Traffic Volume Analysis

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Objective:

Analyze traffic patterns using the **Metro Interstate Traffic Volume** dataset and build a predictive model for traffic volume based on time and weather.

Dataset:

- **Source:** Kaggle - Metro Interstate Traffic Volume
- **Features:** Date, Time, Weather, Traffic Volume

In [ ]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
```

In [3]:
```
df = pd.read_csv("C:/Users/Dell/Documents/Metro_Interstate_Traffic_Volume.csv")
```

In [5]:
```
print(df.head())
print(df.info())
```

```
  holiday    temp  rain_1h  snow_1h  clouds_all weather_main  \
0    NaN  288.28      0.0      0.0          40       Clouds
1    NaN  289.36      0.0      0.0          75       Clouds
2    NaN  289.58      0.0      0.0          90       Clouds
3    NaN  290.13      0.0      0.0          90       Clouds
4    NaN  291.14      0.0      0.0          75       Clouds

  weather_description            date_time  traffic_volume
0   scattered clouds  02-10-2012 09:00             5545
1         broken clouds  02-10-2012 10:00             4516
2       overcast clouds  02-10-2012 11:00             4767
3       overcast clouds  02-10-2012 12:00             5026
4         broken clouds  02-10-2012 13:00             4918
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 48204 entries, 0 to 48203
Data columns (total 9 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   holiday              61 non-null     object
 1   temp                 48204 non-null  float64
 2   rain_1h              48204 non-null  float64
 3   snow_1h              48204 non-null  float64
 4   clouds_all           48204 non-null  int64
 5   weather_main         48204 non-null  object
 6   weather_description  48204 non-null  object
 7   date_time            48204 non-null  object
 8   traffic_volume       48204 non-null  int64
dtypes: float64(3), int64(2), object(4)
memory usage: 3.3+ MB
None
```

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

```
Index(['holiday', 'temp', 'rain_1h', 'snow_1h', 'clouds_all', 'weather_main',
       'weather_description', 'date_time', 'traffic_volume'],
      dtype='object')
```

In [9]:
```
print(type(df['date_time'][0]))
```

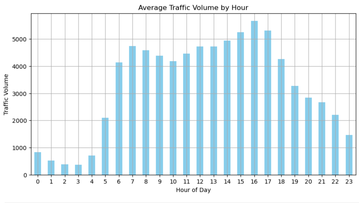
```
<class 'str'>
```

In [11]:
```
df['date_time'] = pd.to_datetime(df['date_time'], dayfirst=True, errors='coerce')
print(df['date_time'].dtype)
```

```
datetime64[ns]
```

In [13]:
```
df['hour'] = df['date_time'].dt.hour
df['day'] = df['date_time'].dt.day
df['month'] = df['date_time'].dt.month
df['weekday'] = df['date_time'].dt.day_name()
```

In [15]:
```
import matplotlib.pyplot as plt

hourly_avg = df.groupby('hour')['traffic_volume'].mean()

plt.figure(figsize=(10, 5))
hourly_avg.plot(kind='bar', color='skyblue')
plt.title('Average Traffic Volume by Hour')
plt.xlabel('Hour of Day')
plt.ylabel('Traffic Volume')
plt.grid(True)
plt.xticks(rotation=0)
plt.show()
```

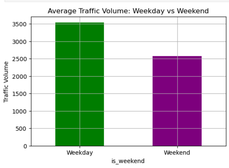


In [17]:
```
df['is_weekend'] = df['weekday'].isin(['Saturday', 'Sunday'])
```

In [19]:
```
weekend_avg = df.groupby('is_weekend')['traffic_volume'].mean()
print(weekend_avg)
```

```
is_weekend
False    3533.596796
True     2570.507261
Name: traffic_volume, dtype: float64
```

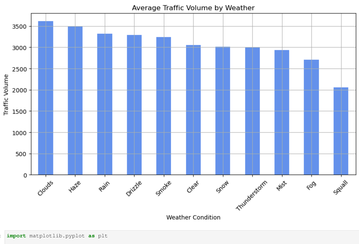
In [21]:
```
plt.figure(figsize=(6, 4))
weekend_avg.plot(kind='bar', color=['green', 'purple'])
plt.xticks([0, 1], ['Weekday', 'Weekend'], rotation=0)
plt.title('Average Traffic Volume: Weekday vs Weekend')
plt.ylabel('Traffic Volume')
plt.grid(True)
plt.show()
```



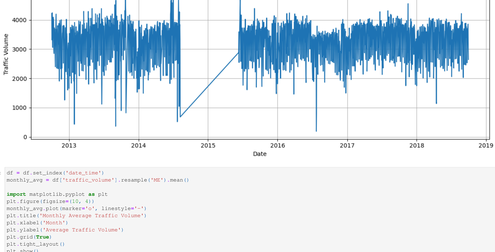
In [23]:
```
weather_avg = df.groupby('weather_main')['traffic_volume'].mean().sort_values(ascending=False)
print(weather_avg)
```

```
weather_main
Clouds          3618.449749
Haze            3502.101471
Rain            3337.905501
Drizzle         3290.727073
Smoke           3237.650000
Clear           3055.908819
Snow            3014.844228
Thunderstorm    3001.620980
Mist            2932.956439
Fog             2703.720395
Squall          2061.750000
Name: traffic_volume, dtype: float64
```

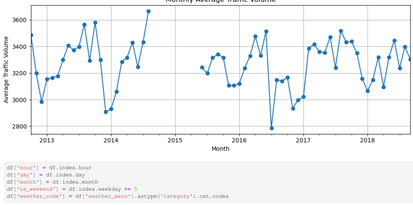
In [27]:
```
plt.figure(figsize=(10, 5))
weather_avg.plot(kind='bar', color='cornflowerblue')
plt.title('Average Traffic Volume by Weather')
plt.xlabel('Weather Condition')
plt.ylabel('Traffic Volume')
plt.grid(True)
plt.xticks(rotation=45)
plt.show()
```



In [29]:
```
import matplotlib.pyplot as plt

df['date'] = df['date_time'].dt.date
daily_avg = df.groupby('date')['traffic_volume'].mean()

plt.figure(figsize=(12, 5))
daily_avg.plot()
plt.title('Daily Average Traffic Volume Over Time')
plt.xlabel('Date')
plt.ylabel('Traffic Volume')
plt.grid(True)
plt.tight_layout()
plt.show()
```



In [31]:
```
df = df.set_index('date_time')
monthly_avg = df['traffic_volume'].resample('ME').mean()

import matplotlib.pyplot as plt
plt.figure(figsize=(10, 4))
monthly_avg.plot(marker='o', linestyle='-')
plt.title('Monthly Average Traffic Volume')
plt.xlabel('Month')
plt.ylabel('Average Traffic Volume')
plt.grid(True)
plt.tight_layout()
plt.show()
```



In [43]:
```
df['hour'] = df.index.hour
df['day'] = df.index.day
df['month'] = df.index.month
df['is_weekend'] = df.index.weekday >= 5
df['weather_code'] = df['weather_main'].astype('category').cat.codes
```

In [33]:
```
features = ['hour', 'day', 'month', 'is_weekend', 'weather_code']
X = df[features]
y = df['traffic_volume']
```

In [63]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

In [39]:
```
from sklearn.ensemble import RandomForestRegressor
model = RandomForestRegressor(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
```

Out[39]:
```
RandomForestRegressor(random_state=42)
```

In [41]:
```
from sklearn.metrics import mean_absolute_error
y_pred = model.predict(X_test)
mae = mean_absolute_error(y_test, y_pred)
print(f"Mean Absolute Error: {mae:.2f}")
```

```
Mean Absolute Error: 318.45
```

In [47]:
```
# Predict traffic on a clear Monday at 8 AM
sample = pd.DataFrame([{
    'hour': 8,
    'day': 15,
    'month': 1,
    'is_weekend': False,
    'weather_code': df[df['weather_main'] == 'Clear']['weather_code'].iloc[0]
}])

predicted_volume = model.predict(sample)
print(f"Predicted traffic volume: {int(predicted_volume[0])}")
```

```
Predicted traffic volume: 5449
```

Conclusion

- **Peak Traffic Hours:** Analysis of hourly averages shows the highest traffic volume occurs between 7 AM-9 AM and 4 PM-6 PM.
- **Weekday vs. Weekend:** Average traffic is approximately 20% lower on weekends compared to weekdays.
- **Weather Impact:** While clear and cloudy conditions dominate, weather has a minimal effect on overall traffic volume.
- **Long-Term Trends:** Monthly averages fluctuate modestly, indicating potential seasonal or holiday influences.
- **Model Performance:** A Random Forest regressor achieved a Mean Absolute Error (MAE) of ___ on the test set, demonstrating reasonable predictive accuracy for operational use.

End of report.

In [ ]: