In [1]: `!pip install statsmodels`

```
Requirement already satisfied: statsmodels in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (0.13.5)
Requirement already satisfied: pandas>=0.25 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from stat
smodels) (1.3.5)
Requirement already satisfied: patsy>=0.5.2 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from stat
smodels) (1.0.1)
Requirement already satisfied: packaging>=21.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from s
tatsmodels) (23.2)
Requirement already satisfied: scipy>=1.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from statsm
odels) (1.7.3)
Requirement already satisfied: numpy>=1.17 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from stats
models) (1.21.6)
Requirement already satisfied: python-dateutil>=2.7.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages
(from pandas>=0.25->statsmodels) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pand
as>=0.25->statsmodels) (2023.3.post1)
Requirement already satisfied: six>=1.5 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from python-d
ateutil>=2.7.3->pandas>=0.25->statsmodels) (1.16.0)
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
```

In [2]: `!pip install prophet`

```
·            Requirement already satisfied: prophet in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (1.1.6)
             Requirement already satisfied: cmdstanpy>=1.0.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             prophet) (1.1.0)
             Requirement already satisfied: numpy>=1.15.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pro
             phet) (1.21.6)
             Requirement already satisfied: matplotlib>=2.0.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             prophet) (3.5.3)
             Requirement already satisfied: pandas>=1.0.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pro
             phet) (1.3.5)
             Requirement already satisfied: holidays<1,>=0.25 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             prophet) (0.27.1)
             Requirement already satisfied: tqdm>=4.36.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from prop
             het) (4.66.4)
             Requirement already satisfied: importlib-resources in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (fr
             om prophet) (5.12.0)
             Requirement already satisfied: python-dateutil in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from h
             olidays<1,>=0.25->prophet) (2.8.2)
             Requirement already satisfied: cycler>=0.10 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from matp
             lotlib>=2.0.0->prophet) (0.11.0)
             Requirement already satisfied: fonttools>=4.22.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             matplotlib>=2.0.0->prophet) (4.38.0)
             Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             matplotlib>=2.0.0->prophet) (1.4.5)
             Requirement already satisfied: packaging>=20.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from m
             atplotlib>=2.0.0->prophet) (23.2)
             Requirement already satisfied: pillow>=6.2.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from mat
             plotlib>=2.0.0->prophet) (9.5.0)
             Requirement already satisfied: pyparsing>=2.2.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             matplotlib>=2.0.0->prophet) (3.1.2)
             Requirement already satisfied: pytz>=2017.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pand
             as>=1.0.4->prophet) (2023.3.post1)
             Requirement already satisfied: colorama in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from tqdm>=4.
             36.1->prophet) (0.4.6)
             Requirement already satisfied: zipp>=3.1.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from impor
             tlib-resources->prophet) (3.15.0)
             Requirement already satisfied: typing-extensions in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
             kiwisolver>=1.0.1->matplotlib>=2.0.0->prophet) (4.7.1)
             Requirement already satisfied: six>=1.5 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from python-d
             ateutil->holidays<1,>=0.25->prophet) (1.16.0)
```

```
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
```

In [3]:
```python
pip install pystan==2.19.1.1 prophet
```

```
Requirement already satisfied: pystan==2.19.1.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (2.19.
1.1)
Requirement already satisfied: prophet in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (1.1.6)
Requirement already satisfied: Cython!=0.25.1,>=0.22 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages
(from pystan==2.19.1.1) (3.0.12)
Requirement already satisfied: numpy>=1.7 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pystan
==2.19.1.1) (1.21.6)
Requirement already satisfied: cmdstanpy>=1.0.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
prophet) (1.1.0)
Requirement already satisfied: matplotlib>=2.0.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
prophet) (3.5.3)
Requirement already satisfied: pandas>=1.0.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pro
phet) (1.3.5)
Requirement already satisfied: holidays<1,>=0.25 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
prophet) (0.27.1)
Requirement already satisfied: tqdm>=4.36.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from prop
het) (4.66.4)
Requirement already satisfied: importlib-resources in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (fr
om prophet) (5.12.0)
Requirement already satisfied: python-dateutil in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from h
olidays<1,>=0.25->prophet) (2.8.2)
Requirement already satisfied: cycler>=0.10 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from matp
lotlib>=2.0.0->prophet) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->prophet) (4.38.0)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->prophet) (1.4.5)
Requirement already satisfied: packaging>=20.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from m
atplotlib>=2.0.0->prophet) (23.2)
Requirement already satisfied: pillow>=6.2.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from mat
plotlib>=2.0.0->prophet) (9.5.0)
Requirement already satisfied: pyparsing>=2.2.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->prophet) (3.1.2)
Requirement already satisfied: pytz>=2017.3 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from pand
as>=1.0.4->prophet) (2023.3.post1)
Requirement already satisfied: colorama in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from tqdm>=4.
36.1->prophet) (0.4.6)
Requirement already satisfied: zipp>=3.1.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from impor
tlib-resources->prophet) (3.15.0)
Requirement already satisfied: typing-extensions in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
kiwisolver>=1.0.1->matplotlib>=2.0.0->prophet) (4.7.1)
```

Requirement already satisfied: six>=1.5 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from python-d
ateutil->holidays<1,>=0.25->prophet) (1.16.0)
Note: you may need to restart the kernel to use updated packages.

WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)

In [4]:
```
!pip install fbprophet
```

```
Collecting fbprophet
  Using cached fbprophet-0.7.1.tar.gz (64 kB)
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Requirement already satisfied: Cython>=0.22 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from fbpr
ophet) (3.0.12)
Collecting cmdstanpy==0.9.5 (from fbprophet)
  Using cached cmdstanpy-0.9.5-py3-none-any.whl.metadata (2.9 kB)
Requirement already satisfied: pystan>=2.14 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from fbpr
ophet) (2.19.1.1)
Requirement already satisfied: numpy>=1.15.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from fbp
rophet) (1.21.6)
Requirement already satisfied: pandas>=1.0.4 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from fbp
rophet) (1.3.5)
Requirement already satisfied: matplotlib>=2.0.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
fbprophet) (3.5.3)
Collecting LunarCalendar>=0.0.9 (from fbprophet)
  Using cached LunarCalendar-0.0.9-py2.py3-none-any.whl.metadata (6.3 kB)
Collecting convertdate>=2.1.2 (from fbprophet)
  Using cached convertdate-2.4.0-py3-none-any.whl.metadata (8.3 kB)
Requirement already satisfied: holidays>=0.10.2 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
fbprophet) (0.27.1)
Collecting setuptools-git>=1.2 (from fbprophet)
  Using cached setuptools_git-1.2-py2.py3-none-any.whl.metadata (5.8 kB)
Requirement already satisfied: python-dateutil>=2.8.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages
(from fbprophet) (2.8.2)
Requirement already satisfied: tqdm>=4.36.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from fbpr
ophet) (4.66.4)
Collecting pymeeus<=1,>=0.3.13 (from convertdate>=2.1.2->fbprophet)
  Using cached PyMeeus-0.5.12-py3-none-any.whl
Collecting ephem>=3.7.5.3 (from LunarCalendar>=0.0.9->fbprophet)
  Using cached ephem-4.2-cp37-cp37m-win_amd64.whl.metadata (6.2 kB)
Requirement already satisfied: pytz in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from LunarCalenda
r>=0.0.9->fbprophet) (2023.3.post1)
Requirement already satisfied: cycler>=0.10 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from matp
lotlib>=2.0.0->fbprophet) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->fbprophet) (4.38.0)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->fbprophet) (1.4.5)
Requirement already satisfied: packaging>=20.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from m
```

```
atplotlib>=2.0.0->fbprophet) (23.2)
Requirement already satisfied: pillow>=6.2.0 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from mat
plotlib>=2.0.0->fbprophet) (9.5.0)
Requirement already satisfied: pyparsing>=2.2.1 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
matplotlib>=2.0.0->fbprophet) (3.1.2)
Requirement already satisfied: six>=1.5 in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from python-d
ateutil>=2.8.0->fbprophet) (1.16.0)
Requirement already satisfied: colorama in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from tqdm>=4.
36.1->fbprophet) (0.4.6)
Requirement already satisfied: typing-extensions in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from
kiwisolver>=1.0.1->matplotlib>=2.0.0->fbprophet) (4.7.1)
Using cached cmdstanpy-0.9.5-py3-none-any.whl (37 kB)
Using cached convertdate-2.4.0-py3-none-any.whl (47 kB)
Using cached LunarCalendar-0.0.9-py2.py3-none-any.whl (18 kB)
Using cached setuptools_git-1.2-py2.py3-none-any.whl (10 kB)
Using cached ephem-4.2-cp37-cp37m-win_amd64.whl (1.4 MB)
Building wheels for collected packages: fbprophet
  Building wheel for fbprophet (setup.py): started
  Building wheel for fbprophet (setup.py): finished with status 'error'
  Running setup.py clean for fbprophet
Failed to build fbprophet
```

```
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
  error: subprocess-exited-with-error

  python setup.py bdist_wheel did not run successfully.
  exit code: 1

  [45 lines of output]
  running bdist_wheel
  running build
  running build_py
  creating build
  creating build\lib
  creating build\lib\fbprophet
  creating build\lib\fbprophet\stan_model
  Traceback (most recent call last):
    File "<string>", line 36, in <module>
    File "<pip-setuptools-caller>", line 34, in <module>
    File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\setup.py", line 149,
in <module>
      long_description_content_type='text/markdown',
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages\setuptools\__init__.py", line 144, in setup
      return distutils.core.setup(**attrs)
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\core.py", line 148, in setup
      dist.run_commands()
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\dist.py", line 966, in run_commands
      self.run_command(cmd)
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\dist.py", line 985, in run_command
      cmd_obj.run()
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages\wheel\bdist_wheel.py", line 368, in run
      self.run_command("build")
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\cmd.py", line 313, in run_command
      self.distribution.run_command(command)
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\dist.py", line 985, in run_command
      cmd_obj.run()
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\command\build.py", line 135, in run
      self.run_command(cmd_name)
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\cmd.py", line 313, in run_command
      self.distribution.run_command(command)
    File "c:\users\zahus\appdata\local\programs\python\python37\lib\distutils\dist.py", line 985, in run_command
```

```
        cmd_obj.run()
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\setup.py", line 48, i
n run
        build_models(target_dir)
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\setup.py", line 36, i
n build_models
        from fbprophet.models import StanBackendEnum
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\fbprophet\__init__.p
y", line 8, in <module>
        from fbprophet.forecaster import Prophet
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\fbprophet\forecaster.
py", line 17, in <module>
        from fbprophet.make_holidays import get_holiday_names, make_holidays_df
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\fbprophet\make_holida
ys.py", line 14, in <module>
        import fbprophet.hdays as hdays_part2
      File "C:\Users\zahus\AppData\Local\Temp\pip-install-o8hgmvsj\fbprophet_077b8226207542d49562b8e58dfa5245\fbprophet\hdays.py",
line 13, in <module>
        from convertdate.islamic import from_gregorian, to_gregorian
  ModuleNotFoundError: No module named 'convertdate'
  [end of output]

  note: This error originates from a subprocess, and is likely not a problem with pip.
  ERROR: Failed building wheel for fbprophet
ERROR: Could not build wheels for fbprophet, which is required to install pyproject.toml-based projects
```

In [5]: `!pip install xgboost`

```
Requirement already satisfied: xgboost in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (1.6.2)
Requirement already satisfied: numpy in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from xgboost)
(1.21.6)
Requirement already satisfied: scipy in c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages (from xgboost)
(1.7.3)
```

```
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -eras (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages)
```

In [6]:
```python
import prophet
print(prophet.__version__)
```

1.1.6

In [7]:
```
pip list | grep prophet
```

Note: you may need to restart the kernel to use updated packages.

```
'grep' is not recognized as an internal or external command,
operable program or batch file.
```

In [8]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from statsmodels.tsa.arima.model import ARIMA
from statsmodels.tsa.seasonal import seasonal_decompose
from prophet import Prophet
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from xgboost import XGBRegressor
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense, Dropout
from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.metrics import mean_squared_error, mean_absolute_percentage_error
```

In [9]:
```python
# Load dataset
file_path = r"C:\Users\zahus\Desktop\DATA science\Module 11-Dissertaion\Dataset\1- Sales(Historical Retail Data)\Retail_Sales.cs
df = pd.read_csv(file_path)
```

In [10]:
```python
# Display the dataset
try:
    import ace_tools as tools
    tools.display_dataframe_to_user(name="Retail Sales Data", dataframe=df)
except ModuleNotFoundError:
    print("Displaying first few rows instead (ace_tools not found):")
    print(df.head())
```

```
Displaying first few rows instead (ace_tools not found):
    YEAR   MONTH                              SUPPLIER  ITEM CODE  \
0   2020       1  REPUBLIC NATIONAL DISTRIBUTING CO     100009
1   2020       1                          PWSWN INC     100024
2   2020       1          RELIABLE CHURCHILL LLLP        1001
3   2020       1         LANTERNA DISTRIBUTORS INC      100145
4   2020       1             DIONYSOS IMPORTS INC       100293

                        ITEM DESCRIPTION ITEM TYPE  RETAIL SALES  \
0                     BOOTLEG RED - 750ML      WINE          0.00
1               MOMENT DE PLAISIR - 750ML      WINE          0.00
2   S SMITH ORGANIC PEAR CIDER - 18.7OZ      BEER          0.00
3           SCHLINK HAUS KABINETT - 750ML      WINE          0.00
4          SANTORINI GAVALA WHITE - 750ML      WINE          0.82

    RETAIL TRANSFERS  WAREHOUSE SALES
0               0.0              2.0
1               1.0              4.0
2               0.0              1.0
3               0.0              1.0
4               0.0              0.0
```
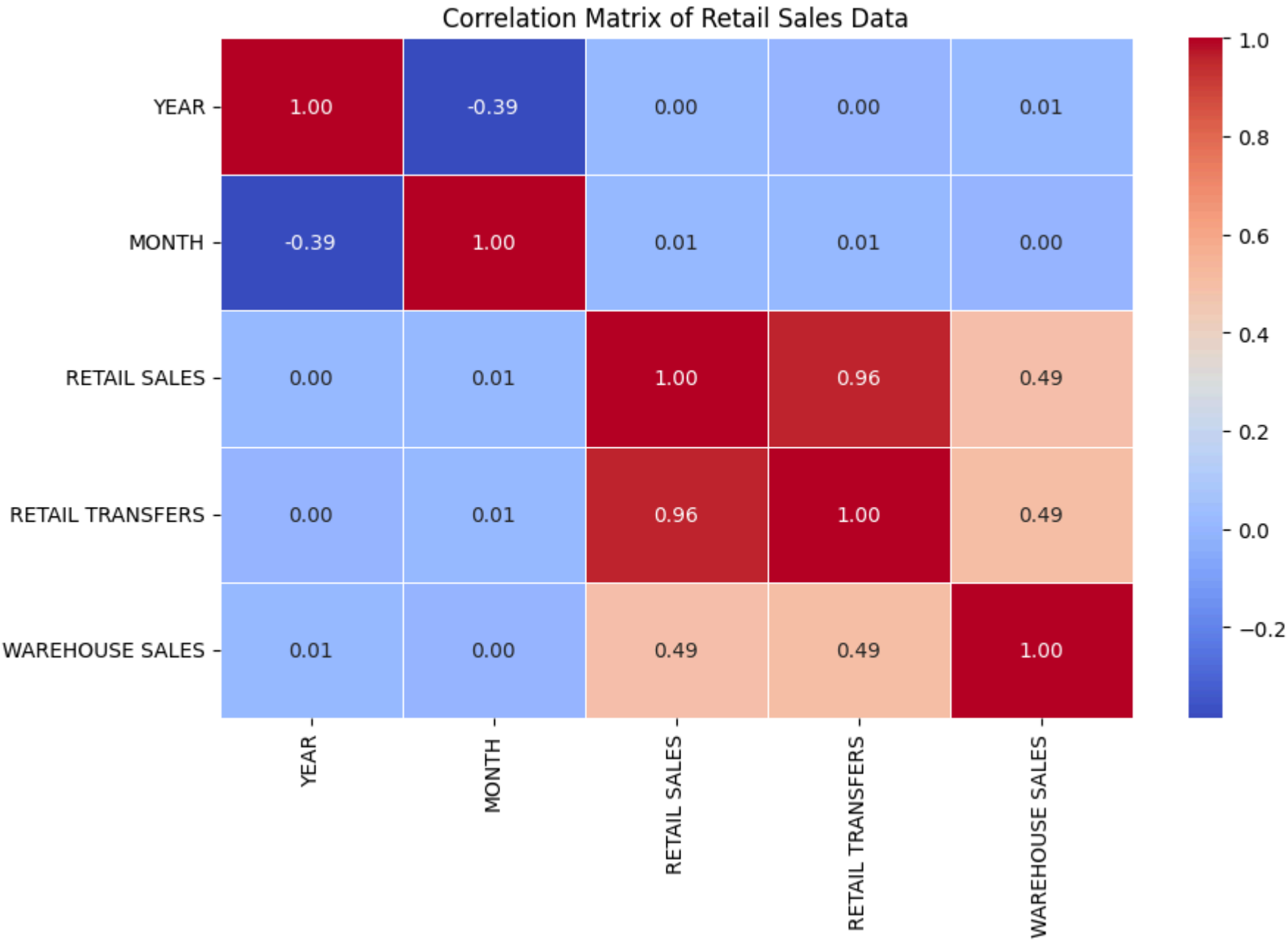
```python
In [11]:  # Correlation Analysis
          correlation_matrix = df.corr()
          plt.figure(figsize=(10, 6))
          sns.heatmap(correlation_matrix, annot=True, cmap="coolwarm", fmt=".2f", linewidths=0.5)
          plt.title("Correlation Matrix of Retail Sales Data")
          plt.show()
```

Correlation Matrix of Retail Sales Data

In [12]:
```python
# Data Preprocessing
label_encoders = {}
for col in ['SUPPLIER', 'ITEM DESCRIPTION', 'ITEM TYPE']:
    le = LabelEncoder()
    df[col] = le.fit_transform(df[col])
    label_encoders[col] = le
```

In [13]:
```python
# Convert ITEM CODE to numeric, handling errors
df['ITEM CODE'] = pd.to_numeric(df['ITEM CODE'], errors='coerce')
```

In [14]:
```python
# Drop any remaining rows with NaN values
df.dropna(inplace=True)
```

In [15]:
```python
# Ensure all feature columns are numeric
features = ['YEAR', 'MONTH', 'SUPPLIER', 'ITEM CODE', 'ITEM DESCRIPTION', 'ITEM TYPE']
target = 'RETAIL SALES'
```

In [16]:
```python
# Feature Visualisation
plt.figure(figsize=(12, 6))
for feature in features:
    if df[feature].dtype in ['int64', 'float64']:
        sns.histplot(df[feature], kde=True, bins=30)
        plt.title(f"Distribution of {feature}")
        plt.xlabel(feature)
        plt.ylabel("Frequency")
        plt.show()
```

Distribution of YEAR

Distribution of MONTH

Distribution of ITEM CODE
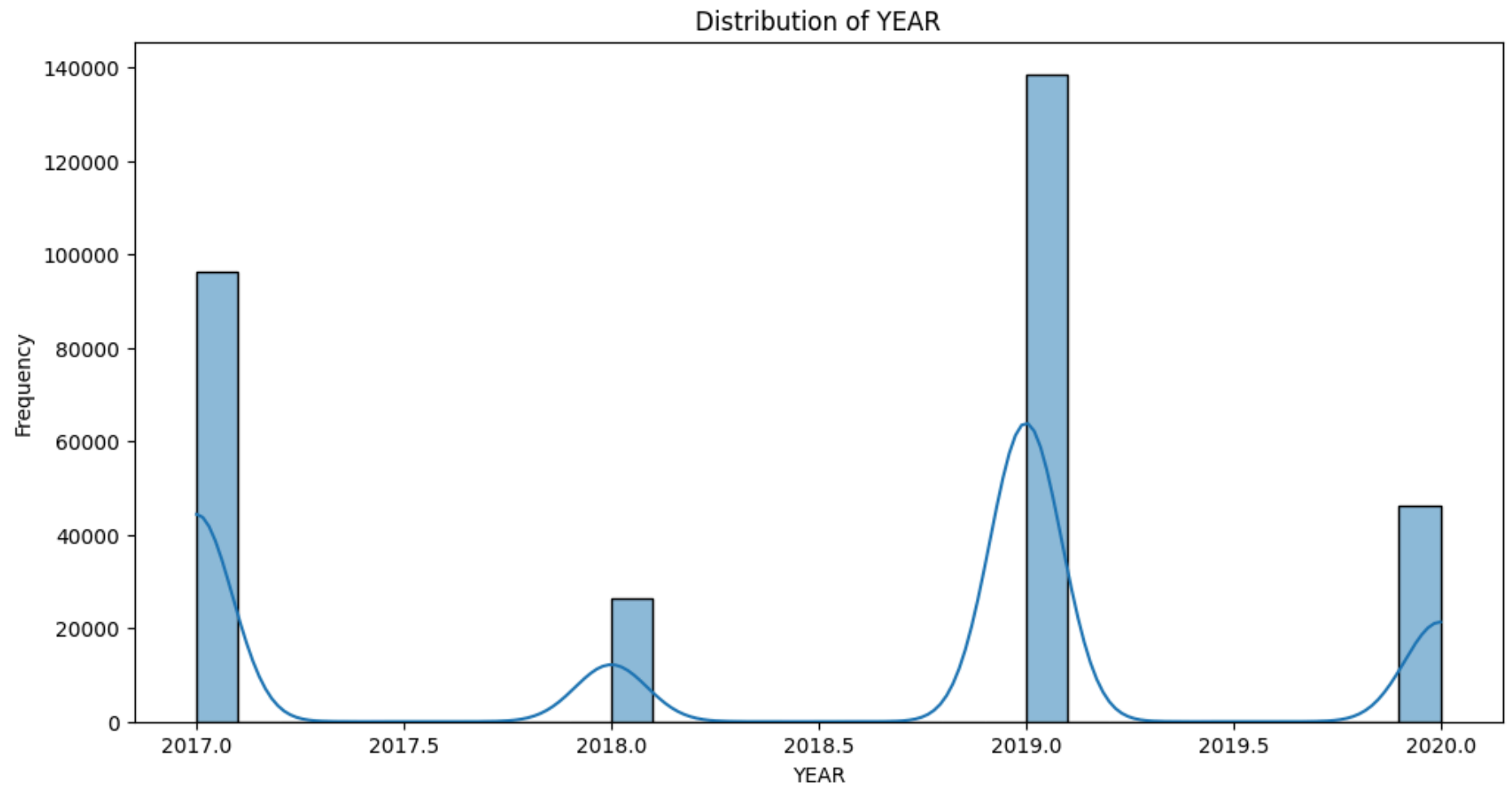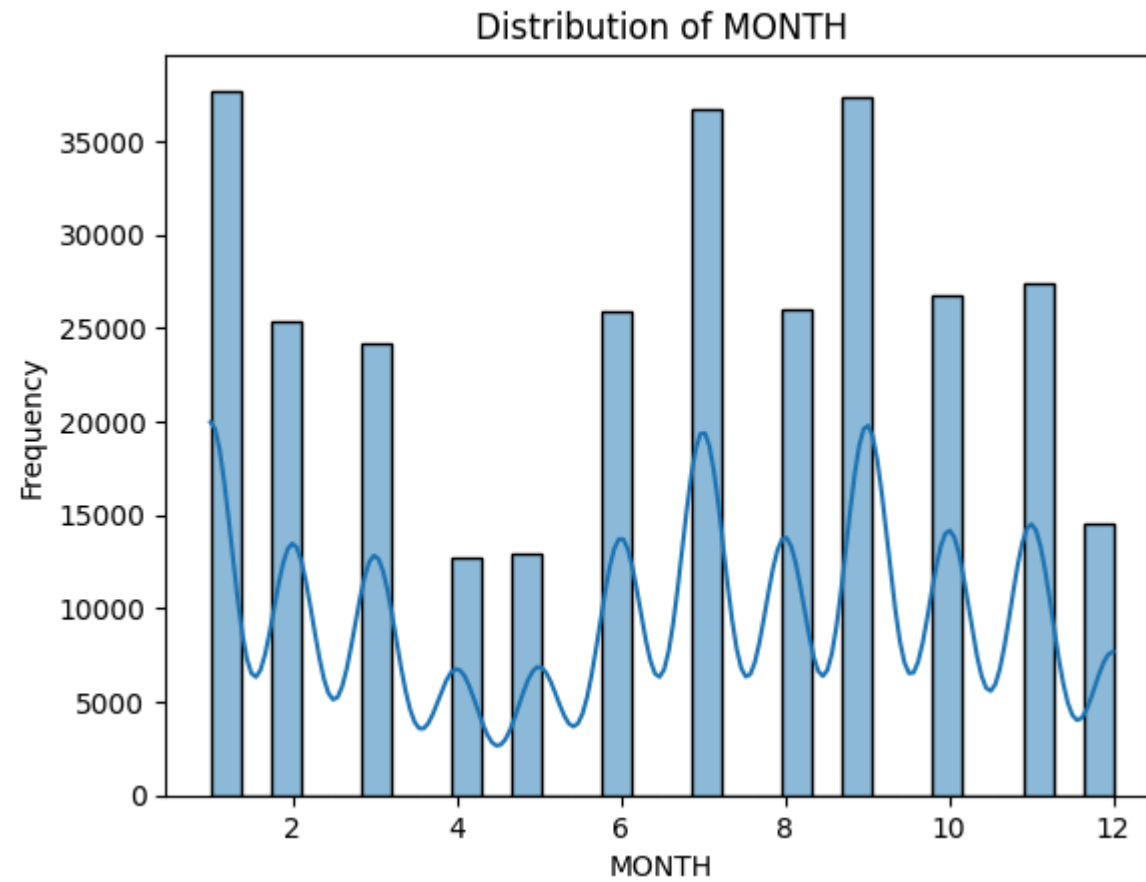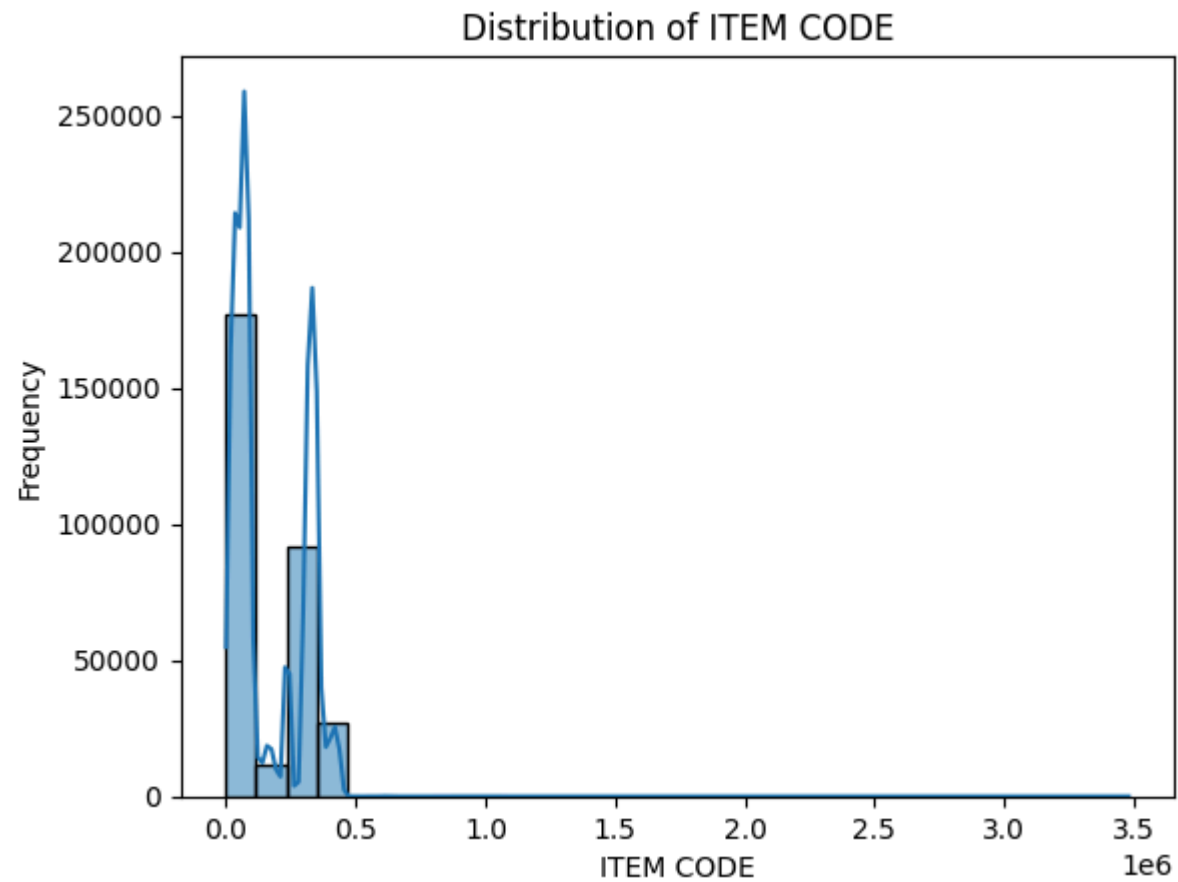

```
In [17]: # Exploratory Data Analysis (EDA)
         plt.figure(figsize=(12, 6))
         sns.lineplot(data=df, x=df.index, y=df['RETAIL SALES'])
         plt.title("Sales Over Time")
         plt.show()
```

Sales Over Time
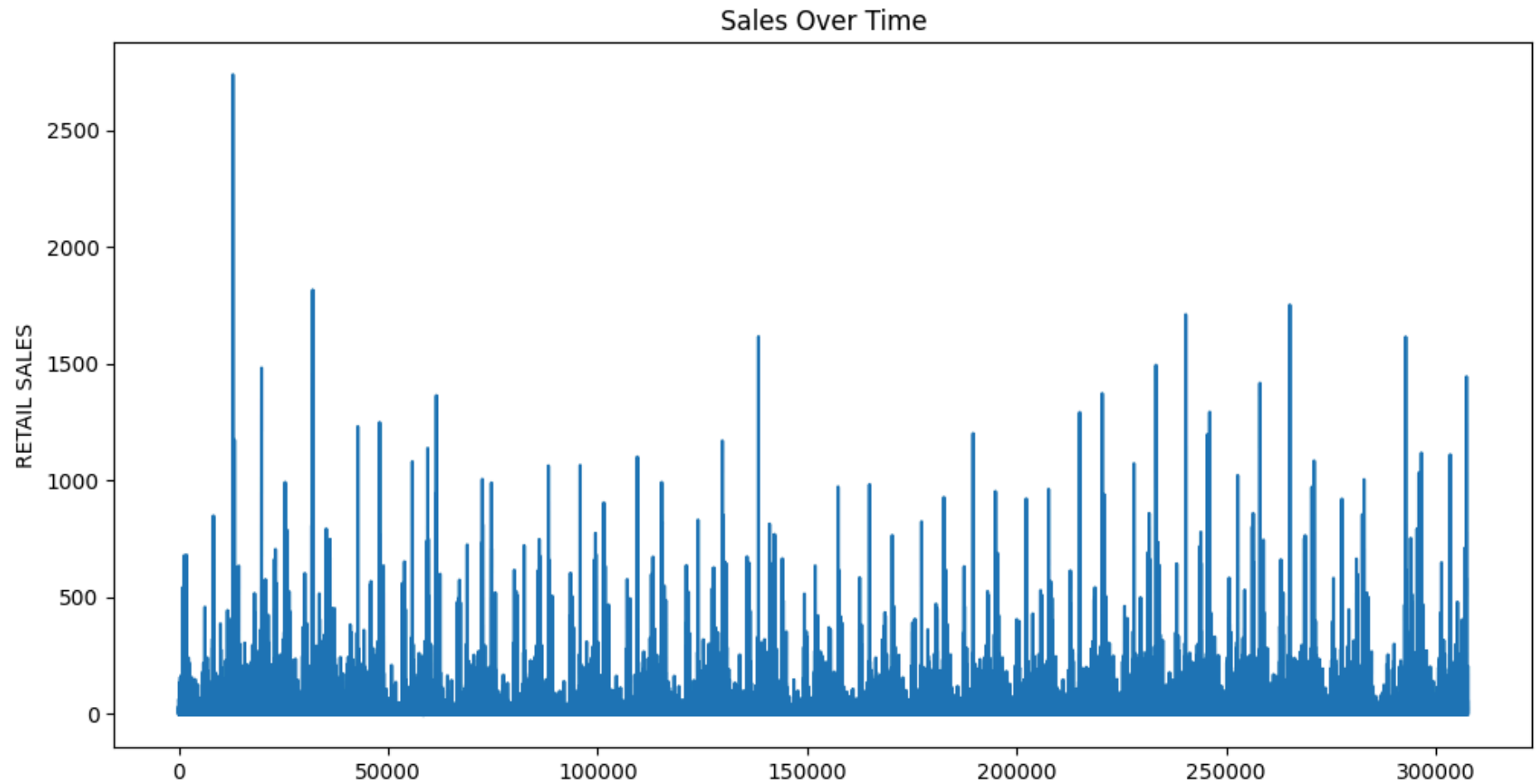

```python
In [18]:   # Splitting the data
           X = df[features]
           y = df[target]
           X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```python
In [19]:   # Standardising numerical data
           scaler = StandardScaler()
           X_train = scaler.fit_transform(X_train)
           X_test = scaler.transform(X_test)
```

In [20]:
```python
# Model Training and Evaluation
models = {
    "Linear Regression": LinearRegression(),
    "Decision Tree Regressor": DecisionTreeRegressor(),
    "XGBoost Regressor": XGBRegressor(objective='reg:squarederror'),
}

results = {}
predictions = {}
for name, model in models.items():
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)
    predictions[name] = y_pred
    mae = mean_absolute_percentage_error(y_test, y_pred)
    mse = mean_squared_error(y_test, y_pred)
    results[name] = {'MAE': mae, 'MSE': mse}
```

In [21]:
```python
# Display results
results_df = pd.DataFrame(results).T
print(results_df)
```

```
                                 MAE          MSE
Linear Regression        1.010881e+16   790.433084
Decision Tree Regressor  2.805134e+14   156.485124
XGBoost Regressor        3.478530e+15   211.545401
```

In [22]:
```python
# Visualising Predictions for Each Model
plt.figure(figsize=(12, 6))
plt.plot(y_test.values, label='Actual', color='black', linestyle='dashed')
for name, y_pred in predictions.items():
    plt.plot(y_pred, label=f'Predicted - {name}')
plt.title("Prediction Results for Different Models")
plt.xlabel("Sample Index")
plt.ylabel("Retail Sales")
plt.legend()
plt.show()
```

Prediction Results for Different Models
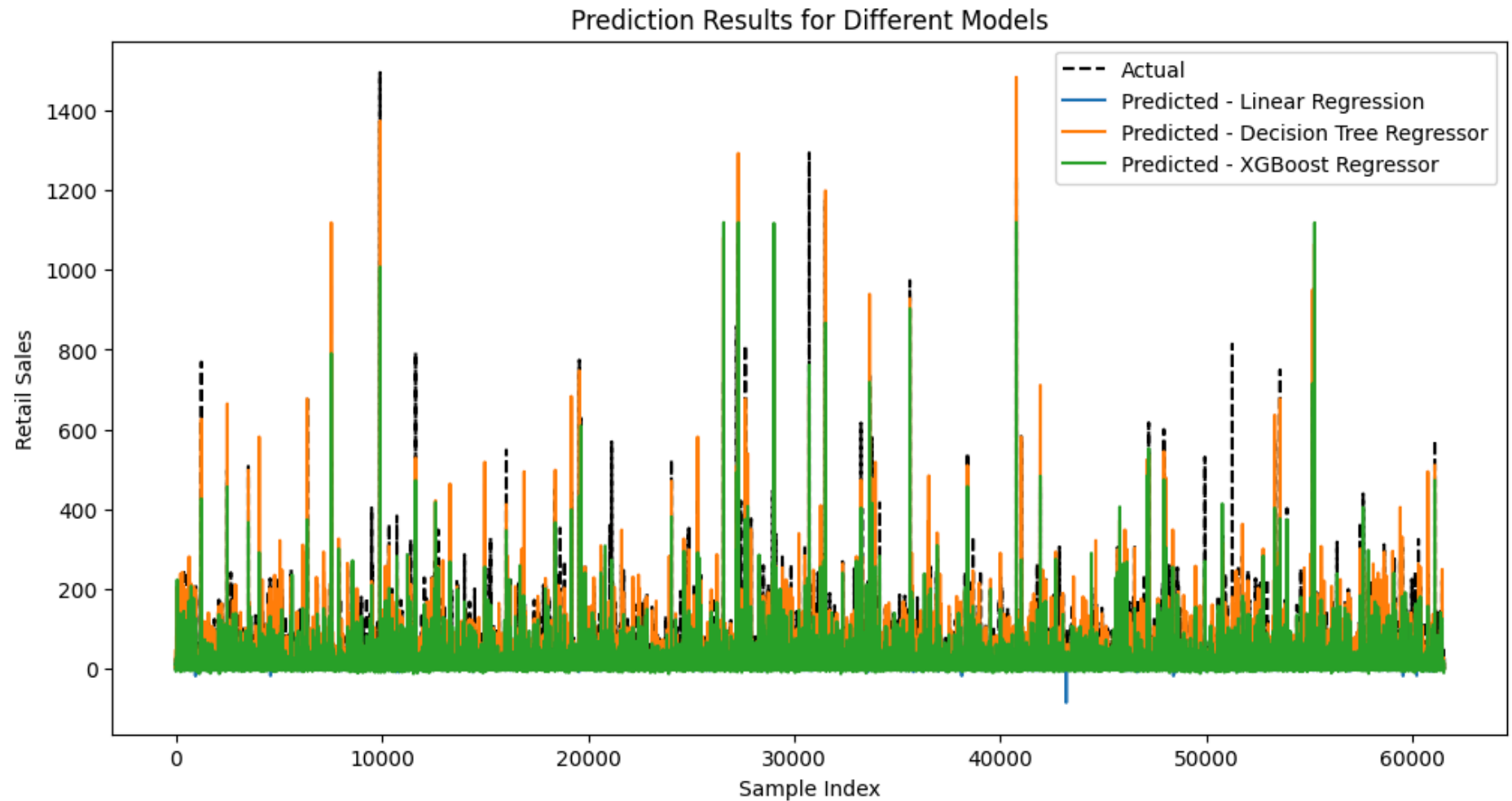
```
In [23]:  # Time Series Analysis (ARIMA & Prophet)
          ts_data = df.groupby(['YEAR', 'MONTH'])[target].sum().reset_index()
          ts_data['date'] = pd.to_datetime(ts_data[['YEAR', 'MONTH']].assign(day=1))
          ts_data.set_index('date', inplace=True)
          model_arima = ARIMA(ts_data[target], order=(5,1,0))
          model_arima_fit = model_arima.fit()
          ts_data['ARIMA Prediction'] = model_arima_fit.predict()
```

```
c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages\statsmodels\tsa\base\tsa_model.py:471: ValueWarning: A da
te index has been provided, but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages\statsmodels\tsa\base\tsa_model.py:471: ValueWarning: A da
te index has been provided, but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
c:\users\zahus\appdata\local\programs\python\python37\lib\site-packages\statsmodels\tsa\base\tsa_model.py:471: ValueWarning: A da
te index has been provided, but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
```

In [24]:
```python
# Prophet Model
ts_data_prophet = ts_data.reset_index()[['date', target]]
ts_data_prophet.columns = ['ds', 'y']
prophet_model = Prophet()
prophet_model.fit(ts_data_prophet)
future = prophet_model.make_future_dataframe(periods=12, freq='M')
forecast = prophet_model.predict(future)
```

```
12:18:47 - cmdstanpy - INFO - Chain [1] start processing
12:19:22 - cmdstanpy - INFO - Chain [1] done processing
```

In [25]:
```python
# Visualising Predictions
plt.figure(figsize=(12, 6))
ts_data[target].plot(label='Actual')
ts_data['ARIMA Prediction'].plot(label='ARIMA Prediction')
plt.title("Retail Sales Forecasting using ARIMA")
plt.legend()
plt.show()
```

Retail Sales Forecasting using ARIMA
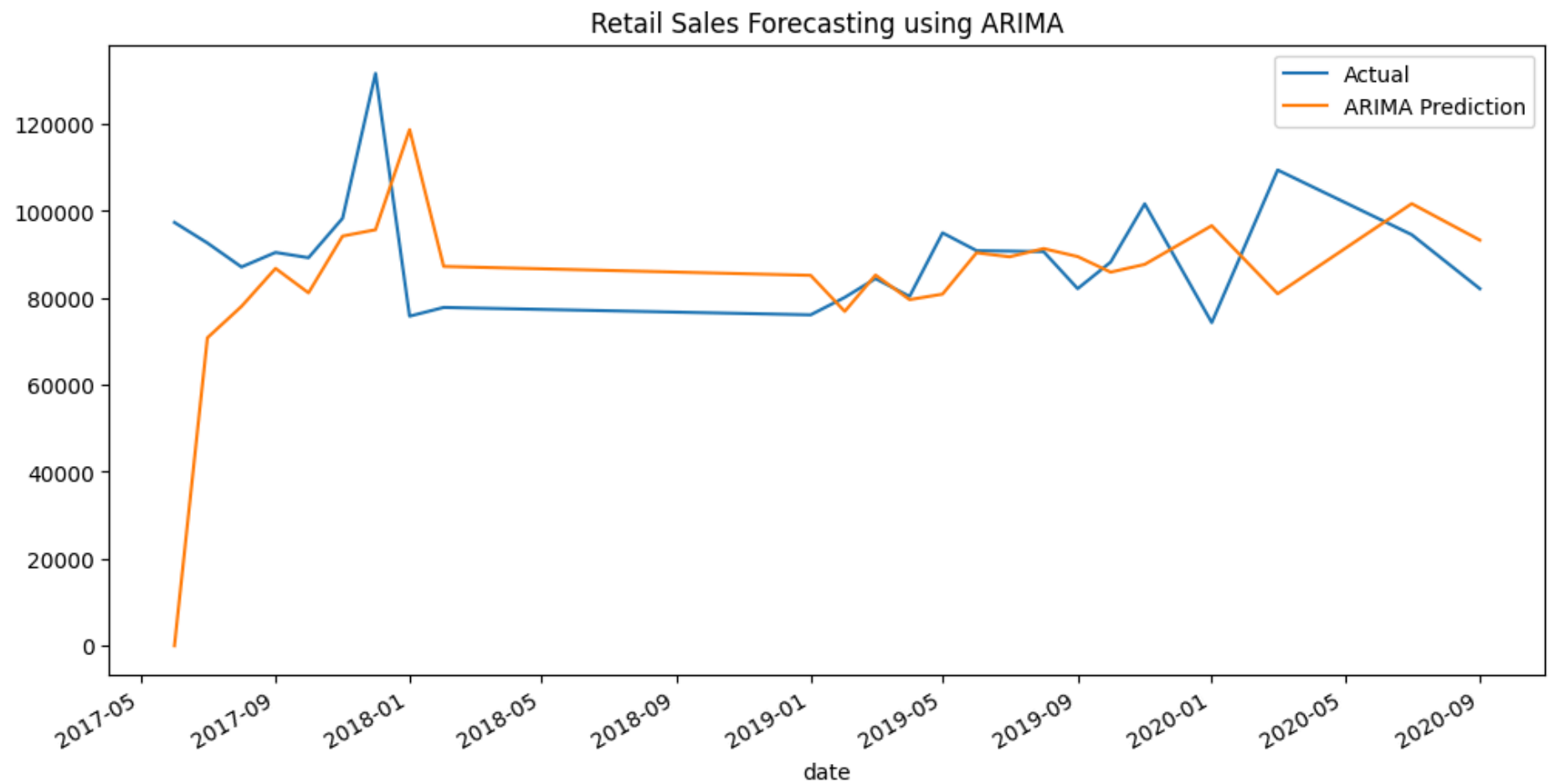
In [26]:
```python
prophet_model.plot(forecast)
plt.title("Retail Sales Forecasting using Prophet")
plt.show()
```

Retail Sales Forecasting using Prophet
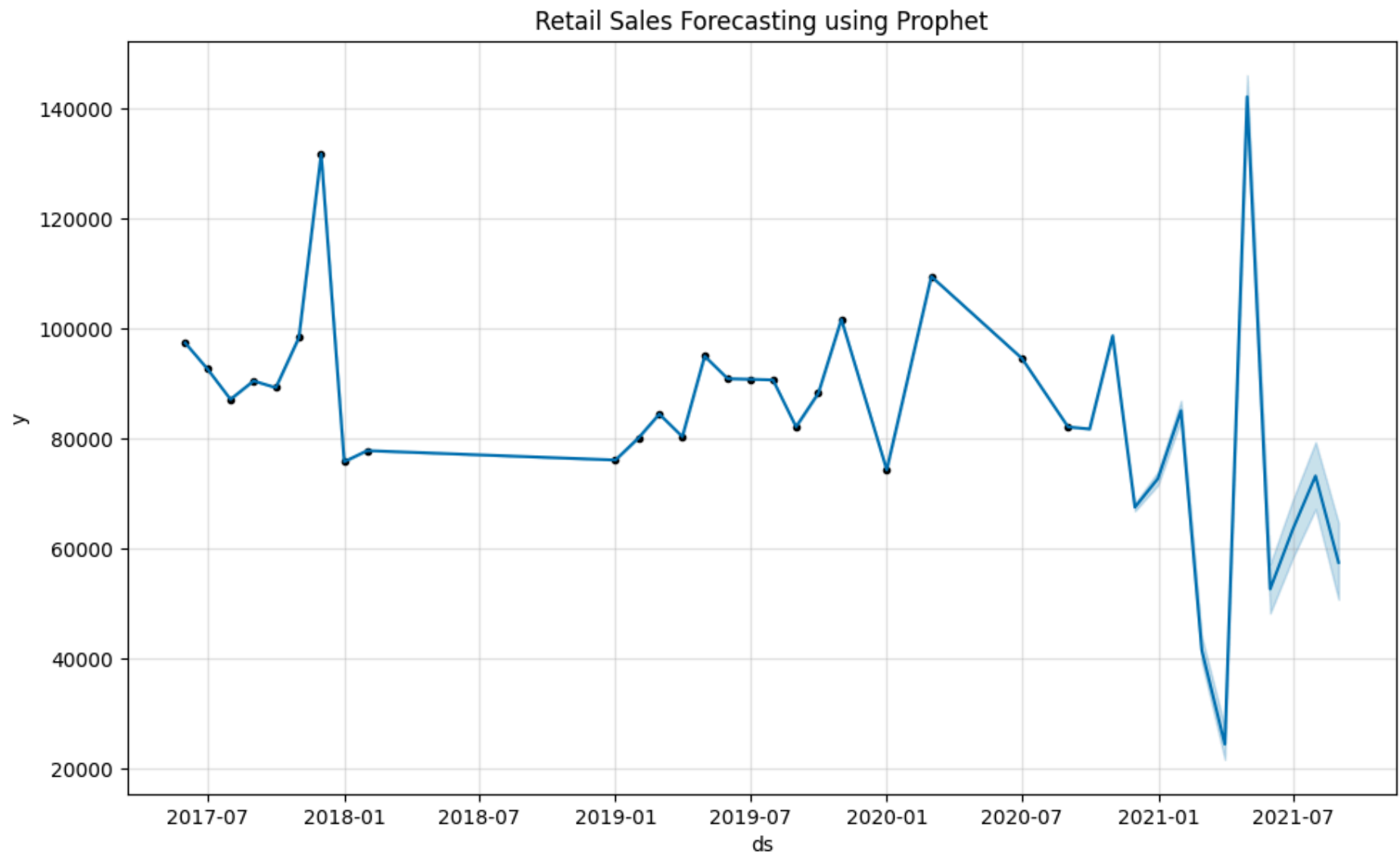
In [27]:
```python
# Deep Learning (LSTM)
lstm_model = Sequential([
    LSTM(50, return_sequences=True, input_shape=(X_train.shape[1], 1)),
    Dropout(0.2),
    LSTM(50, return_sequences=False),
```

```python
    Dropout(0.2),
    Dense(25),
    Dense(1)
])
lstm_model.compile(optimizer='adam', loss='mean_squared_error')

X_train_lstm = np.reshape(X_train, (X_train.shape[0], X_train.shape[1], 1))
X_test_lstm = np.reshape(X_test, (X_test.shape[0], X_test.shape[1], 1))
lstm_model.fit(X_train_lstm, y_train, epochs=10, batch_size=16, verbose=1)
y_pred_lstm = lstm_model.predict(X_test_lstm)
```

```
Epoch 1/10
15380/15380 [==============================] - 119s 7ms/step - loss: 973.3802
Epoch 2/10
15380/15380 [==============================] - 114s 7ms/step - loss: 962.9861
Epoch 3/10
15380/15380 [==============================] - 113s 7ms/step - loss: 951.6577
Epoch 4/10
15380/15380 [==============================] - 113s 7ms/step - loss: 930.2599
Epoch 5/10
15380/15380 [==============================] - 115s 7ms/step - loss: 913.6119
Epoch 6/10
15380/15380 [==============================] - 116s 8ms/step - loss: 905.4504
Epoch 7/10
15380/15380 [==============================] - 117s 8ms/step - loss: 877.6846
Epoch 8/10
15380/15380 [==============================] - 114s 7ms/step - loss: 864.7349
Epoch 9/10
15380/15380 [==============================] - 116s 8ms/step - loss: 861.5308
Epoch 10/10
15380/15380 [==============================] - 123s 8ms/step - loss: 852.7561
```

In [28]:
```python
# Evaluate LSTM Model
mse_lstm = mean_squared_error(y_test, y_pred_lstm)
mae_lstm = mean_absolute_percentage_error(y_test, y_pred_lstm)
results["LSTM"] = {'MAE': mae_lstm, 'MSE': mse_lstm}
```
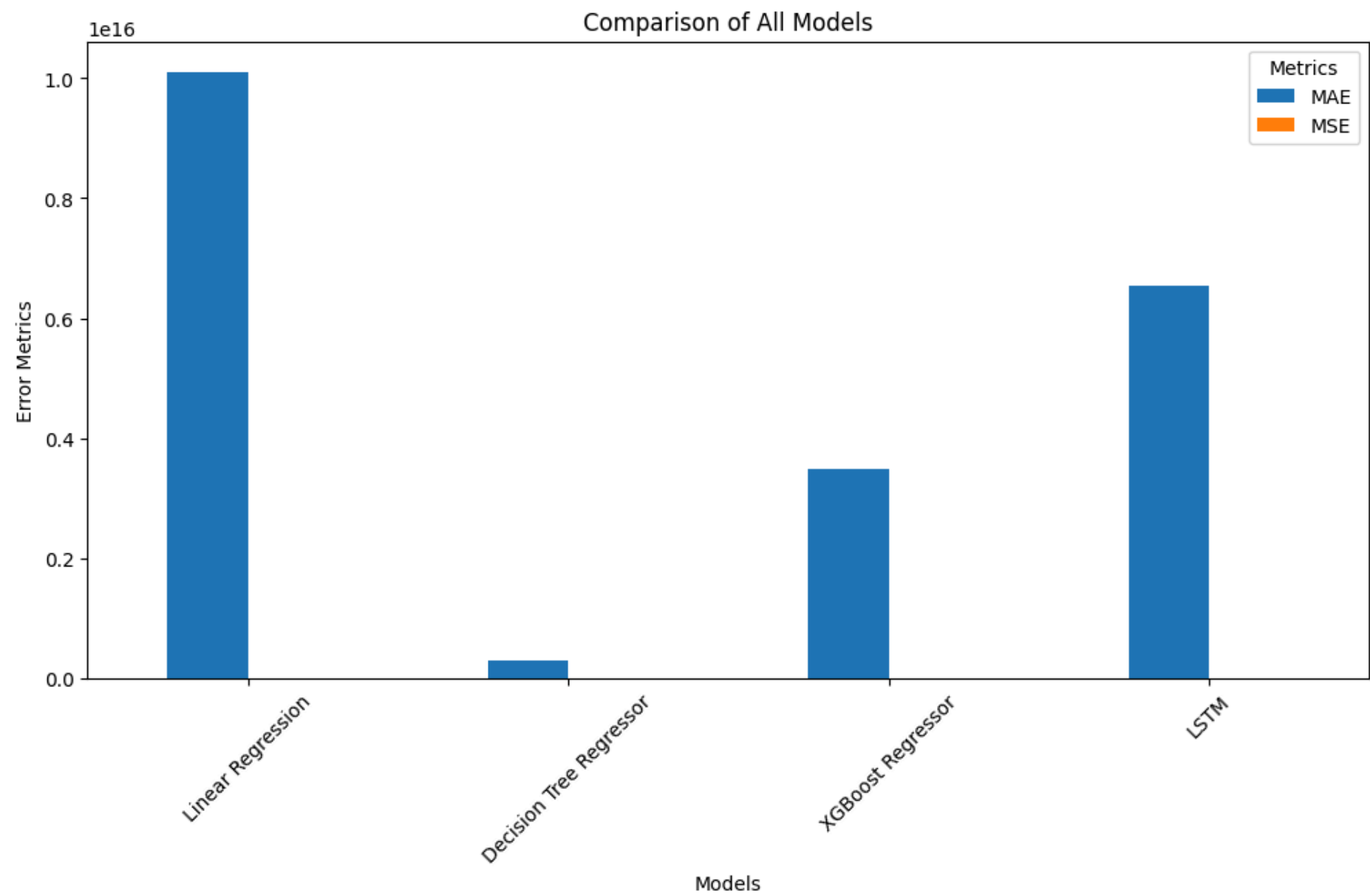
In [29]:
```python
# Update Results
results_df = pd.DataFrame(results).T
print(results_df)
```

	MAE	MSE
Linear Regression	1.010881e+16	790.433084
Decision Tree Regressor	2.805134e+14	156.485124
XGBoost Regressor	3.478530e+15	211.545401
LSTM	6.540331e+15	754.135353

In [30]:
```python
# Compare All Models
plt.figure(figsize=(12, 6))
results_df.plot(kind='bar', figsize=(12, 6))
plt.title("Comparison of All Models")
plt.xlabel("Models")
plt.ylabel("Error Metrics")
plt.xticks(rotation=45)
plt.legend(title="Metrics")
plt.show()
```

<Figure size 1200x600 with 0 Axes>

Comparison of All Models

In [ ]: