RETAIL SALES ANALYSIS & INSIGHTS

Import necessary libraries

In [3]:
```
import pandas as pd
import os
import glob
```

Combine the sales data from all months into a single consolidated CSV file

In [5]:
```
folder_path = r"C:\Monthly_Sales"

# Retrieve all CSV files from the folder using glob
all_files = glob.glob(os.path.join(folder_path, "*.csv"))

# All CSV files combined as one DataFrame
all_data = pd.concat([pd.read_csv(file) for file in all_files], ignore_index=True)

# Merged DataFrame saved into a new CSV
output_file = os.path.join(folder_path, "all_data.csv")
all_data.to_csv(output_file, index=False)

print("All files integrated into:", output_file)
```

```
All files integrated into: C:\Monthly_Sales\all_data.csv
```

Load the updated DataFrame

In [7]:
```
# Skip Blank Rows if present in the dataset

df = pd.read_csv(r'C:\Monthly_Sales\all_data.csv', skip_blank_lines=True)
df.head()
```

Out[7]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address
0	175667	iPhone	1	700.0	04/24/24 19:12	135 Meadow St, Boston, MA 02215
1	175668	AA Batteries (4-pack)	1	5.84	04/20/24 13:45	592 4th St, San Francisco, CA 94016
2	175669	AA Batteries (4-pack)	1	5.84	04/28/24 09:17	632 Park St, Dallas, TX 75001
3	175670	AA Batteries (4-pack)	2	5.84	04/23/24 14:06	131 Pine St, San Francisco, CA 94016
4	175671	Samsung Odyssey Monitor	1	409.99	04/23/24 12:13	836 Forest St, Boston, MA 02215

In [8]:
```
df.shape
```

Out[8]:
```
(9316676, 6)
```

Data Cleaning Process

Thoroughly clean and standardize the data to eliminate errors, ensure consistency, and build a solid foundation for meaningful insights.

Find and remove rows with NaN values

In [11]:
```
df.isna().sum()
```

Out[11]:
```
Order ID            24192
Product Name        24192
Units Purchased     24194
Unit Price          24194
Order Date          24195
Delivery Address    24196
dtype: int64
```

In [12]:
```
# If Nan value is present in Order ID and Unit Purchased, it will be impossible to
# Therefore, drop Nan values in Order ID and Units Purchased.

df.dropna(subset=['Order ID', 'Units Purchased'], inplace=True)
```

In [13]:
```
# Check if Nan value is present

df.isna().sum()
```

Out[13]:
```
Order ID            0
Product Name        0
Units Purchased     0
Unit Price          0
Order Date          1
Delivery Address    2
dtype: int64
```

In [14]:
```
# Further check if any NaN values or blank rows are present

blank_rows_na = df[df.isnull().any(axis=1)]
blank_rows_na
```

Out[14]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address
2195228	Charging Cable	1	14.95	05/24/24 07:04	852 Hickory St, San Francisco, CA 94016	NaN
3001506	150766	iPhone	1	7	NaN	NaN

Find and remove rows with duplicate values

In [16]:
```
# Find duplicate values

df.duplicated()
```

Out[16]:
```
0          False
1          False
2          False
3          False
4          False
           ...
9316671     True
9316672     True
9316673     True
9316674     True
9316675     True
Length: 9292482, dtype: bool
```

In [17]:
```
# Remove duplicated values

df.drop_duplicates(inplace = True)
```

In [18]:
```
# Check again for duplicated values

df.duplicated()
```

Out[18]:
```
0          False
1          False
2          False
3          False
4          False
           ...
172530     False
2195228    False
3001506    False
6370083    False
6403571    False
Length: 171546, dtype: bool
```

Verify and fix incorrect data types in the dataset

In [20]:
```
# check for data types

df.dtypes
```

Out[20]:
```
Order ID            object
Product Name        object
Units Purchased     object
Unit Price          object
Order Date          object
Delivery Address    object
dtype: object
```

Fix incorrect data types

In [22]:
```
df['Order Date'] = pd.to_datetime(df['Order Date'], format='%m/%d/%y %H:%M', errors

df['Units Purchased'] = pd. to_numeric(df['Units Purchased'], errors='coerce')

df['Unit Price'] = pd. to_numeric(df['Unit Price'], errors='coerce')
```

In [23]:
```
# Verify the presence of NaN values remaining in the columns as a result of using e

df.isna().sum()
```

Out[23]:
```
Order ID            0
Product Name        0
Units Purchased     1
Unit Price          2
Order Date          3
Delivery Address    2
dtype: int64
```

In [24]:
```
df = df.dropna()
```

Change the data type to optimize memory usage (Optional)

In [26]:
```
df['Order ID'] = pd.to_numeric(df['Order ID'], downcast='integer')
df['Product Name'] = df['Product Name'].astype('category')
```

```
df['Units Purchased'] = df['Units Purchased']. astype('int8')
df['Unit Price'] = pd.to_numeric(df['Unit Price'], downcast='float')
df['Delivery Address'] = df['Delivery Address'].astype('category')
```

Expand the dataset with supplementary columns

Add month column

In [29]:
```
df['Month'] = df['Order Date'].dt.month
df
```

Out[29]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month
0	175667	iPhone	1	700.00000	2024-04-24 19:12:00	135 Meadow St, Boston, MA 02215	4
1	175668	AA Batteries (4-pack)	1	5.84000	2024-04-20 13:45:00	592 4th St, San Francisco, CA 94016	4
2	175669	AA Batteries (4-pack)	1	5.84000	2024-04-28 09:17:00	632 Park St, Dallas, TX 75001	4
3	175670	AA Batteries (4-pack)	2	5.84000	2024-04-23 14:06:00	131 Pine St, San Francisco, CA 94016	4
4	175671	Samsung Odyssey Monitor	1	409.98999	2024-04-23 12:13:00	836 Forest St, Boston, MA 02215	4
...	...	...	...	...	...	...	...
172528	248378	Google Phone	1	600.00000	2024-09-02 08:53:00	668 Wilson St, Boston, MA 02215	9
172529	248379	Alienware Monitor	1	400.98999	2024-09-04 22:58:00	466 2nd St, Boston, MA 02215	9
172530	248380	AAA Batteries (4-pack)	1	4.99000	2024-09-04 13:09:00	133 Walnut St, Seattle, WA 98101	9
6370083	252436	Apple Airpods Headphones	1	150.00000	2024-10-14 16:44:00	740 Dogwood St, Boston, \rA 02215	10
6403571	233092	USB-C Charging Cable	1	11.95000	2024-08-28 12:39:00	740 Dogwood St, Boston, \rA 02215	8

171543 rows × 7 columns

In [30]:
```
df['Month Name'] = df['Order Date'].dt.strftime('%B')
df
```

Out[30]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
0	175667	iPhone	1	700.00000	2024-04-24 19:12:00	135 Meadow St, Boston, MA 02215	4	
1	175668	AA Batteries (4-pack)	1	5.84000	2024-04-20 13:45:00	592 4th St, San Francisco, CA 94016	4	
2	175669	AA Batteries (4-pack)	1	5.84000	2024-04-28 09:17:00	632 Park St, Dallas, TX 75001	4	
3	175670	AA Batteries (4-pack)	2	5.84000	2024-04-23 14:06:00	131 Pine St, San Francisco, CA 94016	4	
4	175671	Samsung Odyssey Monitor	1	409.98999	2024-04-23 12:13:00	836 Forest St, Boston, MA 02215	4	
...	...	...	...	...	...	...	...	
172528	248378	Google Phone	1	600.00000	2024-09-02 08:53:00	668 Wilson St, Boston, MA 02215	9	Septer
172529	248379	Alienware Monitor	1	400.98999	2024-09-04 22:58:00	466 2nd St, Boston, MA 02215	9	Septer
172530	248380	AAA Batteries (4-pack)	1	4.99000	2024-09-04 13:09:00	133 Walnut St, Seattle, WA 98101	9	Septer
6370083	252436	Apple Airpods Headphones	1	150.00000	2024-10-14 16:44:00	740 Dogwood St, Boston, \rA 02215	10	Oct

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
6403571	233092	USB-C Charging Cable	1	11.95000	2024-08-28 12:39:00	740 Dogwood St, Boston, \rA 02215	8	Au

171543 rows × 8 columns

Add week day column

In [32]:
```
df['Day of Week'] = df['Order Date'].dt.strftime('%a')
df
```

Out[32]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
0	175667	iPhone	1	700.00000	2024-04-24 19:12:00	135 Meadow St, Boston, MA 02215	4	
1	175668	AA Batteries (4-pack)	1	5.84000	2024-04-20 13:45:00	592 4th St, San Francisco, CA 94016	4	
2	175669	AA Batteries (4-pack)	1	5.84000	2024-04-28 09:17:00	632 Park St, Dallas, TX 75001	4	
3	175670	AA Batteries (4-pack)	2	5.84000	2024-04-23 14:06:00	131 Pine St, San Francisco, CA 94016	4	
4	175671	Samsung Odyssey Monitor	1	409.98999	2024-04-23 12:13:00	836 Forest St, Boston, MA 02215	4	
...	...	...	...	...	...	...	...	
172528	248378	Google Phone	1	600.00000	2024-09-02 08:53:00	668 Wilson St, Boston, MA 02215	9	Septer
172529	248379	Alienware Monitor	1	400.98999	2024-09-04 22:58:00	466 2nd St, Boston, MA 02215	9	Septer
172530	248380	AAA Batteries (4-pack)	1	4.99000	2024-09-04 13:09:00	133 Walnut St, Seattle, WA 98101	9	Septer
6370083	252436	Apple Airpods Headphones	1	150.00000	2024-10-14 16:44:00	740 Dogwood St, Boston, \rA 02215	10	Oct

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
6403571	233092	USB-C Charging Cable	1	11.95000	2024-08-28 12:39:00	740 Dogwood St, Boston, \rA 02215	8	Au

171543 rows × 9 columns

Add hour column

In [34]:
```
df['Hour'] = df['Order Date'].dt.hour
df
```

Out[34]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
0	175667	iPhone	1	700.00000	2024-04-24 19:12:00	135 Meadow St, Boston, MA 02215	4	
1	175668	AA Batteries (4-pack)	1	5.84000	2024-04-20 13:45:00	592 4th St, San Francisco, CA 94016	4	
2	175669	AA Batteries (4-pack)	1	5.84000	2024-04-28 09:17:00	632 Park St, Dallas, TX 75001	4	
3	175670	AA Batteries (4-pack)	2	5.84000	2024-04-23 14:06:00	131 Pine St, San Francisco, CA 94016	4	
4	175671	Samsung Odyssey Monitor	1	409.98999	2024-04-23 12:13:00	836 Forest St, Boston, MA 02215	4	
...	...	...	...	...	...	...	...	
172528	248378	Google Phone	1	600.00000	2024-09-02 08:53:00	668 Wilson St, Boston, MA 02215	9	Septer
172529	248379	Alienware Monitor	1	400.98999	2024-09-04 22:58:00	466 2nd St, Boston, MA 02215	9	Septer
172530	248380	AAA Batteries (4-pack)	1	4.99000	2024-09-04 13:09:00	133 Walnut St, Seattle, WA 98101	9	Septer
6370083	252436	Apple Airpods Headphones	1	150.00000	2024-10-14 16:44:00	740 Dogwood St, Boston, \rA 02215	10	Oct

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	M N
6403571	233092	USB-C Charging Cable	1	11.95000	2024-08-28 12:39:00	740 Dogwood St, Boston, \rA 02215	8	Au

171543 rows × 10 columns

Add city column

In [36]:
```
def city(address):
    return address.split(",")[1].strip(" ")

def state_abbrev(address):
    return address.split(",")[2].split(" ")[1]

df['City'] = df['Delivery Address'].apply(lambda x: f"{city(x)}  ({state_abbrev(x)}
df.head()
```

Out[36]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name	Day of Week
0	175667	iPhone	1	700.00000	2024-04-24 19:12:00	135 Meadow St, Boston, MA 02215	4	April	Wed
1	175668	AA Batteries (4-pack)	1	5.84000	2024-04-20 13:45:00	592 4th St, San Francisco, CA 94016	4	April	Sat
2	175669	AA Batteries (4-pack)	1	5.84000	2024-04-28 09:17:00	632 Park St, Dallas, TX 75001	4	April	Sun
3	175670	AA Batteries (4-pack)	2	5.84000	2024-04-23 14:06:00	131 Pine St, San Francisco, CA 94016	4	April	Tue
4	175671	Samsung Odyssey Monitor	1	409.98999	2024-04-23 12:13:00	836 Forest St, Boston, MA 02215	4	April	Tue

Organize Data by Order Date Chronologically and Reindex

In [38]:
```
df = df.sort_values(by = 'Order Date')
df
```

Out[38]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name
78282	160155	Alienware Monitor	1	400.989990	2024-01-01 05:04:00	765 Ridge St, Portland, OR 97035	1	January
68761	151041	AAA Batteries (4-pack)	1	4.990000	2024-01-01 05:04:00	964 Lakeview St, Atlanta, GA 30301	1	January
64303	146765	AAA Batteries (4-pack)	1	4.990000	2024-01-01 05:20:00	546 10th St, San Francisco, CA 94016	1	January
63092	145617	Amana Washing Machine	1	600.000000	2024-01-01 05:24:00	961 Meadow St, Portland, OR 97035	1	January
74502	156535	iPhone	1	700.000000	2024-01-01 05:45:00	451 Elm St, Los Angeles, CA 90001	1	January
...	...	...	...	...	...	...	...	...
44457	297748	iPhone	1	700.000000	2025-01-01 02:37:00	258 Forest St, Los Angeles, CA 90001	1	January
30663	284606	Bose SoundSport Headphones	1	99.989998	2025-01-01 02:50:00	211 Johnson St, Boston, MA 02215	1	January
49246	302330	AA Batteries (4-pack)	1	5.840000	2025-01-01 03:03:00	665 6th St, San Francisco, CA 94016	1	January
30770	284711	AA Batteries (4-pack)	1	5.840000	2025-01-01 03:19:00	250 8th St, San Francisco, CA 94016	1	January

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name
50619	303626	USB-C Charging Cable	3	11.950000	2025-01-01 04:43:00	651 Lakeview St, Dallas, TX 75001	1	January

171543 rows × 11 columns

In [39]:
```
df = df.reset_index(drop=True)
df
```

Out[39]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name
0	160155	Alienware Monitor	1	400.989990	2024-01-01 05:04:00	765 Ridge St, Portland, OR 97035	1	January
1	151041	AAA Batteries (4-pack)	1	4.990000	2024-01-01 05:04:00	964 Lakeview St, Atlanta, GA 30301	1	January
2	146765	AAA Batteries (4-pack)	1	4.990000	2024-01-01 05:20:00	546 10th St, San Francisco, CA 94016	1	January
3	145617	Amana Washing Machine	1	600.000000	2024-01-01 05:24:00	961 Meadow St, Portland, OR 97035	1	January
4	156535	iPhone	1	700.000000	2024-01-01 05:45:00	451 Elm St, Los Angeles, CA 90001	1	January
...	...	...	...	...	...	...	...	...
171538	297748	iPhone	1	700.000000	2025-01-01 02:37:00	258 Forest St, Los Angeles, CA 90001	1	January
171539	284606	Bose SoundSport Headphones	1	99.989998	2025-01-01 02:50:00	211 Johnson St, Boston, MA 02215	1	January
171540	302330	AA Batteries (4-pack)	1	5.840000	2025-01-01 03:03:00	665 6th St, San Francisco, CA 94016	1	January
171541	284711	AA Batteries (4-pack)	1	5.840000	2025-01-01 03:19:00	250 8th St, San Francisco, CA 94016	1	January

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Mont Nam
171542	303626	USB-C Charging Cable	3	11.950000	2025-01-01 04:43:00	651 Lakeview St, Dallas, TX 75001	1	Januar

171543 rows × 11 columns

Exploration Data Analysis (EDA)

1. Monthly Sales Performance Analysis

Which month achieved the highest total sales, and what was the total sales figure recorded during that period?

In [43]:
```
# Add Total Sales column

df['Total Sales'] = df['Units Purchased'] * df['Unit Price']
df.head()
```

Out[43]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name	Day of Week
0	160155	Alienware Monitor	1	400.98999	2024-01-01 05:04:00	765 Ridge St, Portland, OR 97035	1	January	Mon
1	151041	AAA Batteries (4-pack)	1	4.99000	2024-01-01 05:04:00	964 Lakeview St, Atlanta, GA 30301	1	January	Mon
2	146765	AAA Batteries (4-pack)	1	4.99000	2024-01-01 05:20:00	546 10th St, San Francisco, CA 94016	1	January	Mon
3	145617	Amana Washing Machine	1	600.00000	2024-01-01 05:24:00	961 Meadow St, Portland, OR 97035	1	January	Mon
4	156535	iPhone	1	700.00000	2024-01-01 05:45:00	451 Elm St, Los Angeles, CA 90001	1	January	Mon

Format Unit Price and Total Sales to 2 decimal places

In [45]:
```
df['Unit Price'] = df['Unit Price'].apply(lambda x: "%.2f" % x)
```

In [46]:
```
df['Total Sales'] = df['Total Sales'].apply(lambda x: "%.2f" % x)
df.head()
```

Out[46]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name	Day of Week	Hc
0	160155	Alienware Monitor	1	400.99	2024-01-01 05:04:00	765 Ridge St, Portland, OR 97035	1	January	Mon	
1	151041	AAA Batteries (4-pack)	1	4.99	2024-01-01 05:04:00	964 Lakeview St, Atlanta, GA 30301	1	January	Mon	
2	146765	AAA Batteries (4-pack)	1	4.99	2024-01-01 05:20:00	546 10th St, San Francisco, CA 94016	1	January	Mon	
3	145617	Amana Washing Machine	1	600.00	2024-01-01 05:24:00	961 Meadow St, Portland, OR 97035	1	January	Mon	
4	156535	iPhone	1	700.00	2024-01-01 05:45:00	451 Elm St, Los Angeles, CA 90001	1	January	Mon	

In [47]:
```
df['Unit Price'] = pd.to_numeric(df['Unit Price'])
df['Total Sales'] = pd.to_numeric(df['Total Sales'])
```

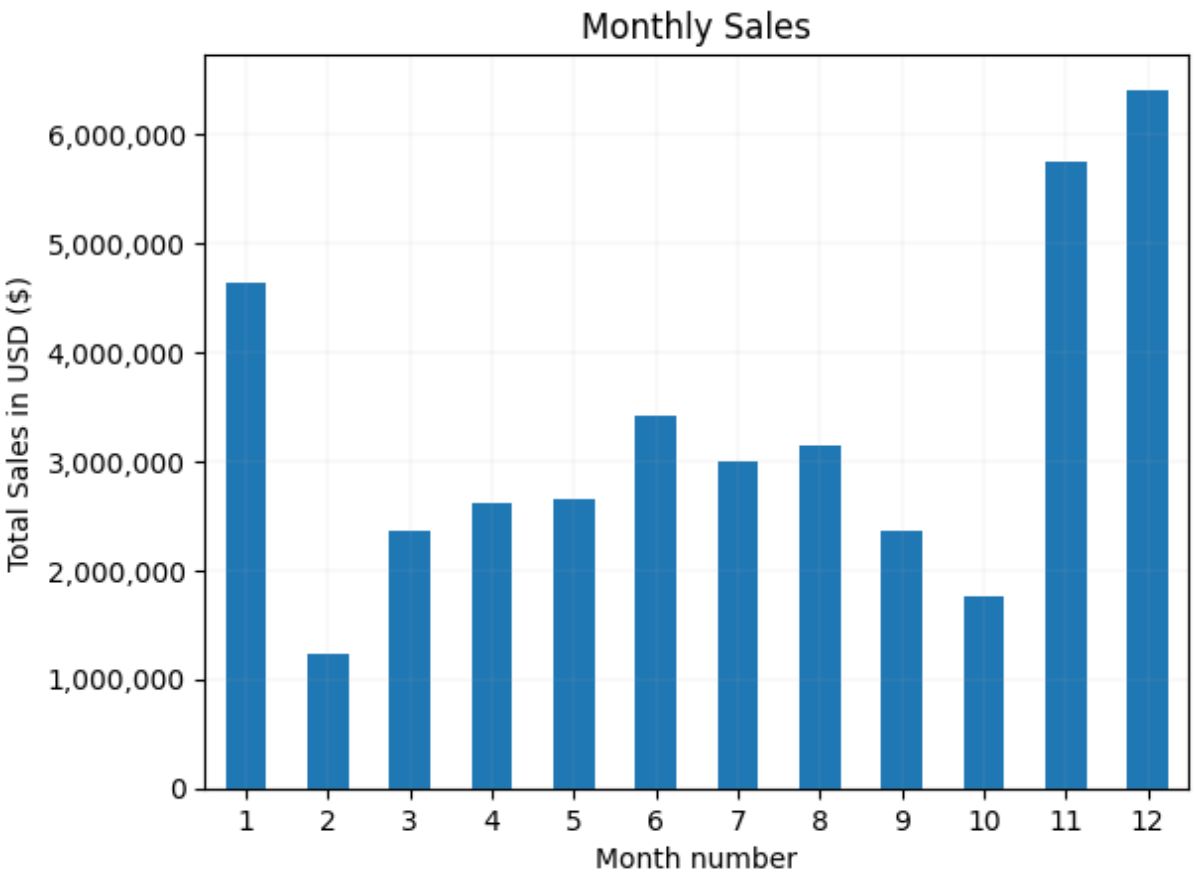
In [48]:
```
df.dtypes
```

Out[48]:
```
Order ID                   int32
Product Name            category
Units Purchased             int8
Unit Price               float64
Order Date         datetime64[ns]
Delivery Address        category
Month                      int32
Month Name                object
Day of Week               object
Hour                       int32
City                      object
Total Sales              float64
dtype: object
```

In [49]:
```
monthly_sales = df.groupby('Month')['Total Sales'].sum()
monthly_sales
```

Out[49]:
```
Month
1     4639312.17
2     1235017.71
3     2358783.67
4     2619873.83
5     2657978.27
6     3408613.54
7     2990038.42
8     3143681.87
9     2368652.05
10    1760182.98
11    5743349.24
12    6404121.28
Name: Total Sales, dtype: float64
```

In [50]:
```
import matplotlib.pyplot as plt

ax = monthly_sales.plot(kind='bar', title="Monthly Sales")

ax.set_xlabel('Month number')
ax.set_ylabel('Total Sales in USD ($)')

ax.get_yaxis().set_major_formatter(plt.FuncFormatter(lambda x, _: f'{int(x):,}'))

plt.xticks(rotation=0)
plt.grid(linewidth=0.1)
plt.show()
```



2. Monthly Sales Growth Analysis

What is the percentage growth in total monthly sales over time, and how does it vary across different months?

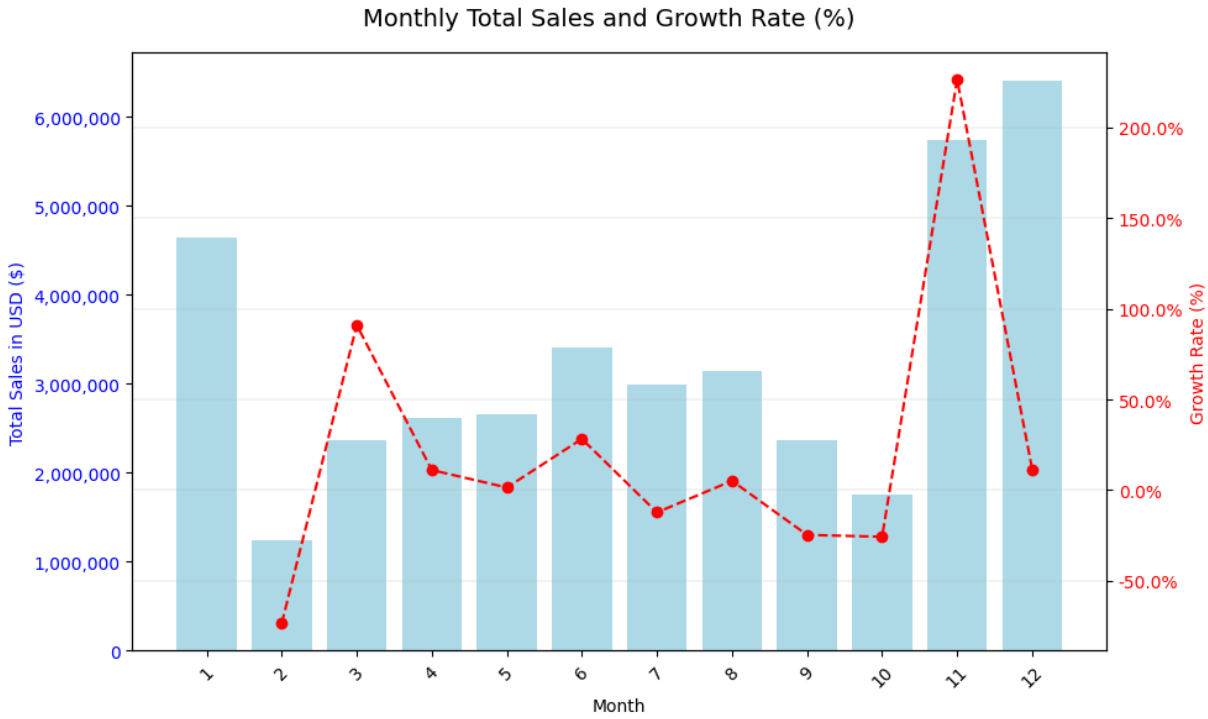
In [53]:
```
# Deep copy to avoid modifying the original DataFrame (df)
df_growth = df.copy(deep=True)

df_msg = df_growth.groupby('Month')['Total Sales'].sum().reset_index()

# Monthly Growth Rate (%)
df_msg['Growth Rate (%)'] = df_msg['Total Sales'].pct_change() * 100

df_msg
```

Out[53]:

	Month	Total Sales	Growth Rate (%)
0	1	4639312.17	NaN
1	2	1235017.71	-73.379293
2	3	2358783.67	90.991890
3	4	2619873.83	11.068847
4	5	2657978.27	1.454438
5	6	3408613.54	28.240835
6	7	2990038.42	-12.279923
7	8	3143681.87	5.138511
8	9	2368652.05	-24.653570
9	10	1760182.98	-25.688411
10	11	5743349.24	226.292738
11	12	6404121.28	11.504995

In [54]:
```
# Monthly Sales Growth Plot
import matplotlib.ticker as ticker

fig, ax1 = plt.subplots(figsize=(10, 6))

# Left y-axis: Total Sales as bar chart
ax1.bar(df_msg['Month'].astype(str), df_msg['Total Sales'], color='lightblue', labe
ax1.set_xlabel('Month')
ax1.set_ylabel('Total Sales in USD ($)', color='blue')
ax1.tick_params(axis='y', labelcolor='blue')
ax1.tick_params(axis='x', rotation=45)

# Numeric and not scientific
ax1.yaxis.set_major_formatter(ticker.FuncFormatter(lambda x, _: f'{x:,.0f}'))
```

```
# Right y-axis: Growth Rate as line plot
ax2 = ax1.twinx()
ax2.plot(df_msg['Month'].astype(str), df_msg['Growth Rate (%)'], color='red', lines
ax2.set_ylabel('Growth Rate (%)', color='red')
ax2.tick_params(axis='y', labelcolor='red')
ax2.yaxis.set_major_formatter(ticker.FuncFormatter(lambda y, _: f'{y:,.1f}%'))

fig.suptitle('Monthly Total Sales and Growth Rate (%)', fontsize=14)
fig.tight_layout()
plt.grid(True, linewidth=0.2)

plt.show()
```



3. Geographic Sales Analysis

Which city achieved the highest total sales, and what was the total sales amount for that city?

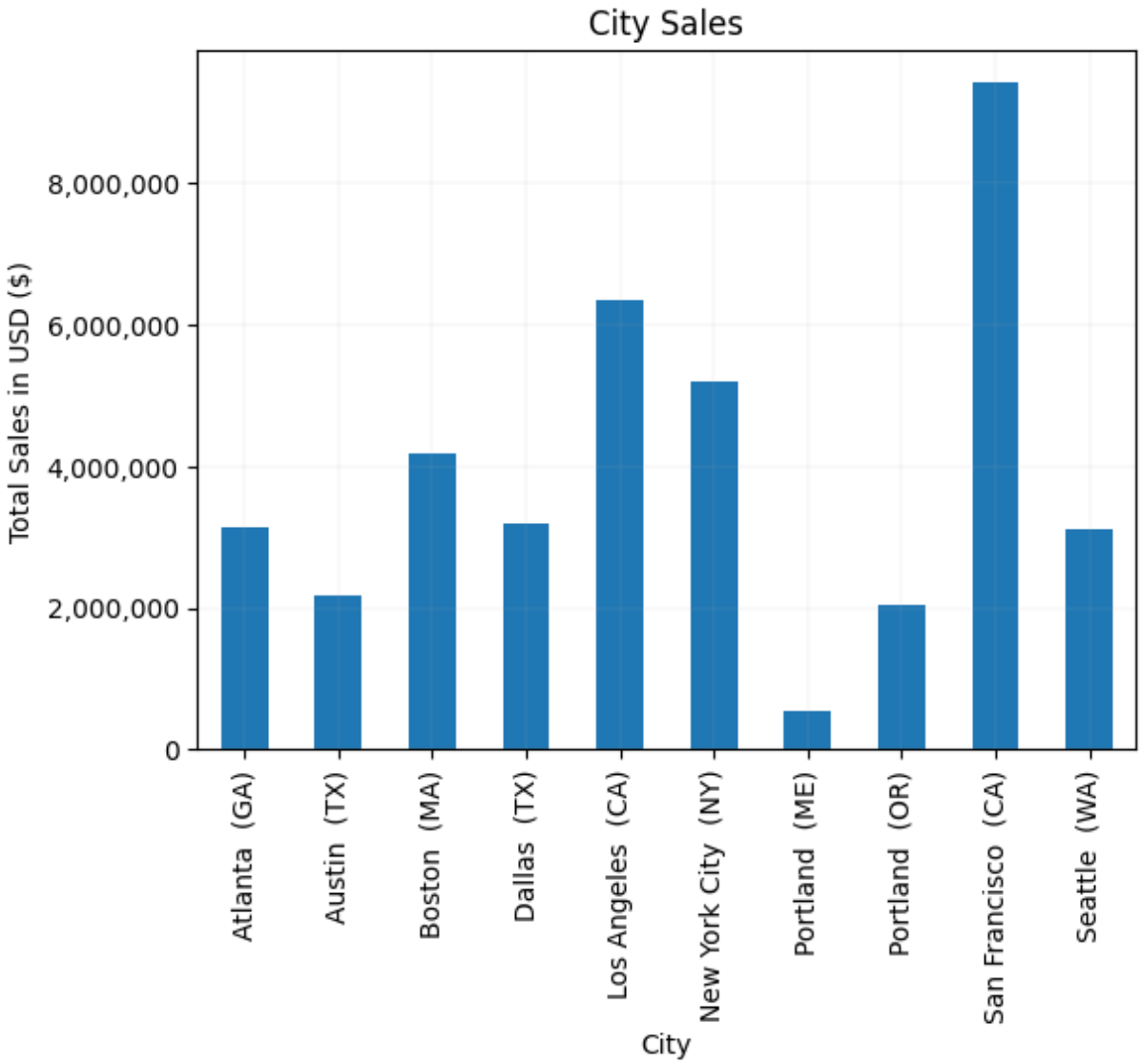
Replace 'Boston (\rA)' with 'Boston (MA)'

In [58]:
```
import re

df['City'] = df['City'].str.replace(r'Boston\s+\(\rA\)', 'Boston  (MA)', regex=True
```

In [59]:
```
City_sales = df.groupby('City', observed=False)['Total Sales'].sum()
City_sales
```

Out[59]:
```
City
Atlanta  (GA)          3145310.00
Austin  (TX)           2178728.99
Boston  (MA)           4166657.99
Dallas  (TX)           3193629.21
Los Angeles  (CA)      6343771.43
New York City  (NY)    5200781.23
Portland  (ME)          541531.52
Portland  (OR)         2053173.81
San Francisco  (CA)    9391881.93
Seattle  (WA)          3114138.92
Name: Total Sales, dtype: float64
```

In [60]:
```
ax = City_sales.plot(kind='bar', title="City Sales")

ax.set_xlabel('City')
ax.set_ylabel('Total Sales in USD ($)')

ax.get_yaxis().set_major_formatter(plt.FuncFormatter(lambda x, _: f'{int(x):,}'))

plt.grid(linewidth=0.1)
plt.show()
```



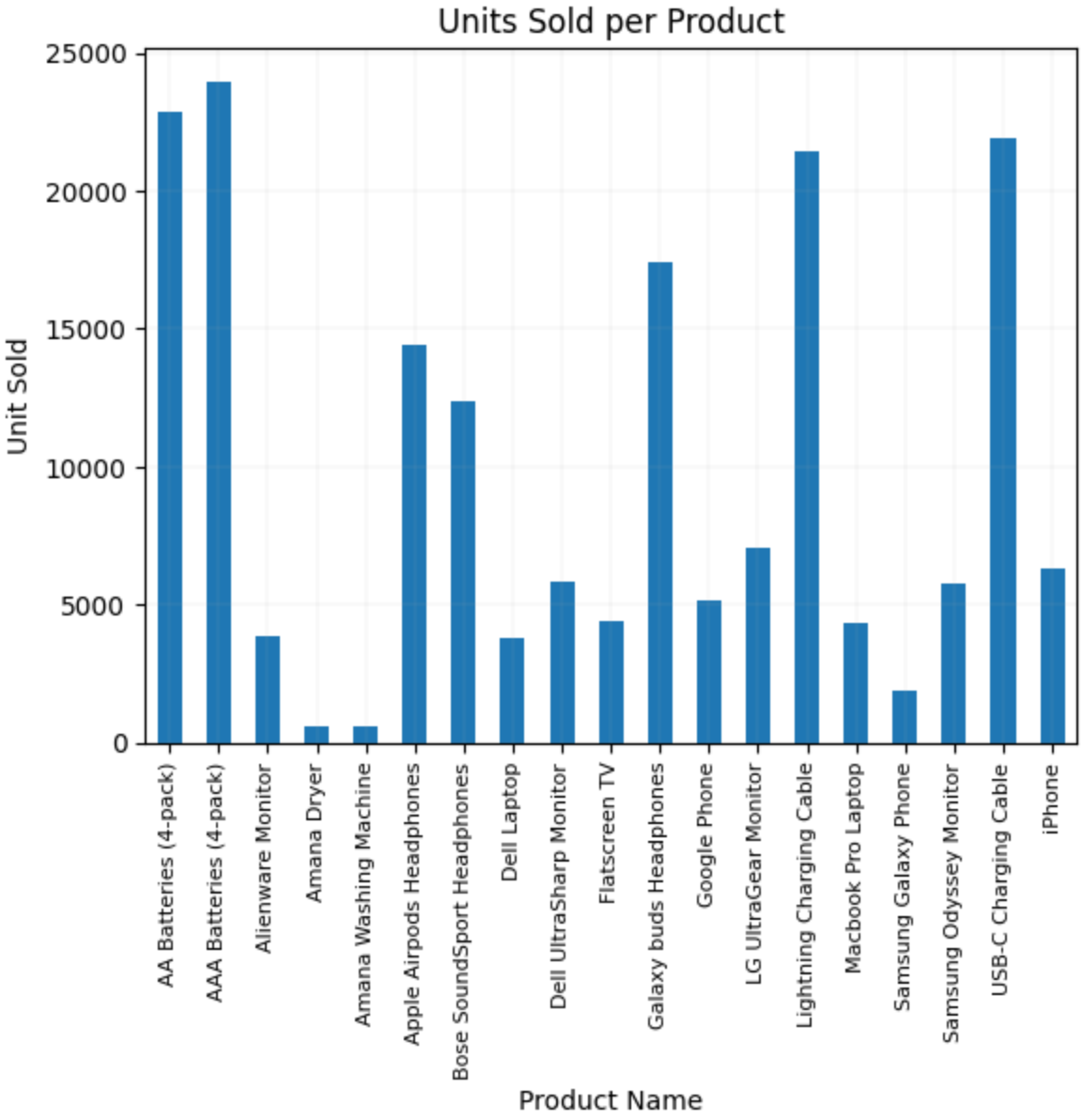
4. Product Analysis

Which product had the highest sales, and what factors do you believe contributed to its success?

In [63]:
```
product_df = df.groupby('Product Name', observed=False)['Units Purchased'].sum()

sorted_product_df = product_df.sort_values(ascending=False)
sorted_product_df
```

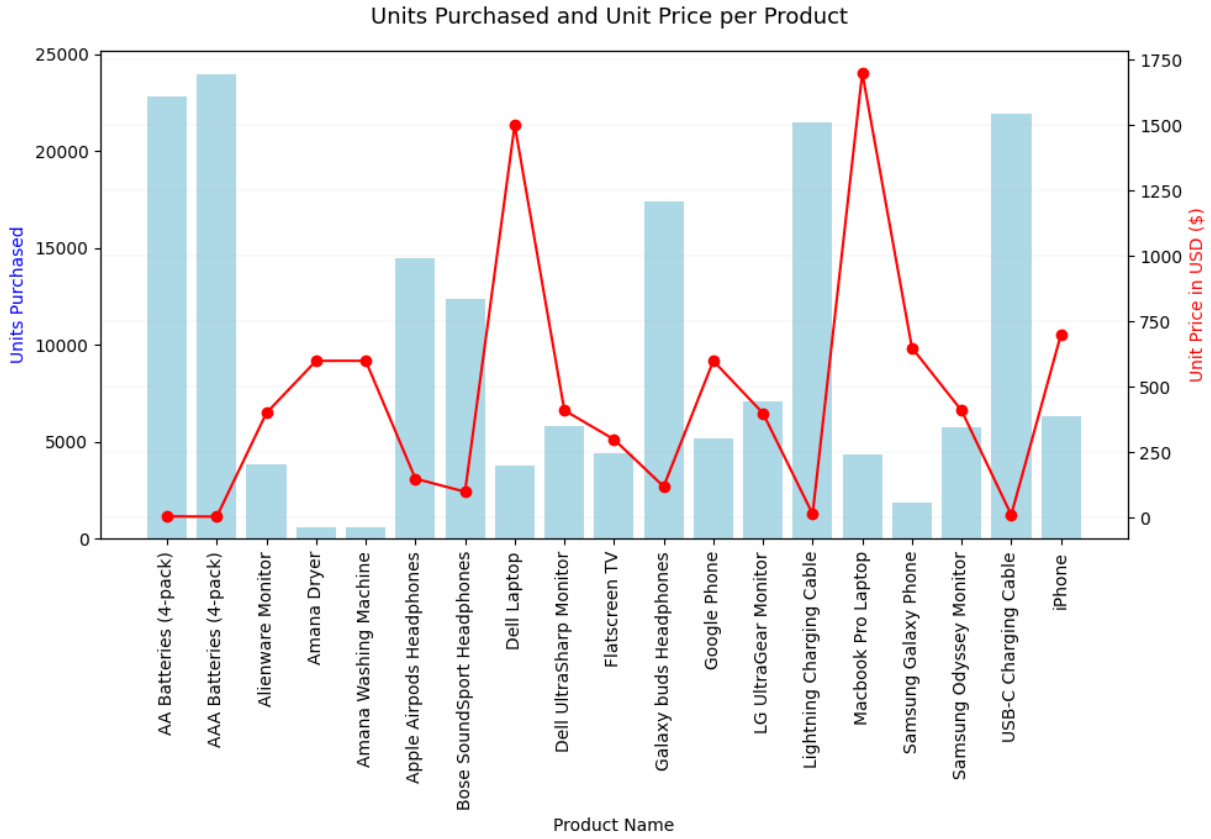
Out[63]:
```
Product Name
AAA Batteries (4-pack)        23970
AA Batteries (4-pack)         22830
USB-C Charging Cable          21927
Lightning Charging Cable      21442
Galaxy buds Headphones        17384
Apple Airpods Headphones      14445
Bose SoundSport Headphones    12386
LG UltraGear Monitor           7096
iPhone                         6294
Dell UltraSharp Monitor        5820
Samsung Odyssey Monitor        5741
Google Phone                   5174
Flatscreen TV                  4422
Macbook Pro Laptop             4344
Alienware Monitor              3861
Dell Laptop                    3798
Samsung Galaxy Phone           1859
Amana Dryer                     622
Amana Washing Machine           611
Name: Units Purchased, dtype: int64
```

In [64]:
```
product_df = df.groupby('Product Name', observed=False)['Units Purchased'].sum()

product_df.plot(kind='bar', title="Units Sold per Product")

plt.xlabel('Product Name')
plt.ylabel('Unit Sold')
plt.xticks(rotation='vertical', size=8)
plt.grid(linewidth=0.1)
plt.show()
```



In [65]:
```
product_df = df.groupby('Product Name', observed=False)['Units Purchased'].sum()
price_df = df.groupby('Product Name', observed=False)['Unit Price'].mean()

# first axis and figure size
fig, ax1 = plt.subplots(figsize=(10, 7))

# Bar chart and first y-axis for Units Purchased
ax1.bar(product_df.index, product_df, color='lightblue', label='Units Purchased')
ax1.set_xlabel('Product Name')
ax1.set_ylabel('Units Purchased', color='b')
ax1.tick_params(axis='x', rotation=90)  # Rotate x-axis labels for better visibilit

# Line chart and the second y-axis for Unit Price
ax2 = ax1.twinx()
ax2.plot(price_df.index, price_df, color='r', label='Unit Price', marker='o')
ax2.set_ylabel('Unit Price in USD ($)', color='r')

plt.grid(linewidth=0.1)
fig.suptitle('Units Purchased and Unit Price per Product', fontsize=13)
```

```
plt.tight_layout()
plt.show()
```



5. Product Sales Performance Analysis

How do product sales vary across different days of the week, and what insights can be drawn from the distribution of order volumes by product and day?

In [68]:
```
pivot_table = df.pivot_table(index = 'Product Name', columns = 'Day of Week' , valu
                             aggfunc = 'sum', observed=False )
pivot_table
```

Out[68]:

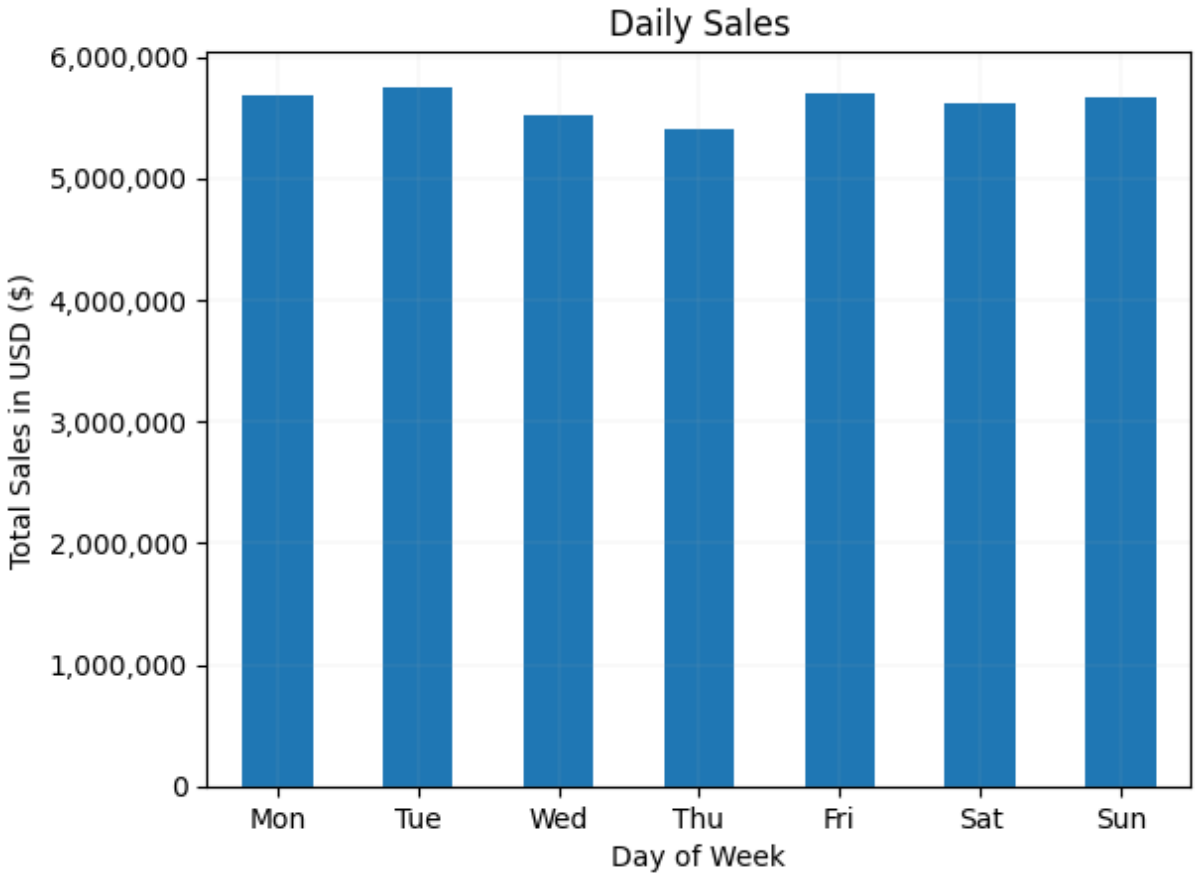
Day of Week	Fri	Mon	Sat	Sun	Thu	Tue	Wed
Product Name							
AA Batteries (4-pack)	3262	3329	3368	3174	3205	3294	3198
AAA Batteries (4-pack)	3347	3519	3448	3457	3362	3485	3352
Alienware Monitor	581	560	570	564	509	556	521
Amana Dryer	94	106	89	87	85	88	73
Amana Washing Machine	88	99	92	90	77	75	90
Apple Airpods Headphones	2053	2166	2000	2096	1985	2082	2063
Bose SoundSport Headphones	1729	1919	1768	1789	1695	1795	1691
Dell Laptop	537	564	560	546	516	541	534
Dell UltraSharp Monitor	827	807	814	898	806	860	808
Flatscreen TV	609	662	646	604	625	629	647
Galaxy buds Headphones	2522	2514	2476	2470	2306	2608	2488
Google Phone	749	771	710	701	734	775	734
LG UltraGear Monitor	1010	1018	1045	1000	1003	998	1022
Lightning Charging Cable	3050	3062	3006	3127	3026	3205	2966
Macbook Pro Laptop	638	577	623	633	598	666	609
Samsung Galaxy Phone	277	275	271	269	256	253	258
Samsung Odyssey Monitor	841	802	792	816	772	837	881
USB-C Charging Cable	3096	3203	3089	3120	3052	3189	3178
iPhone	949	941	875	917	875	923	814

In [69]:
```
import seaborn as sns

plt.figure(figsize=(10, 8))
sns.heatmap(pivot_table, annot = True, cmap = 'Blues', fmt='.1f', annot_kws={'size'

plt.title('Product Sales Distribution by Day of the Week', fontsize=14)
plt.xlabel('Day of the Week', fontsize=12)
plt.ylabel('Product Name', fontsize=12)

plt.tight_layout()
plt.show()
```

6. Weekly Purchase Trends Analysis

On which day of the week do customers make the most purchases?

In [72]:
```
daily_sales = df.groupby('Day of Week', observed=False)['Total Sales'].sum().sort_v
daily_sales

day_order = ['Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat', 'Sun']

daily_sales = daily_sales.reindex(day_order)

ax = daily_sales.plot(kind='bar', title="Daily Sales")

ax.set_xlabel('Day of Week')
ax.set_ylabel('Total Sales in USD ($)')

ax.get_yaxis().set_major_formatter(plt.FuncFormatter(lambda x, _: f'{int(x):,}'))

plt.xticks(rotation=0)
plt.grid(linewidth=0.1)
plt.show()
```

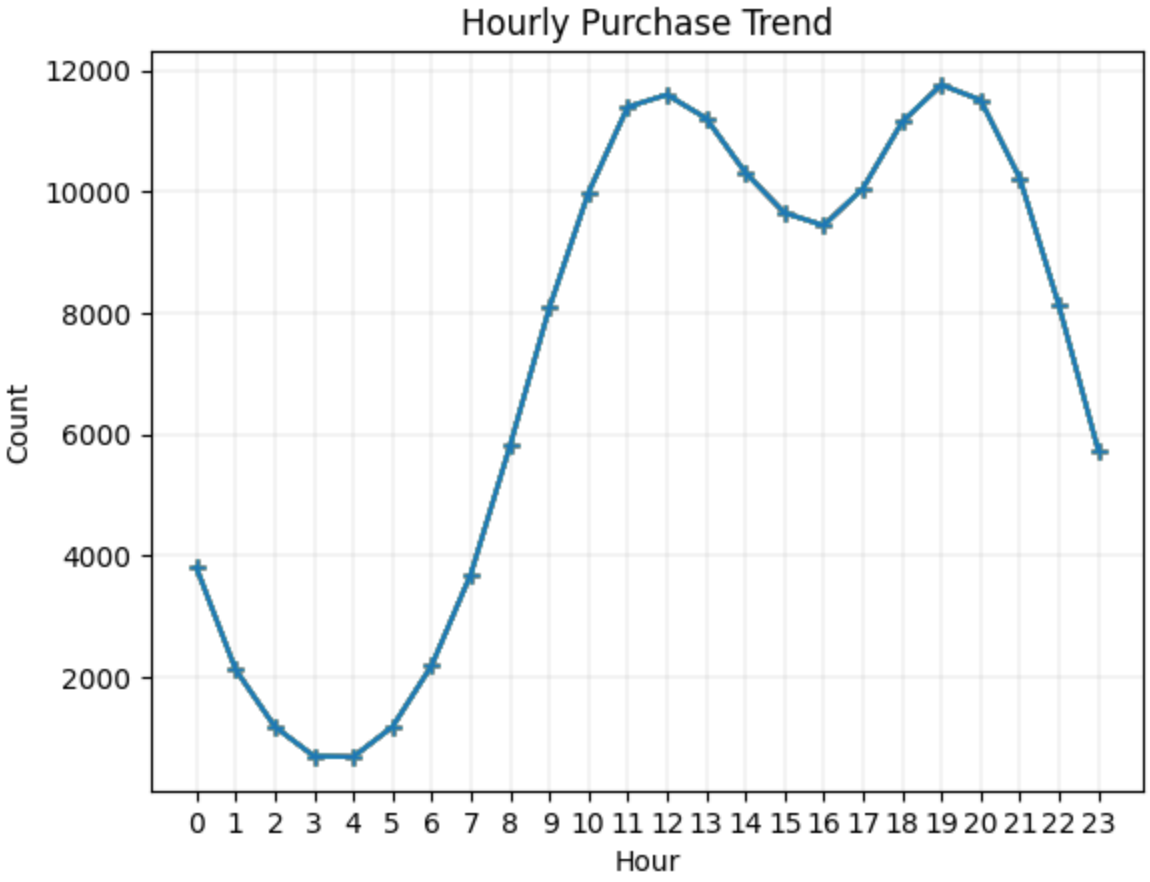


Machine Learning Models

7. Time Series Analysis (Customer Behavior Timing)

What is the optimal timing for advertisements and promotions to maximize customer purchases, based on historical purchase behavior?

In [76]:
```
plt.plot(df.groupby(['Hour']).count(), marker='+')
plt.title('Hourly Purchase Trend')
plt.xlabel('Hour')
plt.ylabel('Count')
plt.xticks(range(0,24))
plt.grid(linewidth=0.2)
plt.show()
```



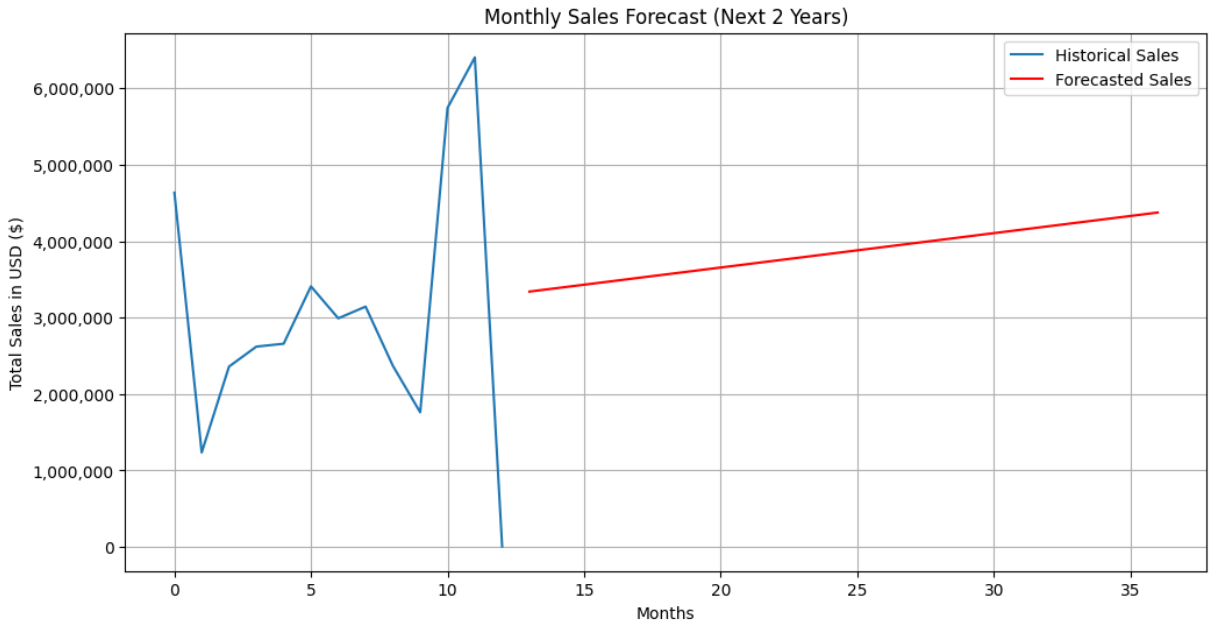
8. Sales Forecasting

What will our monthly sales look like over the next two years based on historical purchasing patterns?

Using Linear Regression model

In [80]:
```
import numpy as np
from matplotlib.ticker import FuncFormatter
from sklearn.linear_model import LinearRegression

# Add Year column
df['Year'] = df['Order Date'].dt.year


monthly_sales = df.groupby(['Year', 'Month'])['Total Sales'].sum().reset_index()

# Time Index' for regression (e.g., 0, 1, 2, ..., n)
monthly_sales = monthly_sales.sort_values(['Year', 'Month'])
monthly_sales['Time'] = np.arange(len(monthly_sales))

# Linear Regression model
X = monthly_sales[['Time']]
y = monthly_sales['Total Sales']
```

```
model = LinearRegression()
model.fit(X, y)

# Forecast for next 24 months (2 years)
future_time = pd.DataFrame({'Time': np.arange(len(monthly_sales), len(monthly_sales
future_sales = model.predict(future_time)

# Future date labels
last_year = monthly_sales['Year'].max()
last_month = monthly_sales['Month'].max()
start_date = pd.Timestamp(year=last_year, month=last_month, day=1) + pd.DateOffset(
future_dates = pd.date_range(start=start_date, periods=24, freq='MS')

plt.figure(figsize=(12, 6))
plt.plot(monthly_sales['Time'], y, label='Historical Sales')
plt.plot(future_time, future_sales, label='Forecasted Sales', color='red')
plt.title('Monthly Sales Forecast (Next 2 Years)')
plt.xlabel('Months')
plt.ylabel('Total Sales in USD ($)')
plt.legend()
plt.grid(True)

# Format Y-axis to numeric (non-scientific)
formatter = FuncFormatter(lambda x, _: f'{x:,.0f}')
plt.gca().yaxis.set_major_formatter(formatter)

plt.show()
```

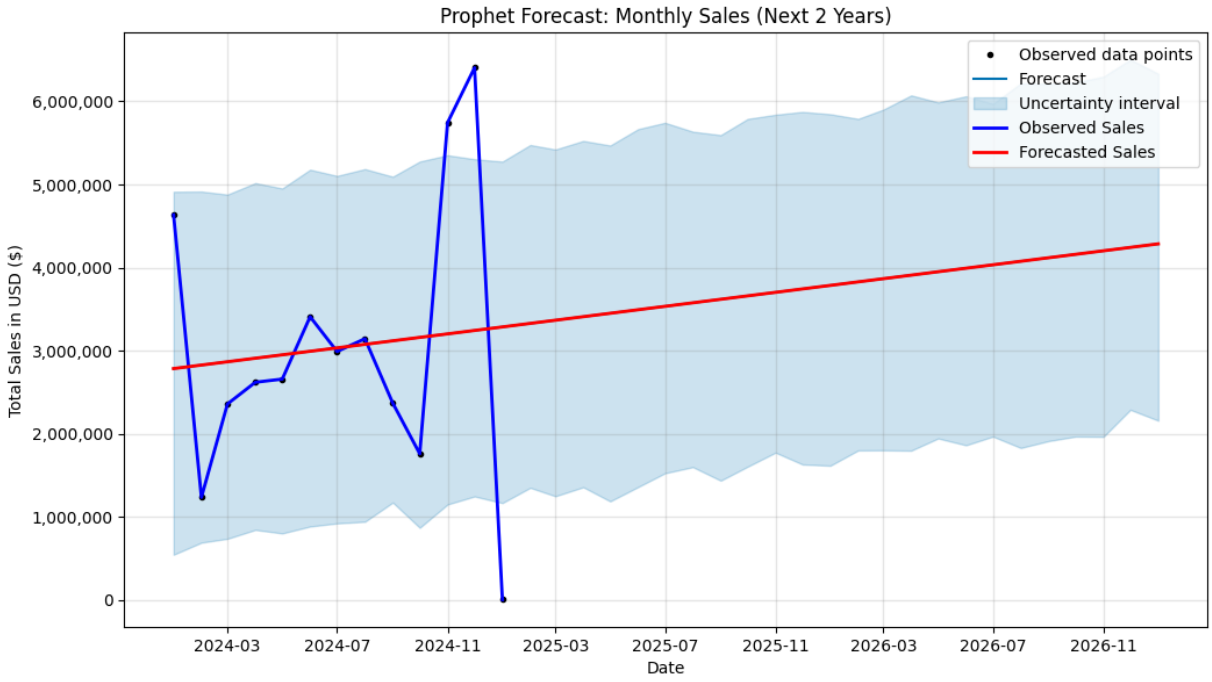


Using Prophet Model

In [82]:
```
from prophet import Prophet

# Deep copy to avoid modifying the original DataFrame (df)
df_prophet = df.copy(deep=True)

# Data preparation
```

```
monthly_sales = df_prophet.resample('MS', on='Order Date')['Total Sales'].sum().res
monthly_sales.columns = ['ds', 'y']

# Fit Prophet model
model = Prophet()
model.fit(monthly_sales)

# Forecast for next 24 months (2 years)
future = model.make_future_dataframe(periods=24, freq='MS')
forecast = model.predict(future)
fig = model.plot(forecast)

# Connect observed data points (historical sales)
plt.plot(monthly_sales['ds'], monthly_sales['y'], color='blue', linewidth=2, label=

# Overlay forecast line
plt.plot(forecast['ds'], forecast['yhat'], color='red', linewidth=2, label='Forecas

plt.title('Prophet Forecast: Monthly Sales (Next 2 Years)')
plt.xlabel('Date')
plt.ylabel('Total Sales in USD ($)')
plt.grid(True)

# Format Y-axis to numeric (non-scientific)
formatter = FuncFormatter(lambda x, _: f'{x:,.0f}')
plt.gca().yaxis.set_major_formatter(formatter)

plt.legend()
plt.show()

# Forecasted values
forecast[['ds', 'yhat', 'yhat_lower', 'yhat_upper']].tail(24)
```

```
23:28:05 - cmdstanpy - INFO - Chain [1] start processing
23:28:09 - cmdstanpy - INFO - Chain [1] done processing
```



Out[82]:

	ds	yhat	yhat_lower	yhat_upper
13	2025-02-01	3.327913e+06	1.350554e+06	5.475150e+06
14	2025-03-01	3.366248e+06	1.249063e+06	5.420682e+06
15	2025-04-01	3.408691e+06	1.357595e+06	5.523899e+06
16	2025-05-01	3.449764e+06	1.187470e+06	5.468978e+06
17	2025-06-01	3.492207e+06	1.359289e+06	5.665686e+06
18	2025-07-01	3.533281e+06	1.526009e+06	5.742422e+06
19	2025-08-01	3.575724e+06	1.599527e+06	5.635174e+06
20	2025-09-01	3.618167e+06	1.436391e+06	5.593912e+06
21	2025-10-01	3.659240e+06	1.604829e+06	5.788730e+06
22	2025-11-01	3.701683e+06	1.773881e+06	5.839067e+06
23	2025-12-01	3.742757e+06	1.631503e+06	5.872943e+06
24	2026-01-01	3.785199e+06	1.616520e+06	5.845487e+06
25	2026-02-01	3.827642e+06	1.800242e+06	5.789377e+06
26	2026-03-01	3.865978e+06	1.801731e+06	5.900877e+06
27	2026-04-01	3.908420e+06	1.797596e+06	6.071830e+06
28	2026-05-01	3.949494e+06	1.944436e+06	5.987339e+06
29	2026-06-01	3.991937e+06	1.862276e+06	6.061306e+06
30	2026-07-01	4.033011e+06	1.967021e+06	5.970532e+06
31	2026-08-01	4.075453e+06	1.829724e+06	6.216276e+06
32	2026-09-01	4.117896e+06	1.912904e+06	6.211802e+06
33	2026-10-01	4.158970e+06	1.966618e+06	6.226751e+06
34	2026-11-01	4.201413e+06	1.964230e+06	6.297223e+06
35	2026-12-01	4.242486e+06	2.289033e+06	6.502626e+06
36	2027-01-01	4.284929e+06	2.158377e+06	6.331737e+06

9. Market Basket Analysis (Customer Purchase Behavior)

What products are frequently bought together?

In [85]:
```
# Filter rows with the same Order ID and add .copy() to avoid settingwithcopyWarnin
df2 = df[df['Order ID'].duplicated(keep=False)].copy()
```

```
# Group Product Name with same Order ID
df2['Grouped'] = df2.groupby('Order ID')['Product Name'].transform(lambda x: ','.jo

# Drop any duplicates that may occur as a result of the grouping
df3 = df2[['Order ID', 'Grouped']].drop_duplicates()

df3.head(10)
```

Out[85]:

	Order ID	Grouped
4	156535	iPhone,Lightning Charging Cable
23	158949	iPhone,Lightning Charging Cable
37	144817	AA Batteries (4-pack),Alienware Monitor
44	157783	Alienware Monitor,AA Batteries (4-pack)
56	149918	Alienware Monitor,Apple Airpods Headphones
63	149417	Dell Laptop,AA Batteries (4-pack)
65	144372	USB-C Charging Cable,Samsung Galaxy Phone
120	141576	Apple Airpods Headphones,Bose SoundSport Headp...
205	143501	Alienware Monitor,Bose SoundSport Headphones
234	160332	Google Phone,USB-C Charging Cable

In [86]:

```
# Top 20 product pairs most frequently ordered together
from itertools import combinations
from collections import Counter

count = Counter()

for row in df3['Grouped']:
    row_list = row.split(',')
    count.update(Counter(combinations(row_list, 2)))

top_combinations = count.most_common(20)

top_combinations
```

Out[86]:
```
[(('iPhone', 'Lightning Charging Cable'), 473),
 (('USB-C Charging Cable', 'Google Phone'), 469),
 (('Google Phone', 'USB-C Charging Cable'), 465),
 (('Lightning Charging Cable', 'iPhone'), 443),
 (('iPhone', 'Galaxy buds Headphones'), 240),
 (('Galaxy buds Headphones', 'iPhone'), 216),
 (('Google Phone', 'Galaxy buds Headphones'), 195),
 (('Galaxy buds Headphones', 'Google Phone'), 178),
 (('Samsung Galaxy Phone', 'USB-C Charging Cable'), 177),
 (('iPhone', 'Apple Airpods Headphones'), 173),
 (('USB-C Charging Cable', 'Samsung Galaxy Phone'), 168),
 (('Apple Airpods Headphones', 'iPhone'), 147),
 (('Bose SoundSport Headphones', 'Google Phone'), 111),
 (('Google Phone', 'Bose SoundSport Headphones'), 94),
 (('USB-C Charging Cable', 'Galaxy buds Headphones'), 86),
 (('Galaxy buds Headphones', 'USB-C Charging Cable'), 82),
 (('Galaxy buds Headphones', 'Samsung Galaxy Phone'), 69),
 (('Lightning Charging Cable', 'Galaxy buds Headphones'), 66),
 (('Galaxy buds Headphones', 'Lightning Charging Cable'), 66),
 (('Samsung Galaxy Phone', 'Galaxy buds Headphones'), 65)]
```

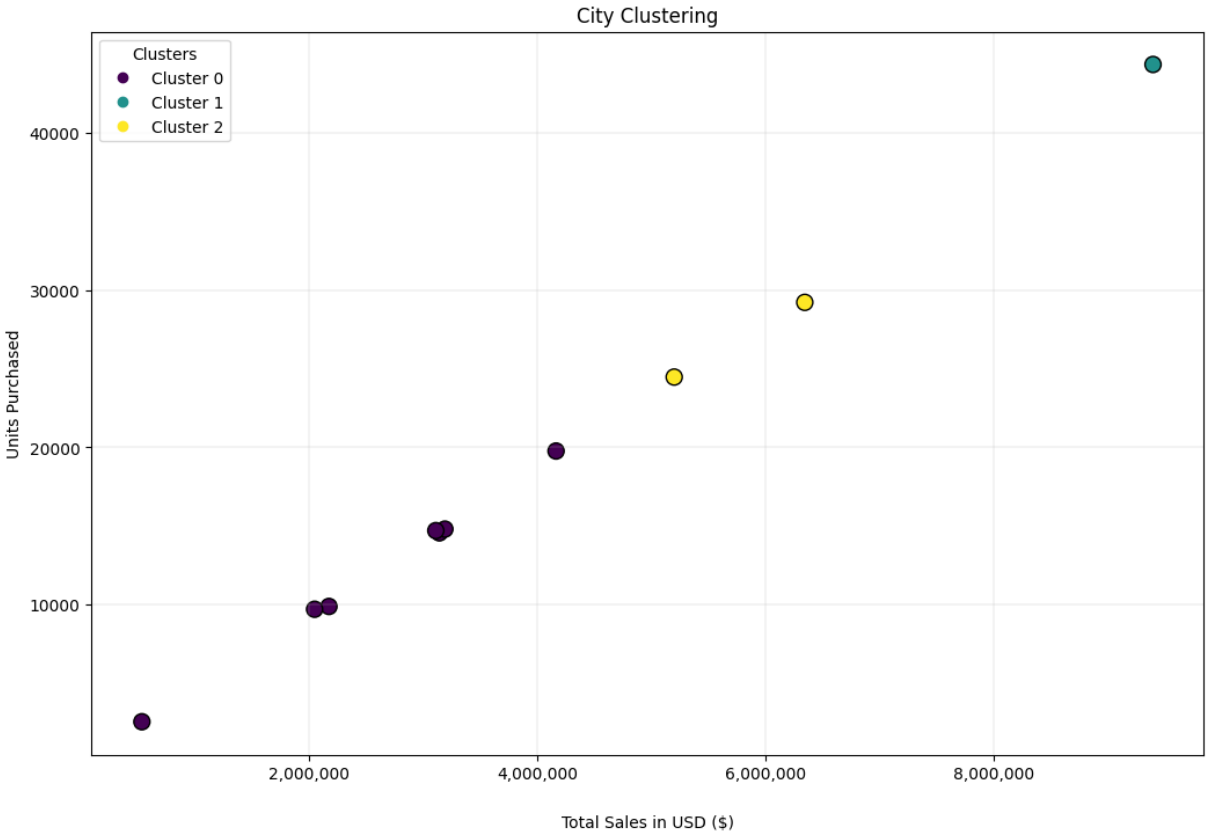
In [87]:
```
# Top 10 sets of three (3) products most commonly ordered together
from itertools import combinations
from collections import Counter

count = Counter()

for row in df3['Grouped']:
    row_list = row.split(',')
    count.update(Counter(combinations(row_list, 3)))

# Collect top 10 most common combinations
top_combinations = count.most_common(10)

# Display results
top_combinations
```

Out[87]:
```
[(('Google Phone', 'USB-C Charging Cable', 'Galaxy buds Headphones'), 22),
 (('iPhone', 'Lightning Charging Cable', 'Galaxy buds Headphones'), 17),
 (('Galaxy buds Headphones', 'USB-C Charging Cable', 'Google Phone'), 17),
 (('iPhone', 'Lightning Charging Cable', 'Apple Airpods Headphones'), 15),
 (('Galaxy buds Headphones', 'Lightning Charging Cable', 'iPhone'), 11),
 (('Google Phone', 'USB-C Charging Cable', 'Bose SoundSport Headphones'), 10),
 (('Lightning Charging Cable', 'iPhone', 'Galaxy buds Headphones'), 10),
 (('iPhone', 'Galaxy buds Headphones', 'Lightning Charging Cable'), 10),
 (('USB-C Charging Cable', 'Google Phone', 'Galaxy buds Headphones'), 9),
 (('Bose SoundSport Headphones', 'USB-C Charging Cable', 'Google Phone'), 9)]
```

10. Clustering Cities Using the KMeans Model

How can we group cities based on sales performance to uncover patterns for better sales strategy?

In [90]:
```
from sklearn.cluster import KMeans

# Deep copy to avoid modifying the original DataFrame
df_cluster = df.copy(deep=True)

# Cluster Cities based on total sales
city_sales_data = df_cluster.groupby('City').agg({'Total Sales': 'sum','Units Purch

# KMeans clustering
kmeans = KMeans(n_clusters=3, random_state=42)
city_sales_data['Cluster'] = kmeans.fit_predict(city_sales_data[['Total Sales', 'Un

fig, ax = plt.subplots(figsize=(12, 8))

# Scatter plot
df_scatter = ax.scatter(
    city_sales_data['Total Sales'],
    city_sales_data['Units Purchased'],
    c=city_sales_data['Cluster'],
    cmap='viridis',
    s=100,
    edgecolor='black'
)

# Axis labels and formatting
ax.set_xlabel('Total Sales in USD ($)', labelpad=20)
ax.set_ylabel('Units Purchased')
ax.set_title('City Clustering')
ax.grid(linewidth=0.2)
ax.xaxis.set_major_formatter(FuncFormatter(lambda x, _: f'{x:,.0f}'))

# Legend
handles, _ = df_scatter.legend_elements()
ax.legend(handles, [f'Cluster {i}' for i in range(len(handles))], title='Clusters')

# Prepare table data
table_data = city_sales_data[['Cluster', 'City', 'Units Purchased', 'Total Sales']]
table_data['Units Purchased'] = table_data['Units Purchased'].apply(lambda x: f'{x:
table_data['Total Sales'] = table_data['Total Sales'].apply(lambda x: f'${x:,.0f}')

cell_text = table_data.values.tolist()
columns = table_data.columns.tolist()

table = plt.table(
    cellText=cell_text,
    colLabels=columns,
    loc='bottom',
    cellLoc='center',
    bbox=[0.0, -0.6, 1, 0.4]  # Lowered the table further
)
table.auto_set_font_size(False)
table.set_fontsize(10)

plt.subplots_adjust(left=0.1, bottom=0.10)
plt.show()
```



Cluster	City	Units Purchased	Total Sales
0	Atlanta (GA)	14,561	$3,145,310
0	Austin (TX)	9,878	$2,178,729
0	Boston (MA)	19,769	$4,166,658
0	Dallas (TX)	14,800	$3,193,629
2	Los Angeles (CA)	29,229	$6,343,771
2	New York City (NY)	24,476	$5,200,781
0	Portland (ME)	2,541	$541,532
0	Portland (OR)	9,700	$2,053,174
1	San Francisco (CA)	44,368	$9,391,882
0	Seattle (WA)	14,704	$3,114,139