In [4]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import math
from sklearn.preprocessing import MinMaxScaler
import plotly.express as px
import plotly.graph_objects as go
import numpy as np




# URL of the CSV file
url = "https://storage.googleapis.com/courses_data/Assignment%20CSV/finance_liquor_sales.csv"

# Read the CSV file into a DataFrame
df = pd.read_csv(url)

# Display the first few rows of the DataFrame
print(df)
```

```
    invoice_and_item_number        date  store_number  \
0           INV-31797900035  2020-11-10          4967
1           INV-23548800092  2019-11-27          2601
2           INV-23609300026  2019-12-02          4962
3           INV-39482900037  2021-08-24          3719
4           INV-39520400088  2021-08-25          5423
..                      ...         ...           ...
195         INV-28352300005  2020-06-29          5292
196         INV-33910800023  2021-01-29          2644
197            S30234800064  2016-01-15          4829
198            S13771300075  2013-08-07          3354
199            S21330500108  2014-09-22          2560

                          store_name                    address  \
0           Jeff's Market / Blue Grass            102, W Mayne St
1        Hy-Vee Food Store / Fairfield   1300 West Burlington Ave
2                     Hilltop Grocery           1312 Harrison St
3         Wal-Mart 0581 / Marshalltown           2802 S Center St
4                  Stammer Liquor Corp                615 2nd Ave
..                                 ...                      ...
195                   John's Qwik Stop                814, C Ave
196  Hy-Vee Fort Dodge Wine and Spirits         1511 2nd Ave North
197                    Central City 2          1501 MICHIGAN AVE
198        Sam's Club 8238 / Davenport           3845 ELMORE AVE.
199         Hy-Vee Food Store / Marion  3600 BUSINESS HWY 151 EAST

             city  zip_code                store_location  county_number  \
0     Blue Grass   52726.0  POINT (-90.766126 41.509119)           82.0
1      Fairfield   52556.0  POINT (-91.978702 41.006456)           51.0
2      Davenport   52803.0                           NaN           82.0
3   Marshalltown   50158.0   POINT (-92.91231 42.012918)           64.0
4        Sheldon   51201.0  POINT (-95.854899 43.184242)           71.0
..           ...      ...                           ...            ...
195       Vinton   52349.0  POINT (-92.027865 42.163119)            6.0
196    Fort Dodge   50501.0  POINT (-94.177165 42.508344)           94.0
197   DES MOINES   50314.0   POINT (-93.613739 41.60572)           77.0
198     DAVENPORT   52807.0  POINT (-90.527081 41.559731)           82.0
199        MARION   52302.0                           NaN           57.0

       county  ...  item_number  \
0       SCOTT  ...        26858
1    JEFFERSON  ...        86251
2       SCOTT  ...        41844
3    MARSHALL  ...        65259
4      OBRIEN  ...        77487
..        ...  ...          ...
195    BENTON  ...        43038
196   WEBSTER  ...       101217
197      Polk  ...        86251
198     Scott  ...        36887
199      Linn  ...        33717

                                  item_description  pack bottle_volume_ml  \
0                                Templeton 4YR Rye    12             375
1                                Juarez Triple Sec    12            1000
2                                Everclear Alcohol    24             375
3                 Jagermeister Liqueur Mini Meisters    12              20
4                                Tortilla Gold DSS    12            1000
..                                             ...   ...             ...
195                                   Bacardi Gold     6            1750
196  Captain Morgan OSR PET 6/1.75l  w/ 50ml CM Sli...     6            1750
197                              Juarez Triple Sec    12            1000
198                                McCormick Vodka    12            1000
199                             Paramount Sloe Gin    12            1000

     state_bottle_cost state_bottle_retail  bottles_sold  sale_dollars  \
0                 9.99               14.99             1         14.99
1                 2.42                3.63             6         21.78
2                 4.20                6.30             3         18.90
3                 4.93                7.40            12         88.80
4                 4.85                7.28             4         29.12
..                 ...                 ...           ...           ...
195              15.00               22.50             3         67.50
196              18.00               27.00           156       4212.00
197               2.42                3.63            60        217.80
198               4.13                6.20           204       1264.80
199               5.17                7.76             4         31.04

     volume_sold_liters  volume_sold_gallons
0                  0.37                 0.09
1                  6.00                 1.58
2                  1.12                 0.29
3                  0.24                 0.06
4                  4.00                 1.05
..                  ...                  ...
195                5.25                 1.38
196              273.00                72.11
197               60.00                15.85
198              204.00                53.89
199                4.00                 1.06

[200 rows x 24 columns]
```

In [5]:
```
# Check the data types of each column in the DataFrame
data_types = df.dtypes

# Display the data types
print(data_types)
```

```
invoice_and_item_number     object
date                        object
store_number                 int64
store_name                  object
address                     object
city                        object
zip_code                   float64
store_location              object
county_number              float64
county                      object
category                   float64
category_name               object
vendor_number              float64
vendor_name                 object
item_number                  int64
item_description            object
pack                         int64
bottle_volume_ml             int64
state_bottle_cost          float64
state_bottle_retail        float64
bottles_sold                 int64
sale_dollars               float64
volume_sold_liters         float64
volume_sold_gallons        float64
dtype: object
```

In [6]:
```
# Check for missing values in the DataFrame
missing_values = df.isnull().sum()

# Display the number of missing values for each column
print(missing_values)
```

```
invoice_and_item_number     0
date                        0
store_number                0
store_name                  0
address                     0
city                        0
zip_code                    0
store_location             18
county_number               1
county                      1
category                    3
category_name               9
vendor_number               0
vendor_name                 0
item_number                 0
item_description            0
pack                        0
bottle_volume_ml            0
state_bottle_cost           0
state_bottle_retail         0
bottles_sold                0
sale_dollars                0
volume_sold_liters          0
volume_sold_gallons         0
dtype: int64
```

In [7]:
```
# Calculate the percentage of missing values for each column
missing_percentage = (df.isnull().mean() * 100).round(2)

# Display the percentage of missing values for each column
print(missing_percentage)
```

```
invoice_and_item_number    0.0
date                       0.0
store_number               0.0
store_name                 0.0
address                    0.0
city                       0.0
zip_code                   0.0
store_location             9.0
county_number              0.5
county                     0.5
category                   1.5
category_name              4.5
vendor_number              0.0
vendor_name                0.0
item_number                0.0
item_description           0.0
pack                       0.0
bottle_volume_ml           0.0
state_bottle_cost          0.0
state_bottle_retail        0.0
bottles_sold               0.0
sale_dollars               0.0
volume_sold_liters         0.0
volume_sold_gallons        0.0
dtype: float64
```

In [8]:
```
# Set the threshold to the number of non-null values you want to keep
threshold = len(df.columns) - 1  # Set the threshold to len(df.columns) - 1 for more than 2 null values

# Drop rows with more than 2 null values
df_cleaned = df.dropna(axis=0,thresh=threshold)
print(df_cleaned)
# Drop rows with missing values
df_cleaned2 = df_cleaned.dropna(axis=1)

# Display the first few rows of the cleaned DataFrame
print(df_cleaned2)
df=df_cleaned2.copy()
```

```
    invoice_and_item_number        date  store_number  \
0           INV-31797900035  2020-11-10          4967
1           INV-23548800092  2019-11-27          2601
2           INV-23609300026  2019-12-02          4962
3           INV-39482900037  2021-08-24          3719
4           INV-39520400088  2021-08-25          5423
..                      ...         ...           ...
195         INV-28352300005  2020-06-29          5292
196         INV-33910800023  2021-01-29          2644
197            S30234800064  2016-01-15          4829
198            S13771300075  2013-08-07          3354
199            S21330500108  2014-09-22          2560

                          store_name                    address  \
0           Jeff's Market / Blue Grass            102, W Mayne St
1        Hy-Vee Food Store / Fairfield   1300 West Burlington Ave
2                     Hilltop Grocery           1312 Harrison St
3         Wal-Mart 0581 / Marshalltown           2802 S Center St
4                  Stammer Liquor Corp                615 2nd Ave
..                                 ...                        ...
195                   John's Qwik Stop                814, C Ave
196  Hy-Vee Fort Dodge Wine and Spirits         1511 2nd Ave North
197                    Central City 2          1501 MICHIGAN AVE
198        Sam's Club 8238 / Davenport           3845 ELMORE AVE.
199         Hy-Vee Food Store / Marion  3600 BUSINESS HWY 151 EAST

             city  zip_code                store_location  county_number  \
0     Blue Grass   52726.0  POINT (-90.766126 41.509119)           82.0
1      Fairfield   52556.0  POINT (-91.978702 41.006456)           51.0
2      Davenport   52803.0                           NaN           82.0
3   Marshalltown   50158.0   POINT (-92.91231 42.012918)           64.0
4        Sheldon   51201.0  POINT (-95.854899 43.184242)           71.0
..           ...      ...                           ...            ...
195       Vinton   52349.0  POINT (-92.027865 42.163119)            6.0
196    Fort Dodge   50501.0  POINT (-94.177165 42.508344)           94.0
197    DES MOINES   50314.0   POINT (-93.613739 41.60572)           77.0
198     DAVENPORT   52807.0  POINT (-90.527081 41.559731)           82.0
199        MARION   52302.0                           NaN           57.0

       county  ...  item_number  \
0       SCOTT  ...        26858
1    JEFFERSON  ...        86251
2       SCOTT  ...        41844
3    MARSHALL  ...        65259
4      OBRIEN  ...        77487
..        ...  ...          ...
195    BENTON  ...        43038
196   WEBSTER  ...       101217
197      Polk  ...        86251
198     Scott  ...        36887
199      Linn  ...        33717

                                  item_description  pack bottle_volume_ml  \
0                                Templeton 4YR Rye    12              375
1                                Juarez Triple Sec    12             1000
2                                Everclear Alcohol    24              375
3                 Jagermeister Liqueur Mini Meisters    12               20
4                                Tortilla Gold DSS    12             1000
..                                             ...   ...              ...
195                                   Bacardi Gold     6             1750
196  Captain Morgan OSR PET 6/1.75l  w/ 50ml CM Sli...     6             1750
197                              Juarez Triple Sec    12             1000
198                                McCormick Vodka    12             1000
199                             Paramount Sloe Gin    12             1000

     state_bottle_cost state_bottle_retail  bottles_sold  sale_dollars  \
0                 9.99               14.99             1         14.99
1                 2.42                3.63             6         21.78
2                 4.20                6.30             3         18.90
3                 4.93                7.40            12         88.80
4                 4.85                7.28             4         29.12
..                 ...                 ...           ...           ...
195              15.00               22.50             3         67.50
196              18.00               27.00           156       4212.00
197               2.42                3.63            60        217.80
198               4.13                6.20           204       1264.80
199               5.17                7.76             4         31.04

     volume_sold_liters  volume_sold_gallons
0                  0.37                 0.09
1                  6.00                 1.58
2                  1.12                 0.29
3                  0.24                 0.06
4                  4.00                 1.05
..                  ...                  ...
195                5.25                 1.38
196              273.00                72.11
197               60.00                15.85
198              204.00                53.89
199                4.00                 1.06

[195 rows x 24 columns]
    invoice_and_item_number        date  store_number  \
0           INV-31797900035  2020-11-10          4967
1           INV-23548800092  2019-11-27          2601
2           INV-23609300026  2019-12-02          4962
3           INV-39482900037  2021-08-24          3719
4           INV-39520400088  2021-08-25          5423
..                      ...         ...           ...
195         INV-28352300005  2020-06-29          5292
196         INV-33910800023  2021-01-29          2644
197            S30234800064  2016-01-15          4829
198            S13771300075  2013-08-07          3354
199            S21330500108  2014-09-22          2560

                          store_name                    address  \
0           Jeff's Market / Blue Grass            102, W Mayne St
```

```
1         Hy-Vee Food Store / Fairfield    1300 West Burlington Ave
2                       Hilltop Grocery            1312 Harrison St
3          Wal-Mart 0581 / Marshalltown            2802 S Center St
4                   Stammer Liquor Corp                 615 2nd Ave
..                                  ...                         ...
195                   John's Qwik Stop                  814, C Ave
196  Hy-Vee Fort Dodge Wine and Spirits         1511 2nd Ave North
197                     Central City 2           1501 MICHIGAN AVE
198         Sam's Club 8238 / Davenport            3845 ELMORE AVE.
199          Hy-Vee Food Store / Marion  3600 BUSINESS HWY 151 EAST

              city  zip_code  county_number     county   category  ...  \
0      Blue Grass   52726.0           82.0      SCOTT  1011600.0  ...
1       Fairfield   52556.0           51.0  JEFFERSON  1081500.0  ...
2       Davenport   52803.0           82.0      SCOTT  1091200.0  ...
3    Marshalltown   50158.0           64.0   MARSHALL  1082100.0  ...
4         Sheldon   51201.0           71.0    OBRIEN  1092100.0  ...
..            ...       ...            ...       ...        ...  ...
195        Vinton   52349.0            6.0     BENTON  1062100.0  ...
196    Fort Dodge   50501.0           94.0    WEBSTER  1700000.0  ...
197    DES MOINES   50314.0           77.0       Polk  1081400.0  ...
198     DAVENPORT   52807.0           82.0      Scott  1031100.0  ...
199        MARION   52302.0           57.0       Linn  1041200.0  ...

     item_number                                 item_description  pack  \
0          26858                                 Templeton 4YR Rye    12
1          86251                                 Juarez Triple Sec    12
2          41844                                 Everclear Alcohol    24
3          65259               Jagermeister Liqueur Mini Meisters    12
4          77487                                 Tortilla Gold DSS    12
..           ...                                               ...   ...
195        43038                                     Bacardi Gold     6
196       101217  Captain Morgan OSR PET 6/1.75l  w/ 50ml CM Sli...     6
197        86251                                 Juarez Triple Sec    12
198        36887                                   McCormick Vodka    12
199        33717                                Paramount Sloe Gin    12

     bottle_volume_ml  state_bottle_cost  state_bottle_retail  bottles_sold  \
0                 375               9.99                14.99             1
1                1000               2.42                 3.63             6
2                 375               4.20                 6.30             3
3                  20               4.93                 7.40            12
4                1000               4.85                 7.28             4
..                ...                ...                  ...           ...
195              1750              15.00                22.50             3
196              1750              18.00                27.00           156
197              1000               2.42                 3.63            60
198              1000               4.13                 6.20           204
199              1000               5.17                 7.76             4

     sale_dollars  volume_sold_liters  volume_sold_gallons
0           14.99                0.37                 0.09
1           21.78                6.00                 1.58
2           18.90                1.12                 0.29
3           88.80                0.24                 0.06
4           29.12                4.00                 1.05
..            ...                 ...                  ...
195         67.50                5.25                 1.38
196       4212.00              273.00                72.11
197        217.80               60.00                15.85
198       1264.80              204.00                53.89
199         31.04                4.00                 1.06

[195 rows x 22 columns]
```

In [9]:
```
# Check for missing values in the DataFrame
missing_values = df.isnull().sum()

# Display the number of missing values for each column
print(missing_values)
```

```
invoice_and_item_number    0
date                       0
store_number               0
store_name                 0
address                    0
city                       0
zip_code                   0
county_number              0
county                     0
category                   0
vendor_number              0
vendor_name                0
item_number                0
item_description           0
pack                       0
bottle_volume_ml           0
state_bottle_cost          0
state_bottle_retail        0
bottles_sold               0
sale_dollars               0
volume_sold_liters         0
volume_sold_gallons        0
dtype: int64
```

In [10]:
```
# Convert the 'date' column to datetime
df['date'] = pd.to_datetime(df['date'])

# Filter rows with date between 2016-01-01 and 2019-12-31
filtered_df = df[(df['date'] >= '2016-01-01') & (df['date'] <= '2019-12-31')]

# Display the result
print(filtered_df.reset_index())
```

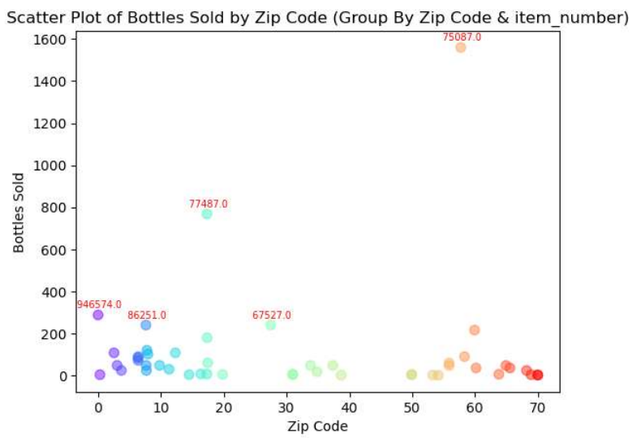
```
    index invoice_and_item_number       date  store_number  \
0       1         INV-23548800092 2019-11-27          2601
1       2         INV-23609300026 2019-12-02          4962
2       6            S30390600011 2016-01-26          2641
3       7            S30348700047 2016-01-25          3162
4       8            S30466200002 2016-02-01          2633
..    ...                     ...        ...           ...
68    185         INV-00002300008 2016-08-29          5244
69    187         INV-24116900112 2019-12-23          2670
70    193         INV-08495400086 2017-11-07          4167
71    194         INV-08632500071 2017-11-14          3385
72    197            S30234800064 2016-01-15          4829

                          store_name                  address  \
0      Hy-Vee Food Store / Fairfield  1300 West Burlington Ave
1                    Hilltop Grocery          1312 Harrison St
2   Hy-Vee Drugstore / Council Bluffs            757 W BROADWAY
3         Nash Finch / Wholesale Food             807 GRANDVIEW
4        Hy-Vee #3 / BDI / Des Moines           3221 SE 14TH ST
..                                ...                      ...
68   The Ox & Wren Spirits and Gifts          708 2nd  AVE  SE
69     Hy-Vee Food Store / Coralville              2004 8th  St
70          Iowa Street Market, Inc.              1256 Iowa St
71     Sam's Club 8162 / Cedar Rapids   2605 Blairs Ferry Rd NE
72                   Central City 2         1501 MICHIGAN AVE

              city  zip_code  county_number         county  ...  item_number  \
0        Fairfield   52556.0           51.0      JEFFERSON  ...        86251
1        Davenport   52803.0           82.0          SCOTT  ...        41844
2   COUNCIL BLUFFS   51501.0           78.0  Pottawattamie  ...        81124
3        MUSCATINE   52761.0           70.0      Muscatine  ...        82847
4       DES MOINES   50320.0           77.0           Polk  ...       973627
..             ...        ...            ...            ...  ...          ...
68          Cresco   52136.0           45.0        HOWARD  ...        35917
69      Coralville   52241.0           52.0       JOHNSON  ...        65750
70         Dubuque   52001.0           31.0       DUBUQUE  ...        67557
71    Cedar Rapids   52402.0           57.0          LINN  ...        86390
72       DES MOINES   50314.0           77.0           Polk  ...        86251

           item_description pack  bottle_volume_ml state_bottle_cost  \
0         Juarez Triple Sec   12              1000             2.42
1         Everclear Alcohol   24               375             4.20
2        99 Peppermint Mini   10               600             5.94
3        Dekuyper Peachtree   12              1000             7.62
4   Di Amore Quattro Orange   12              1000             9.75
..                      ...  ...               ...              ...
68       Five O'clock Vodka   12              1000             4.17
69    Maestro Agavero Gold   12              1000             7.00
70   Kamora Coffee Liqueur   12              1000             8.39
71    Montezuma Triple Sec   12              1000             2.13
72        Juarez Triple Sec   12              1000             2.42

    state_bottle_retail  bottles_sold  sale_dollars  volume_sold_liters  \
0                  3.63             6         21.78                6.00
1                  6.30             3         18.90                1.12
2                  8.91             2         17.82                1.20
3                 11.43             4         45.72                4.00
4                 14.63           120       1755.60              120.00
..                  ...           ...           ...                 ...
68                 6.26             2         75.12                2.00
69                10.50            48        504.00               48.00
70                12.59             4         50.36                4.00
71                 3.20           216        691.20              216.00
72                 3.63            60        217.80               60.00

    volume_sold_gallons
0                  1.58
1                  0.29
2                  0.32
3                  1.06
4                 31.70
..                  ...
68                 0.52
69                12.68
70                 1.06
71                57.06
72                15.85

[73 rows x 23 columns]
```

In [11]:

```
#df=filtered_df
# Group by 'zip_code' and 'item_number', and sum 'bottles_sold'
sum_by_zip_item = filtered_df.groupby(['zip_code', 'item_number'])['bottles_sold'].sum().reset_index()

# Find the index of the row with the maximum sum of 'bottles_sold' for each 'item_number' within each 'zip_code' group
idxmax_sum = sum_by_zip_item.groupby('zip_code')['bottles_sold'].idxmax()

# Select the corresponding rows from the original DataFrame
result_df = sum_by_zip_item.loc[idxmax_sum].reset_index()

# Display the result
print(result_df)
```

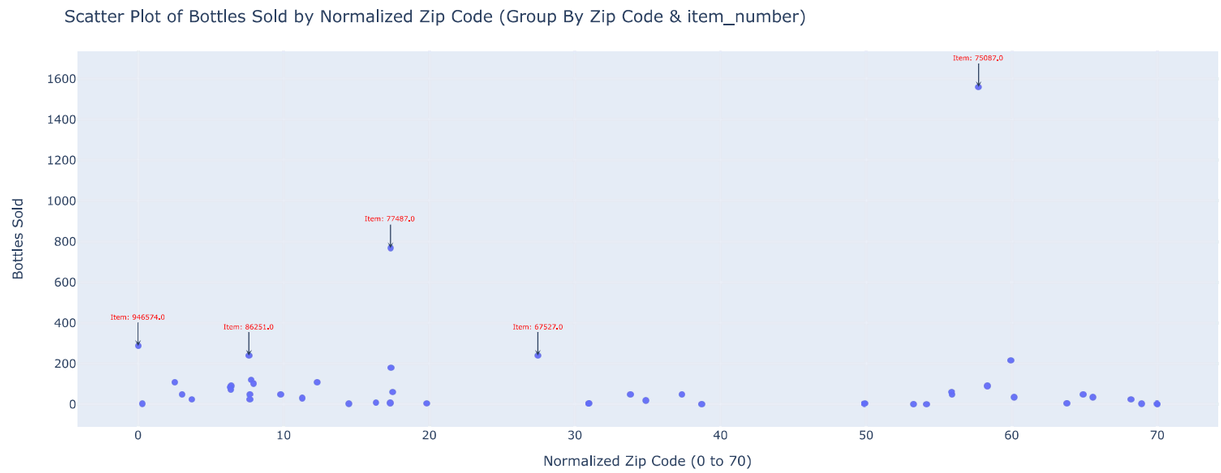
	index	zip_code	item_number	bottles_sold
0	0	50010.0	946574	288
1	1	50022.0	86507	4
2	2	50111.0	77805	108
3	3	50131.0	38089	48
4	4	50158.0	48099	24
5	7	50263.0	3135	84
6	8	50265.0	67526	72
7	9	50266.0	250	90
8	12	50314.0	86251	240
9	13	50316.0	48099	48
10	14	50317.0	56193	24
11	17	50320.0	973627	120
12	18	50327.0	43040	102
13	20	50401.0	986845	48
14	21	50461.0	35918	30
15	22	50501.0	38176	108
16	23	50588.0	84617	4
17	24	50662.0	86739	8
18	26	50701.0	43034	7
19	28	50702.0	77487	768
20	30	50703.0	168	180
21	34	50707.0	15626	60
22	35	50801.0	43037	5
23	36	51106.0	67527	240
24	39	51246.0	82187	5
25	40	51247.0	86112	6
26	41	51360.0	77487	48
27	42	51401.0	27189	18
28	48	51501.0	86251	48
29	49	51555.0	45247	2
30	50	52001.0	67557	4
31	51	52003.0	43031	5
32	52	52136.0	35917	2
33	53	52172.0	67524	1
34	55	52240.0	86251	60
35	57	52241.0	65750	48
36	58	52314.0	75087	1560
37	59	52338.0	27357	90
38	61	52402.0	86390	216
39	62	52411.0	41846	36
40	63	52556.0	86251	6
41	64	52601.0	35913	48
42	66	52627.0	67586	36
43	67	52732.0	45248	24
44	68	52761.0	82847	4
45	69	52803.0	41844	3
46	70	52804.0	48690	2

In [12]:
```
from sklearn.preprocessing import MinMaxScaler


# Create a color map with rainbow colors
colors = plt.cm.rainbow(np.linspace(0, 1, len(result_df)))
# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
result_df['zip_code_normalized'] = scaler.fit_transform(result_df[['zip_code']])
# Identify the top 5 rows based on 'bottles_sold'
top5 = result_df.nlargest(5, 'bottles_sold')

# Scatter plot with rainbow colors
plt.scatter(result_df['zip_code_normalized'], result_df['bottles_sold'], alpha=0.5, c=colors,s=50)
for i, row in top5.iterrows():
    plt.annotate(f" {row['item_number']}",
                 (row['zip_code_normalized'], row['bottles_sold']),
                 textcoords="offset points", xytext=(0,5), ha='center', fontsize=7, color='red')

# Adding labels and title
plt.xlabel('Zip Code')
plt.ylabel('Bottles Sold')
plt.title('Scatter Plot of Bottles Sold by Zip Code (Group By Zip Code & item_number)')

# Display the plot
plt.show()
```

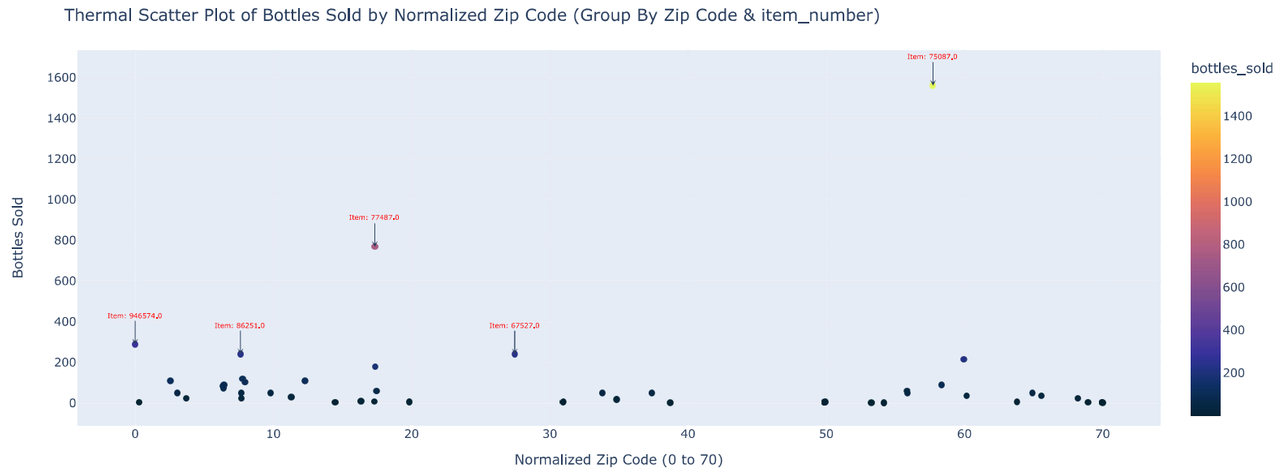


In [13]:
```
# Identify the top 5 rows based on 'bottles_sold'
top5 = result_df.nlargest(5, 'bottles_sold')
```

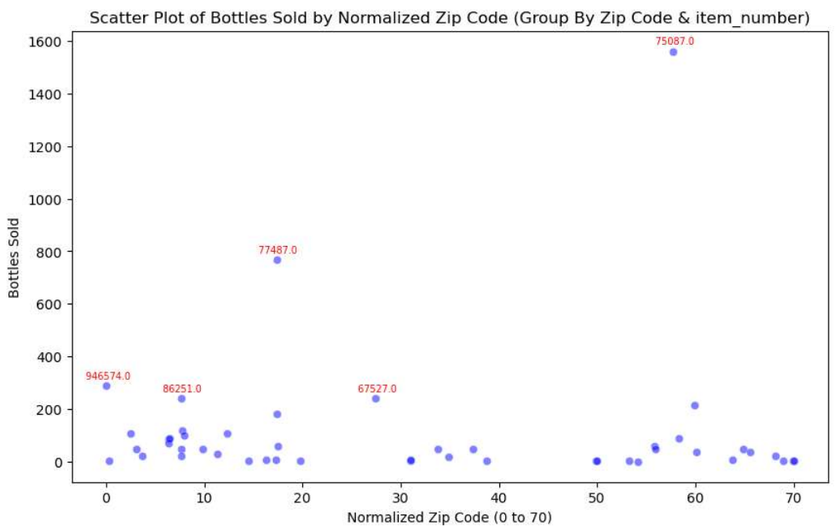
```
# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
result_df['zip_code_normalized'] = scaler.fit_transform(result_df[['zip_code']])

# Scatter plot with rainbow colors using Plotly Express
fig = px.scatter(result_df, x='zip_code_normalized', y='bottles_sold', opacity=0.95)

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    fig.add_annotation(
        x=row['zip_code_normalized'],
        y=row['bottles_sold'],
        text=f"Item: {row['item_number']}",
        showarrow=True,
        arrowhead=3,
        arrowwidth=1,
        ax=0,
        ay=-30,
        font=dict(size=7, color='red')
    )

# Updating axis labels and title
fig.update_xaxes(title_text='Normalized Zip Code (0 to 70)')
fig.update_yaxes(title_text='Bottles Sold')
fig.update_layout(title_text='Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)',
                  showlegend=False)

# Show the plot
fig.show()
```



In [14]:
```
# Identify the top 5 rows based on 'bottles_sold'
top5 = result_df.nlargest(5, 'bottles_sold')

# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
result_df['zip_code_normalized'] = scaler.fit_transform(result_df[['zip_code']])

# Thermal scatter plot using Plotly Express
fig = px.scatter(result_df,
                 x='zip_code_normalized',
                 y='bottles_sold',
                 color='bottles_sold',
                 opacity=0.99,
                 color_continuous_scale='thermal',
                 color_discrete_map={'bottles_sold': 'black'},
                 size_max=20)

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    fig.add_annotation(
        x=row['zip_code_normalized'],
        y=row['bottles_sold'],
        text=f"Item: {row['item_number']}",
        showarrow=True,
        arrowhead=3,
        arrowwidth=1,
        ax=0,
        ay=-30,
        font=dict(size=7, color='red')
    )

# Updating axis labels and title
fig.update_xaxes(title_text='Normalized Zip Code (0 to 70)')
fig.update_yaxes(title_text='Bottles Sold')
fig.update_layout(title_text='Thermal Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)',
                  showlegend=False)

# Show the plot
fig.show()
```



In [15]:
```
# Identify the top 5 rows based on 'bottles_sold'
top5 = result_df.nlargest(5, 'bottles_sold')

# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
result_df['zip_code_normalized'] = scaler.fit_transform(result_df[['zip_code']])

# Scatter plot with Seaborn
plt.figure(figsize=(10, 6))
sns.scatterplot(x='zip_code_normalized', y='bottles_sold', data=result_df, alpha=0.5,color='blue')

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    plt.annotate(f" {row['item_number']}",
                 (row['zip_code_normalized'], row['bottles_sold']),
                 textcoords="offset points", xytext=(0, 5), ha='center', fontsize=7, color='red')

# Adding labels and title
plt.xlabel('Normalized Zip Code (0 to 70)')
plt.ylabel('Bottles Sold')
plt.title('Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)')

# Display the plot
plt.show()
```



In [16]:
```
# Assuming result_df is your DataFrame
# 'zip_code' is the column you want to group by

# Group by 'zip_code' and print only the 'zip_code' column
grouped_data1 = filtered_df.groupby('zip_code').size().reset_index(name='count')

# Print only the 'zip_code' column
print(grouped_data1)
```

	zip_code	count
0	50010.0	1
1	50022.0	1
2	50111.0	1
3	50131.0	1
4	50158.0	3
5	50263.0	1
6	50265.0	1
7	50266.0	1
8	50314.0	4
9	50316.0	1
10	50317.0	1
11	50320.0	3
12	50327.0	1
13	50401.0	2
14	50461.0	1
15	50501.0	1
16	50588.0	1
17	50662.0	1
18	50701.0	3
19	50702.0	2
20	50703.0	4
21	50707.0	1
22	50801.0	1
23	51106.0	3
24	51246.0	1
25	51247.0	1
26	51360.0	1
27	51401.0	3
28	51501.0	4
29	51555.0	1
30	52001.0	1
31	52003.0	1
32	52136.0	1
33	52172.0	1
34	52240.0	2
35	52241.0	2
36	52314.0	2
37	52338.0	1
38	52402.0	2
39	52411.0	1
40	52556.0	1
41	52601.0	2
42	52627.0	1
43	52732.0	1
44	52761.0	1
45	52803.0	1
46	52804.0	1

In [17]:
```
# Group by 'zip_code' and 'item_number', and sum 'bottles_sold'
grouped_data = filtered_df.groupby(['zip_code','item_number'])['bottles_sold'].sum().reset_index()

# Print the grouped data
print(grouped_data)
```

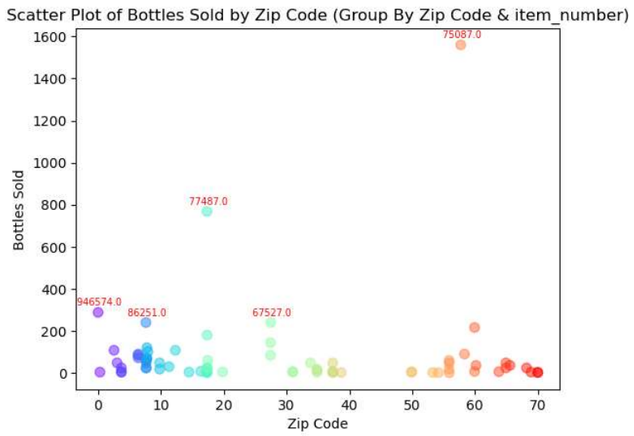
	zip_code	item_number	bottles_sold
0	50010.0	946574	288
1	50022.0	86507	4
2	50111.0	77805	108
3	50131.0	38089	48
4	50158.0	48099	24
..	...	...	...
66	52627.0	67586	36
67	52732.0	45248	24
68	52761.0	82847	4
69	52803.0	41844	3
70	52804.0	48690	2

[71 rows x 3 columns]

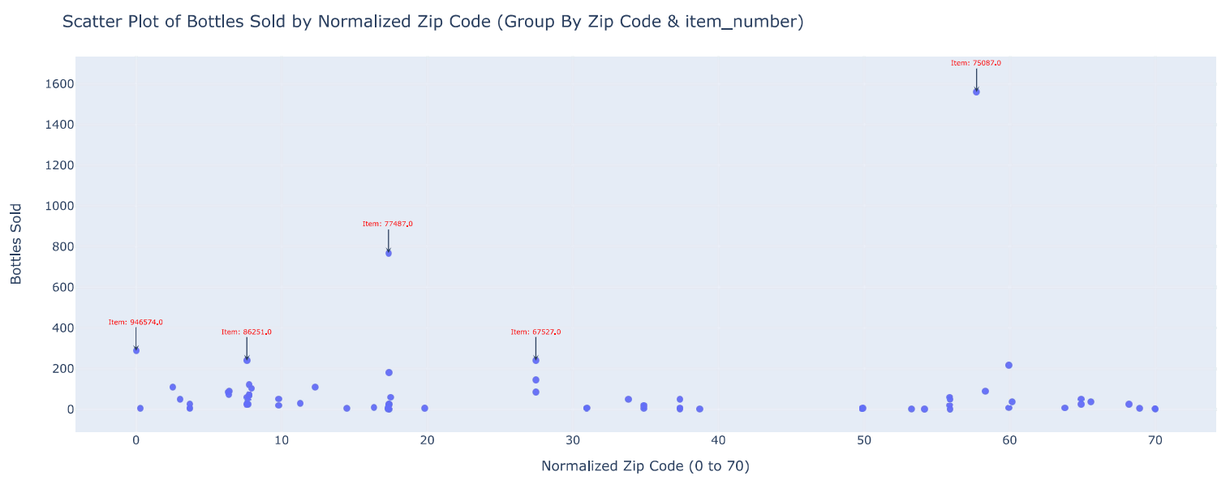
In [18]:
```
# Specify the Excel file path
excel_file_path = 'grouped_data_for_theory1.xlsx'

# Export the grouped data to Excel
grouped_data.to_excel(excel_file_path, index=True)

print(f"Grouped data has been exported to {excel_file_path}")
```

Grouped data has been exported to grouped_data_for_theory1.xlsx

In [19]:
```
from sklearn.preprocessing import MinMaxScaler

# Create a color map with rainbow colors
colors = plt.cm.rainbow(np.linspace(0, 1, len(grouped_data)))
# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
grouped_data['zip_code_normalized'] = scaler.fit_transform(grouped_data[['zip_code']])
# Identify the top 5 rows based on 'bottles_sold'
top5 = grouped_data.nlargest(5, 'bottles_sold')

# Scatter plot with rainbow colors
plt.scatter(grouped_data['zip_code_normalized'], grouped_data['bottles_sold'], alpha=0.5, c=colors,s=50)
for i, row in top5.iterrows():
    plt.annotate(f" {row['item_number']}",
                 (row['zip_code_normalized'], row['bottles_sold']),
                 textcoords="offset points", xytext=(0,5), ha='center', fontsize=7, color='red')

# Adding labels and title
plt.xlabel('Zip Code')
plt.ylabel('Bottles Sold')
plt.title('Scatter Plot of Bottles Sold by Zip Code (Group By Zip Code & item_number)')

# Display the plot
plt.show()
```

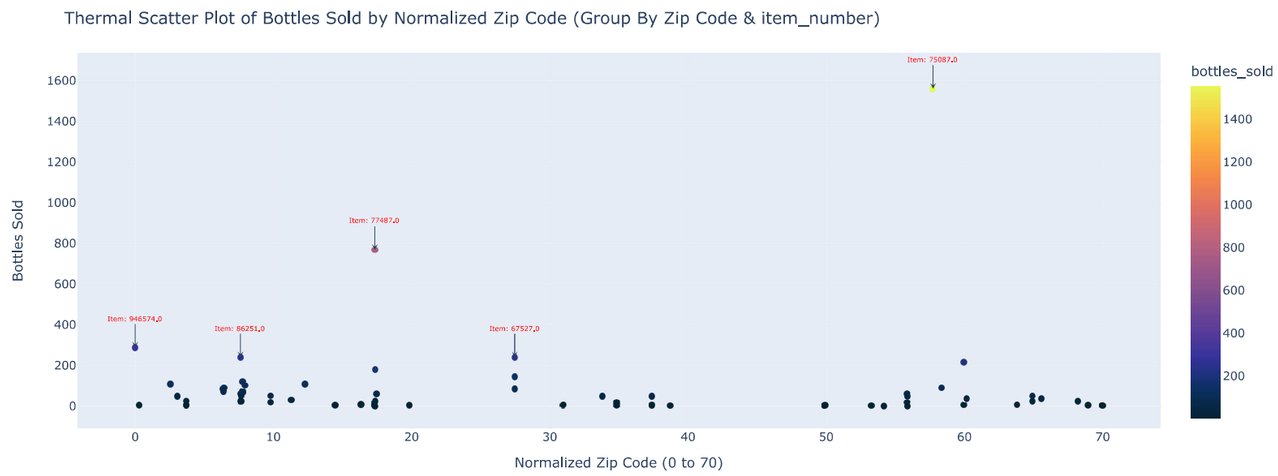


In [20]:
```
# Identify the top 5 rows based on 'bottles_sold'
top5 = grouped_data.nlargest(5, 'bottles_sold')

# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
grouped_data['zip_code_normalized'] = scaler.fit_transform(grouped_data[['zip_code']])

# Scatter plot with rainbow colors using Plotly Express
fig = px.scatter(grouped_data, x='zip_code_normalized', y='bottles_sold', opacity=0.95)

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    fig.add_annotation(
        x=row['zip_code_normalized'],
        y=row['bottles_sold'],
        text=f"Item: {row['item_number']}",
        showarrow=True,
        arrowhead=3,
        arrowwidth=1,
        ax=0,
        ay=-30,
        font=dict(size=7, color='red')
    )

# Updating axis labels and title
fig.update_xaxes(title_text='Normalized Zip Code (0 to 70)')
fig.update_yaxes(title_text='Bottles Sold')
fig.update_layout(title_text='Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)',
                  showlegend=False)

# Show the plot
fig.show()
```



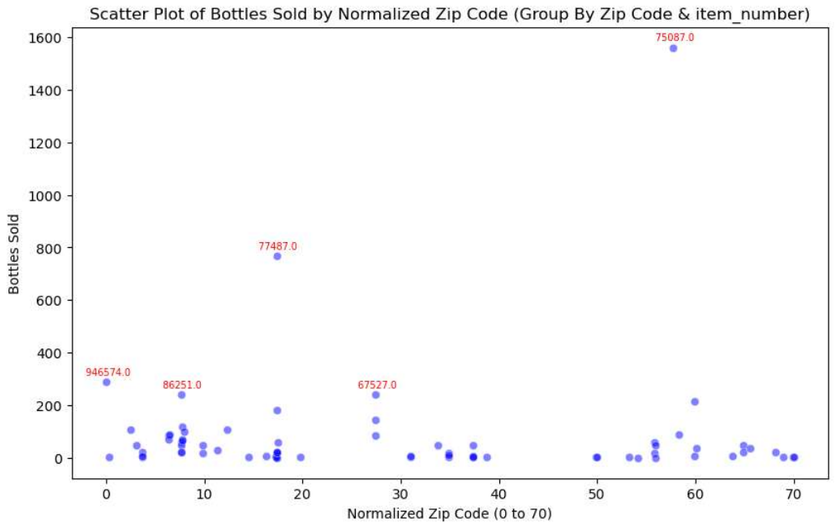
In [21]:
```
# Identify the top 5 rows based on 'bottles_sold'
top5 = grouped_data.nlargest(5, 'bottles_sold')

# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
grouped_data['zip_code_normalized'] = scaler.fit_transform(grouped_data[['zip_code']])

# Thermal scatter plot using Plotly Express
fig = px.scatter(grouped_data,
                 x='zip_code_normalized',
                 y='bottles_sold',
```

```
                color='bottles_sold',
                opacity=0.99,
                color_continuous_scale='thermal',
                color_discrete_map={'bottles_sold': 'black'},
                size_max=20)

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    fig.add_annotation(
        x=row['zip_code_normalized'],
        y=row['bottles_sold'],
        text=f"Item: {row['item_number']}",
        showarrow=True,
        arrowhead=3,
        arrowwidth=1,
        ax=0,
        ay=-30,
        font=dict(size=7, color='red')
    )

# Updating axis labels and title
fig.update_xaxes(title_text='Normalized Zip Code (0 to 70)')
fig.update_yaxes(title_text='Bottles Sold')
fig.update_layout(title_text='Thermal Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)',
                  showlegend=False)

# Show the plot
fig.show()
```



In [22]:

```
# Identify the top 5 rows based on 'bottles_sold'
top5 = grouped_data.nlargest(5, 'bottles_sold')

# Normalize the 'zip_code' values to be between 0 and 75
scaler = MinMaxScaler(feature_range=(0, 70))
grouped_data['zip_code_normalized'] = scaler.fit_transform(grouped_data[['zip_code']])

# Scatter plot with Seaborn
plt.figure(figsize=(10, 6))
sns.scatterplot(x='zip_code_normalized', y='bottles_sold', data=grouped_data, alpha=0.5,color='blue')

# Annotate the top 5 points with item numbers only
for i, row in top5.iterrows():
    plt.annotate(f" {row['item_number']}",
                 (row['zip_code_normalized'], row['bottles_sold']),
                 textcoords="offset points", xytext=(0, 5), ha='center', fontsize=7, color='red')

# Adding labels and title
plt.xlabel('Normalized Zip Code (0 to 70)')
plt.ylabel('Bottles Sold')
plt.title('Scatter Plot of Bottles Sold by Normalized Zip Code (Group By Zip Code & item_number)')

# Display the plot
plt.show()
```



In [23]:
```
# Display the filter data
print(filtered_df.reset_index())
```

```
    index invoice_and_item_number       date  store_number  \
0       1         INV-23548800092 2019-11-27          2601
1       2         INV-23609300026 2019-12-02          4962
2       6            S30390600011 2016-01-26          2641
3       7            S30348700047 2016-01-25          3162
4       8            S30466200002 2016-02-01          2633
..    ...                     ...        ...           ...
68    185         INV-00002300008 2016-08-29          5244
69    187         INV-24116900112 2019-12-23          2670
70    193         INV-08495400086 2017-11-07          4167
71    194         INV-08632500071 2017-11-14          3385
72    197            S30234800064 2016-01-15          4829

                          store_name                  address  \
0      Hy-Vee Food Store / Fairfield  1300 West Burlington Ave
1                    Hilltop Grocery          1312 Harrison St
2   Hy-Vee Drugstore / Council Bluffs            757 W BROADWAY
3         Nash Finch / Wholesale Food             807 GRANDVIEW
4        Hy-Vee #3 / BDI / Des Moines           3221 SE 14TH ST
..                                ...                      ...
68   The Ox & Wren Spirits and Gifts          708 2nd  AVE  SE
69    Hy-Vee Food Store / Coralville              2004 8th  St
70          Iowa Street Market, Inc.              1256 Iowa St
71    Sam's Club 8162 / Cedar Rapids   2605 Blairs Ferry Rd NE
72                    Central City 2         1501 MICHIGAN AVE

              city  zip_code  county_number         county  ...  item_number  \
0        Fairfield   52556.0           51.0      JEFFERSON  ...        86251
1        Davenport   52803.0           82.0          SCOTT  ...        41844
2   COUNCIL BLUFFS   51501.0           78.0  Pottawattamie  ...        81124
3        MUSCATINE   52761.0           70.0      Muscatine  ...        82847
4       DES MOINES   50320.0           77.0           Polk  ...       973627
..             ...        ...            ...            ...  ...          ...
68         Cresco   52136.0           45.0        HOWARD  ...        35917
69      Coralville   52241.0           52.0        JOHNSON  ...        65750
70         Dubuque   52001.0           31.0        DUBUQUE  ...        67557
71    Cedar Rapids   52402.0           57.0           LINN  ...        86390
72      DES MOINES   50314.0           77.0           Polk  ...        86251

           item_description pack  bottle_volume_ml state_bottle_cost  \
0         Juarez Triple Sec   12              1000              2.42
1         Everclear Alcohol   24               375              4.20
2        99 Peppermint Mini   10               600              5.94
3        Dekuyper Peachtree   12              1000              7.62
4   Di Amore Quattro Orange   12              1000              9.75
..                      ...  ...               ...               ...
68       Five O'clock Vodka   12              1000              4.17
69    Maestro Agavero Gold   12              1000              7.00
70   Kamora Coffee Liqueur   12              1000              8.39
71    Montezuma Triple Sec   12              1000              2.13
72        Juarez Triple Sec   12              1000              2.42

    state_bottle_retail  bottles_sold  sale_dollars  volume_sold_liters  \
0                  3.63             6         21.78                6.00
1                  6.30             3         18.90                1.12
2                  8.91             2         17.82                1.20
3                 11.43             4         45.72                4.00
4                 14.63           120       1755.60              120.00
..                  ...           ...           ...                 ...
68                 6.26             2         75.12                2.00
69                10.50            48        504.00               48.00
70                12.59             4         50.36                4.00
71                 3.20           216        691.20              216.00
72                 3.63            60        217.80               60.00

    volume_sold_gallons
0                  1.58
1                  0.29
2                  0.32
3                  1.06
4                 31.70
..                  ...
68                 0.52
69                12.68
70                 1.06
71                57.06
72                15.85

[73 rows x 23 columns]
```

In [24]:
```
# Group by 'store_name' and sum the 'sale_dollars' column
grouped_df = filtered_df.groupby('store_name')['sale_dollars'].sum().reset_index()

# Display the result
print(grouped_df)
```

```
                         store_name  sale_dollars
0          Bootleggin' Barzini's Fin          6.75
1                  Burlington Shell        206.64
2   CVS Pharmacy #8526 / Cedar Rapids         42.00
3              Cedar Ridge Vineyards       3712.50
4                    Central City 2       2580.60
..                              ...           ...
56                Speedy Gas N Shop         68.18
57            Tequila's Liquor Store        413.28
58    The Ox & Wren Spirits and Gifts         75.12
59   Tobacco Hut #14 / Council Bluffs         33.24
60                    Wilkie Liquors      11620.80

[61 rows x 2 columns]
```

In [25]:
```
# Sort in descending order based on the sum of 'sale_dollars'
grouped_df_sorted = grouped_df.sort_values(by='sale_dollars', ascending=False)

# Display the result
print(grouped_df_sorted)
```

```
                         store_name  sale_dollars
60                     Wilkie Liquors      11620.80
50        Sam's Club 6432 / Sioux City       6641.04
51          Sam's Club 6514 / Waterloo       5199.36
18        Hy-Vee #3 / BDI / Des Moines       4124.04
52              Sam's Club 6568 / Ames       3913.92
..                                 ...          ...
21   Hy-Vee Drugstore / Council Bluffs         17.82
16              Food Land Super Markets         13.26
6                 Double D Liquor Store          9.74
38  Hy-Vee Wine and Spirits / Waterloo          7.00
0             Bootleggin' Barzini's Fin          6.75

[61 rows x 2 columns]
```

In [26]:
```
# Keep only the first 15 rows
top_15_rows = grouped_df_sorted.head(15)

# Display the result
print(top_15_rows)
```

```
                         store_name  sale_dollars
60                     Wilkie Liquors      11620.80
50          Sam's Club 6432 / Sioux City       6641.04
51            Sam's Club 6514 / Waterloo       5199.36
18          Hy-Vee #3 / BDI / Des Moines       4124.04
52                Sam's Club 6568 / Ames       3913.92
3                  Cedar Ridge Vineyards       3712.50
37         Hy-Vee Wine and Spirits / WDM       3372.30
4                        Central City 2       2580.60
10   Fareway Stores #138 / Pleasant Hill       2295.00
23       Hy-Vee Food Store #2 / Waterloo       1992.15
28        Hy-Vee Food Store / Fort Dodge       1563.84
20                     Hy-Vee / Waukee       1518.72
9        Fareway Stores #067 / Evansdale       1349.40
11  Fareway Stores #153  /  W Des Moines       1349.28
15          Fareway Stores #983 / Grimes       1296.00
```

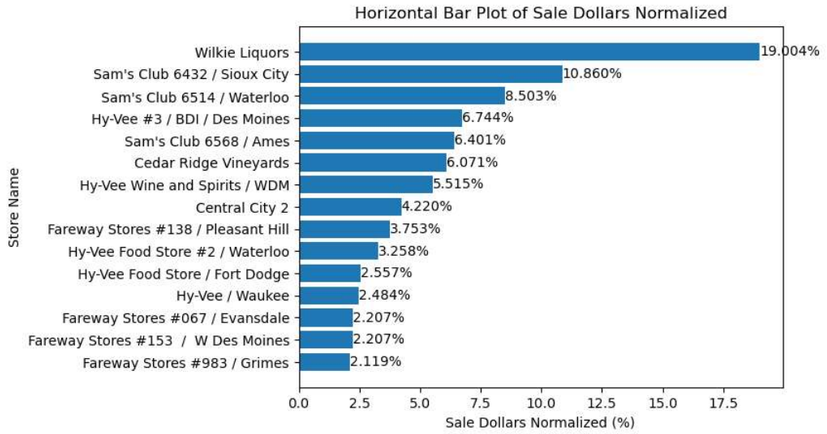
In [27]:
```
# Find the sum of the 'sale_dollars' column as a float
total_sale_dollars = float(grouped_df_sorted['sale_dollars'].sum())

# Display the result
print(total_sale_dollars)
```

```
61149.54
```

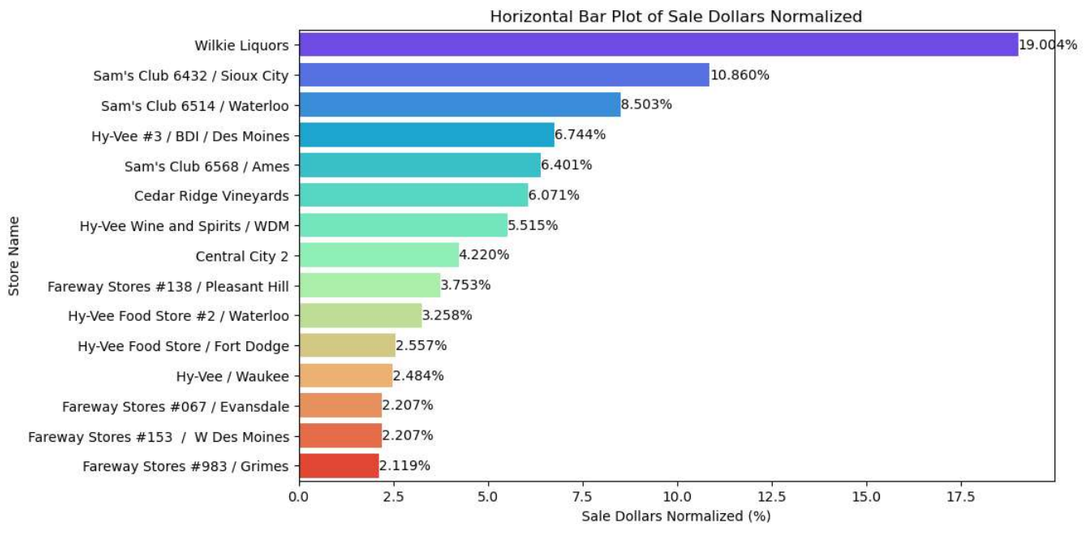
In [32]:
```
# Use .loc to create a new column by dividing 'sale_dollars' by the total sale dollars
top_15_rows.loc[:, 'sale_dollars_normalized'] = ((top_15_rows['sale_dollars'] / total_sale_dollars) * 100).copy()

# Display the result
print(top_15_rows)
```

```
                         store_name  sale_dollars  \
60                     Wilkie Liquors      11620.80
50          Sam's Club 6432 / Sioux City       6641.04
51            Sam's Club 6514 / Waterloo       5199.36
18          Hy-Vee #3 / BDI / Des Moines       4124.04
52                Sam's Club 6568 / Ames       3913.92
3                  Cedar Ridge Vineyards       3712.50
37         Hy-Vee Wine and Spirits / WDM       3372.30
4                        Central City 2       2580.60
10   Fareway Stores #138 / Pleasant Hill       2295.00
23       Hy-Vee Food Store #2 / Waterloo       1992.15
28        Hy-Vee Food Store / Fort Dodge       1563.84
20                     Hy-Vee / Waukee       1518.72
9        Fareway Stores #067 / Evansdale       1349.40
11  Fareway Stores #153  /  W Des Moines       1349.28
15          Fareway Stores #983 / Grimes       1296.00

    sale_dollars_normalized
60                19.003904
50                10.860327
51                 8.502697
18                 6.744188
52                 6.400571
3                  6.071182
37                 5.514841
4                  4.220146
10                 3.753094
23                 3.257833
28                 2.557403
20                 2.483616
9                  2.206721
11                 2.206525
15                 2.119395
```

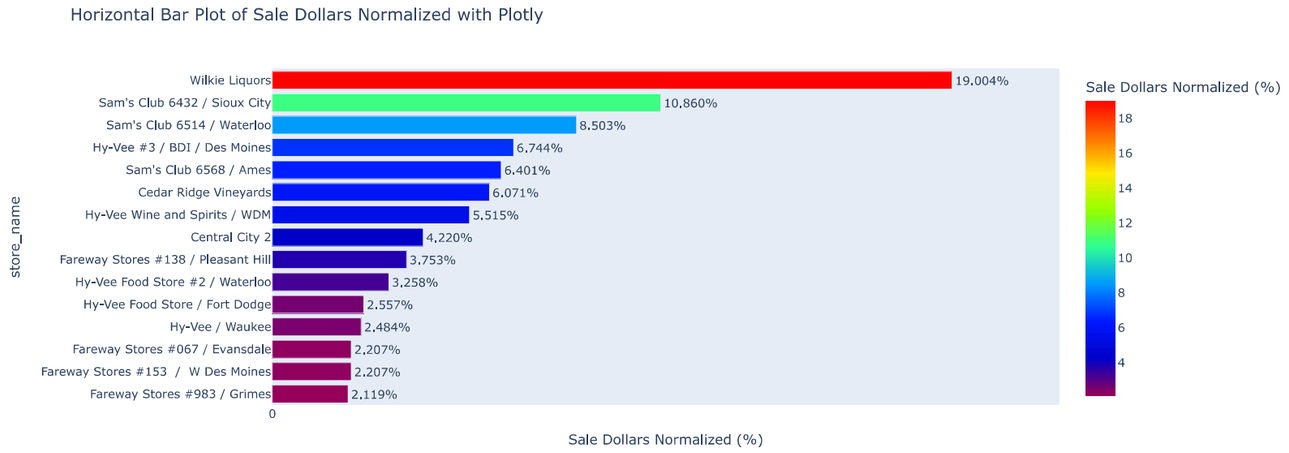
In [29]:
```
# Sort the DataFrame by 'sale_dollars_normalized' in descending order
top_15_rows_sorted = top_15_rows.sort_values(by='sale_dollars_normalized', ascending=True)

# Create a horizontal bar plot
fig, ax = plt.subplots()
bars = ax.barh(top_15_rows_sorted['store_name'], top_15_rows_sorted['sale_dollars_normalized'])
plt.xlabel('Sale Dollars Normalized (%)')
plt.ylabel('Store Name')
plt.title('Horizontal Bar Plot of Sale Dollars Normalized')

# Add percentage numbers to the bars
for bar in bars:
    plt.text(bar.get_width(), bar.get_y() + bar.get_height() / 2, f'{bar.get_width():.3f}%',
             va='center', ha='left')

# Display the plot
plt.show()
```



In [30]:
```python
# Sort the DataFrame by 'sale_dollars_normalized' in descending order
top_15_rows_sorted = top_15_rows.sort_values(by='sale_dollars_normalized', ascending=False)

# Create a horizontal bar plot with Seaborn
plt.figure(figsize=(10, 6))  # Adjust the figure size if needed
rainbow_colors = sns.color_palette('rainbow', n_colors=len(top_15_rows_sorted))
ax = sns.barplot(x='sale_dollars_normalized', y='store_name', data=top_15_rows_sorted, palette=rainbow_colors)

# Add percentage numbers to the bars
for p in ax.patches:
    width = p.get_width()
    plt.text(width, p.get_y() + p.get_height() / 2, f'{width:.3f}%', va='center', ha='left')

# Set labels and title
plt.xlabel('Sale Dollars Normalized (%)')
plt.ylabel('Store Name')
plt.title('Horizontal Bar Plot of Sale Dollars Normalized')

# Display the plot
plt.show()
```



In [31]:
```python
# Sort the DataFrame by 'sale_dollars_normalized' in descending order
top_15_rows_sorted = top_15_rows.sort_values(by='sale_dollars_normalized', ascending=True)

# Create a horizontal bar plot with Plotly
fig = px.bar(top_15_rows_sorted,
             x='sale_dollars_normalized',
             y='store_name',
             text='sale_dollars_normalized',
             labels={'sale_dollars_normalized': 'Sale Dollars Normalized (%)'},
             title='Horizontal Bar Plot of Sale Dollars Normalized with Plotly',
             color='sale_dollars_normalized',
             color_continuous_scale='Rainbow')

# Adjust the x-axis width
fig.update_layout(xaxis=dict(tickvals=[0, 25, 50, 75, 100], range=[0, 22]))
# Display percentage numbers on the bars
fig.update_traces(texttemplate='%{text:.3f}%', textposition='outside')

# Show the figure
fig.show()
```


Horizontal Bar Plot of Sale Dollars Normalized with Plotly
Wilkie Liquors
Sam's Club 6432 / Sioux City
Sam's Club 6514 / Waterloo
Hy-Vee #3 / BDI / Des Moines
Sam's Club 6568 / Ames
Cedar Ridge Vineyards
Hy-Vee Wine and Spirits / WDM
Central City 2
Fareway Stores #138 / Pleasant Hill
Hy-Vee Food Store #2 / Waterloo
Hy-Vee Food Store / Fort Dodge
Hy-Vee / Waukee
Fareway Stores #067 / Evansdale
Fareway Stores #153 / W Des Moines
Fareway Stores #983 / Grimes
19.004%
10.860%
8.503%
6.744%
6.401%
6.071%
5.515%
4.220%
3.753%
3.258%
2.557%
2.484%
2.207%
2.207%
2.119%
0
store_name
Sale Dollars Normalized (%)
Sale Dollars Normalized (%)
18
16
14
12
10
8
6
4

In [ ]: