In [1]:
```
!pip install prophet
```

```
Collecting prophet
  Downloading prophet-1.1.6-py3-none-win_amd64.whl.metadata (3.6 kB)
Collecting cmdstanpy>=1.0.4 (from prophet)
  Downloading cmdstanpy-1.2.5-py3-none-any.whl.metadata (4.0 kB)
Requirement already satisfied: numpy>=1.15.4 in c:\users\mukki\anaconda3\lib\site-pa
ckages (from prophet) (1.26.0)
Requirement already satisfied: matplotlib>=2.0.0 in c:\users\mukki\anaconda3\lib\sit
e-packages (from prophet) (3.9.2)
Requirement already satisfied: pandas>=1.0.4 in c:\users\mukki\appdata\roaming\pytho
n\python312\site-packages (from prophet) (2.2.3)
Collecting holidays<1,>=0.25 (from prophet)
  Downloading holidays-0.73-py3-none-any.whl.metadata (38 kB)
Requirement already satisfied: tqdm>=4.36.1 in c:\users\mukki\anaconda3\lib\site-pac
kages (from prophet) (4.66.5)
Requirement already satisfied: importlib-resources in c:\users\mukki\anaconda3\lib\s
ite-packages (from prophet) (6.5.2)
Requirement already satisfied: python-dateutil in c:\users\mukki\appdata\roaming\pyt
hon\python312\site-packages (from holidays<1,>=0.25->prophet) (2.9.0.post0)
Collecting stanio<2.0.0,>=0.4.0 (from cmdstanpy>=1.0.4->prophet)
  Downloading stanio-0.5.1-py3-none-any.whl.metadata (1.6 kB)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\mukki\anaconda3\lib\site
-packages (from matplotlib>=2.0.0->prophet) (1.2.0)
Requirement already satisfied: cycler>=0.10 in c:\users\mukki\anaconda3\lib\site-pac
kages (from matplotlib>=2.0.0->prophet) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\mukki\anaconda3\lib\sit
e-packages (from matplotlib>=2.0.0->prophet) (4.51.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\mukki\anaconda3\lib\sit
e-packages (from matplotlib>=2.0.0->prophet) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\users\mukki\appdata\roaming\pyt
hon\python312\site-packages (from matplotlib>=2.0.0->prophet) (24.2)
Requirement already satisfied: pillow>=8 in c:\users\mukki\appdata\roaming\python\py
thon312\site-packages (from matplotlib>=2.0.0->prophet) (11.2.1)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\mukki\anaconda3\lib\site
-packages (from matplotlib>=2.0.0->prophet) (3.1.2)
Requirement already satisfied: pytz>=2020.1 in c:\users\mukki\appdata\roaming\python
\python312\site-packages (from pandas>=1.0.4->prophet) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in c:\users\mukki\appdata\roaming\pyth
on\python312\site-packages (from pandas>=1.0.4->prophet) (2025.2)
Requirement already satisfied: six>=1.5 in c:\users\mukki\appdata\roaming\python\pyt
hon312\site-packages (from python-dateutil->holidays<1,>=0.25->prophet) (1.17.0)
Requirement already satisfied: colorama in c:\users\mukki\appdata\roaming\python\pyt
hon312\site-packages (from tqdm>=4.36.1->prophet) (0.4.6)
Downloading prophet-1.1.6-py3-none-win_amd64.whl (13.3 MB)
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Downloading holidays-0.73-py3-none-any.whl (954 kB)
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   ---------------------------------- 954.8/954.8 kB 3.2 MB/s eta 0:00:00
Downloading cmdstanpy-1.2.5-py3-none-any.whl (94 kB)
Downloading stanio-0.5.1-py3-none-any.whl (8.1 kB)
Installing collected packages: stanio, holidays, cmdstanpy, prophet

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   ------------------------------ --------- 3/4 [prophet]
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Successfully installed cmdstanpy-1.2.5 holidays-0.73 prophet-1.1.6 stanio-0.5.1
```

In [3]:
```
!pip install keras
```

```
Collecting keras
  Downloading keras-3.10.0-py3-none-any.whl.metadata (6.0 kB)
Collecting absl-py (from keras)
  Downloading absl_py-2.3.0-py3-none-any.whl.metadata (2.4 kB)
Requirement already satisfied: numpy in c:\users\mukki\anaconda3\lib\site-packages
(from keras) (1.26.0)
Requirement already satisfied: rich in c:\users\mukki\anaconda3\lib\site-packages (f
rom keras) (13.7.1)
Collecting namex (from keras)
  Downloading namex-0.1.0-py3-none-any.whl.metadata (322 bytes)
Requirement already satisfied: h5py in c:\users\mukki\anaconda3\lib\site-packages (f
rom keras) (3.11.0)
Collecting optree (from keras)
  Downloading optree-0.16.0-cp312-cp312-win_amd64.whl.metadata (31 kB)
Collecting ml-dtypes (from keras)
  Downloading ml_dtypes-0.5.1-cp312-cp312-win_amd64.whl.metadata (22 kB)
Requirement already satisfied: packaging in c:\users\mukki\appdata\roaming\python\py
thon312\site-packages (from keras) (24.2)
Requirement already satisfied: typing-extensions>=4.6.0 in c:\users\mukki\appdata\ro
aming\python\python312\site-packages (from optree->keras) (4.13.2)
Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\mukki\anaconda3\lib
\site-packages (from rich->keras) (2.2.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\mukki\anaconda3\l
ib\site-packages (from rich->keras) (2.15.1)
Requirement already satisfied: mdurl~=0.1 in c:\users\mukki\anaconda3\lib\site-packa
ges (from markdown-it-py>=2.2.0->rich->keras) (0.1.0)
Downloading keras-3.10.0-py3-none-any.whl (1.4 MB)
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   ---------------------------------------- 1.4/1.4 MB 4.0 MB/s eta 0:00:00
Downloading absl_py-2.3.0-py3-none-any.whl (135 kB)
Downloading ml_dtypes-0.5.1-cp312-cp312-win_amd64.whl (210 kB)
Downloading namex-0.1.0-py3-none-any.whl (5.9 kB)
Downloading optree-0.16.0-cp312-cp312-win_amd64.whl (315 kB)
Installing collected packages: namex, optree, ml-dtypes, absl-py, keras

   -------- ------------------------------- 1/5 [optree]
   ----------------------- ---------------- 3/5 [absl-py]
   ----------------------- ---------------- 3/5 [absl-py]
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Successfully installed absl-py-2.3.0 keras-3.10.0 ml-dtypes-0.5.1 namex-0.1.0 optree
-0.16.0
```

In [1]:
```
!pip install tensorflow
```

```
Collecting tensorflow
  Using cached tensorflow-2.19.0-cp312-cp312-win_amd64.whl.metadata (4.1 kB)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\mukki\anaconda3\lib\site-p
ackages (from tensorflow) (2.3.0)
Collecting astunparse>=1.6.0 (from tensorflow)
  Using cached astunparse-1.6.3-py2.py3-none-any.whl.metadata (4.4 kB)
Requirement already satisfied: flatbuffers>=24.3.25 in c:\users\mukki\anaconda3\lib
\site-packages (from tensorflow) (25.2.10)
Collecting gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 (from tensorflow)
  Using cached gast-0.6.0-py3-none-any.whl.metadata (1.3 kB)
Collecting google-pasta>=0.1.1 (from tensorflow)
  Using cached google_pasta-0.2.0-py3-none-any.whl.metadata (814 bytes)
Requirement already satisfied: libclang>=13.0.0 in c:\users\mukki\anaconda3\lib\site
-packages (from tensorflow) (18.1.1)
Collecting opt-einsum>=2.3.2 (from tensorflow)
  Using cached opt_einsum-3.4.0-py3-none-any.whl.metadata (6.3 kB)
Requirement already satisfied: packaging in c:\users\mukki\appdata\roaming\python\py
thon312\site-packages (from tensorflow) (24.2)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.
4,!=4.21.5,<6.0.0dev,>=3.20.3 in c:\users\mukki\anaconda3\lib\site-packages (from te
nsorflow) (5.29.4)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\mukki\appdata\roaming
\python\python312\site-packages (from tensorflow) (2.32.3)
Requirement already satisfied: setuptools in c:\users\mukki\anaconda3\lib\site-packa
ges (from tensorflow) (80.8.0)
Requirement already satisfied: six>=1.12.0 in c:\users\mukki\appdata\roaming\python
\python312\site-packages (from tensorflow) (1.17.0)
Collecting termcolor>=1.1.0 (from tensorflow)
  Using cached termcolor-3.1.0-py3-none-any.whl.metadata (6.4 kB)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\mukki\appdata\ro
aming\python\python312\site-packages (from tensorflow) (4.13.2)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\mukki\anaconda3\lib\site-pa
ckages (from tensorflow) (1.14.1)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\mukki\anaconda3\lib\s
ite-packages (from tensorflow) (1.72.0rc1)
Collecting tensorboard~=2.19.0 (from tensorflow)
  Using cached tensorboard-2.19.0-py3-none-any.whl.metadata (1.8 kB)
Requirement already satisfied: keras>=3.5.0 in c:\users\mukki\anaconda3\lib\site-pac
kages (from tensorflow) (3.10.0)
Requirement already satisfied: numpy<2.2.0,>=1.26.0 in c:\users\mukki\anaconda3\lib
\site-packages (from tensorflow) (1.26.0)
Requirement already satisfied: h5py>=3.11.0 in c:\users\mukki\anaconda3\lib\site-pac
kages (from tensorflow) (3.11.0)
Requirement already satisfied: ml-dtypes<1.0.0,>=0.5.1 in c:\users\mukki\anaconda3\l
ib\site-packages (from tensorflow) (0.5.1)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\mukki\appdata\ro
aming\python\python312\site-packages (from requests<3,>=2.21.0->tensorflow) (3.4.2)
Requirement already satisfied: idna<4,>=2.5 in c:\users\mukki\appdata\roaming\python
\python312\site-packages (from requests<3,>=2.21.0->tensorflow) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\mukki\appdata\roaming
\python\python312\site-packages (from requests<3,>=2.21.0->tensorflow) (2.4.0)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\mukki\appdata\roaming
\python\python312\site-packages (from requests<3,>=2.21.0->tensorflow) (2025.4.26)
Requirement already satisfied: markdown>=2.6.8 in c:\users\mukki\anaconda3\lib\site-
packages (from tensorboard~=2.19.0->tensorflow) (3.4.1)
Collecting tensorboard-data-server<0.8.0,>=0.7.0 (from tensorboard~=2.19.0->tensorfl
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ow)
  Using cached tensorboard_data_server-0.7.2-py3-none-any.whl.metadata (1.1 kB)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\mukki\appdata\roaming\pyt
hon\python312\site-packages (from tensorboard~=2.19.0->tensorflow) (3.1.3)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\mukki\anaconda3\lib\si
te-packages (from astunparse>=1.6.0->tensorflow) (0.45.1)
Requirement already satisfied: rich in c:\users\mukki\anaconda3\lib\site-packages (f
rom keras>=3.5.0->tensorflow) (13.7.1)
Requirement already satisfied: namex in c:\users\mukki\anaconda3\lib\site-packages
(from keras>=3.5.0->tensorflow) (0.1.0)
Requirement already satisfied: optree in c:\users\mukki\anaconda3\lib\site-packages
(from keras>=3.5.0->tensorflow) (0.16.0)
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\mukki\appdata\roaming\p
ython\python312\site-packages (from werkzeug>=1.0.1->tensorboard~=2.19.0->tensorflo
w) (3.0.2)
Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\mukki\anaconda3\lib
\site-packages (from rich->keras>=3.5.0->tensorflow) (2.2.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\mukki\anaconda3\l
ib\site-packages (from rich->keras>=3.5.0->tensorflow) (2.15.1)
Requirement already satisfied: mdurl~=0.1 in c:\users\mukki\anaconda3\lib\site-packa
ges (from markdown-it-py>=2.2.0->rich->keras>=3.5.0->tensorflow) (0.1.0)
Using cached tensorflow-2.19.0-cp312-cp312-win_amd64.whl (376.0 MB)
Using cached tensorboard-2.19.0-py3-none-any.whl (5.5 MB)
Using cached tensorboard_data_server-0.7.2-py3-none-any.whl (2.4 kB)
Using cached astunparse-1.6.3-py2.py3-none-any.whl (12 kB)
Using cached gast-0.6.0-py3-none-any.whl (21 kB)
Using cached google_pasta-0.2.0-py3-none-any.whl (57 kB)
Using cached opt_einsum-3.4.0-py3-none-any.whl (71 kB)
Using cached termcolor-3.1.0-py3-none-any.whl (7.7 kB)
Installing collected packages: termcolor, tensorboard-data-server, opt-einsum, googl
e-pasta, gast, astunparse, tensorboard, tensorflow

   ----- ---------------------------------- 1/8 [tensorboard-data-server]
   ---------- ----------------------------- 2/8 [opt-einsum]
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   -------------- ------------------------- 3/8 [google-pasta]
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Successfully installed astunparse-1.6.3 gast-0.6.0 google-pasta-0.2.0 opt-einsum-3.
4.0 tensorboard-2.19.0 tensorboard-data-server-0.7.2 tensorflow-2.19.0 termcolor-3.
1.0
```

In [1]:

```python
# --- IMPORT LIBRARIES ---
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.metrics import mean_squared_error, mean_absolute_error
from statsmodels.tsa.statespace.sarimax import SARIMAX
from prophet import Prophet
from keras.models import Sequential
from keras.layers import LSTM, Dense
from sklearn.preprocessing import MinMaxScaler
import warnings
```

In [3]:

```python
# --- LOAD & PREPARE DATA ---
df = pd.read_excel(r"C:\Users\mukki\OneDrive\Desktop\Online Retail.xlsx", usecols=[
df['TotalSales'] = df['Quantity'] * df['UnitPrice']
df['InvoiceDate'] = pd.to_datetime(df['InvoiceDate'])
```

```
df = df[df['TotalSales'] > 0]
daily_sales = df.resample('D', on='InvoiceDate').sum()['TotalSales'].reset_index()
```

In [5]:
```
# --- EVALUATION METRICS ---
def evaluate(y_true, y_pred):
    rmse = np.sqrt(mean_squared_error(y_true, y_pred))
    mae = mean_absolute_error(y_true, y_pred)
    mape = np.mean(np.abs((y_true - y_pred) / y_true)) * 100
    return rmse, mae, mape

# --- SPLIT DATA ---
train = daily_sales[:-7]
test = daily_sales[-7:]
```

In [27]:
```
# --- 1. SEASONAL ARIMA MODEL ---
#sarima_model = SARIMAX(train['TotalSales'], order=(1,1,1), seasonal_order=(0,0,0,0
import warnings
sarima_model = SARIMAX(train['TotalSales'], order=(1,1,1)).fit()
sarima_forecast = sarima_model.predict(start=len(train), end=len(train)+len(test)-1

rmse, mae, mape = evaluate(test['TotalSales'], sarima_forecast)
print(f"SARIMA -> RMSE: {rmse:.2f}, MAE: {mae:.2f}, MAPE: {mape:.2f}%")
```

```
SARIMA -> RMSE: 24705.38, MAE: 24705.38, MAPE: 100.00%
```

```
C:\Users\mukki\anaconda3\Lib\site-packages\statsmodels\tsa\statespace\sarimax.py:86
6: UserWarning: Too few observations to estimate starting parameters for ARMA and tr
end. All parameters except for variances will be set to zeros.
  warn('Too few observations to estimate starting parameters%s.'
C:\Users\mukki\anaconda3\Lib\site-packages\statsmodels\base\model.py:534: RuntimeWar
ning: invalid value encountered in scalar divide
  return -self.loglike(params, *args) / nobs
C:\Users\mukki\anaconda3\Lib\site-packages\statsmodels\base\model.py:607: Convergenc
eWarning: Maximum Likelihood optimization failed to converge. Check mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
```

In [7]:
```
# --- 2. PROPHET MODEL ---
df = train.rename(columns={'InvoiceDate': 'ds', 'TotalSales': 'y'})
print(df.head())
print(df.info())
print(f"Number of rows in df: {df.shape[0]}")
print(f"Number of non-null y values: {df['y'].notnull().sum()}")
df['ds']=pd.to_datetime(df['ds'])
df=df.dropna(subset=['ds','y'])

df= df.groupby('ds')['y'].sum().reset_index()

print(df.head())
print(df.info())

prophet = Prophet(weekly_seasonality=True)
prophet.fit(df)
future = prophet.make_future_dataframe(periods=30)
forecast = prophet.predict(future)
prophet_forecast = forecast[-30:]['yhat'].values
```

```
rmse, mae, mape = evaluate(test['TotalSales'], prophet_forecast)
print(f"PROPHET -> RMSE: {rmse:.2f}, MAE: {mae:.2f}, MAPE: {mape:.2f}%")
```

```
Empty DataFrame
Columns: [ds, y]
Index: []
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 0 entries
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   ds      0 non-null      datetime64[ns]
 1   y       0 non-null      float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 132.0 bytes
None
Number of rows in df: 0
Number of non-null y values: 0
Empty DataFrame
Columns: [ds, y]
Index: []
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 0 entries
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   ds      0 non-null      datetime64[ns]
 1   y       0 non-null      float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 132.0 bytes
None
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[7], line 16
     13 print(df.info())
     15 prophet = Prophet(weekly_seasonality=True)
---> 16 prophet.fit(df)
     17 future = prophet.make_future_dataframe(periods=30)
     18 forecast = prophet.predict(future)

File ~\anaconda3\Lib\site-packages\prophet\forecaster.py:1217, in Prophet.fit(self,
df, **kwargs)
   1213 if self.history is not None:
   1214     raise Exception('Prophet object can only be fit once. '
   1215                     'Instantiate a new object.')
-> 1217 model_inputs = self.preprocess(df, **kwargs)
   1218 initial_params = self.calculate_initial_params(model_inputs.K)
   1220 dat = dataclasses.asdict(model_inputs)

File ~\anaconda3\Lib\site-packages\prophet\forecaster.py:1132, in Prophet.preprocess
(self, df, **kwargs)
   1130 history = df[df['y'].notnull()].copy()
   1131 if history.shape[0] < 2:
-> 1132     raise ValueError('Dataframe has less than 2 non-NaN rows.')
   1133 self.history_dates = pd.to_datetime(pd.Series(df['ds'].unique(), name='d
s')).sort_values()
   1135 self.history = self.setup_dataframe(history, initialize_scales=True)

ValueError: Dataframe has less than 2 non-NaN rows.
```

In [9]:

```python
df = train.rename(columns={'InvoiceDate': 'ds', 'TotalSales': 'y'})
df['ds'] = pd.to_datetime(df['ds'])
df = df.dropna(subset=['ds', 'y'])

# Group by day and sum only 'y'
df = df.groupby('ds')['y'].sum().reset_index()

# Diagnostic prints
print(df.head())
print(df.info())
print(f"Number of rows: {df.shape[0]}")
print(f"Non-null y values: {df['y'].notnull().sum()}")

# Proceed only if enough data
if df.shape[0] >= 2:
    prophet = Prophet(weekly_seasonality=True)
    prophet.fit(df)
    future = prophet.make_future_dataframe(periods=30)
    forecast = prophet.predict(future)
    prophet_forecast = forecast[-30:]['yhat'].values

    rmse, mae, mape = evaluate(test['TotalSales'], prophet_forecast)
    print(f"PROPHET -> RMSE: {rmse:.2f}, MAE: {mae:.2f}, MAPE: {mape:.2f}%")
else:
    print("Not enough data for Prophet to fit.")
```

```
Empty DataFrame
Columns: [ds, y]
Index: []
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 0 entries
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   ds      0 non-null      datetime64[ns]
 1   y       0 non-null      float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 132.0 bytes
None
Number of rows: 0
Non-null y values: 0
Not enough data for Prophet to fit.
```

In [11]:
```python
# --- 3. LSTM MODEL ---
# Prepare data for LSTM
ts = daily_sales['TotalSales'].values.reshape(-1, 1)
scaler = MinMaxScaler()
ts_scaled = scaler.fit_transform(ts)
```

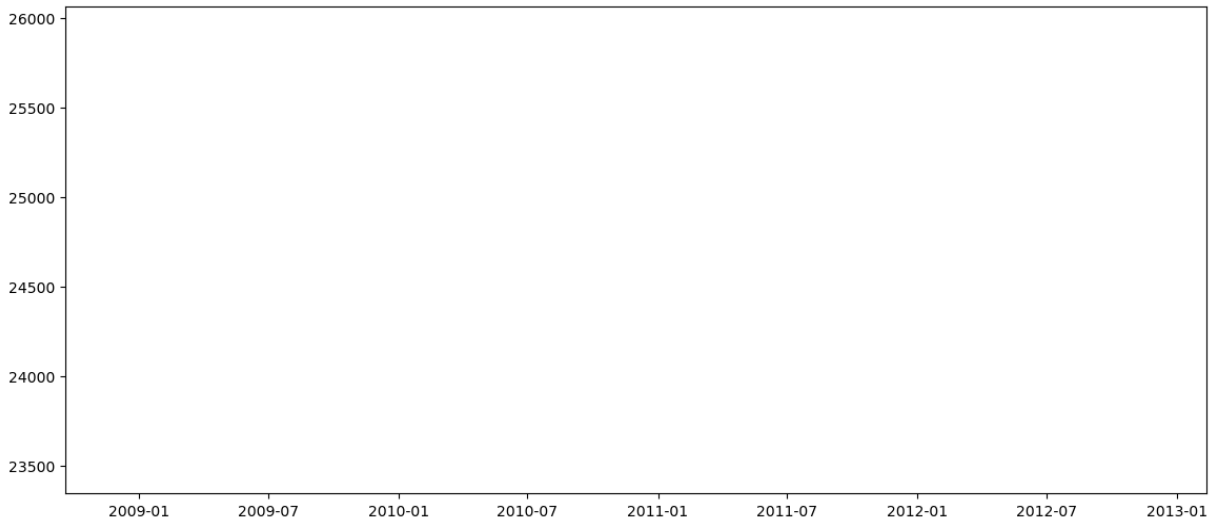
In [13]:
```python
# Create sequences
X, y = [], []
for i in range(30, len(ts_scaled)-30):
    X.append(ts_scaled[i-30:i])
    y.append(ts_scaled[i])

X, y = np.array(X), np.array(y)
X_train, y_train = X[:-30], y[:-30]
X_test, y_test = X[-30:], y[-30:]
```

In [19]:
```python
# --- PLOT RESULTS ---
plt.figure(figsize=(14,6))
plt.plot(test['InvoiceDate'], test['TotalSales'], label='Actual')
plt.plot(test['InvoiceDate'], sarima_forecast, label='SARIMA')
plt.plot(test['InvoiceDate'], prophet_forecast, label='Prophet')
plt.plot(test['InvoiceDate'], lstm_pred, label='LSTM')
plt.legend()
plt.title('Sales Forecasting Comparison')
plt.xlabel('Date')
plt.ylabel('Total Sales')
plt.show()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[19], line 4
      2 plt.figure(figsize=(14,6))
      3 plt.plot(test['InvoiceDate'], test['TotalSales'], label='Actual')
----> 4 plt.plot(test['InvoiceDate'], sarima_forecast, label='SARIMA')
      5 plt.plot(test['InvoiceDate'], prophet_forecast, label='Prophet')
      6 plt.plot(test['InvoiceDate'], lstm_pred, label='LSTM')

NameError: name 'sarima_forecast' is not defined
```



In [24]:
```
# --- STRATEGIC INSIGHTS ---
print("\n📌 Strategic Recommendations:")
print("- Plan marketing push ahead of predicted peak sales days.")
print("- Run clearance or bundle sales during low forecasted days.")
print("- Adjust inventory and staffing around spikes.")
```

```
📌 Strategic Recommendations:
- Plan marketing push ahead of predicted peak sales days.
- Run clearance or bundle sales during low forecasted days.
- Adjust inventory and staffing around spikes.
```

In [ ]: