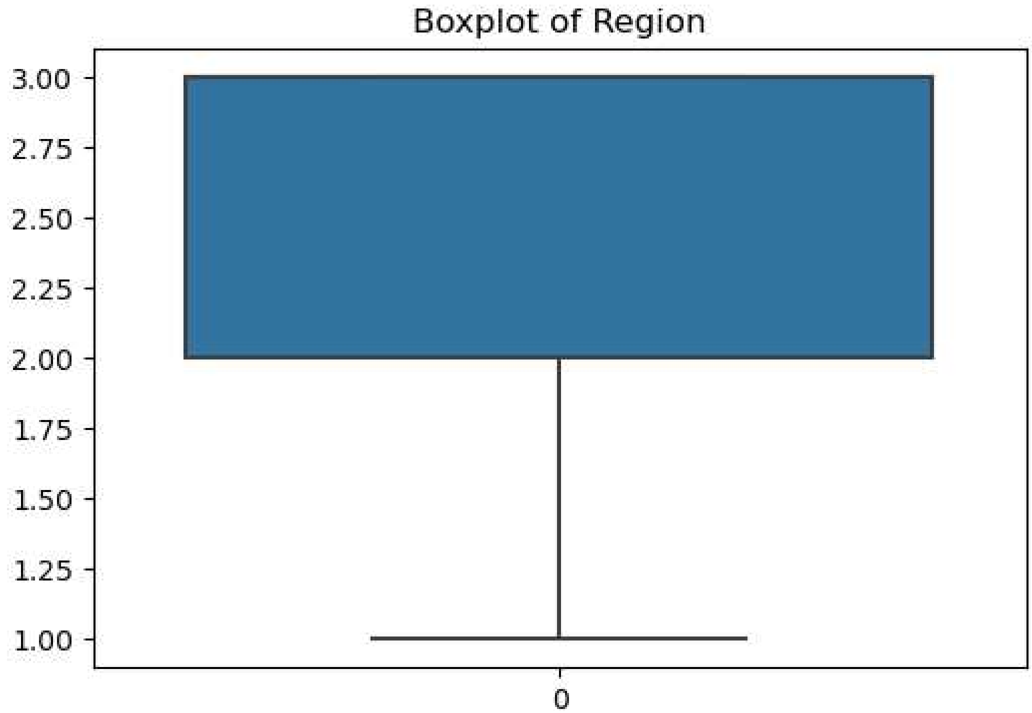

```
Number of outliers in Channel: 0
Number of outliers in Region: 0
Number of outliers in Fresh: 20
Number of outliers in Milk: 28
Number of outliers in Grocery: 24
Number of outliers in Frozen: 43
Number of outliers in Detergents_Paper: 30
Number of outliers in Delicassen: 27
```

In [11]:

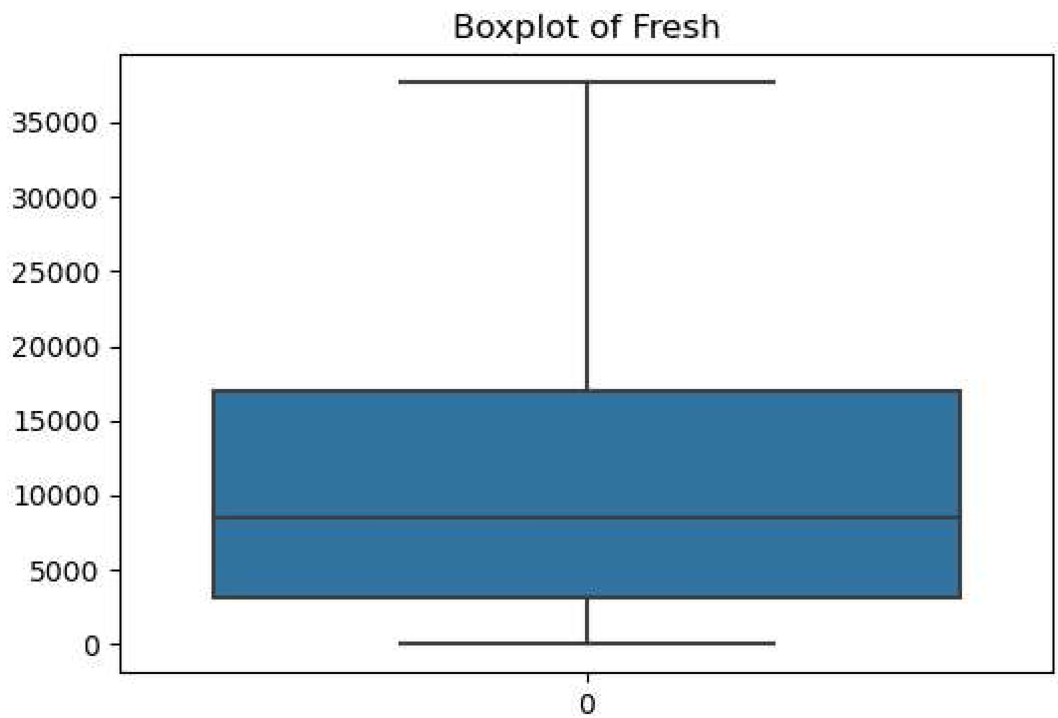
```
def handle_outliers(dataframe, column):
    Q1 = dataframe[column].quantile(0.25)
    Q3 = dataframe[column].quantile(0.75)
    IQR = Q3 - Q1
    lower_limit = Q1 - 1.5*IQR
    upper_limit = Q3 + 1.5*IQR
    dataframe[column] = dataframe[column].apply(lambda x: upper_limit if x > u

for column in df.columns:
    handle_outliers(df, column)
```

In [12]:
```
import seaborn as sns
import matplotlib.pyplot as plt

for column in df.columns:
    plt.figure(figsize=(6, 4))
    sns.boxplot(df[column])
    plt.title(f'Boxplot of {column}')
    plt.show()

for column in df.columns:
    plt.figure(figsize=(6, 4))
    sns.histplot(df[column], bins=30, kde=True)
    plt.title(f'Distribution of {column}')
    plt.show()
```

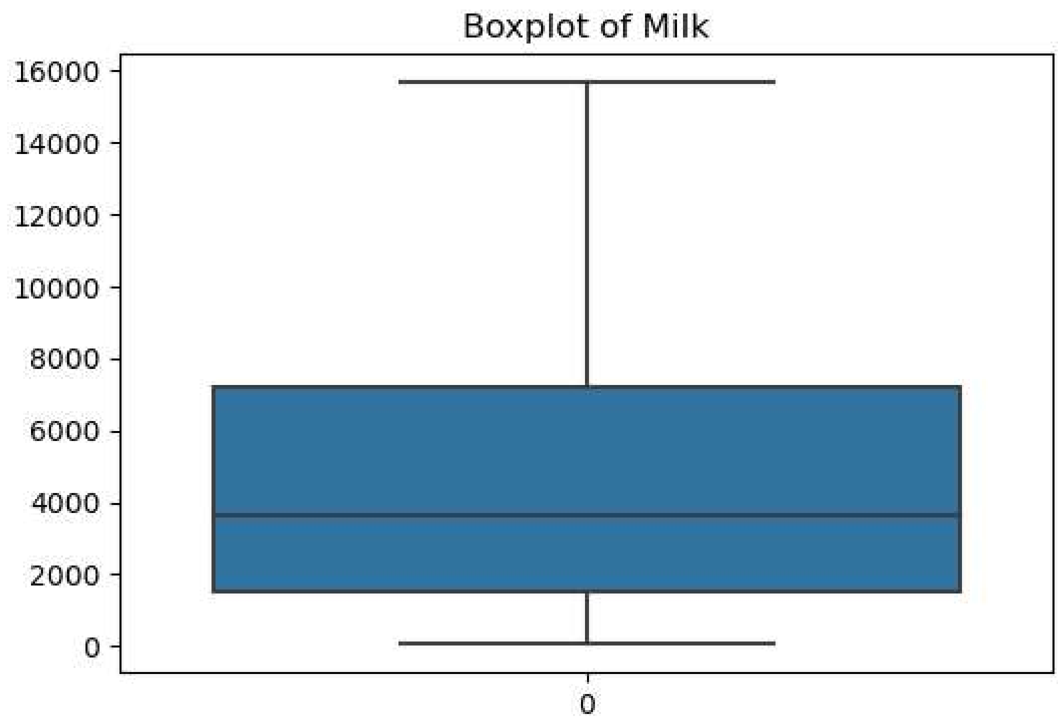




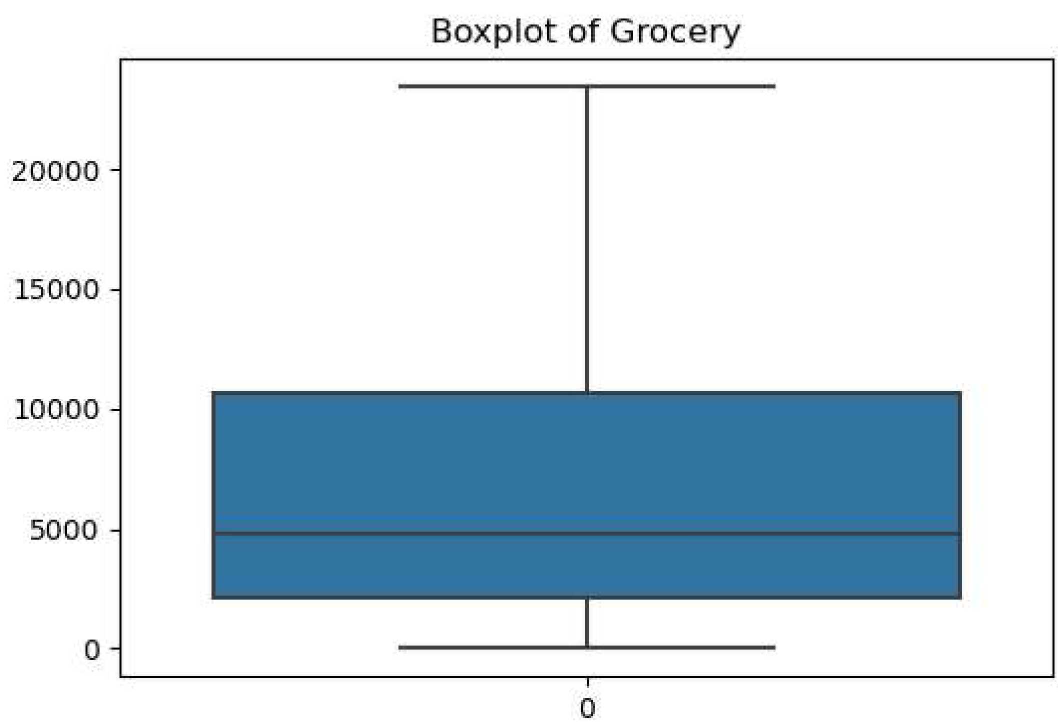
Boxplot of Region
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0



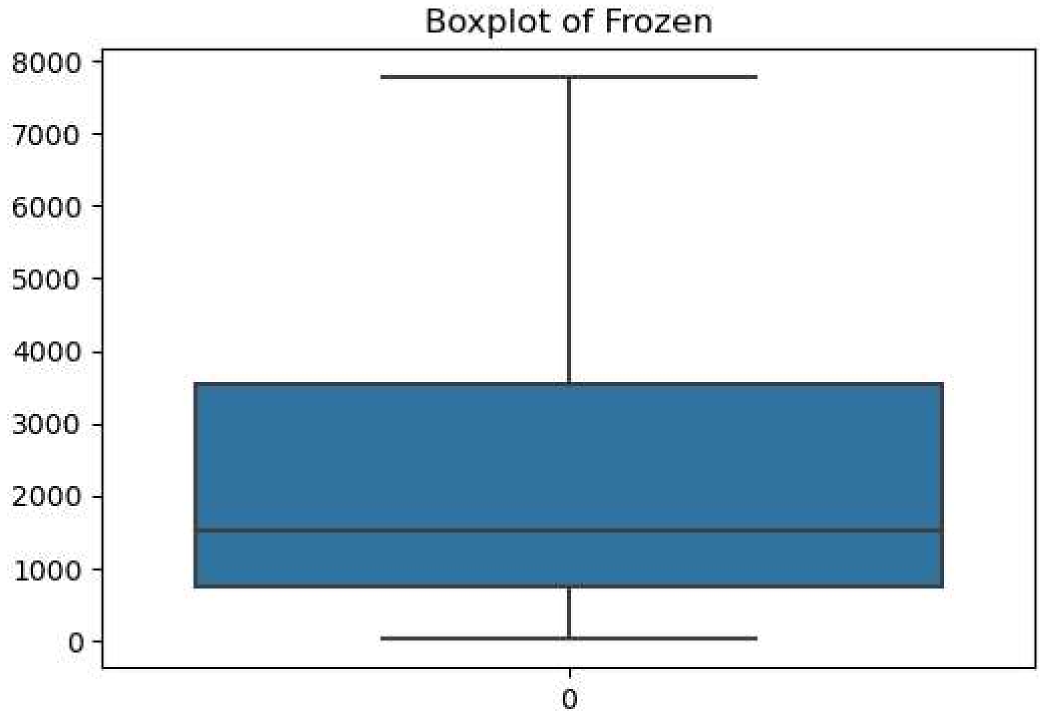
Boxplot of Fresh
35000
30000
25000
20000
15000
10000
5000
0
0

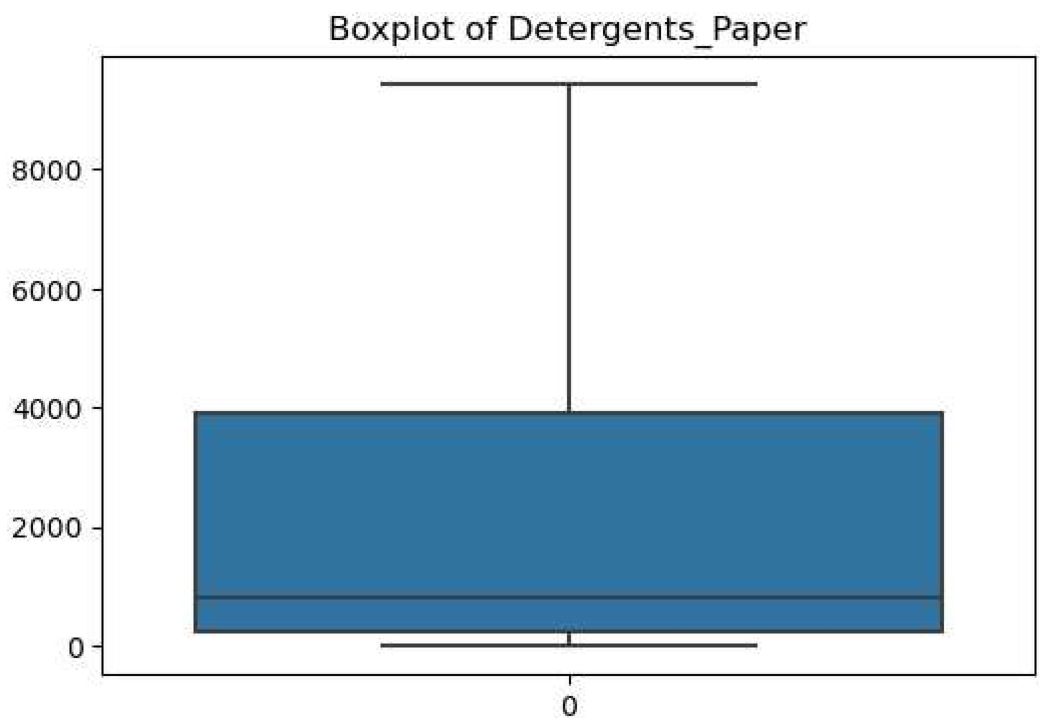


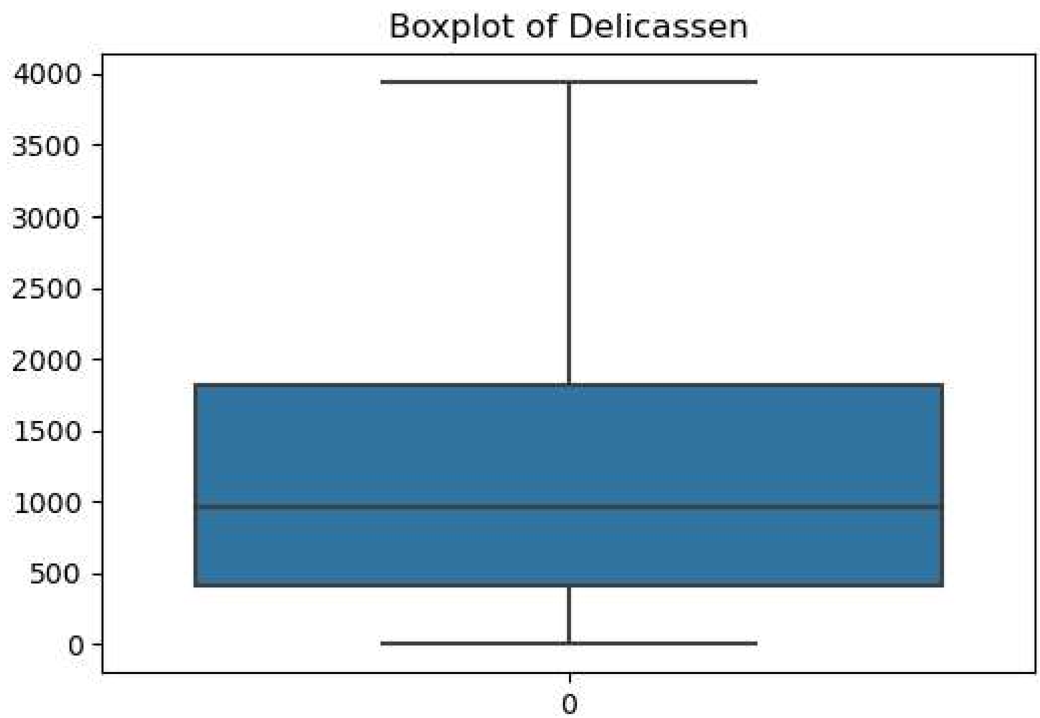
Boxplot of Milk
16000
14000
12000
10000
8000
6000
4000
2000
0
0



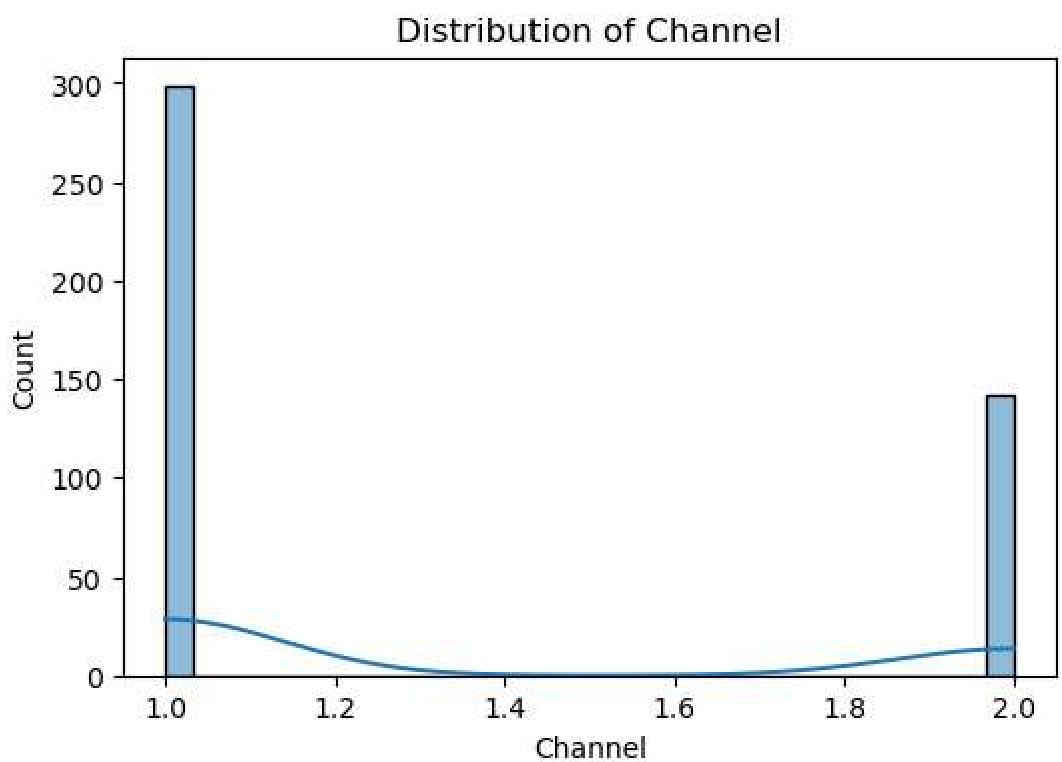
Boxplot of Grocery
20000
15000
10000
5000
0
0


Boxplot of Frozen
8000
7000
6000
5000
4000
3000
2000
1000
0
0

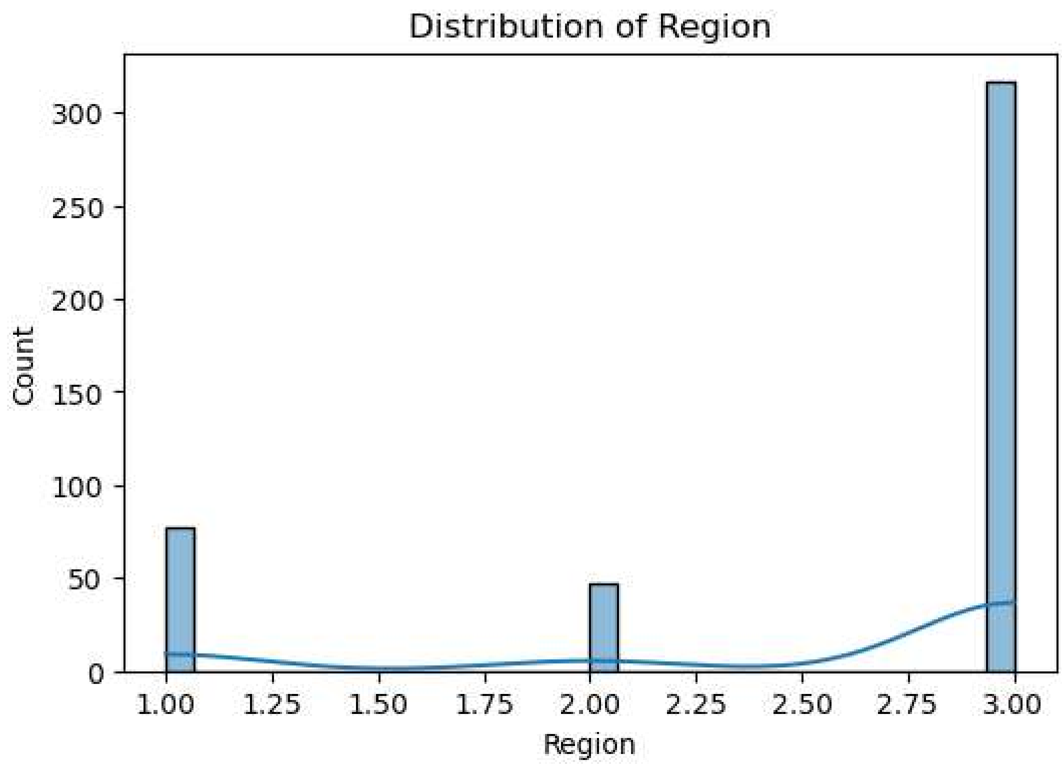

Boxplot of Detergents_Paper
8000
6000
4000
2000
0
0

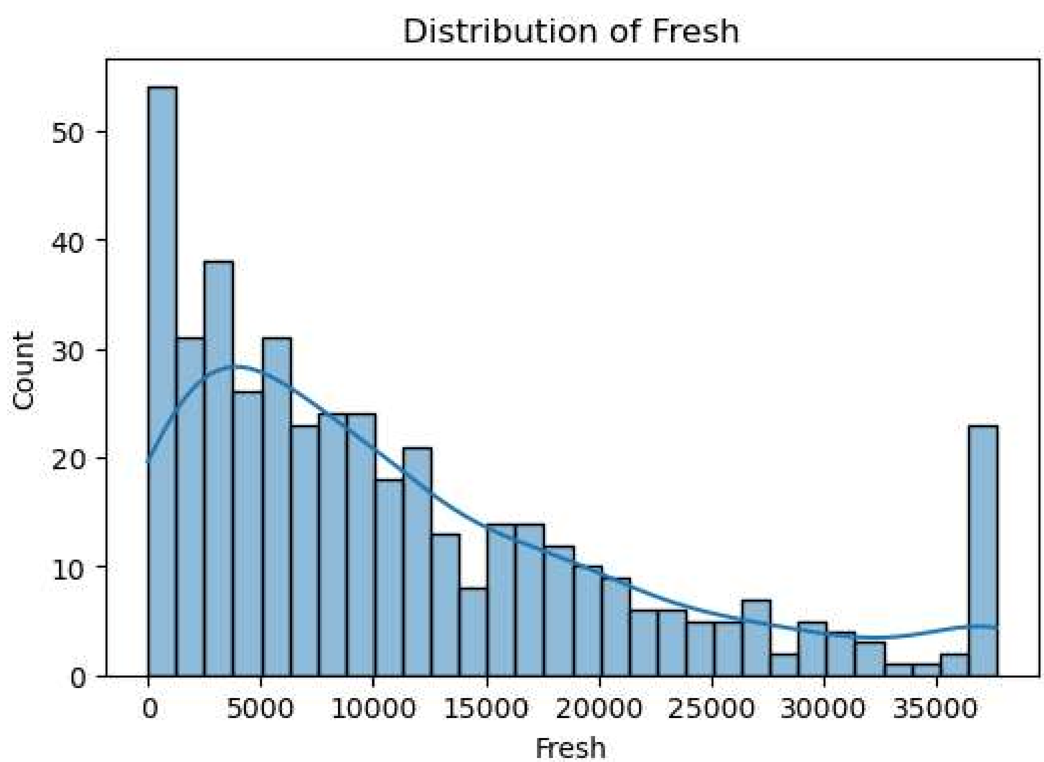


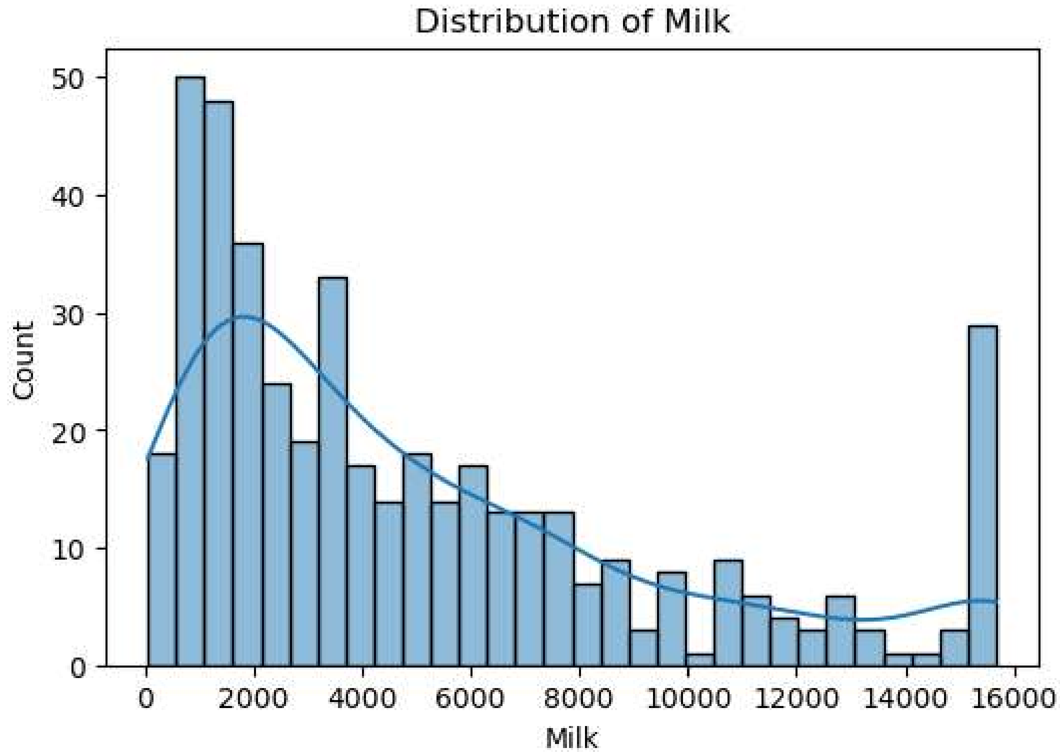
Boxplot of Delicassen
4000
3500
3000
2500
2000
1500
1000
500
0
0



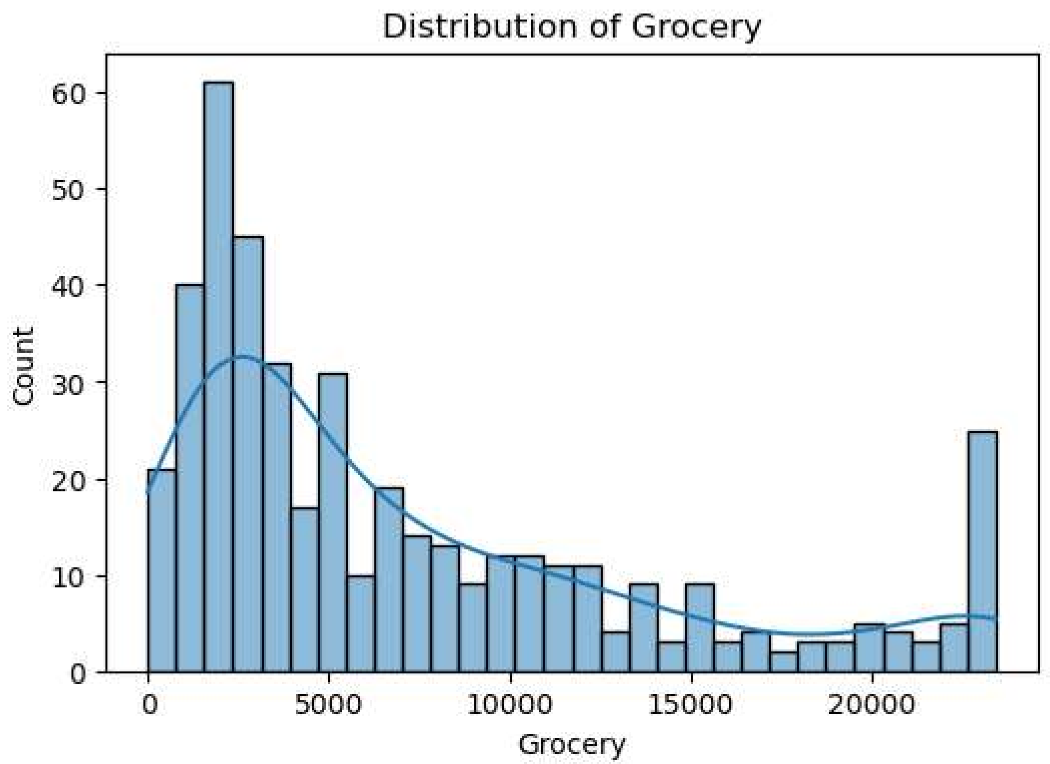
Distribution of Channel
300
250
200
150
100
50
0
Count
1.0
1.2
1.4
1.6
1.8
2.0
Channel


Distribution of Region
Count
Region
0
50
100
150
200
250
300
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00

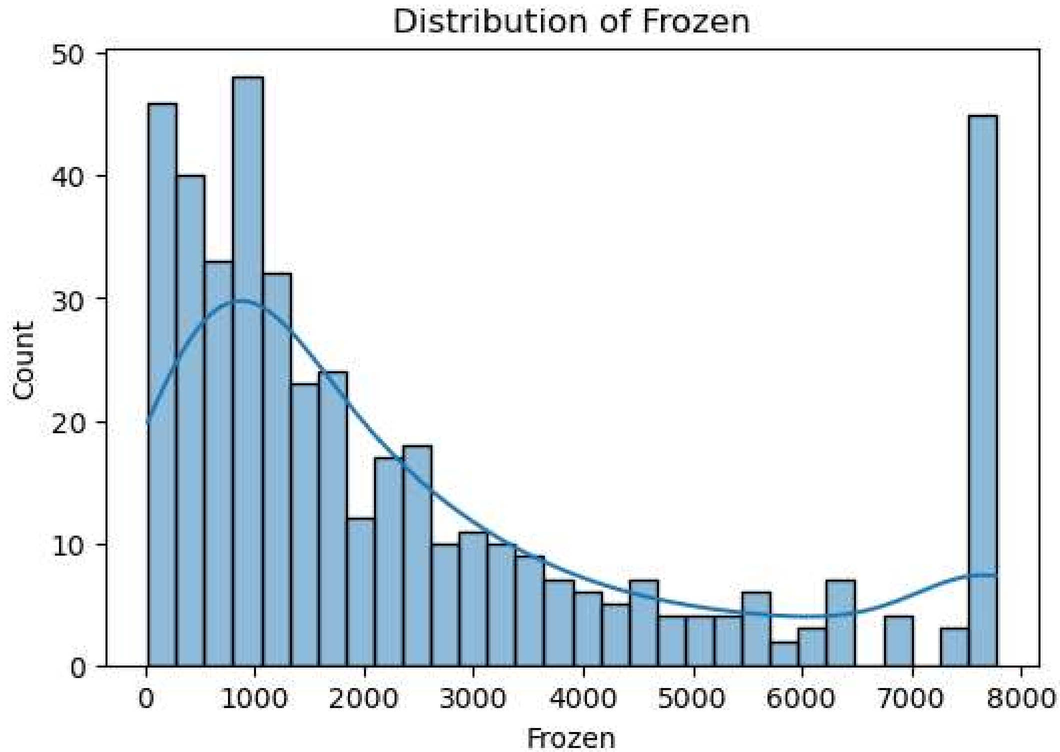

Distribution of Fresh
Count
Fresh
0
10
20
30
40
50
0
5000
10000
15000
20000
25000
30000
35000

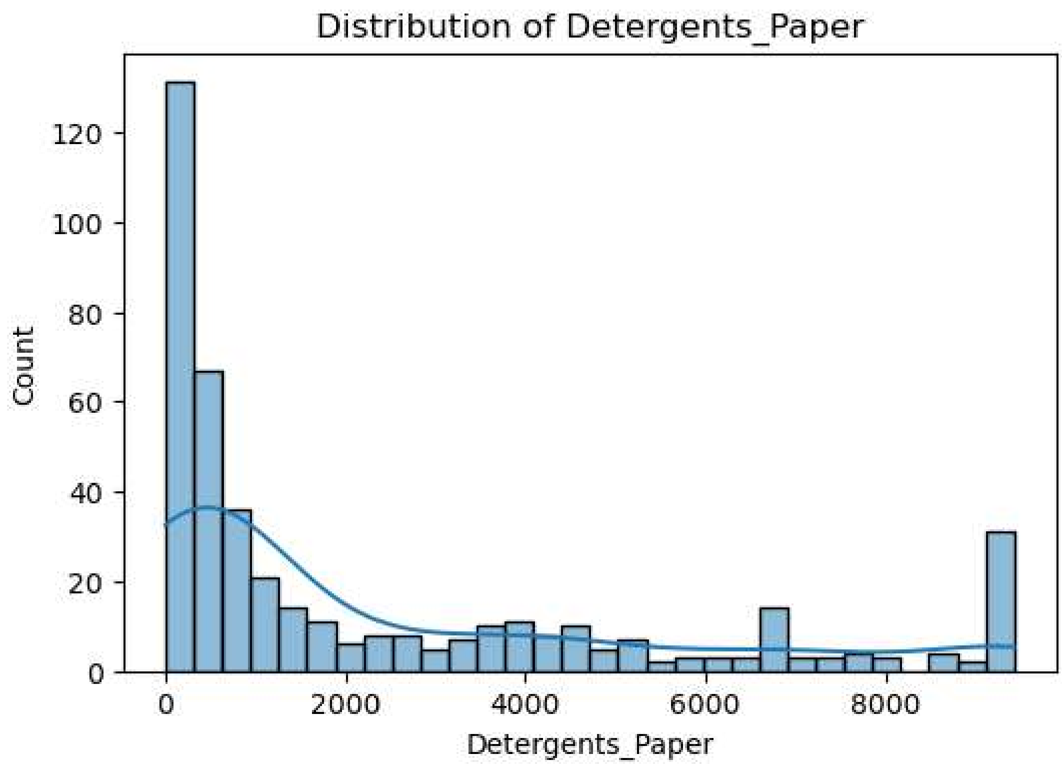


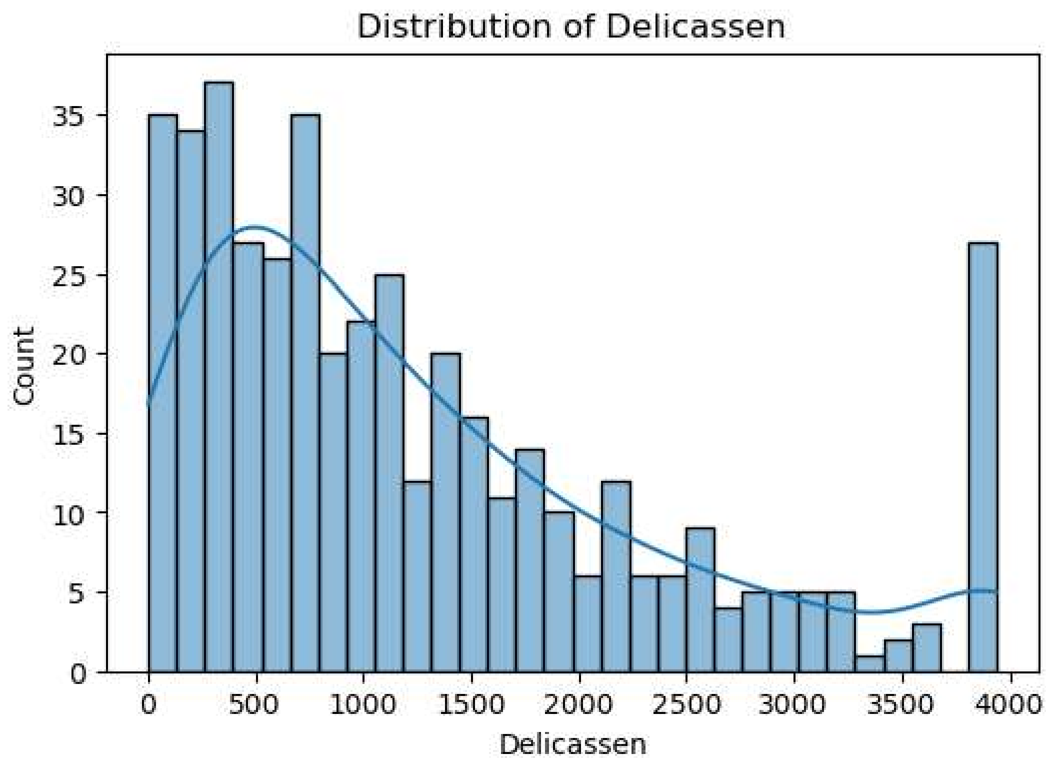
Distribution of Milk
Count
Milk
0
10
20
30
40
50
0
2000
4000
6000
8000
10000
12000
14000
16000



Distribution of Grocery
Count
Grocery
0
10
20
30
40
50
60
0
5000
10000
15000
20000


Distribution of Frozen
Count
Frozen
0
10
20
30
40
50
0
1000
2000
3000
4000
5000
6000
7000
8000


Distribution of Detergents_Paper
Count
Detergents_Paper
0
20
40
60
80
100
120
0
2000
4000
6000
8000

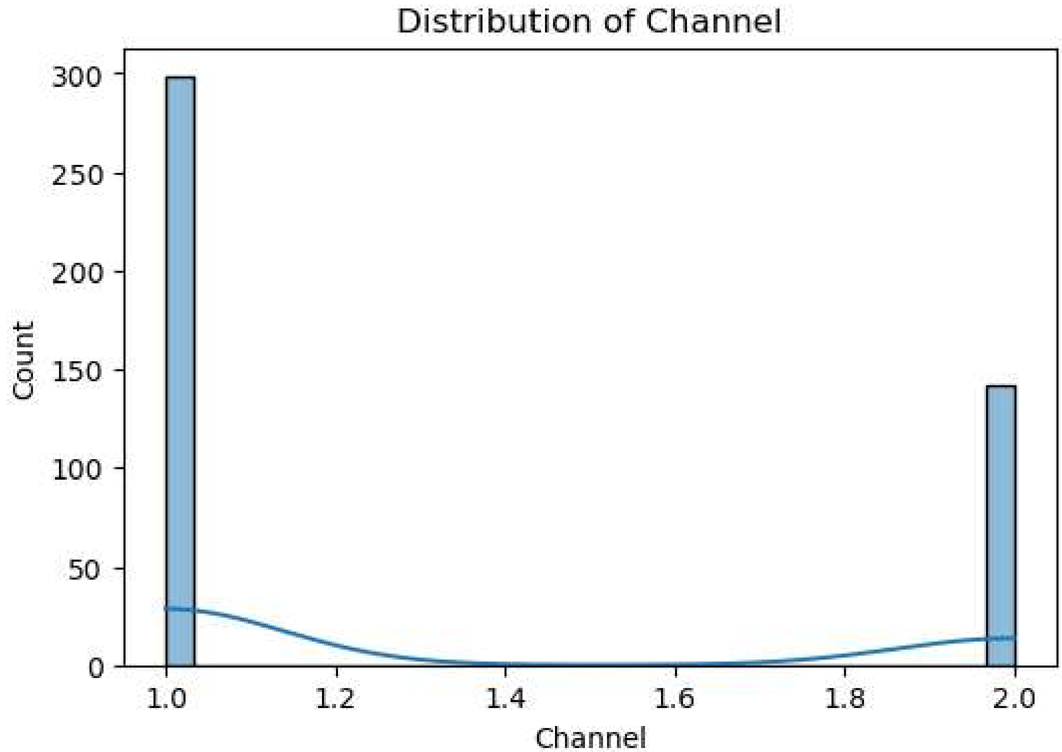


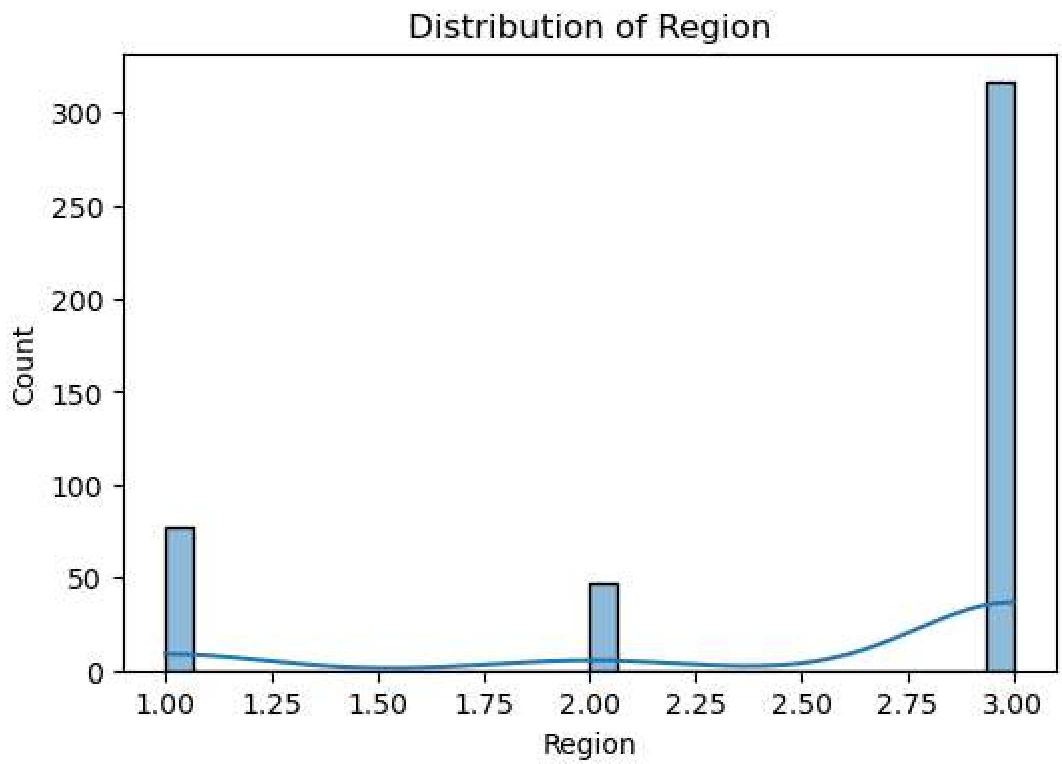
In [13]:
```
def detect_outliers(dataframe, column):
    Q1 = dataframe[column].quantile(0.25)
    Q3 = dataframe[column].quantile(0.75)
    IQR = Q3 - Q1
    outliers = dataframe[(dataframe[column] < Q1 - 1.5*IQR) | (dataframe[colur
    return outliers

for column in df.columns:
    outliers = detect_outliers(df, column)
    print(f'Number of outliers in {column}: {len(outliers)}')
```

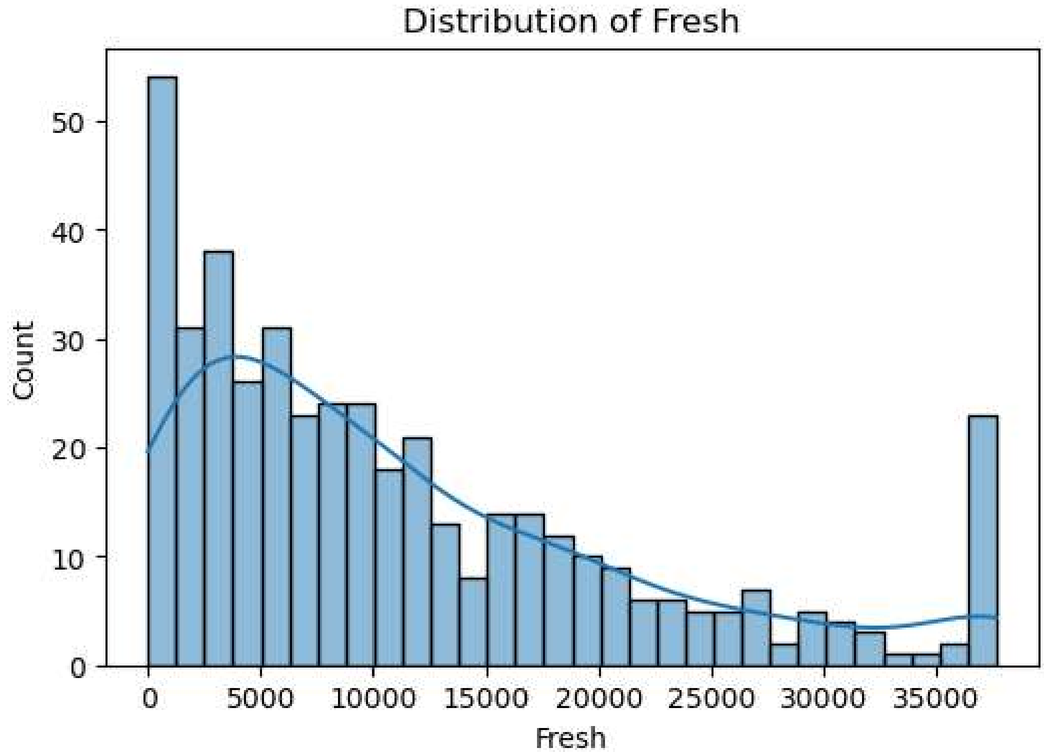
```
Number of outliers in Channel: 0
Number of outliers in Region: 0
Number of outliers in Fresh: 0
Number of outliers in Milk: 0
Number of outliers in Grocery: 0
Number of outliers in Frozen: 0
Number of outliers in Detergents_Paper: 0
Number of outliers in Delicassen: 0
```

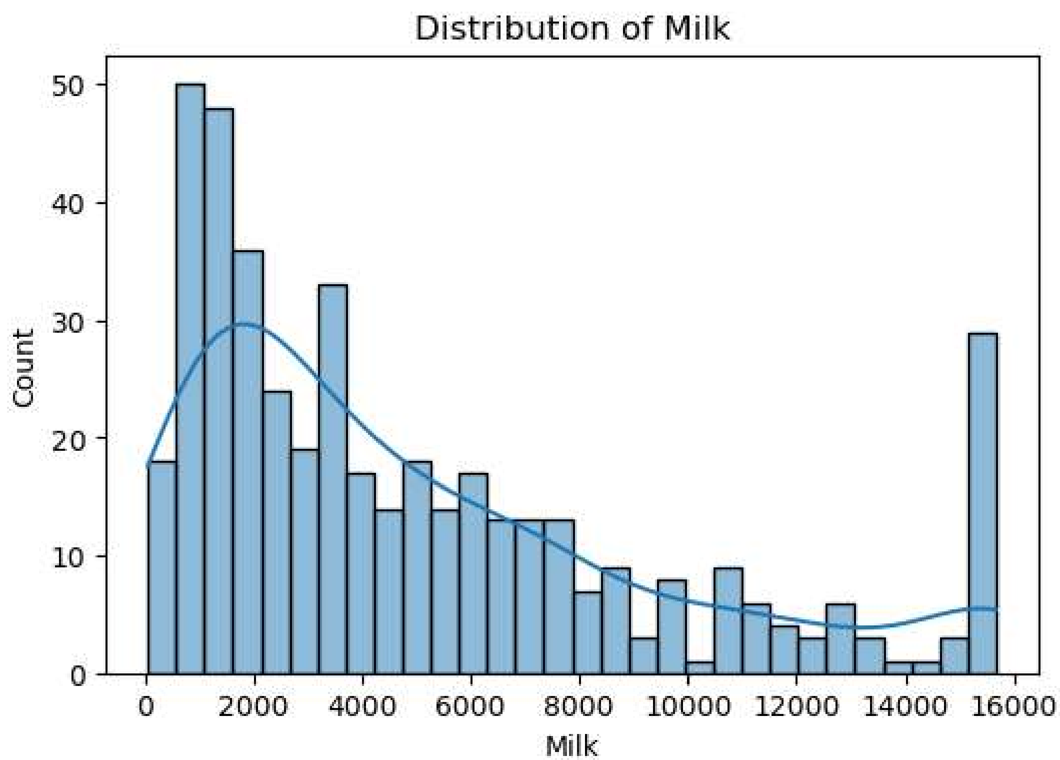
In [14]:
```
print("Descriptive Statistics:")
print(df.describe())

print("Number of duplicate rows: ", df.duplicated().sum())

for column in df.columns:
    plt.figure(figsize=(6, 4))
    sns.histplot(df[column], bins=30, kde=True)
    plt.title(f'Distribution of {column}')
    plt.show()

plt.figure(figsize=(10, 8))
sns.heatmap(df.corr(), annot=True, cmap='coolwarm', center=0)
plt.title('Correlation Heatmap')
plt.show()
```

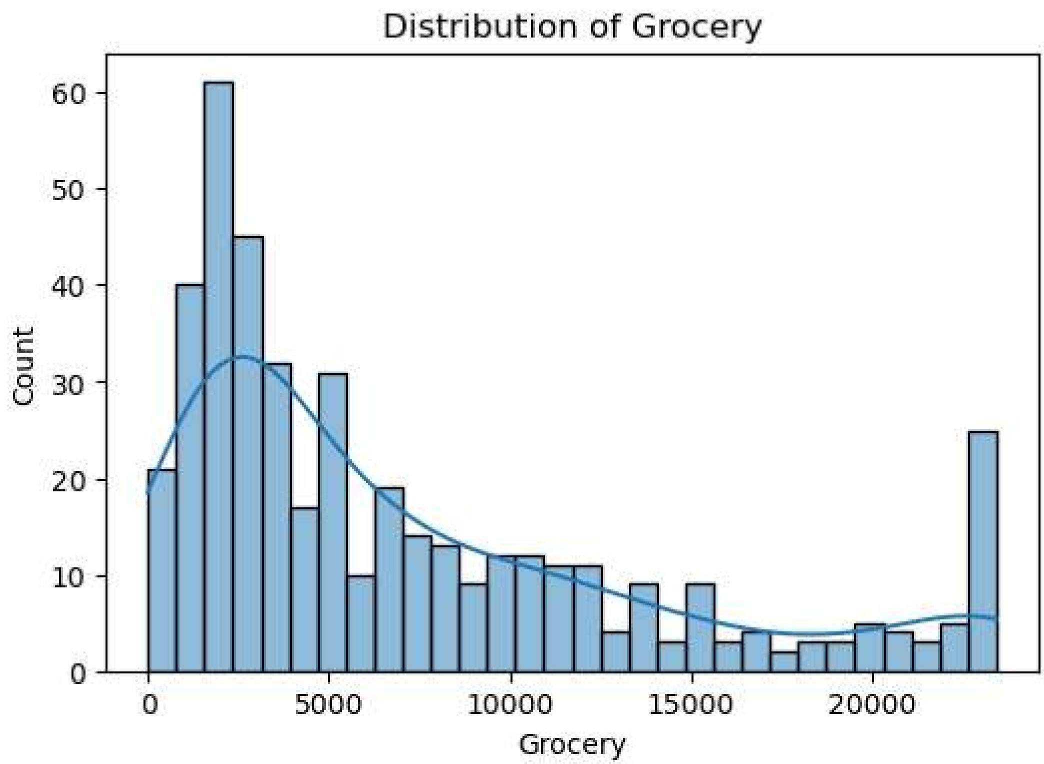
```
Descriptive Statistics:
          Channel      Region         Fresh          Milk      Grocery  \
count  440.000000  440.000000    440.000000    440.000000    440.00000   
mean     1.322727    2.543182  11357.568182   5048.592045   7236.37500   
std      0.468052    0.774272  10211.542235   4386.377073   6596.53308   
min      1.000000    1.000000      3.000000     55.000000      3.00000   
25%      1.000000    2.000000   3127.750000   1533.000000   2153.00000   
50%      1.000000    3.000000   8504.000000   3627.000000   4755.50000   
75%      2.000000    3.000000  16933.750000   7190.250000  10655.75000   
max      2.000000    3.000000  37642.750000  15676.125000  23409.87500   

            Frozen  Detergents_Paper   Delicassen  
count   440.000000        440.000000   440.000000  
mean   2507.085795       2392.616477  1266.715341  
std    2408.297738       2940.794090  1083.069792  
min      25.000000          3.000000     3.000000  
25%     742.250000        256.750000   408.250000  
50%    1526.000000        816.500000   965.500000  
75%    3554.250000       3922.000000  1820.250000  
max    7772.250000       9419.875000  3938.250000  
Number of duplicate rows:  0
```


Distribution of Channel
300
250
200
150
100
50
0
Count
1.0
1.2
1.4
1.6
1.8
2.0
Channel

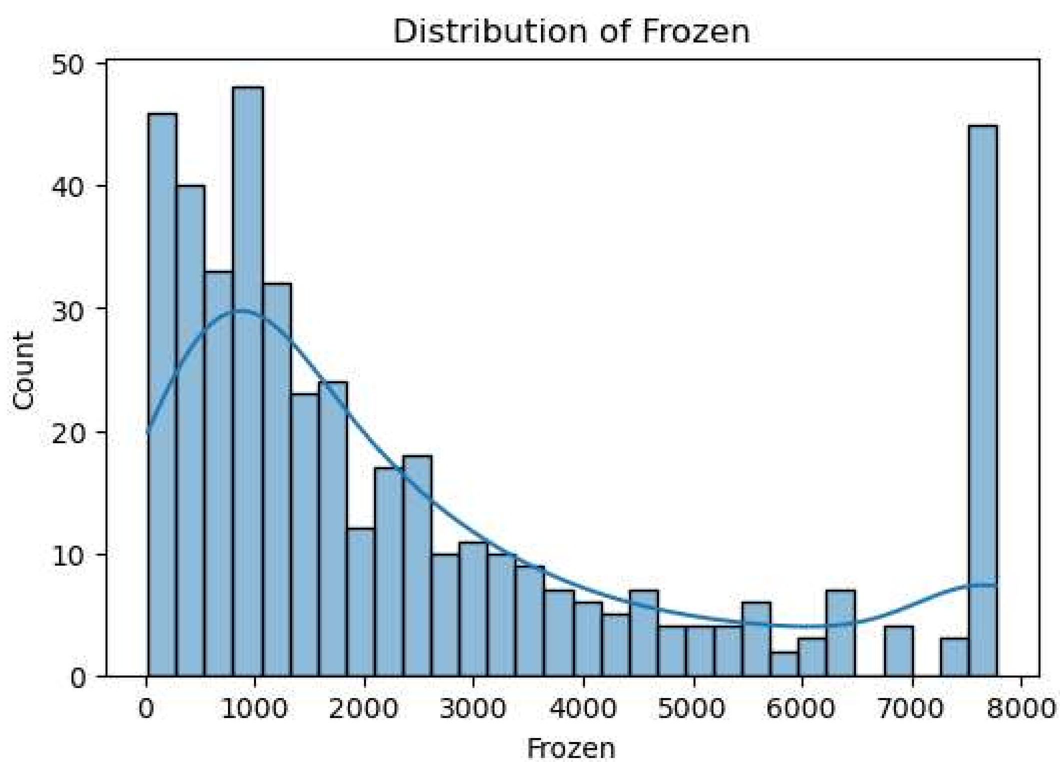

Distribution of Region
300
250
200
150
100
50
0
Count
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
Region


Distribution of Fresh
Count
0
10
20
30
40
50
0
5000
10000
15000
20000
25000
30000
35000
Fresh

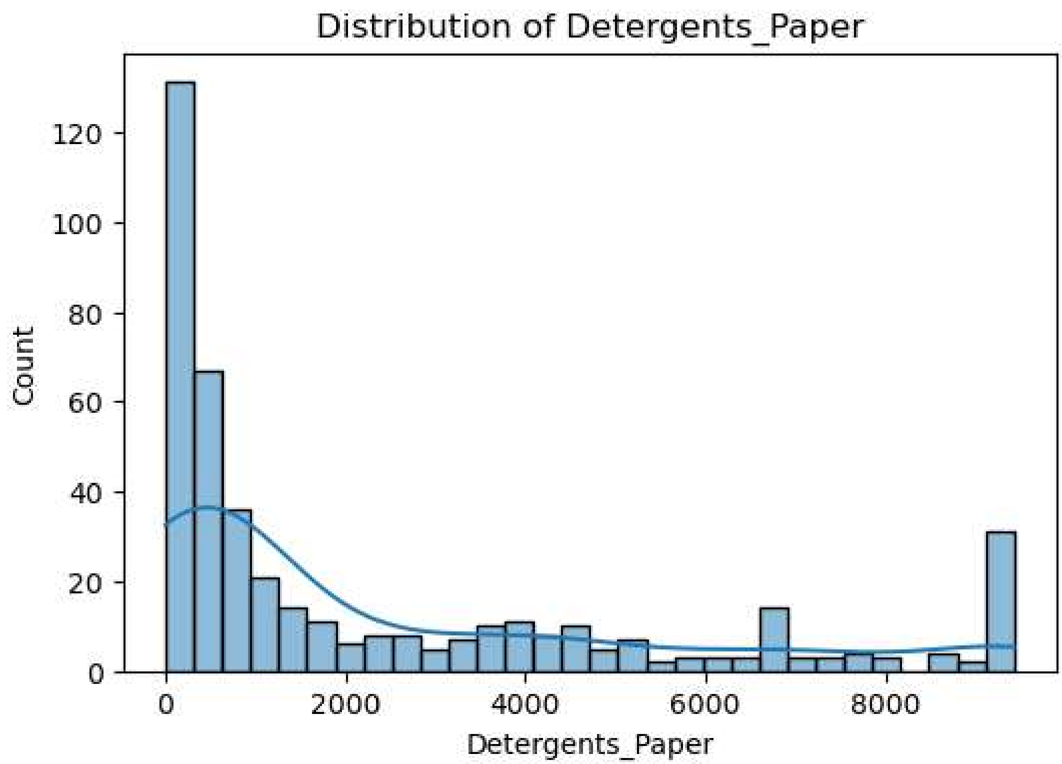

Distribution of Milk
Count
0
10
20
30
40
50
0
2000
4000
6000
8000
10000
12000
14000
16000
Milk

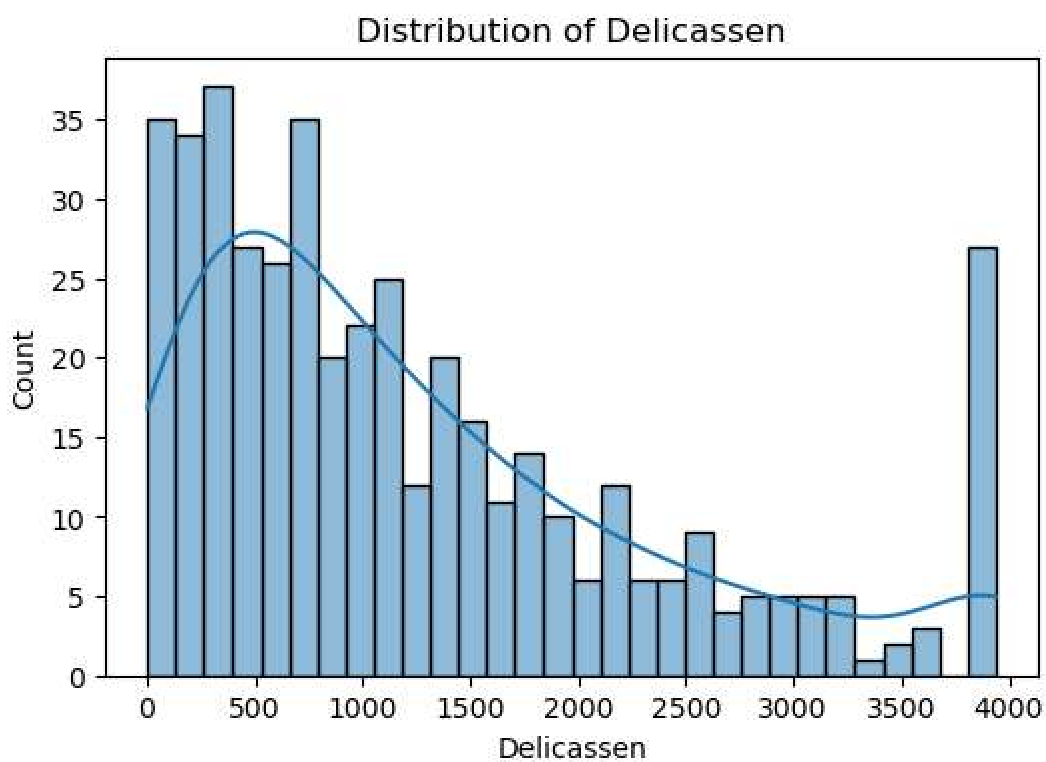


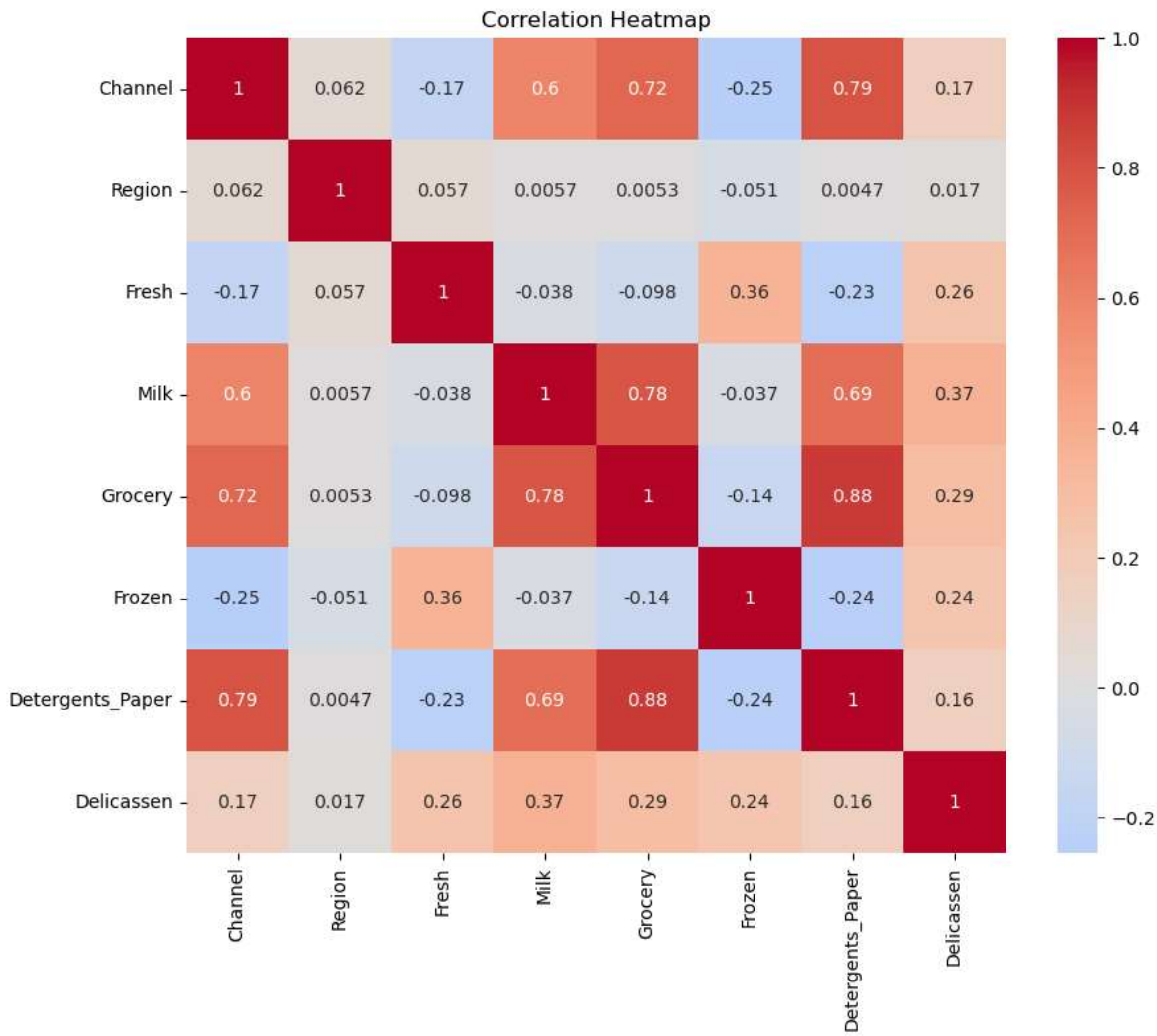
Distribution of Grocery
Count
Grocery
0
10
20
30
40
50
60
0
5000
10000
15000
20000



Distribution of Frozen
Count
Frozen
0
10
20
30
40
50
0
1000
2000
3000
4000
5000
6000
7000
8000


Distribution of Detergents_Paper
Count
120
100
80
60
40
20
0
0
2000
4000
6000
8000
Detergents_Paper


Distribution of Delicassen
Count
35
30
25
20
15
10
5
0
0
500
1000
1500
2000
2500
3000
3500
4000
Delicassen

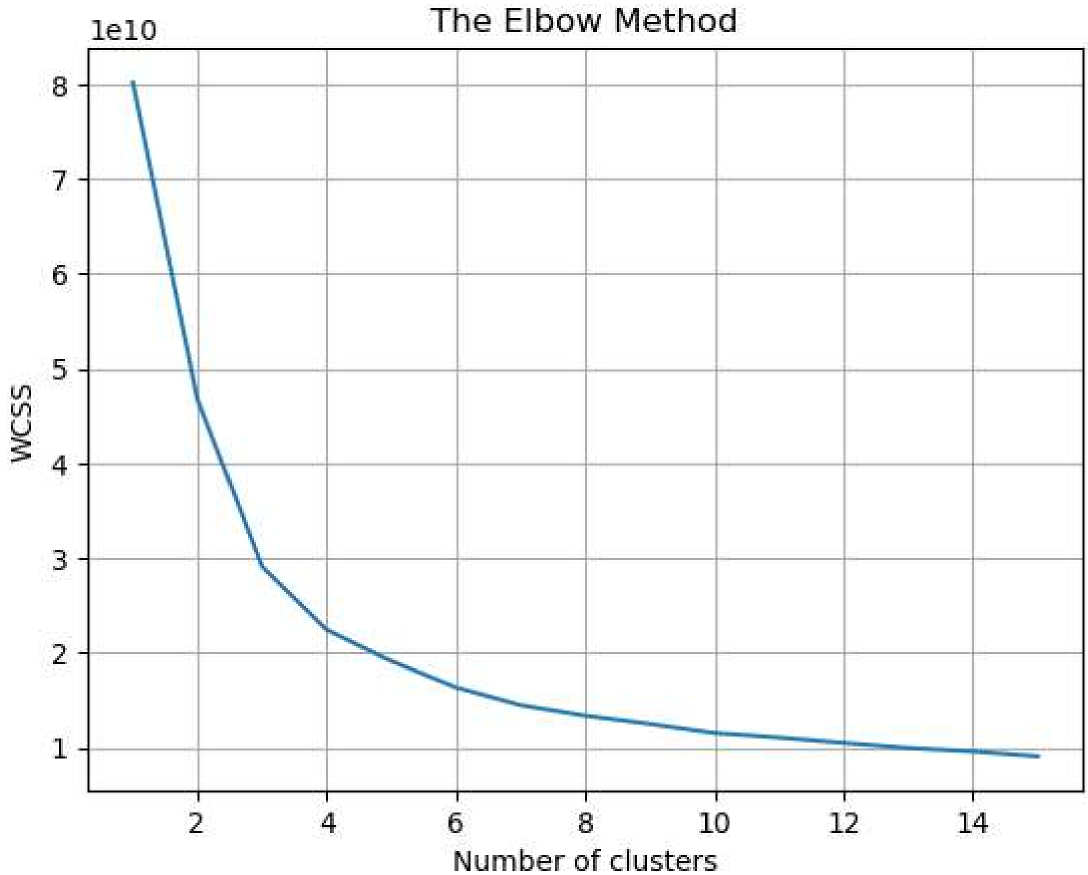


In [15]:
```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
df_scaled = pd.DataFrame(scaler.fit_transform(df), columns=df.columns)
```

In [16]:
```
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt

wcss = []
max_clusters = 15
for i in range(1, max_clusters+1):
    kmeans = KMeans(n_clusters=i, init='k-means++', random_state=42)
    kmeans.fit(df)
    wcss.append(kmeans.inertia_)

plt.plot(range(1, max_clusters+1), wcss)
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.grid(True)
plt.show()
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
```

```
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```



In [17]:
```
from sklearn.cluster import KMeans

kmeans = KMeans(n_clusters=4, init='k-means++', random_state=42)
kmeans.fit(df)

cluster_labels = kmeans.labels_

df['Cluster'] = cluster_labels

print(df.head())
```

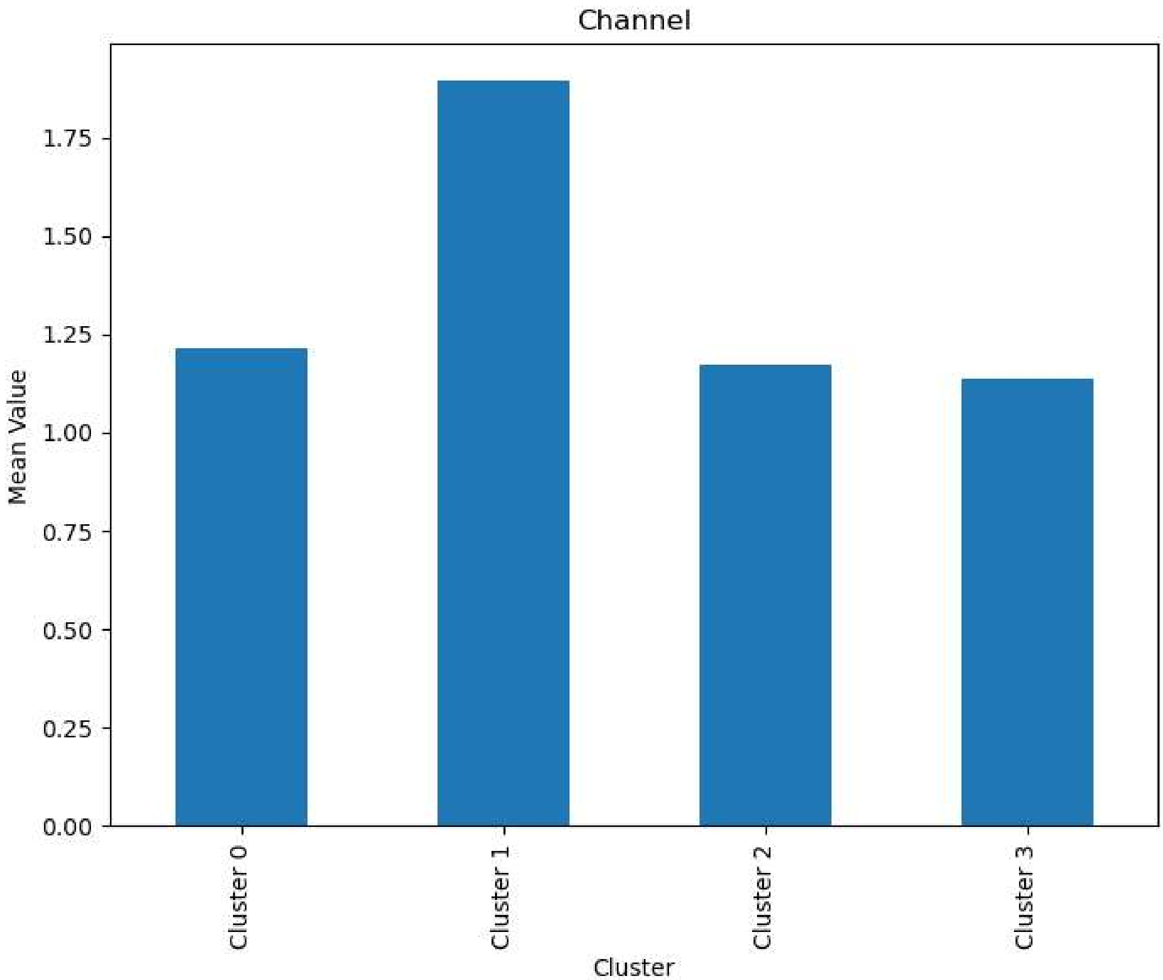
```
   Channel  Region    Fresh    Milk  Grocery  Frozen  Detergents_Paper  \
0        2       3  12669.0  9656.0   7561.0   214.0            2674.0   
1        2       3   7057.0  9810.0   9568.0  1762.0            3293.0   
2        2       3   6353.0  8808.0   7684.0  2405.0            3516.0   
3        1       3  13265.0  1196.0   4221.0  6404.0             507.0   
4        2       3  22615.0  5410.0   7198.0  3915.0            1777.0   

   Delicassen  Cluster  
0     1338.00        0  
1     1776.00        1  
2     3938.25        3  
3     1788.00        0  
4     3938.25        0  

/opt/conda/lib/python3.10/site-packages/sklearn/cluster/_kmeans.py:870: Futu
reWarning: The default value of `n_init` will change from 10 to 'auto' in 1.
4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

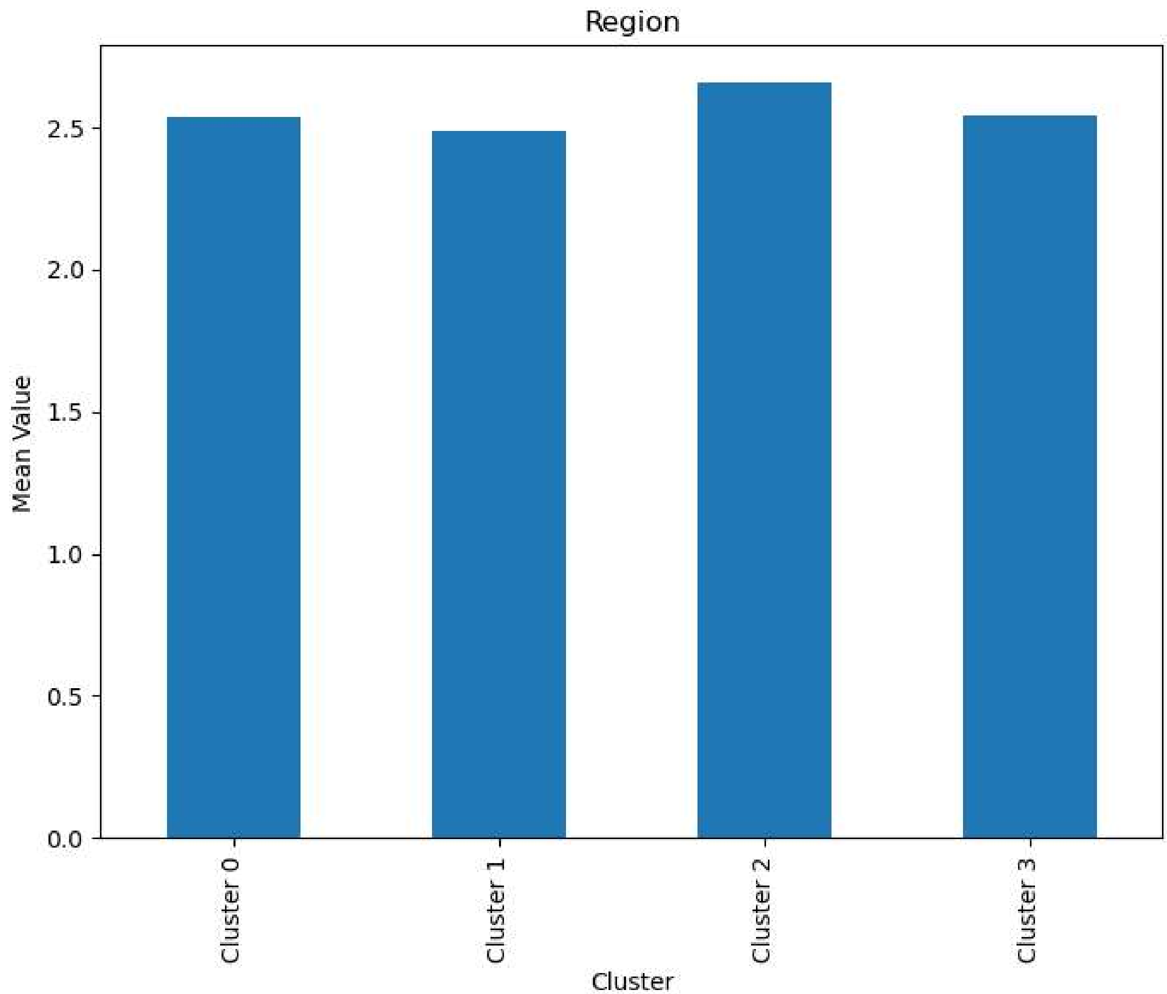
In [18]:
```
df['Cluster'] = kmeans.labels_

print("Cluster Sizes:\n", df['Cluster'].value_counts())

for i in range(4):
    print("\nCluster ", i)
    print(df[df['Cluster'] == i].describe())
```

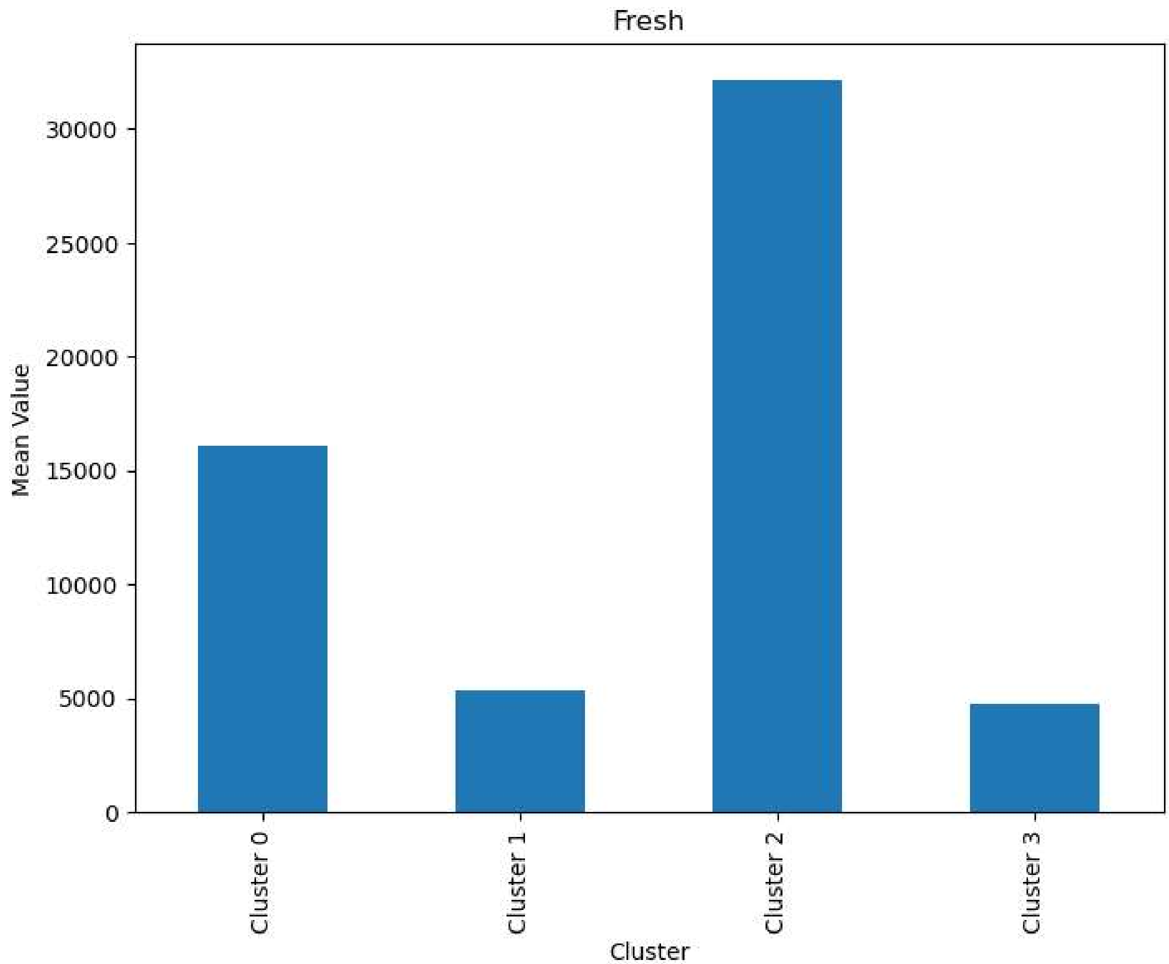
```
Cluster Sizes:
 3    176
0    112
1     94
2     58
Name: Cluster, dtype: int64

Cluster  0
          Channel      Region          Fresh          Milk       Grocery  \
count  112.000000  112.000000    112.000000    112.000000    112.000000
mean     1.214286    2.535714  16051.205357   3135.813616   4211.589286
std      0.412170    0.781873   3763.633078   2524.464860   3150.441587
min      1.000000    1.000000  10379.000000    134.000000      3.000000
25%      1.000000    2.000000  12419.750000   1283.500000   1970.500000
50%      1.000000    3.000000  16195.000000   2252.000000   3203.000000
75%      1.000000    3.000000  18830.250000   4537.000000   5700.250000
max      2.000000    3.000000  24929.000000  15676.125000  14982.000000

            Frozen  Detergents_Paper   Delicassen  Cluster
count   112.000000        112.000000   112.000000    112.0
mean   2988.859375        994.785714  1229.573661      0.0
std    2531.352938       1245.589613   963.527882      0.0
min     118.000000          3.000000    51.000000      0.0
25%    1018.750000        188.500000   514.250000      0.0
50%    2157.500000        456.500000   879.000000      0.0
75%    4276.000000       1404.000000  1804.500000      0.0
max    7772.250000       6707.000000  3938.250000      0.0

Cluster  1
         Channel     Region         Fresh          Milk       Grocery  \
count  94.000000  94.000000     94.000000     94.000000     94.000000
mean    1.893617   2.489362   5331.893617  10454.450798  17196.140957
std     0.309980   0.799794   5111.448153   3937.245330   4905.345002
min     1.000000   1.000000     18.000000   1266.000000   8852.000000
25%     2.000000   2.000000   1409.500000   7576.000000  12563.250000
50%     2.000000   3.000000   4047.000000  10601.000000  16596.000000
75%     2.000000   3.000000   7870.500000  14316.500000  22288.500000
max     2.000000   3.000000  22925.000000  15676.125000  23409.875000

            Frozen  Detergents_Paper   Delicassen  Cluster
count    94.000000         94.000000    94.000000     94.0
mean   1496.428191       6936.898936  1547.364362      1.0
std    1538.882840       2383.035957  1176.131062      0.0
min      25.000000        241.000000     3.000000      1.0
25%     438.500000       5274.250000   680.000000      1.0
50%     973.000000       6931.500000  1366.500000      1.0
75%    1900.000000       9419.875000  2157.750000      1.0
max    7772.250000       9419.875000  3938.250000      1.0

Cluster  2
         Channel     Region         Fresh          Milk       Grocery  \
count  58.000000  58.000000     58.000000     58.000000     58.000000
mean    1.172414   2.655172  32136.810345   5973.515086   7309.012931
std     0.381039   0.714554   5122.024937   4808.223223   5915.174661
min     1.000000   1.000000  22647.000000    286.000000    471.000000
25%     1.000000   3.000000  27207.500000   2393.000000   2726.250000
50%     1.000000   3.000000  31664.000000   4347.000000   5259.500000
```

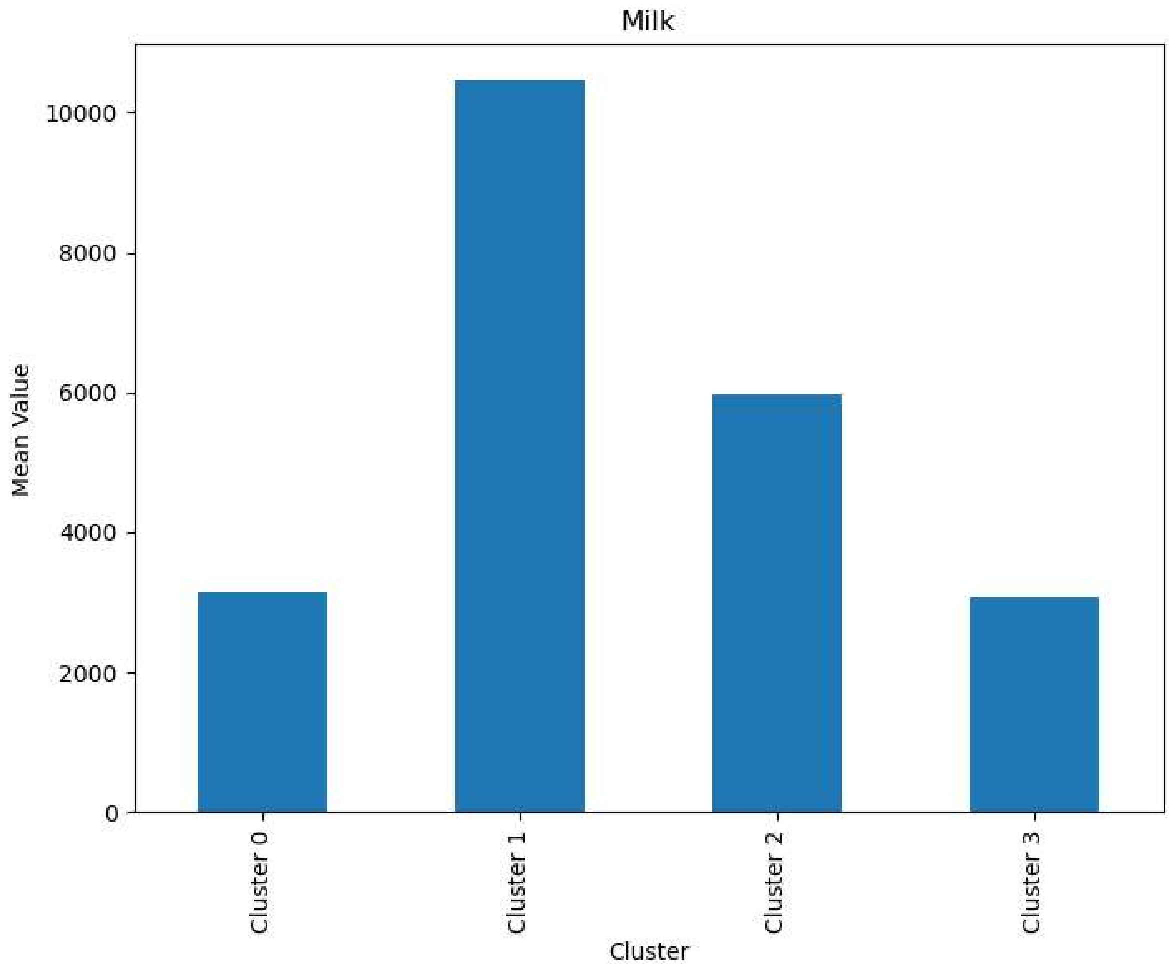
```
75%     1.000000   3.000000  37642.750000   7829.500000   9344.000000
max     2.000000   3.000000  37642.750000  15676.125000  23409.875000

            Frozen  Detergents_Paper   Delicassen  Cluster
count    58.000000         58.000000    58.000000     58.0
mean   4170.017241       1417.426724  1967.702586      2.0
std    2841.060439       2055.702539  1267.507352      0.0
min     127.000000         10.000000     3.000000      2.0
25%    1370.750000        250.250000  1037.250000      2.0
50%    3662.000000        617.500000  1821.500000      2.0
75%    7772.250000       1428.000000  2910.250000      2.0
max    7772.250000       9419.875000  3938.250000      2.0

Cluster  3
          Channel      Region          Fresh          Milk       Grocery  \
count  176.000000  176.000000    176.000000    176.000000    176.000000
mean     1.136364    2.539773   4741.261364   3073.790483   3817.880682
std      0.344153    0.777254   3072.006036   2492.137013   2790.348628
min      1.000000    1.000000      3.000000     55.000000    137.000000
25%      1.000000    2.000000   2116.000000   1109.000000   1739.250000
50%      1.000000    3.000000   4659.500000   2268.000000   2765.500000
75%      1.000000    3.000000   7369.250000   4394.250000   5494.500000
max      2.000000    3.000000  10290.000000  15676.125000  12400.000000

            Frozen  Detergents_Paper   Delicassen  Cluster
count   176.000000        176.000000   176.000000    176.0
mean   2192.274148       1176.454545   909.451705      3.0
std    2210.017535       1473.393792   872.339683      0.0
min      47.000000          5.000000     3.000000      3.0
25%     587.750000        216.500000   308.250000      3.0
50%    1310.000000        472.500000   674.500000      3.0
75%    2964.250000       1545.000000  1154.750000      3.0
max    7772.250000       7271.000000  3938.250000      3.0
```

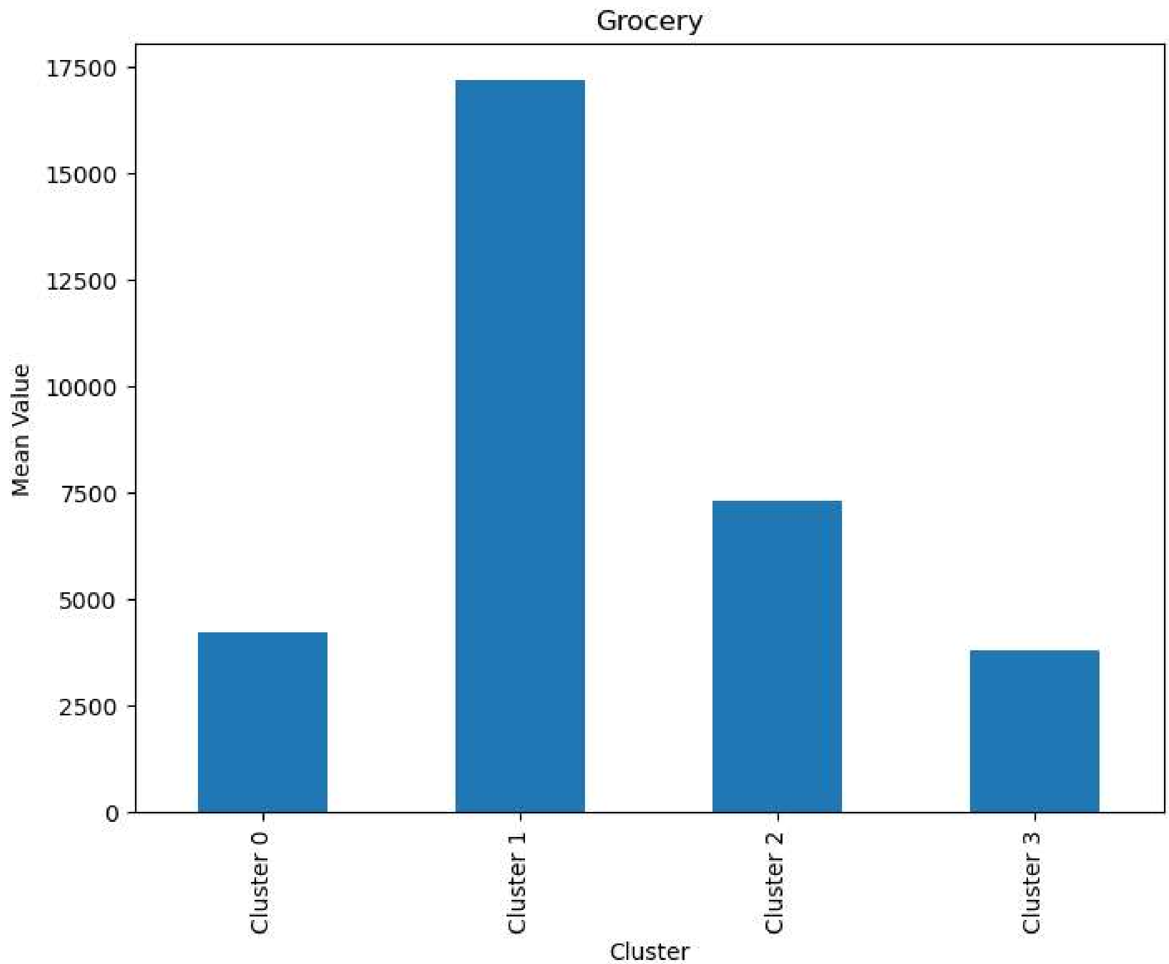
In [19]:
```
cluster_means = df.groupby('Cluster').mean()

cluster_means = cluster_means.transpose()

for feature in cluster_means.index:
    cluster_means.loc[feature].plot(kind='bar', figsize=(8,6))
    plt.title(feature)
    plt.ylabel('Mean Value')
    plt.xticks(ticks=range(4), labels=['Cluster 0', 'Cluster 1', 'Cluster 2',
    plt.show()
```



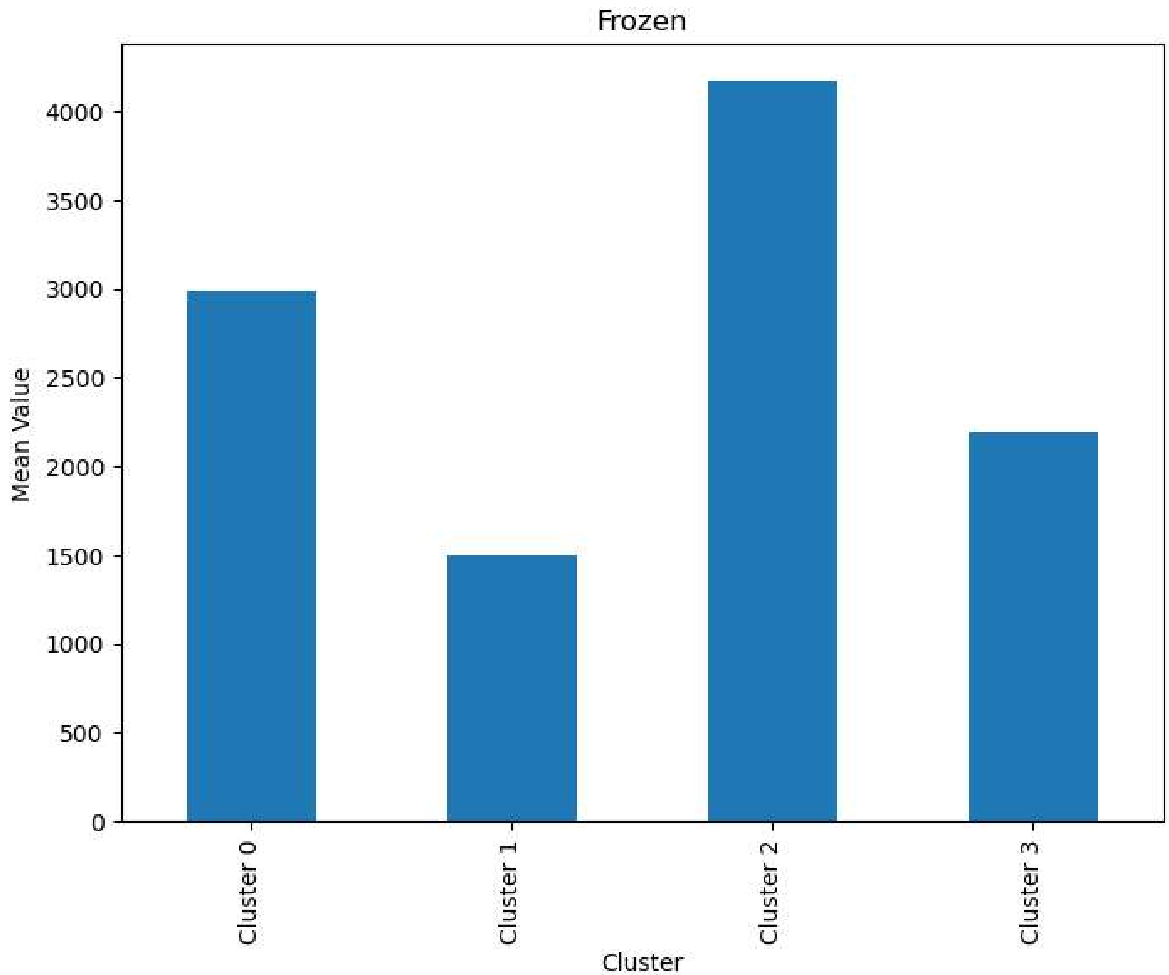

Region
Mean Value
0.0
0.5
1.0
1.5
2.0
2.5
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster

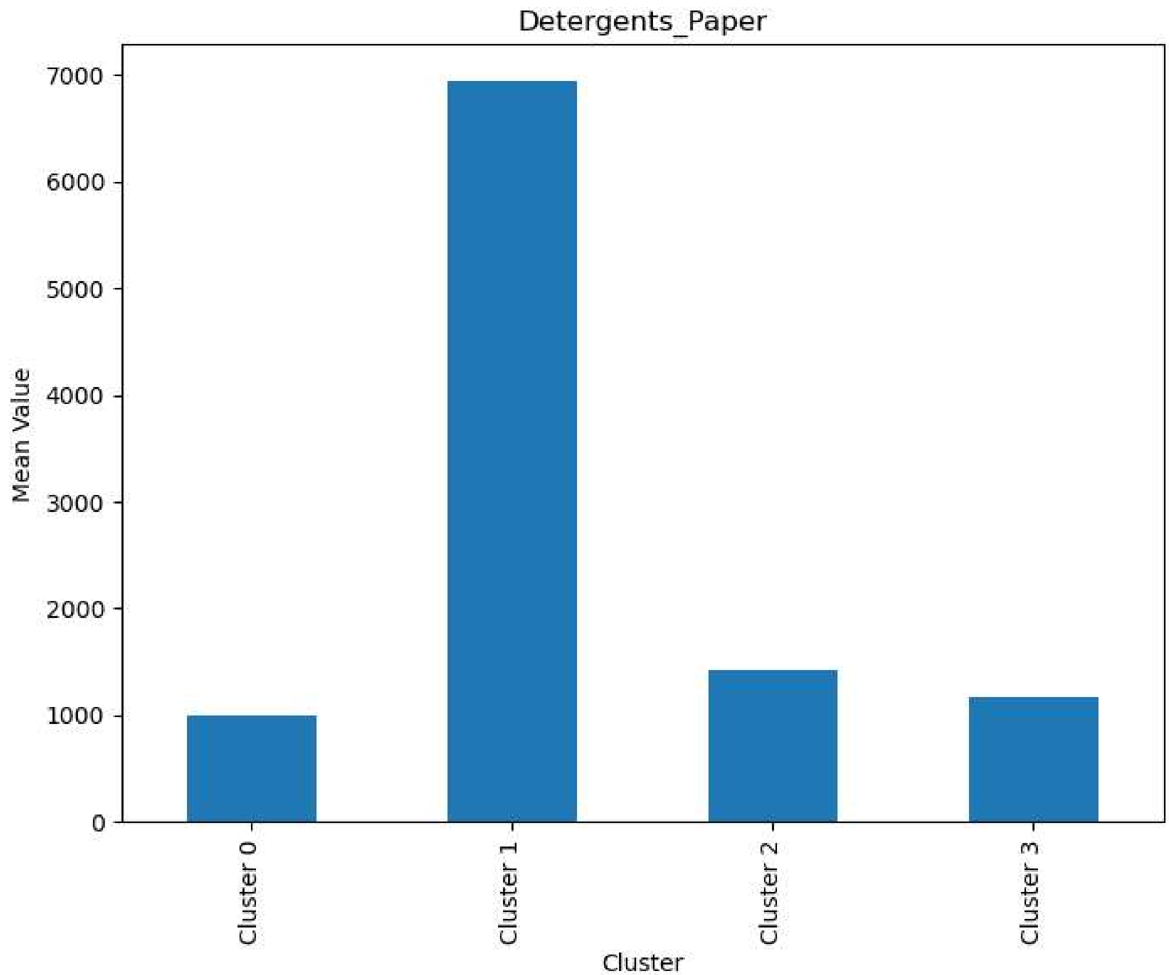

Fresh
Mean Value
30000
25000
20000
15000
10000
5000
0
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster


Milk
Mean Value
10000
8000
6000
4000
2000
0
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster

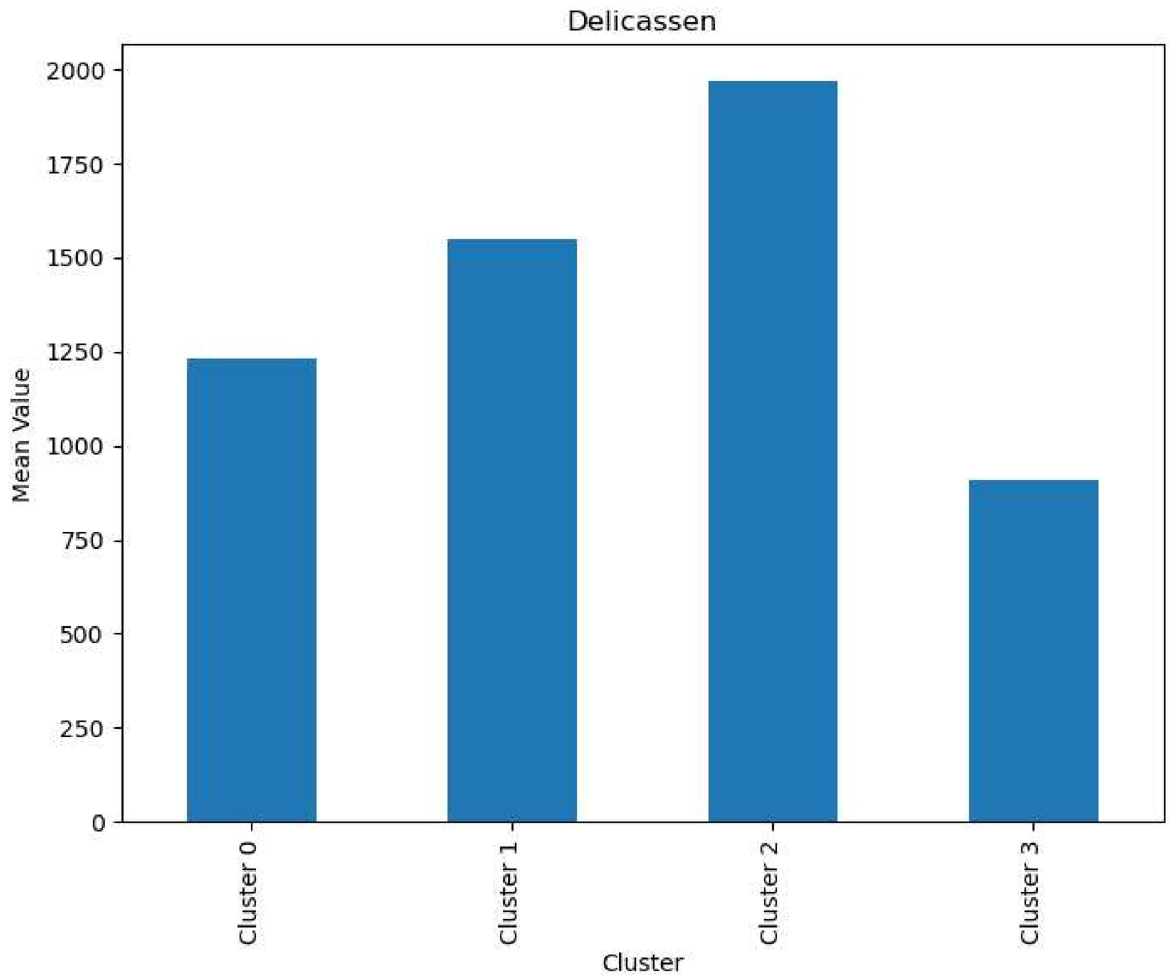


Grocery
Mean Value
17500
15000
12500
10000
7500
5000
2500
0
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster

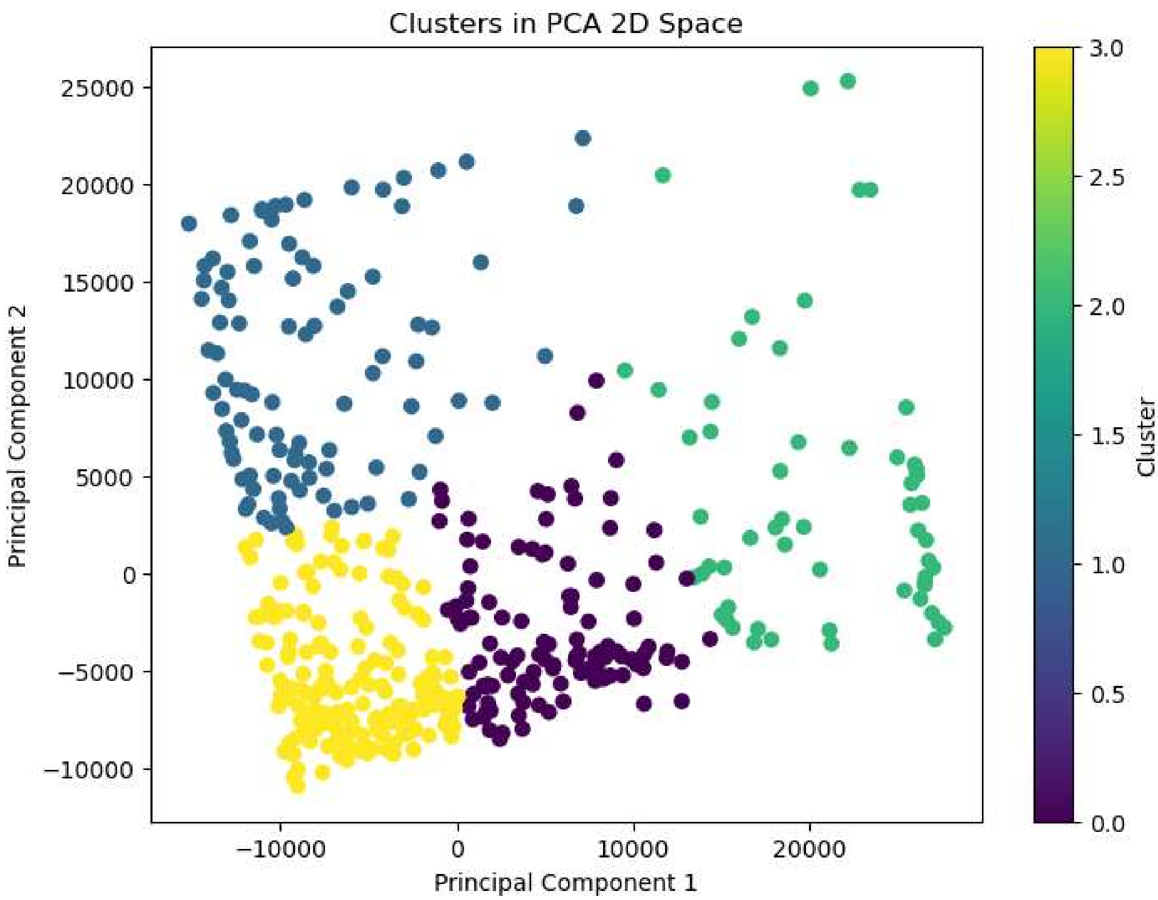

Frozen
4000
3500
3000
2500
2000
1500
1000
500
0
Mean Value
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster



Detergents_Paper
Mean Value
7000
6000
5000
4000
3000
2000
1000
0
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster


Delicassen
2000
1750
1500
1250
1000
750
500
250
0
Mean Value
Cluster 0
Cluster 1
Cluster 2
Cluster 3
Cluster

In [20]:
```
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt

pca = PCA(n_components=2)
principalComponents = pca.fit_transform(df.drop('Cluster', axis=1))

PCA_components = pd.DataFrame(principalComponents, columns=['Principal Compone

PCA_components['Cluster'] = df['Cluster']

plt.figure(figsize=(8,6))
plt.scatter(PCA_components['Principal Component 1'], PCA_components['Principal
plt.title('Clusters in PCA 2D Space')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.colorbar(label='Cluster')
plt.show()
```



Conclusion:

1. The clusters obtained by implementing the Kmeans algorithm on the wholesale customers dataset can be used for a wide variety of business use cases such as grouping customers with similar purchasing behaviors together to make better marketing strategies or to recommend products to customers based on which cluster which they belong too or by exploring associations between products that are frequently purchased together within each cluster etc.
2. The customers present in each of the different clusters may have diverse needs and expectations and the impact of a specific delivery scheme can vary widely among them however for each customer segment by assessing how well a proposed delivery scheme aligns with their characteristics and preferences can be considered.