Exploratory Data Analysis (EDA): Diagnosing Sales Patterns and Anomalies

Monthly Sales Growth Analysis: Unveiling the Momentum

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

1. Overview

This analysis investigates the monthly progression of total sales, focusing on identifying trends, fluctuations, and growth patterns across time. By calculating the percentage growth rate of sales month-over-month, we gain insights into how well the business is scaling and where seasonal or operational factors may be influencing performance. A dual-axis visualization enhances interpretability by combining total sales (bar chart) with monthly growth rates (line chart) to tell a cohesive story of revenue dynamics.

2. Goal

- Evaluate how total sales evolve across different months.
- Quantify monthly sales performance through growth rates.
- Identify high-growth and low-growth periods to spot seasonal or strategic impacts.
- Provide visual insights that support better decision-making and business forecasting.

3. Business Challenge

- Inconsistent sales performance: Management lacks clarity on why some months underperform while others spike.
- Uncertainty in strategy execution: It's unclear whether recent sales strategies are yielding consistent month-over-month improvements.
- Limited visibility into growth dynamics: Without quantifying growth, it's hard to identify whether revenue growth is sustainable or driven by short-term factors.

4. Analysis Approach

- Clean and aggregate data to ensure accurate insights and avoid distorted growth

metrics.

- Perform diagnostic analysis on total monthly sales using historical data.
- Compute and visualize month-over-month growth rates to identify patterns and anomalies.
- Create a dual-axis plot to present both sales volume and growth trajectory in a single, intuitive visualization.
- Translate findings into strategic recommendations, highlighting months with explosive or declining growth for targeted business actions.

Importing libraries

In [9]:
```
import pandas as pd
import matplotlib.pyplot as plt
```

Loading the clean dataframe (post-ETL process)

In [11]:
```
df = pd.read_csv("C:\\Monthly_Sales\\cleaned_data.csv")
```

In [12]:
```
df.head()
```

Out[12]:

	Order ID	Product Name	Units Purchased	Unit Price	Order Date	Delivery Address	Month	Month Name	Year	D We
0	160155	Alienware Monitor	1	400.99	2024-01-01 05:04:00	765 Ridge St, Portland, OR 97035	1	January	2024	M
1	151041	AAA Batteries (4-pack)	1	4.99	2024-01-01 05:04:00	964 Lakeview St, Atlanta, GA 30301	1	January	2024	M
2	146765	AAA Batteries (4-pack)	1	4.99	2024-01-01 05:20:00	546 10th St, San Francisco, CA 94016	1	January	2024	M
3	145617	Amana Washing Machine	1	600.00	2024-01-01 05:24:00	961 Meadow St, Portland, OR 97035	1	January	2024	M
4	156535	Lightning Charging Cable	2	14.95	2024-01-01 05:45:00	451 Elm St, Los Angeles, CA 90001	1	January	2024	M

Monthly Total Sales (USD) and Growth Rate (%)

In [14]:
```
# Deep copy to avoid modifying the original DataFrame (df)
df_growth = df.copy(deep=True)

# Defining the Proper Month Order for Chronological Sorting
month_order = ['January', 'February', 'March', 'April', 'May', 'June',
               'July', 'August', 'September', 'October', 'November', 'December']

# Grouping by Month Name and Calculating Total Sales
df_monthly_growth_rate = df_growth.groupby('Month Name')['Total Sales'].sum().reset

# Re-ordering months chronologically
df_monthly_growth_rate['Month Name'] = pd.Categorical(df_monthly_growth_rate['Month
                                                      categories=month_order,
                                                      ordered=True)
df_monthly_growth_rate = df_monthly_growth_rate.sort_values('Month Name').reset_ind

# Calculating Monthly Growth Rate (%)
df_monthly_growth_rate['Growth Rate (%)'] = df_monthly_growth_rate['Total Sales'].p
```

```
df_monthly_growth_rate
```

Out[14]:

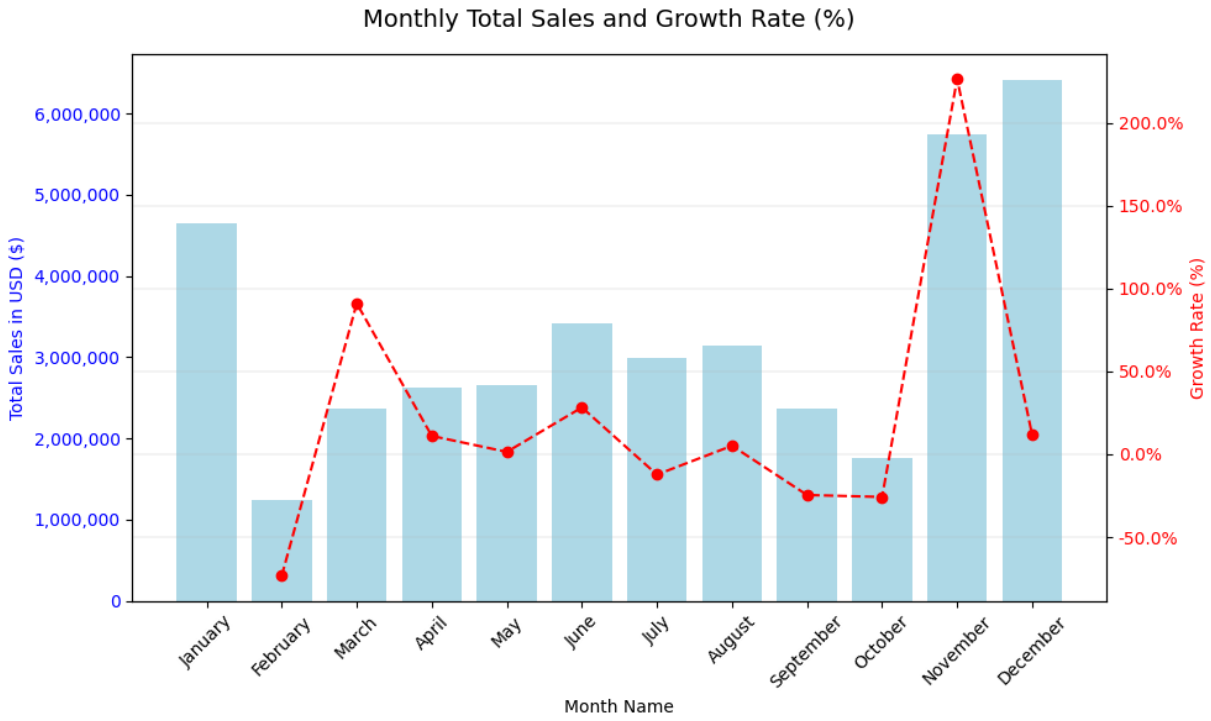
	Month Name	Total Sales	Growth Rate (%)
0	January	4643726.50	NaN
1	February	1235808.22	-73.387575
2	March	2360571.99	91.014427
3	April	2621378.14	11.048430
4	May	2658910.61	1.431784
5	June	3409702.73	28.236832
6	July	2990650.83	-12.289983
7	August	3144247.72	5.135902
8	September	2371339.60	-24.581655
9	October	1760284.20	-25.768363
10	November	5746819.31	226.471107
11	December	6412321.59	11.580359

Plotting Monthly Total Sales (USD) and Growth Rate (%)

In [16]:

```
# 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_monthly_growth_rate['Month Name'].astype(str), df_monthly_growth_rate['T
ax1.set_xlabel('Month Name')
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_monthly_growth_rate['Month Name'].astype(str), df_monthly_growth_rate['
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.savefig(r"C:/Users/DELL/OneDrive - COVENANT UNIVERSITY/Desktop/1. Retail Sales

plt.show()
```



Key Insights

1. High Volatility in Monthly Sales: The growth rates fluctuate significantly, with both steep declines (e.g., -73.39% in February, -25.77% in October) and sharp increases (e.g., +226.47% in November, +91.01% in March).

2. Exceptional Growth in November: The highest sales growth occurred in Month November (+226.47%), likely due to a seasonal or promotional event. This also marks the peak in total sales ($5.75M).

3. Absolute peak occurred in December ($6.41M) with sales growth of +11.58%.

4. Sustained Growth Toward Year-End: Despite mid-year dips (July to October), November and December show strong recovery and surpass all previous months in both growth and absolute sales.

5. Underperformance Early in the Year: February experienced a dramatic -73.39% drop from January, suggesting either a data anomaly or external factor disrupting sales continuity.

Strategic Recommendations

1. Investigate Sales Drop Causes: Analyze February , September, and October to determine the reasons behind sharp declines. This can uncover operational inefficiencies, seasonal patterns, or external disruptions that can be mitigated in future planning.

2. Capitalize on Peak Months (November & December): Strengthen promotional activities around these high-performing months. Consider expanding festive campaigns or bundling offers to extend the momentum.

3. Stabilize Mid-Year Growth: Develop a mid-year marketing boost strategy (May–September) using loyalty incentives, product refreshes, or geo-targeted ads to maintain momentum.

4. Build Forecast Models: Use this growth trend as input for predictive models to anticipate low-performing months and proactively plan inventory, staffing, and promotional efforts.

5. Apply Data-Driven Planning: Set monthly sales targets using historical growth data. Tailor resource allocation and budgeting based on expected performance to reduce surprises.