The aim of the project is to analyze a time series data for various insights. The data contains monthly sales record of a retail brand with stores across USA for 2019 as 12 separate files. For ease of use I have combined all the files into one single csv file which I am using in the script below. Our intent is to analyze and deduce the following information using EDA.

1. Average number of orders per month
2. Average Revenue per month
3. Daily/Monthly Order volume
4. Daily Order Value Distribution

There are more pattern that can be discovered but for now we are sticking to the above list. Let us get started. This notebook focuses on time based analysis and visualizations.

In [47]:
```
#Importing all necessary libraries
import pandas as pd
import numpy as np
import os
import glob
import logging
from pathlib import Path
```

In [48]:
```
# import file
file="G:\\Projects\\DataAnalysis\\SalesDataAnalysis\\ProcessedData\\Consolidated2019Sales.csv"
df = pd.read_csv(file)
```

In [49]:
```
# Print rows and columns in the file
df.shape
```

Out[49]: (185916, 10)

In [50]:
```
# Print the top Rows to get underlying structure
df.head()
```

Out[50]:

	Order ID	Product	Quantity	UnitPrice	OrderDate	OrderTime	Store Address	City	State Code	Pincode
0	319662	Bose SoundSport Headphones	1	99.99	12/31/2019	19:07	939 8th St	San Francisco	CA	94016
1	319637	Wired Headphones	1	11.99	12/31/2019	22:14	641 Adams St	Portland	OR	97035
2	319609	AAA Batteries (4-pack)	2	2.99	12/31/2019	22:56	513 Pine St	New York City	NY	10001
3	319595	ThinkPad Laptop	1	999.99	12/31/2019	22:38	788 6th St	San Francisco	CA	94016
4	319444	USB-C Charging Cable	1	11.95	12/31/2019	21:27	603 Meadow St	New York City	NY	10001

In [51]:
```
df.dtypes
```

Out[51]:
```
Order ID          int64
Product          object
Quantity          int64
UnitPrice       float64
OrderDate        object
OrderTime        object
Store Address    object
City             object
State Code       object
Pincode           int64
dtype: object
```

In [52]:
```
df.describe()
```

Out[52]:

	Order ID	Quantity	UnitPrice	Pincode
count	185916.000000	185916.000000	185916.000000	185916.000000
mean	230403.546526	1.124368	184.387720	63878.895888
std	51506.924899	0.442749	332.722426	37775.518475
min	141234.000000	1.000000	2.990000	2215.000000
25%	185822.750000	1.000000	11.950000	10001.000000
50%	230351.500000	1.000000	14.950000	90001.000000
75%	275015.250000	1.000000	150.000000	94016.000000
max	319670.000000	9.000000	1700.000000	98101.000000

In [53]:
```
df.dtypes
```

Out[53]:
```
Order ID          int64
Product          object
Quantity          int64
UnitPrice       float64
OrderDate        object
OrderTime        object
Store Address    object
City             object
State Code       object
Pincode           int64
dtype: object
```

In [54]:
```
# Calculate total amount for each order using UnitPrice column
df['Total amount'] = (df['Quantity'] * df['UnitPrice']).round(2)

# Create order summary with unique orders
order_data = df.groupby(['OrderDate', 'Order ID']).agg({
            'Total amount': 'sum',
            'Quantity': 'sum'
        }).reset_index()

# Round Total amount to 2 decimal places
```

```
order_data['Total amount'] = order_data['Total amount'].round(2)

# Rename columns for clarity
order_data = order_data.rename(columns={
            'Total amount': 'Total Revenue',
            'Quantity': 'Total Items'
        })

# Sort by date and order ID
order_data = order_data.sort_values(['OrderDate', 'Order ID'])
```

In [55]:
```
# Monthly Summarization of order details, total revenue, average revenue, total orders, total items sold across all l
order_data['Month'] = pd.to_datetime(order_data['OrderDate']).dt.to_period('M')
monthly_data = order_data.groupby('Month').agg({
            'Order ID': 'count',
            'Total Items': 'sum',
            'Total Revenue': 'sum'
        }).reset_index()

# Rename columns for monthly report
monthly_data = monthly_data.rename(columns={
            'Order ID': 'Number of Orders',
            'Total Items': 'Total Items Sold',
            'Total Revenue': 'Monthly Revenue'
        })

# Calculate average order value per month
monthly_data['Average Order Value'] = (monthly_data['Monthly Revenue'] / monthly_data['Number of Orders']).round(2)

# Sort by month
monthly_data = monthly_data.sort_values('Month')
```

In [56]:
```
# Hourly Summarization of order details, total revenue, average revenue, total orders, total items sold across all lo
df['Hour'] = df['OrderTime'].str.split(':').str[0].astype(int)

# Calculate total amount for each row
df['Total amount'] = (df['Quantity'] * df['UnitPrice']).round(2)

# Create a DataFrame with all hours (0-23)
all_hours = pd.DataFrame({'Hour': range(24)})
```

```
# Aggregate metrics by hour
hourly_stats = df.groupby('Hour').agg({
            'Order ID': 'nunique',
            'Total amount': 'sum',
            'Quantity': 'sum',
            'City': 'nunique'  # Number of active cities per hour
        }).reset_index()

# Merge with all_hours to ensure we have all 24 hours
hourly_analysis = all_hours.merge(hourly_stats, on='Hour', how='left').fillna(0)

# Rename columns
hourly_analysis = hourly_analysis.rename(columns={
            'Order ID': 'Number of Orders',
            'Total amount': 'Total Revenue',
            'Quantity': 'Total Items',
            'City': 'Active Cities'
        })

# Calculate totals for percentages
total_revenue = hourly_analysis['Total Revenue'].sum()
total_orders = hourly_analysis['Number of Orders'].sum()
total_items = hourly_analysis['Total Items'].sum()

# Add time ranges and percentages
hourly_analysis['Time Range'] = hourly_analysis['Hour'].apply(
            lambda x: f"{x:02d}:00 - {(x+1):02d}:00"
        )

hourly_analysis['Revenue Percentage'] = (hourly_analysis['Total Revenue'] / total_revenue * 100).round(2)
hourly_analysis['Order Percentage'] = (hourly_analysis['Number of Orders'] / total_orders * 100).round(2)
hourly_analysis['Items Percentage'] = (hourly_analysis['Total Items'] / total_items * 100).round(2)

# Calculate average metrics
hourly_analysis['Average Order Value'] = np.where(hourly_analysis['Number of Orders'] > 0, (hourly_analysis['Total Re
                                                                                            hourly_analysis['Number o

hourly_analysis['Items per Order'] = np.where(
            hourly_analysis['Number of Orders'] > 0,
            (hourly_analysis['Total Items'] / hourly_analysis['Number of Orders']).round(2),
            0
```

```
        )

hourly_analysis['Revenue per Item'] = np.where(
            hourly_analysis['Total Items'] > 0,
            (hourly_analysis['Total Revenue'] / hourly_analysis['Total Items']).round(2),
            0
        )

# Sort by hour
hourly_analysis = hourly_analysis.sort_values('Hour')
```

Storing the results

In [57]:
```
output_dir = Path('G:\\Projects\\DataAnalysis\\SalesDataAnalysis\\ProcessedData\\TimelyAnalysisData')
output_dir.mkdir(parents=True, exist_ok=True)
daily_path = output_dir / 'daily_order_data.csv'
order_data.to_csv(daily_path, index=False, float_format='%.2f')

# Save monthly data
monthly_path = output_dir / 'monthly_order_data.csv'
monthly_data.to_csv(monthly_path, index=False, float_format='%.2f')

# Save hourly analysis to CSV
hourly_analysis.to_csv(output_dir / 'hourly_patterns.csv', index=False, float_format='%.2f')
```

Next we are targeting the visualization of the summary generation and output reports. We import the required libraries matplotlib and seaborn.

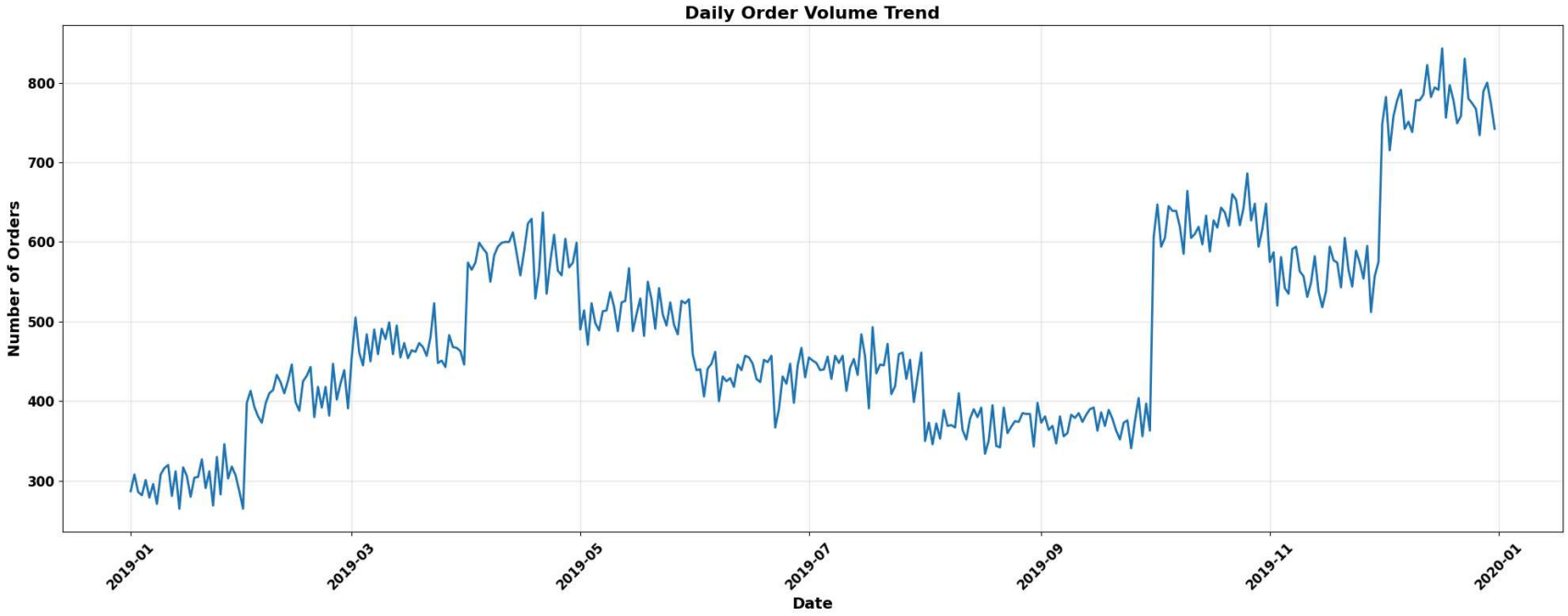
In [58]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from pathlib import Path
```

In [59]:
```
data_dir = Path('G:\\Projects\\DataAnalysis\\SalesDataAnalysis\\ProcessedData\\OrderData')
daily_data = pd.read_csv(data_dir / 'daily_order_data.csv')
monthly_data = pd.read_csv(data_dir / 'monthly_order_data.csv')

# Use default style
plt.style.use('default')

# Create visualization directory
```

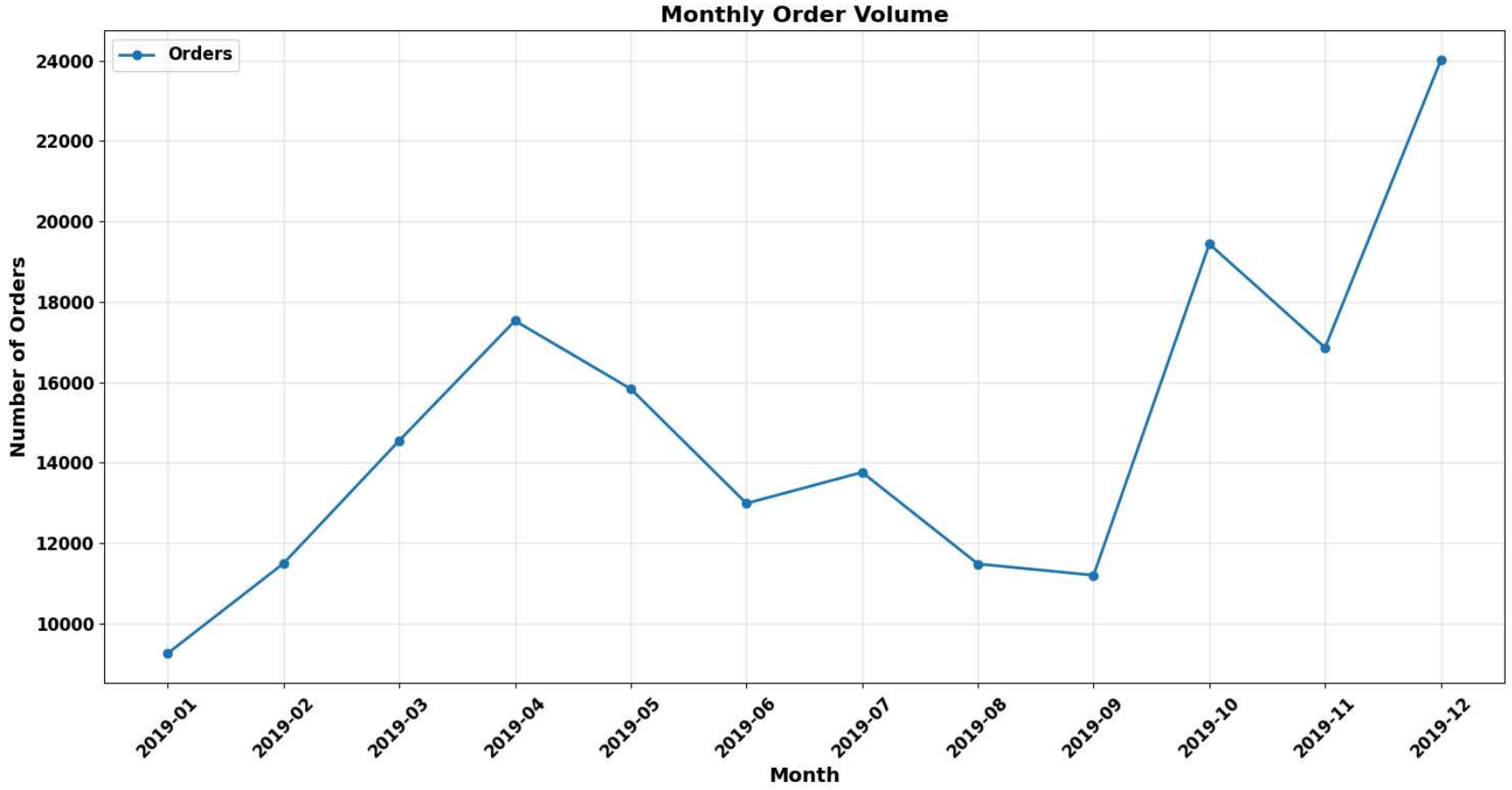
```
viz_dir = Path('Visualizations/OrderAnalysis')
viz_dir.mkdir(parents=True, exist_ok=True)

# Convert dates
daily_data['OrderDate'] = pd.to_datetime(daily_data['OrderDate'])

# Set global font sizes and style parameters
plt.rcParams.update({
            'figure.facecolor': 'white',
            'axes.facecolor': 'white',
            'axes.grid': True,
            'grid.alpha': 0.3,
            'font.size': 12,
            'font.weight': 'bold',
            'axes.labelsize': 14,
            'axes.titlesize': 16,
            'axes.labelweight': 'bold',
            'axes.titleweight': 'bold',
            'xtick.labelsize': 12,
            'ytick.labelsize': 12
        })
```

In [60]:

```
# 1. Daily Order Count Trend
plt.figure(figsize=(20, 8))
daily_orders = daily_data.groupby('OrderDate').size()
plt.plot(daily_orders.index, daily_orders.values, linewidth=2)
plt.title('Daily Order Volume Trend')
plt.xlabel('Date')
plt.ylabel('Number of Orders')
plt.grid(True, alpha=0.3)
plt.xticks(rotation=45)
plt.tight_layout()
plt.savefig(viz_dir / 'daily_order_trend.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```

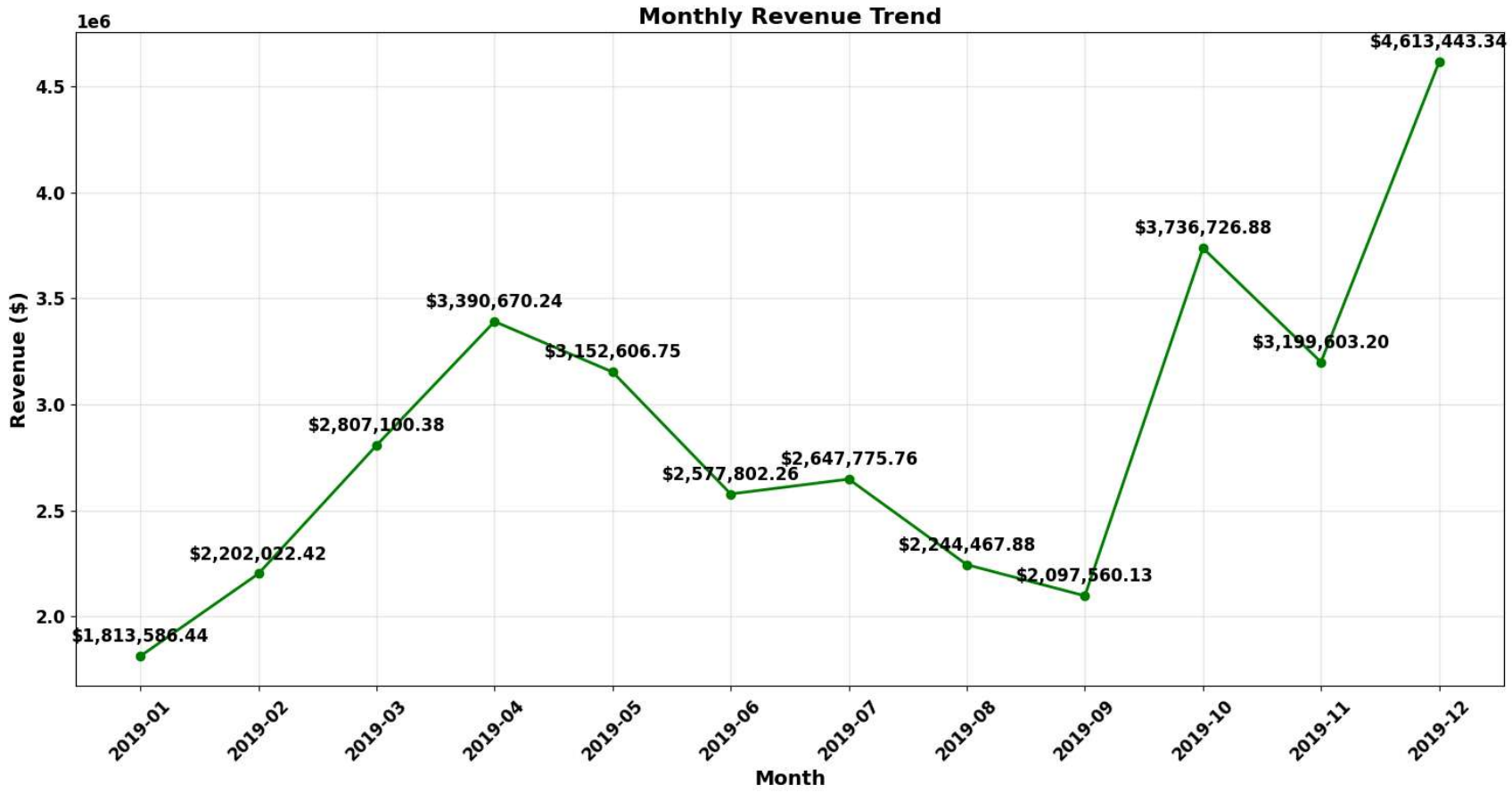


In [61]:
```
# 2. Monthly Order Metrics
plt.figure(figsize=(15, 8))
x = range(len(monthly_data))
plt.plot(x, monthly_data['Number of Orders'], 'o-', linewidth=2, label='Orders')
plt.title('Monthly Order Volume')
plt.xlabel('Month')
plt.ylabel('Number of Orders')
plt.xticks(x, monthly_data['Month'], rotation=45)
plt.grid(True, alpha=0.3)
plt.legend()
plt.tight_layout()
plt.savefig(viz_dir / 'monthly_order_volume.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```



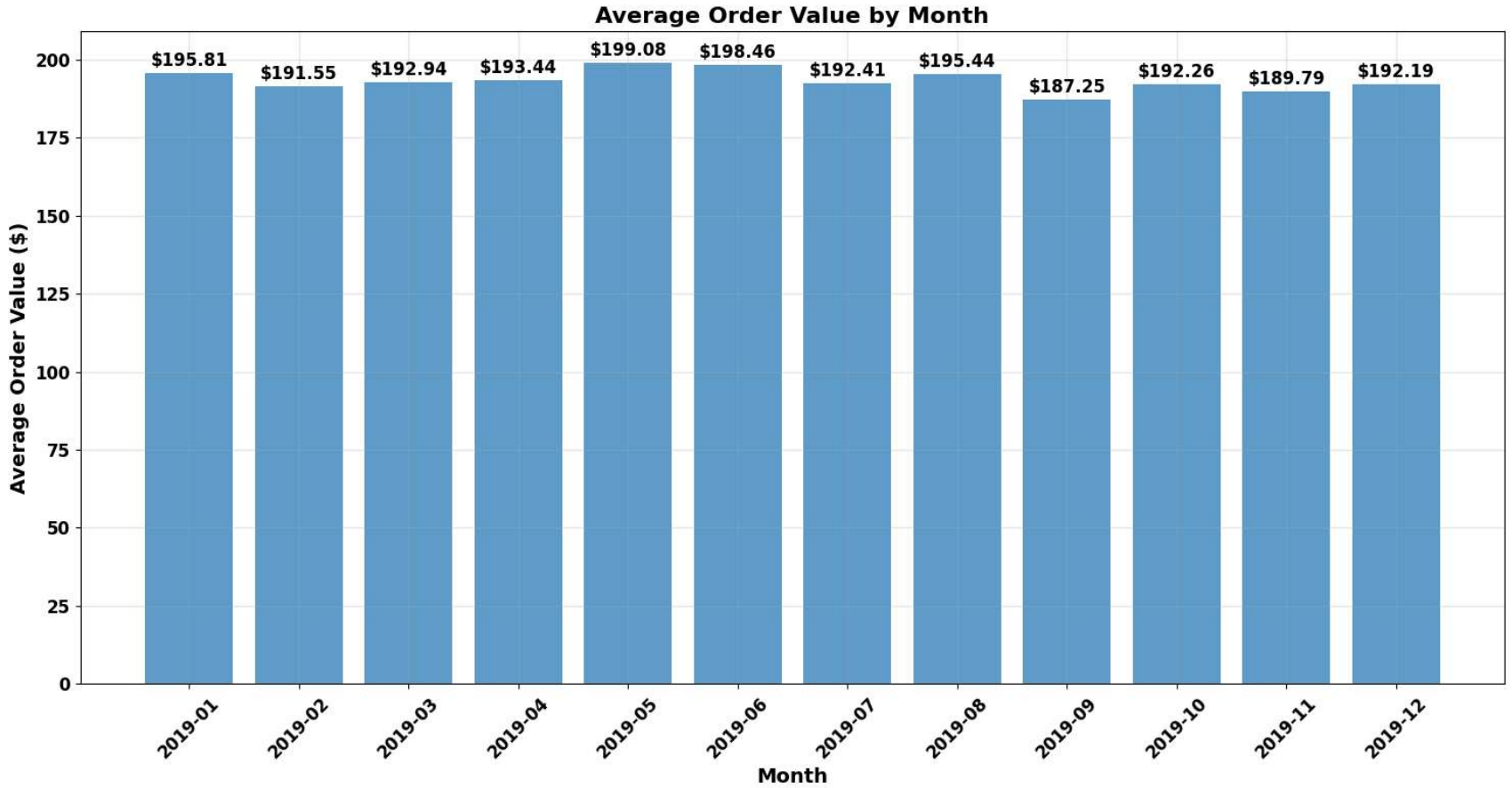
In [62]:
```
# 3. Monthly Revenue Trend
plt.figure(figsize=(15, 8))
plt.plot(x, monthly_data['Monthly Revenue'], 'o-', linewidth=2, color='green')
plt.title('Monthly Revenue Trend')
plt.xlabel('Month')
plt.ylabel('Revenue ($)')
plt.xticks(x, monthly_data['Month'], rotation=45)

for i, rev in enumerate(monthly_data['Monthly Revenue']):
    plt.annotate(f'${rev:,.2f}', (i, rev), textcoords="offset points",
    xytext=(0,10), ha='center', fontweight='bold')
    plt.grid(True, alpha=0.3)
    plt.tight_layout()
    plt.savefig(viz_dir / 'monthly_revenue_trend.png', dpi=300, bbox_inches='tight')
```

```
plt.show()
plt.close()
```



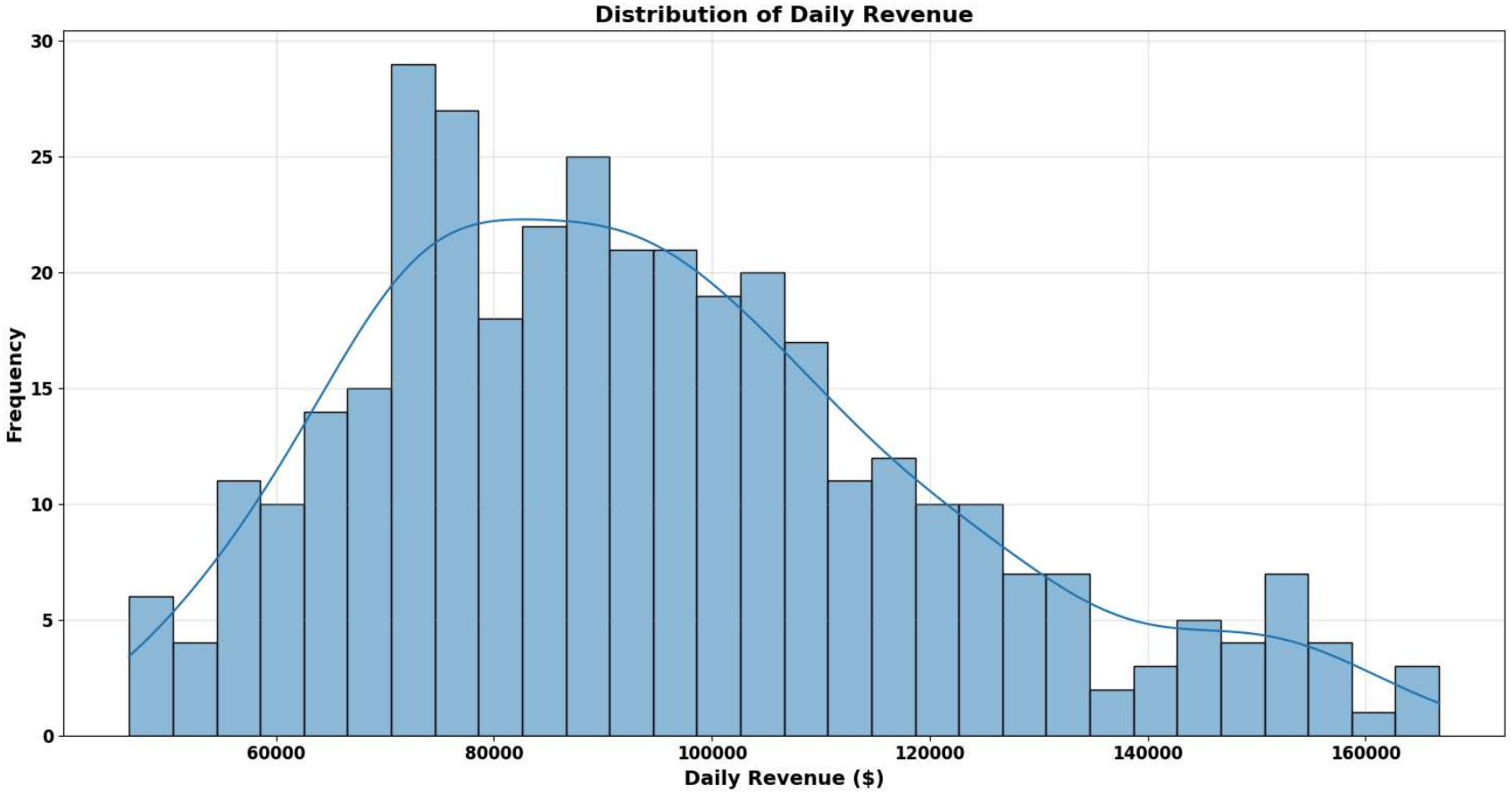
In [63]:
```
# 4. Average Order Value by Month
plt.figure(figsize=(15, 8))
plt.bar(x, monthly_data['Average Order Value'], alpha=0.7)
plt.title('Average Order Value by Month')
plt.xlabel('Month')
plt.ylabel('Average Order Value ($)')
plt.xticks(x, monthly_data['Month'], rotation=45)
for i, val in enumerate(monthly_data['Average Order Value']):
    plt.annotate(f'${val:.2f}', (i, val), textcoords="offset points",
                         xytext=(0,5), ha='center', fontweight='bold')
```

```
    plt.grid(True, alpha=0.3)
    plt.tight_layout()
    plt.savefig(viz_dir / 'monthly_avg_order_value.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```



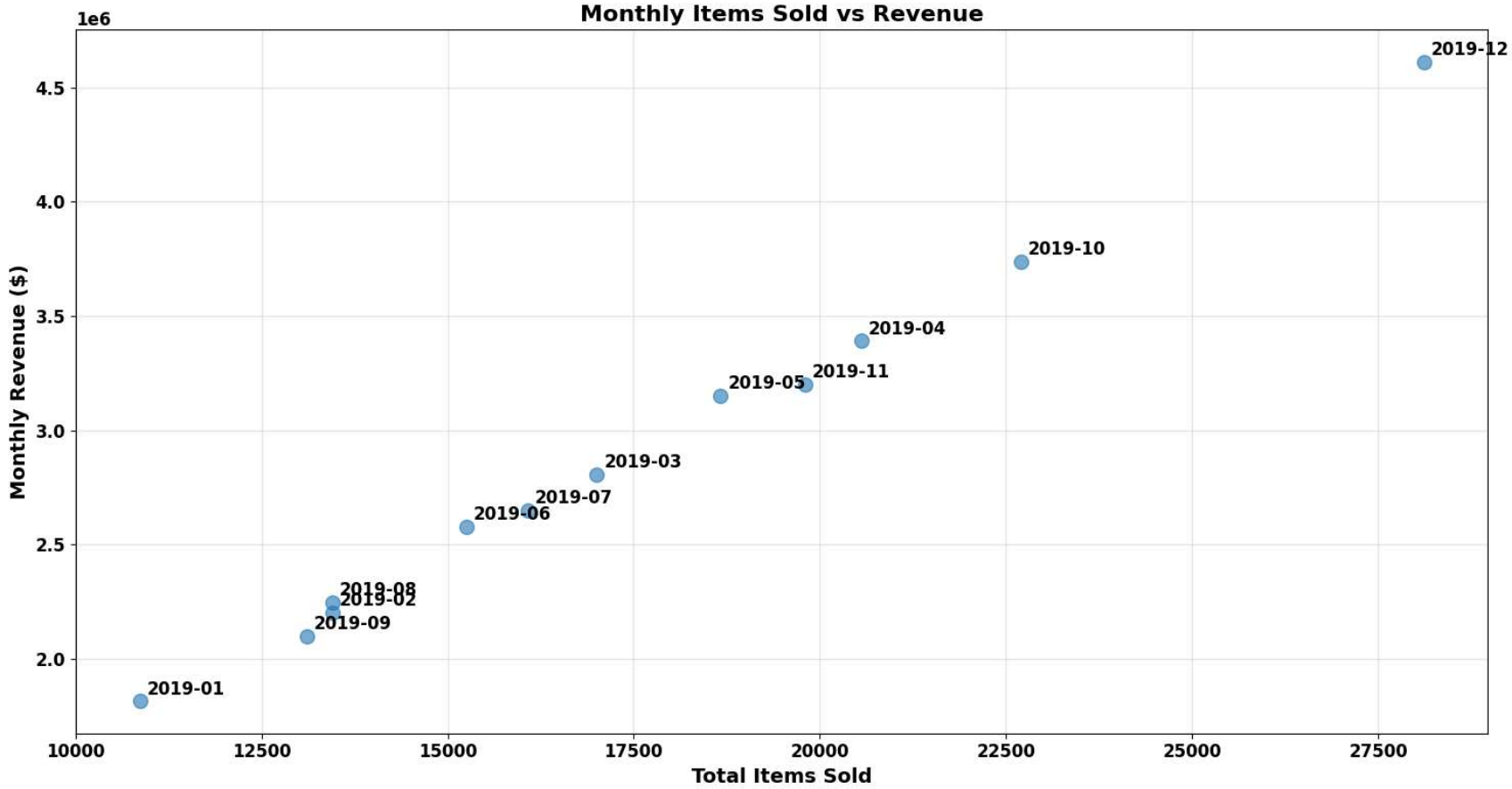
In [64]:
```
# 5. Daily Revenue Distribution
plt.figure(figsize=(15, 8))
daily_revenue = daily_data.groupby('OrderDate')['Total Revenue'].sum()
sns.histplot(data=daily_revenue, bins=30, kde=True)
plt.title('Distribution of Daily Revenue')
plt.xlabel('Daily Revenue ($)')
plt.ylabel('Frequency')
plt.grid(True, alpha=0.3)
plt.tight_layout()
```

```
plt.savefig(viz_dir / 'daily_revenue_distribution.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```



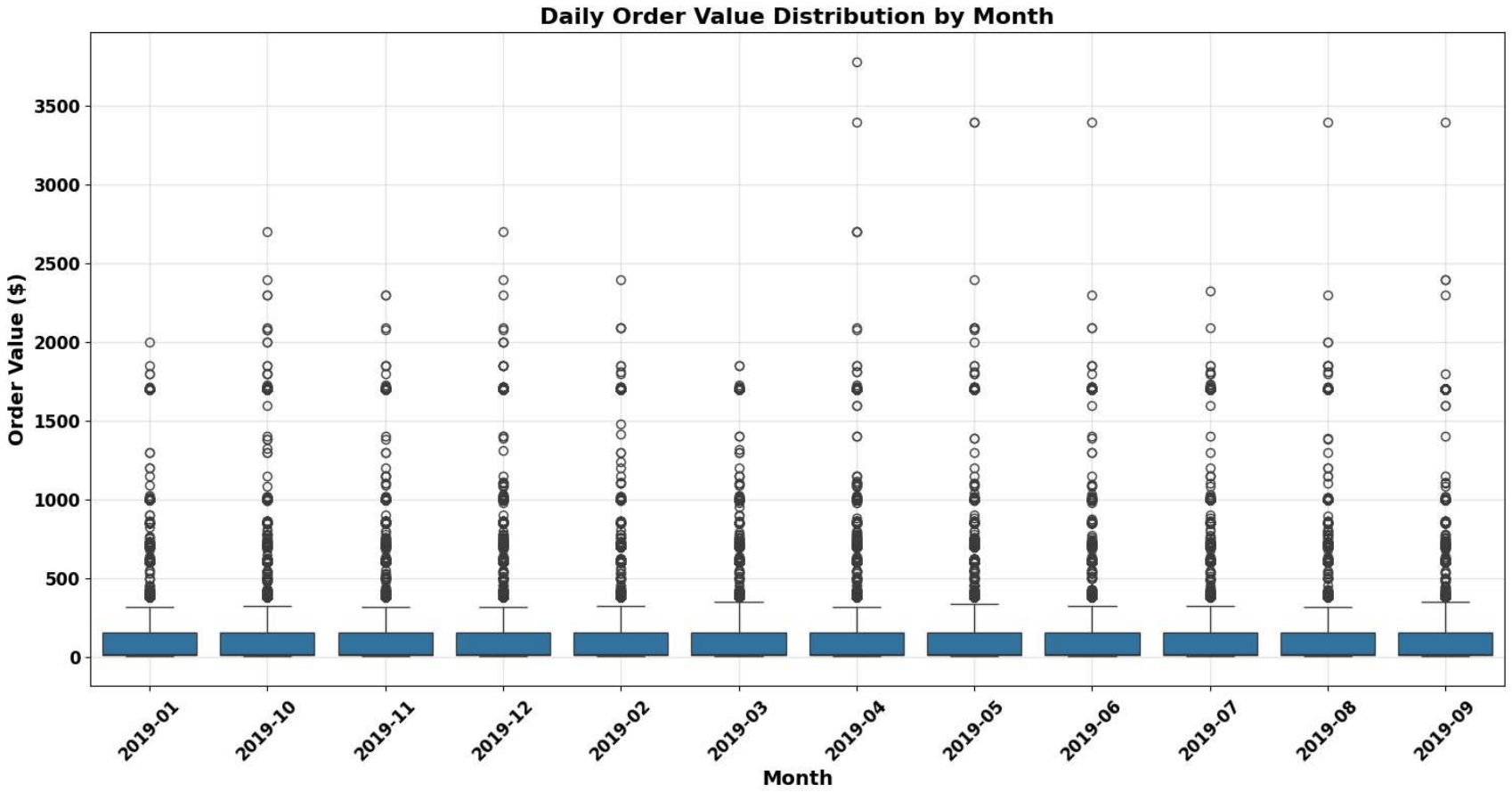
In [65]:
```
# 6. Monthly Items Sold vs Revenue
plt.figure(figsize=(15, 8))
plt.scatter(monthly_data['Total Items Sold'], monthly_data['Monthly Revenue'], s=100, alpha=0.6)
plt.title('Monthly Items Sold vs Revenue')
plt.xlabel('Total Items Sold')
plt.ylabel('Monthly Revenue ($)')
for i, row in monthly_data.iterrows():
    plt.annotate(row['Month'], (row['Total Items Sold'], row['Monthly Revenue']),
                         xytext=(5, 5), textcoords='offset points')
    plt.grid(True, alpha=0.3)
    plt.tight_layout()
```

```
    plt.savefig(viz_dir / 'monthly_items_vs_revenue.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```



In [66]:
```
# 7. Daily Order Value Box Plot by Month
plt.figure(figsize=(15, 8))
daily_data['Month'] = daily_data['OrderDate'].dt.strftime('%Y-%m')
sns.boxplot(data=daily_data, x='Month', y='Total Revenue')
plt.title('Daily Order Value Distribution by Month')
plt.xlabel('Month')
plt.ylabel('Order Value ($)')
plt.xticks(rotation=45)
plt.grid(True, alpha=0.3)
plt.tight_layout()
plt.savefig(viz_dir / 'daily_order_value_boxplot.png', dpi=300, bbox_inches='tight')
```

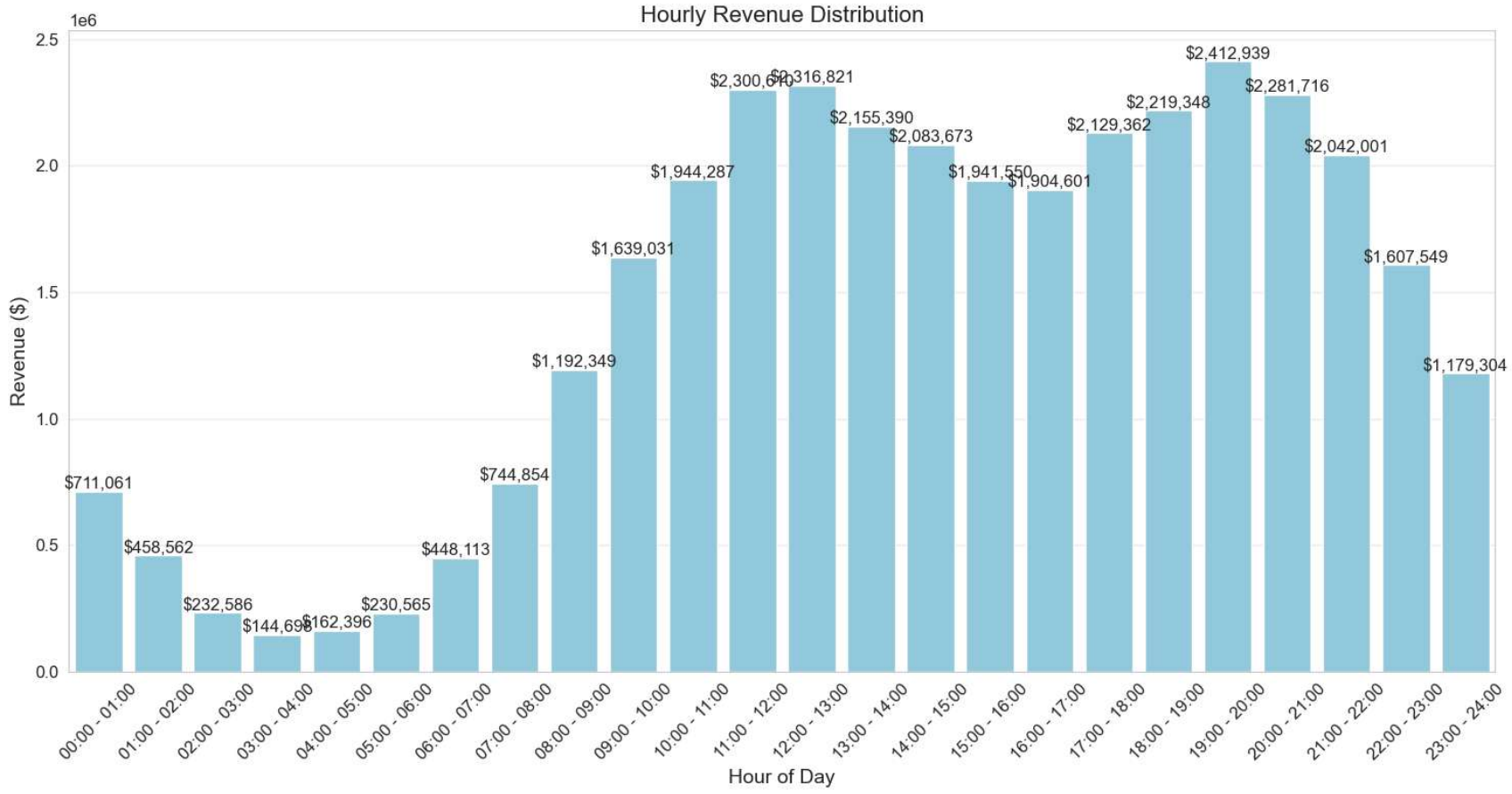
```
plt.show()
plt.close()
```



In [75]:
```
# Set style parameters for the hourly data Visualizations
file_path = Path('G:\\Projects\\DataAnalysis\\SalesDataAnalysis\\ProcessedData\\TimelyAnalysisData\\hourly_patterns.c
df_hour = pd.read_csv(file_path)
plt.style.use('default')
plt.rcParams.update({
            'figure.figsize': (15, 8),
            'figure.facecolor': 'white',
            'axes.facecolor': 'white',
            'axes.grid': True,
            'grid.alpha': 0.3,
            'font.family': 'sans-serif',
            'font.size': 12,
```

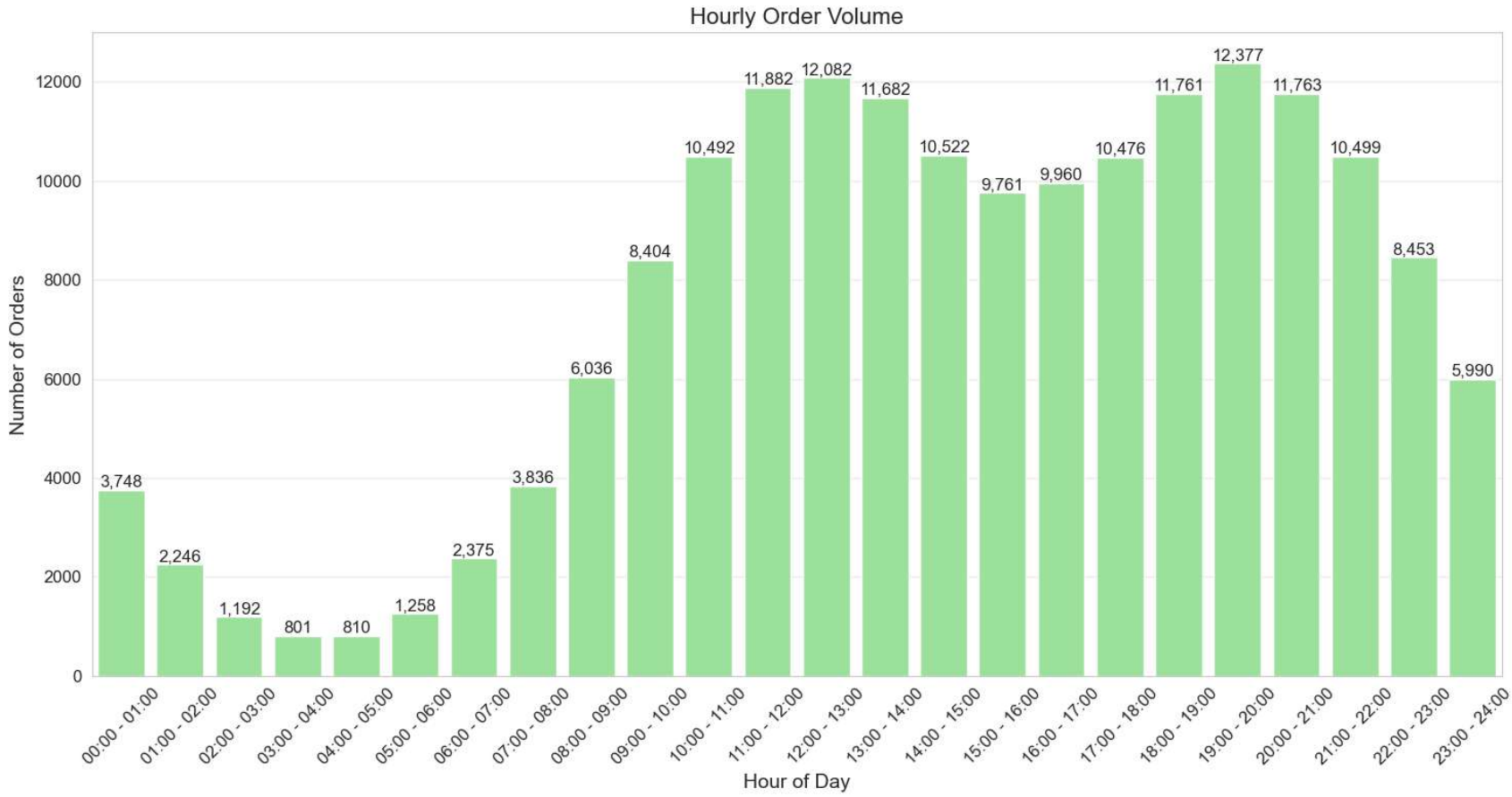
```
            'axes.labelsize': 14,
            'axes.titlesize': 16
        })

# Create output directory
output_dir = Path('G:\\Projects\\DataAnalysis\\SalesDataAnalysis\\Visualizations\\HourlyAnalysis')
output_dir.mkdir(parents=True, exist_ok=True)
```

In [78]:
```
# Set Seaborn style for better visuals
sns.set_style("whitegrid")

# 1. Revenue Distribution by Hour
plt.figure()
sns.barplot(data=df_hour, x='Time Range', y='Total Revenue', color='skyblue')
plt.title('Hourly Revenue Distribution')
plt.xlabel('Hour of Day')
plt.ylabel('Revenue ($)')
plt.xticks(rotation=45)
for i, v in enumerate(df_hour['Total Revenue']):
    plt.text(i, v, f'${v:,.0f}', ha='center', va='bottom')
    plt.tight_layout()
    plt.savefig(output_dir / 'hourly_revenue.png', dpi=300, bbox_inches='tight')

plt.show()
plt.close()
```



In [80]:
```
 # 2. Order Volume by Hour
df=df_hour
plt.figure()
sns.barplot(data=df, x='Time Range', y='Number of Orders', color='lightgreen')
plt.title('Hourly Order Volume')
plt.xlabel('Hour of Day')
plt.ylabel('Number of Orders')
plt.xticks(rotation=45)
for i, v in enumerate(df['Number of Orders']):
    plt.text(i, v, f'{int(v):,}', ha='center', va='bottom')
    plt.tight_layout()
    plt.savefig(output_dir / 'hourly_orders.png', dpi=300, bbox_inches='tight')
```

```
plt.show()
plt.close()
```

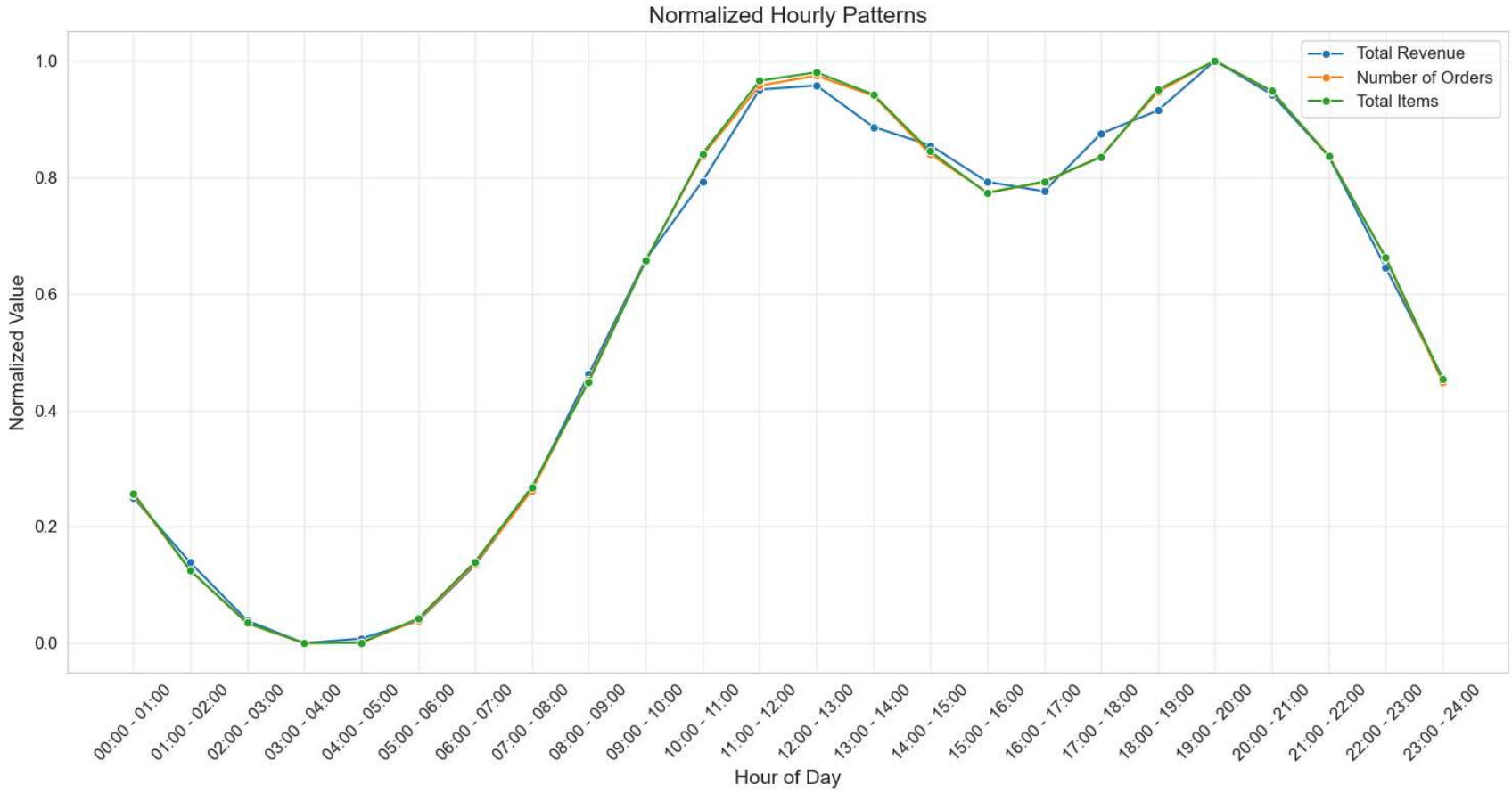


In [81]:
```
# 3. Percentage Distribution (Line Plot)
plt.figure()
percentage_data = df[['Time Range', 'Revenue Percentage', 'Order Percentage', 'Items Percentage']].melt(
            id_vars=['Time Range'],
            var_name='Metric',
            value_name='Percentage'
        )
sns.lineplot(data=percentage_data, x='Time Range', y='Percentage', hue='Metric', marker='o')
plt.title('Hourly Distribution of Revenue, Orders, and Items')
plt.xlabel('Hour of Day')
plt.ylabel('Percentage (%)')
plt.xticks(rotation=45)
```

```
plt.legend(title='')
plt.tight_layout()
plt.savefig(output_dir / 'hourly_percentages.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```

In [82]:
```
plt.figure()
metrics = ['Total Revenue', 'Number of Orders', 'Total Items']
normalized_data = df[['Time Range'] + metrics].copy()
for metric in metrics:
    normalized_data[metric] = (df[metric] - df[metric].min()) / (df[metric].max() - df[metric].min())
    normalized_plot_data = normalized_data.melt(
            id_vars=['Time Range'],
            value_vars=metrics,
            var_name='Metric',
```

```
            value_name='Normalized Value'
        )
sns.lineplot(data=normalized_plot_data, x='Time Range', y='Normalized Value', hue='Metric', marker='o')
plt.title('Normalized Hourly Patterns')
plt.xlabel('Hour of Day')
plt.ylabel('Normalized Value')
plt.xticks(rotation=45)
plt.legend(title='')
plt.tight_layout()
plt.savefig(output_dir / 'normalized_patterns.png', dpi=300, bbox_inches='tight')
plt.show()
plt.close()
```



In [ ]: