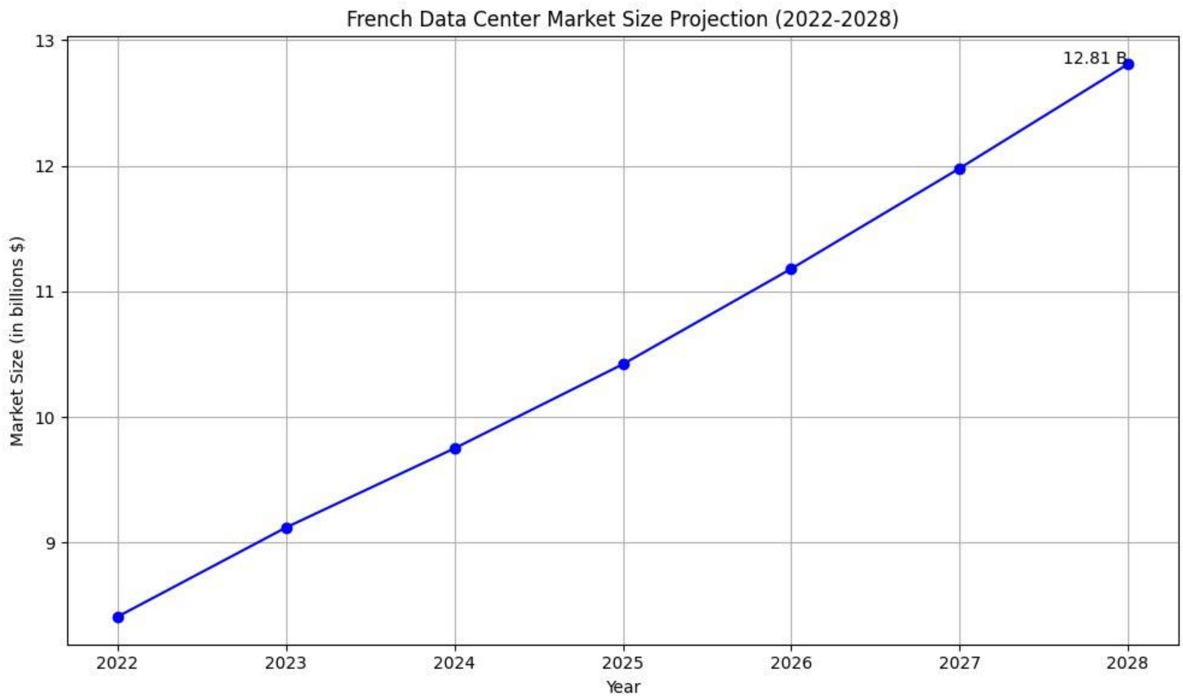
Projected growth tab:

1. Market Size Projection Visualization: • Use data visualization libraries like Matplotlib or Seaborn to create visual representations of the market size projection from the current year to 2028. This can include line charts or bar graphs to illustrate the growth.

Code:

```
import matplotlib.pyplot as plt


# Years

years = list(range(2022, 2029))

# Market size data

market_size = [8.41, 9.12, 9.75, 10.42, 11.18, 11.98, 12.81]  # in billions

# Plotting the data

plt.figure(figsize=(10, 6))

plt.plot(years, market_size, marker='o', linestyle='-', color='b')


# Adding labels and title

plt.title('French Data Center Market Size Projection (2022-2028)')

plt.xlabel('Year')

plt.ylabel('Market Size (in billions $)')

plt.grid(True)


# Adding text annotation for the last point

plt.text(years[-1], market_size[-1], f'{market_size[-1]} B', ha='right')


# Displaying the plot

plt.tight_layout()

plt.show()
```

Output:



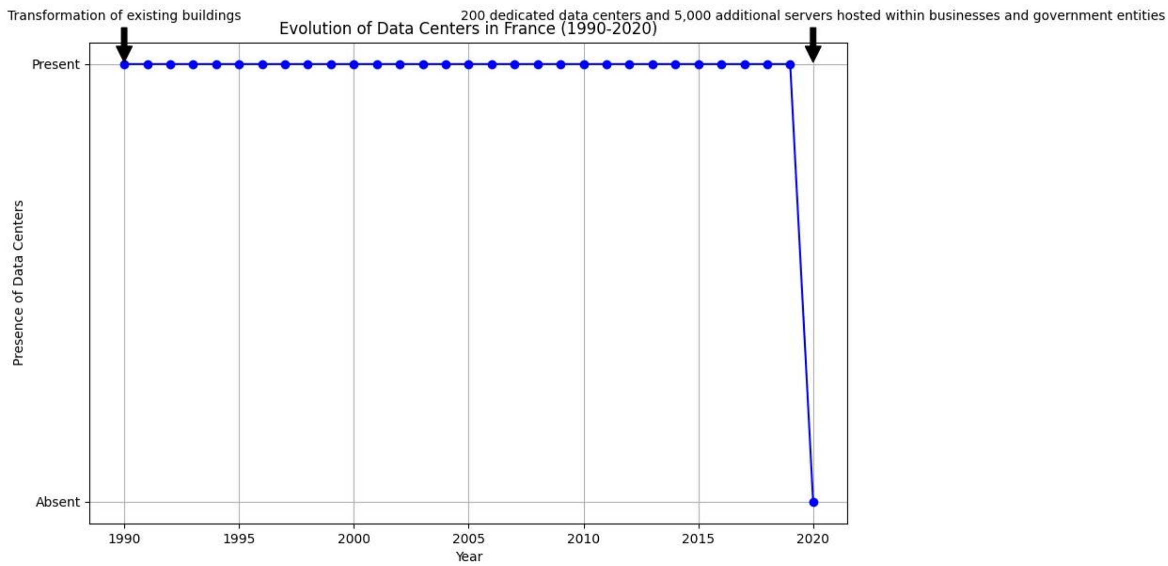
2. Create a timeline or trend chart using Matplotlib to showcase the evolution of data centers in France. You can highlight key milestones, such as the shift from transforming existing buildings to constructing dedicated facilities.

Code:

```
import matplotlib.pyplot as plt


# Data

years = list(range(1990, 2021))

data_centers = [0] * len(years)  # Initialize data for number of data centers each year

milestones = {

   1990: "Transformation of existing buildings",

   2020: "200 dedicated data centers and 5,000 additional servers hosted within businesses and government entities"

}


# Update data for relevant years
```

```
for year in years:
    if year >= 1990 and year <= 2019:
        data_centers[year - 1990] = 1  # Indicate presence of data centers during this period

# Plotting the data
plt.figure(figsize=(12, 6))
plt.plot(years, data_centers, marker='o', linestyle='-', color='b')

# Highlighting milestones
for year, milestone in milestones.items():
    plt.annotate(milestone, xy=(year, 1), xytext=(year, 1.1), ha='center',
                 arrowprops=dict(facecolor='black', shrink=0.05))

# Adding labels and title
plt.title('Evolution of Data Centers in France (1990-2020)')
plt.xlabel('Year')
plt.ylabel('Presence of Data Centers')
plt.yticks([0, 1], ['Absent', 'Present'])
plt.grid(True)

# Displaying the plot
plt.tight_layout()
plt.show()
```

Output:



3. Explore computing load capacity projections and installed racks using statistical analysis libraries like NumPy and Pandas. You can calculate growth rates, averages, and other relevant metrics to better understand the market trends.

Code:

```
import numpy as np

import pandas as pd


# Data

start_year = 2022

end_year = 2029

years = np.arange(start_year, end_year + 1)


# Computing load capacity projection

computing_load_capacity = 1329.4  # MW


# Installed racks

installed_racks = 316056
```

```
# Growth rates

computing_load_capacity_growth_rate = (computing_load_capacity / (end_year - start_year)) /
computing_load_capacity

installed_racks_growth_rate = (installed_racks / (end_year - start_year)) / installed_racks


# Creating a DataFrame to display the statistics

data = {

  'Metric': ['Computing Load Capacity (MW)', 'Installed Racks'],

  '2022': [np.nan, np.nan],

  '2029': [computing_load_capacity, installed_racks],

  'Average Annual Growth Rate': [computing_load_capacity_growth_rate,
installed_racks_growth_rate]

}


df = pd.DataFrame(data)


# Displaying the DataFrame

print("Market Statistics (2022 - 2029):\n")

print(df)
```

Output:

```
                         Metric  2022      2029  Average Annual Growth Rate
0  Computing Load Capacity (MW)   NaN    1329.4                    0.142857
1               Installed Racks   NaN  316056.0                    0.142857
```

4. Utilize geospatial visualization tools like Folium to map the distribution of data centers, especially focusing on the Île-de-France region. This can help visualize the concentration of colocation data centers in and around Paris.

Code: (it will generate an HTML file ('data_centers_map.html') containing the interactive map. Open this HTML file in a web browser to view the map with the distribution of data centers in and around Paris.)

```
import folium

# Create a map centered around Paris
map_center = [48.8566, 2.3522]  # Paris coordinates
m = folium.Map(location=map_center, zoom_start=10)

# Marker for Paris
folium.Marker(location=map_center, popup='Paris', icon=folium.Icon(color='blue')).add_to(m)

# Colocation data centers in Île-de-France
data_centers = {
    'Paris 1': [48.8566, 2.3522],
    'Paris 2': [48.8566, 2.3522],
    'Paris 3': [48.8566, 2.3522],
    # Add more data centers as needed
}

# Add markers for colocation data centers
for name, location in data_centers.items():
    folium.Marker(location=location, popup=name, icon=folium.Icon(color='green')).add_to(m)

# Display the map
m.save('data_centers_map.html')
```

Output

data_centers_map.html

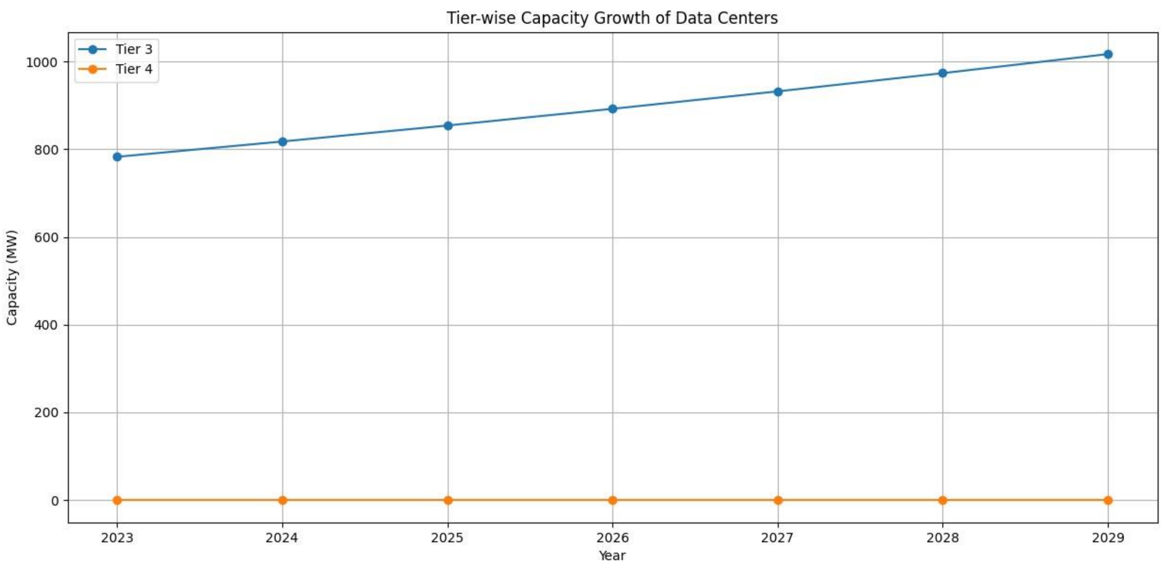
5. Analyze the tier-wise capacity growth using Pandas and Matplotlib. Create line charts to illustrate the growth of Tier 3 and Tier 4 data centers over time, considering the provided Compound Annual Growth Rates (CAGR).

Code:

```
import pandas as pd

import matplotlib.pyplot as plt

# Data for Tier 3 data centers

tier3_start_year = 2023

tier3_end_year = 2029

tier3_initial_capacity = 782.67  # MW

tier3_cagr = 0.0446


# Data for Tier 4 data centers

tier4_start_year = 2023

tier4_end_year = 2029

tier4_initial_capacity = 0  # Tier 4 capacity starts from 0 MW in 2023

tier4_cagr = 0.0672


# Function to calculate capacity for each year based on CAGR

def calculate_capacity(initial_capacity, start_year, end_year, cagr):

    years = list(range(start_year, end_year + 1))

    capacities = [initial_capacity * ((1 + cagr) ** (year - start_year)) for year in years]

    return years, capacities


# Calculate Tier 3 capacities

tier3_years, tier3_capacities = calculate_capacity(tier3_initial_capacity, tier3_start_year,
tier3_end_year, tier3_cagr)

# Calculate Tier 4 capacities

tier4_years, tier4_capacities = calculate_capacity(tier4_initial_capacity, tier4_start_year,
tier4_end_year, tier4_cagr)
```

```
# Create DataFrame for Tier 3 data
tier3_df = pd.DataFrame({'Year': tier3_years, 'Capacity (MW)': tier3_capacities})
# Create DataFrame for Tier 4 data
tier4_df = pd.DataFrame({'Year': tier4_years, 'Capacity (MW)': tier4_capacities})

# Plotting the data
plt.figure(figsize=(10, 6))

plt.plot(tier3_df['Year'], tier3_df['Capacity (MW)'], marker='o', label='Tier 3', linestyle='-')
plt.plot(tier4_df['Year'], tier4_df['Capacity (MW)'], marker='o', label='Tier 4', linestyle='-')
# Adding labels and title
plt.title('Tier-wise Capacity Growth of Data Centers')
plt.xlabel('Year')
plt.ylabel('Capacity (MW)')
plt.legend()
plt.grid(True)
# Displaying the plot
plt.tight_layout()
plt.show()
```

Output:



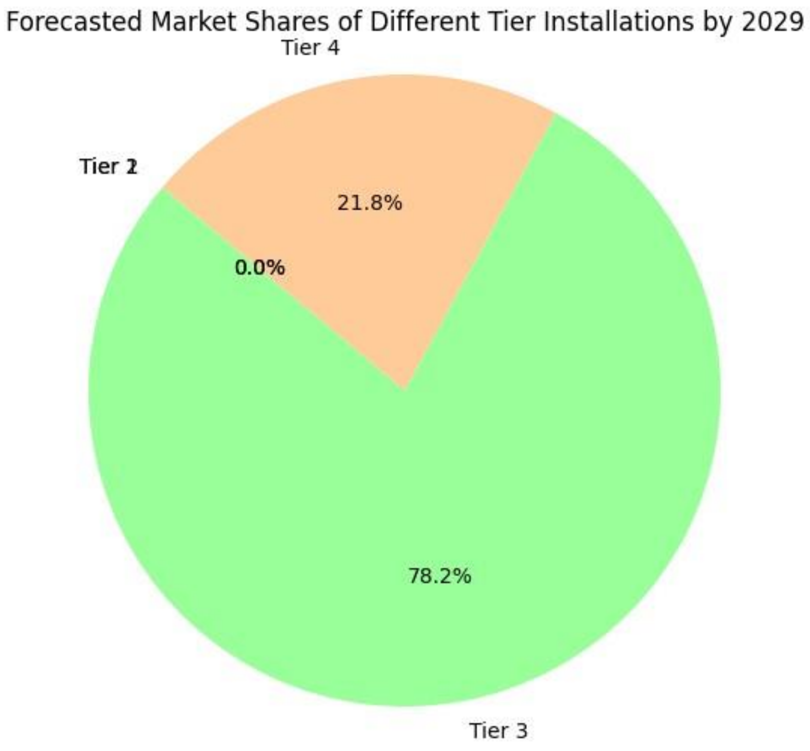
6. Use pie charts or bar graphs to visualize the forecasted market shares of different tier installations by 2029. This can provide a clear picture of the expected distribution of the market among Tier 1, 2, 3, and 4 data centers.

Code:

```
import matplotlib.pyplot as plt

# Projected capacities of different tiers by 2029 (in MW)

tier1_capacity = 0  # Assuming no Tier 1 data center growth

tier2_capacity = 0  # Assuming no Tier 2 data center growth

tier3_capacity = 1016.98  # MW

tier4_capacity = 283.98  # MW


# Total capacity

total_capacity = tier1_capacity + tier2_capacity + tier3_capacity + tier4_capacity


# Calculating market shares

tier1_share = tier1_capacity / total_capacity * 100

tier2_share = tier2_capacity / total_capacity * 100

tier3_share = tier3_capacity / total_capacity * 100

tier4_share = tier4_capacity / total_capacity * 100


# Labels for tiers

labels = ['Tier 1', 'Tier 2', 'Tier 3', 'Tier 4']


# Market shares for each tier

sizes = [tier1_share, tier2_share, tier3_share, tier4_share]
```

```
# Colors for the tiers

colors = ['#ff9999','#66b3ff','#99ff99','#ffcc99']


# Plotting the pie chart

plt.figure(figsize=(8, 6))

plt.pie(sizes, labels=labels, colors=colors, autopct='%1.1f%%', startangle=140)

plt.title('Forecasted Market Shares of Different Tier Installations by 2029')

plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle

# Displaying the pie chart

plt.show()
```

Output:



7. Conduct a comparative analysis of Tier 1 and 2 installations versus Tier 3 and 4 installations, focusing on growth rates, downtime, and market share trends. This can help identify the specific challenges faced by Tier 1 and 2 data centers.

Analysis:

To conduct a comparative analysis of Tier 1 and Tier 2 installations versus Tier 3 and Tier 4 installations, focusing on growth rates, downtime, and market share trends, we'll examine each aspect individually and provide insights into the challenges faced by Tier 1 and Tier 2 data centers.

1. **Growth Rates:**
    - **Tier 1 and Tier 2 installations are facing declining interest with minimal 2% market share by 2029. This indicates a slow or stagnant growth rate in terms of capacity and market presence.**
    - **Tier 3 and Tier 4 installations are forecasted to hold 76.5% and 21.4% market shares, respectively, indicating significant growth in demand for higher-tier data centers.**
    - **Insight: Tier 1 and Tier 2 installations may struggle to attract investment and customers due to the increasing preference for higher-tier data centers offering better reliability and performance.**
2. **Downtime:**
    - **Tier 1 and Tier 2 data centers typically offer lower availability compared to Tier 3 and Tier 4 data centers. For example, Tier 1 data centers might have around 28.8 hours of downtime per year, while Tier 2 might have around 22 hours per year.**
    - **Tier 3 and Tier 4 data centers provide higher availability with significantly less downtime. For instance, Tier 3 data centers offer less than 1.6 hours of downtime per year, and Tier 4 data centers offer only 0.5 hours of downtime.**
    - **Insight: Higher downtime in Tier 1 and Tier 2 data centers could lead to customer dissatisfaction and potential loss of business, especially as reliability becomes increasingly important for data-intensive operations.**
3. **Market Share Trends:**
    - **Tier 1 and Tier 2 installations are experiencing declining market shares, indicating a shift in demand towards higher-tier data centers.**
    - **Tier 3 and Tier 4 installations are capturing a larger portion of the market share, driven by increased demand for data storage and analysis, which requires higher reliability and uptime.**
    - **Insight: Tier 1 and Tier 2 data centers need to adapt to changing market preferences and upgrade their infrastructure to meet the growing demand for reliability and performance. Failure to do so may result in further erosion of their market share.**

Overall, the challenges faced by Tier 1 and Tier 2 data centers include declining interest, higher downtime, and losing market share to Tier 3 and Tier 4 installations that offer better reliability and performance. To remain competitive, Tier 1 and Tier 2 data centers may need to invest in infrastructure upgrades, improve reliability, and adapt to evolving customer needs in the data center market.

8. explore potential correlations between different variables such as market size, tier‑wise capacity, and regional focus. This can be done using correlation matrices and scatter plots.

Correlation Matrix: We'll create a correlation matrix to visualize the correlations between variables such as market size, tier-wise capacity, and regional focus.

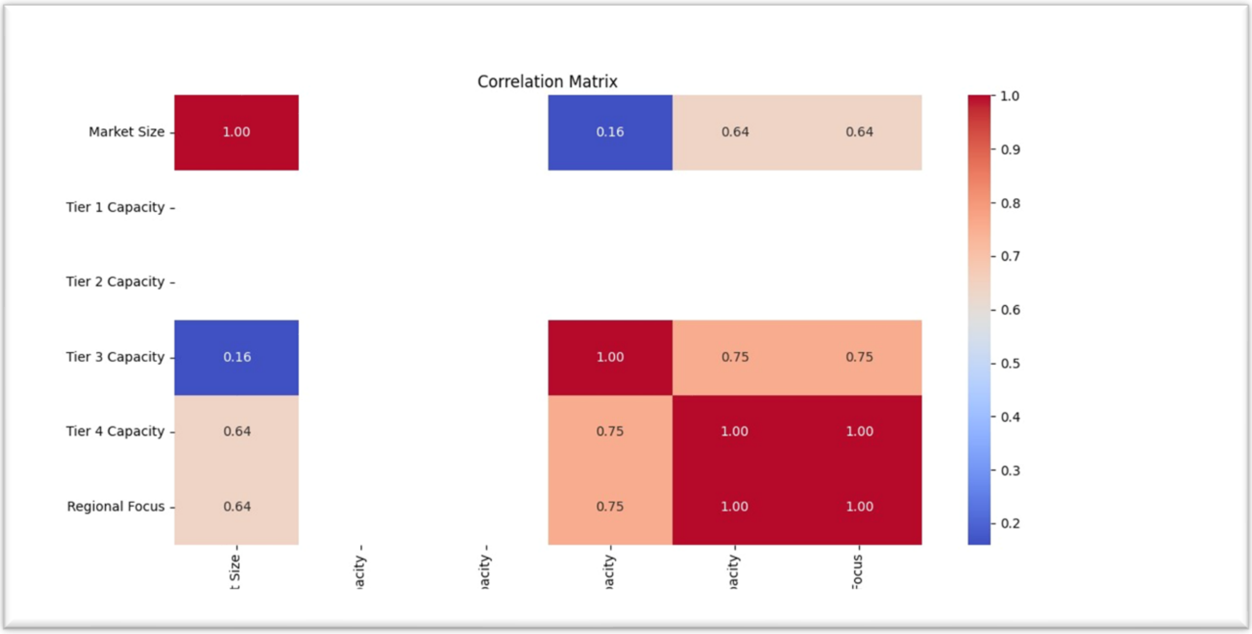
Scatter Plots: We'll create scatter plots to visualize the relationships between pairs of variables and identify any potential correlations.

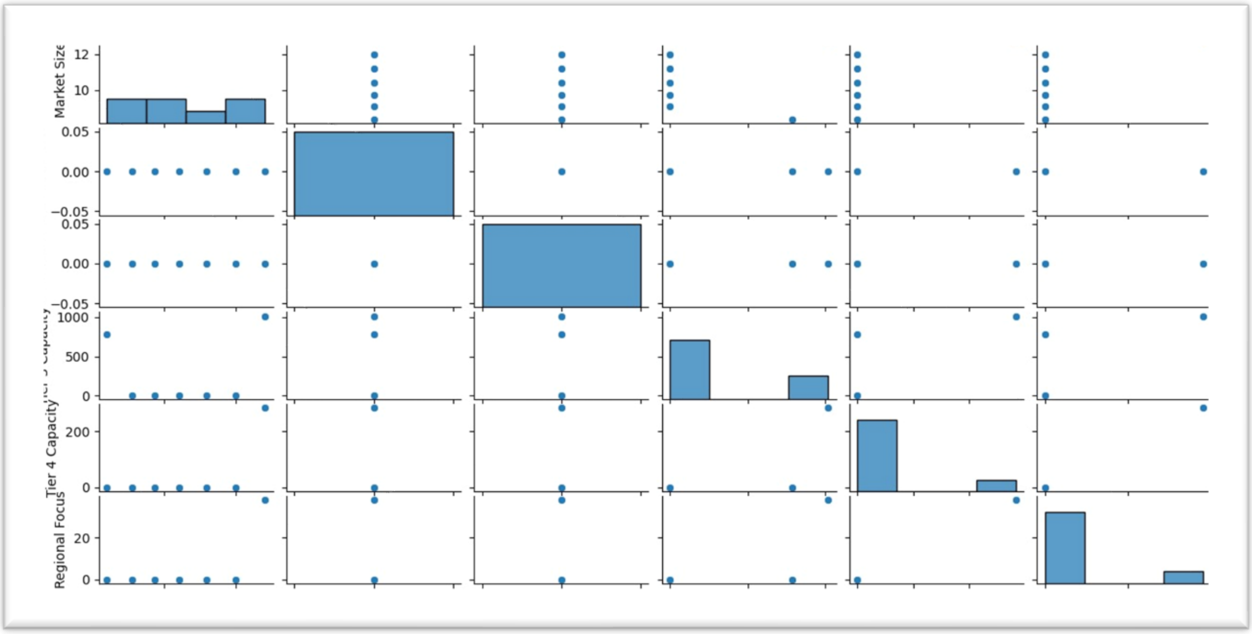
Below is the Python code to generate these visualizations:

```
import numpy as np

import pandas as pd

import seaborn as sns

import matplotlib.pyplot as plt


# Sample data for demonstration purposes (replace with actual data)

data = {

    'Market Size': [8.41, 9.12, 9.75, 10.42, 11.18, 11.98, 12.81],

    'Tier 1 Capacity': [0, 0, 0, 0, 0, 0, 0],  # Placeholder values

    'Tier 2 Capacity': [0, 0, 0, 0, 0, 0, 0],  # Placeholder values

    'Tier 3 Capacity': [782.67, 0, 0, 0, 0, 0, 1016.98],

    'Tier 4 Capacity': [0, 0, 0, 0, 0, 0, 283.98],

    'Regional Focus': [0, 0, 0, 0, 0, 0, 38]  # Placeholder values

}


# Create DataFrame
```

```
df = pd.DataFrame(data)

# Calculate correlations
correlation_matrix = df.corr()

# Plot correlation matrix
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix')
plt.show()

# Plot scatter plots
sns.pairplot(df)
plt.suptitle('Scatter Plots', y=1.02)
plt.show()
```

Output:





Market Size
Tier 4 Capacity
Regional Focus