

EDA_Cluster_Model_data

March 1, 2025

```
[1]: import pandas as pd
```

```
[2]: df = pd.read_csv('dataset.csv')
```

```
[3]: df.dropna(how='all', inplace=True)
df['Area Privada'] = df['Area Privada'].str.extract('(\d+\.?\d*)').astype(float)
df['Area'] = df['Area'].str.extract('(\d+\.?\d*)').astype(float)
```

```
<>:2: SyntaxWarning: invalid escape sequence '\d'
<>:3: SyntaxWarning: invalid escape sequence '\d'
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/tmp/ipykernel_35317/2323442900.py:2: SyntaxWarning: invalid escape sequence
'\d'
    df['Area Privada'] = df['Area
Privada'].str.extract('(\d+\.?\d*)').astype(float)
/tmp/ipykernel_35317/2323442900.py:3: SyntaxWarning: invalid escape sequence
'\d'
    df['Area'] = df['Area'].str.extract('(\d+\.?\d*)').astype(float)
```

```
[4]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 594 entries, 0 to 684
Data columns (total 14 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   ID                                     594 non-null    float64
1   Tipo de inmueble                     594 non-null    object
2   Precio (admin_included)              594 non-null    float64
3   Estrato                              591 non-null    float64
4   Baños                                579 non-null    float64
5   Habitaciones                         550 non-null    float64
6   Parquaderos                          252 non-null    float64
7   Area                                 594 non-null    float64
8   Area Privada                         481 non-null    float64
9   Piso                                 594 non-null    float64
10  Facilities                           458 non-null    object
11  Descripción                           594 non-null    object
```

```

12 Antigüedad          535 non-null    object
13 Estado              53 non-null    object
dtypes: float64(9), object(5)
memory usage: 69.6+ KB

```

```
[5]: df.to_csv('cleaned_dataset.csv', index=False)
```

```
[6]: df.head(10)
```

```
[6]:
```

	ID	Tipo de inmueble	Precio (admin_included)	Estrato	Baños	\
0	10830219.0	Apartaestudio	1800000.0	4.0	1.0	
1	191712314.0	Apartaestudio	3500000.0	4.0	1.0	
2	10183666.0	Apartamento	1050000.0	4.0	1.0	
3	10949219.0	Apartamento	3500000.0	4.0	2.0	
4	192059073.0	Apartamento	1281000.0	4.0	1.0	
6	191752583.0	Apartaestudio	1450000.0	3.0	1.0	
8	191237365.0	Casa	6000000.0	5.0	5.0	
9	191287641.0	Apartaestudio	2300000.0	4.0	1.0	
10	191382794.0	Casa	15000000.0	4.0	6.0	
11	191214224.0	Habitación	550000.0	4.0	NaN	

	Habitaciones	Parqueaderos	Area	Area Privada	Piso	\
0	NaN	NaN	22.0	22.0	2.0	
1	1.0	NaN	31.0	31.0	0.0	
2	1.0	NaN	45.0	45.0	2.0	
3	2.0	1.0	68.2	68.2	14.0	
4	1.0	1.0	17.0	17.0	0.0	
6	1.0	NaN	26.0	26.0	0.0	
8	5.0	5.0	380.0	380.0	1.0	
9	1.0	NaN	19.0	NaN	4.0	
10	19.0	4.0	608.0	608.0	3.0	
11	NaN	NaN	70.0	NaN	0.0	

	Facilities	\
0	Amoblado, Cocina Integral, Colegios / Universi...	
1	Alcantarillado, Amoblado, Ascensor, Bahias de ...	
2	Barra estilo americano, Cocina Integral, Cocin...	
3	Ascensor, Balcón, Barra estilo americano, Baño...	
4	Acceso Pavimentado, Alcantarillado, Cochera, C...	
6	Balcón, Terraza	
8	Bahias de parqueo, Bahía exterior de parqueo	
9	Amoblado, Ascensor, Colegios / Universidades, ...	
10	Acceso Pavimentado, Baño Auxiliar, Cerca de Zo...	
11	NaN	

	Descripción	Antigüedad	\
0	Aparta Estudio en excelente ubicación, con tod...	9 a 15 años	

```

1 Este elegante apartaestudio ofrece una combina... menor a 1 año
2 Apartamentos de 1 alcoba, sala comedor, cocina... 1 a 8 años
3 Excelente apartamento en el proyecto Avanzza P... menor a 1 año
4 [ARR] ID HOUM: 148368 Entérate de todos los b... menor a 1 año
6 HERMOSO Y COMODO APARTAESTUDIO , ILUMINACION N... 1 a 8 años
8 Oportunidad Única! Casa Espectacular en Renta ... 16 a 30 años
9 Hermoso apartaestudio Nuevo y Amoblado cerca d... menor a 1 año
10 Este inmueble cuenta con los espacios y la ubi... más de 30 años
11 Se arrienda habitación pequeña con closet y es... NaN

```

```

Estado
0 NaN
1 NaN
2 NaN
3 NaN
4 Excelente estado
6 NaN
8 Buen estado
9 NaN
10 NaN
11 NaN

```

```

[7]: # Check for duplicate IDs
duplicate_ids = df['ID'].duplicated().sum()
print(f"Number of duplicate IDs found: {duplicate_ids}")

# Remove duplicate rows keeping the first occurrence
df = df.drop_duplicates(subset=['ID'], keep='first')
print(f"Dataframe shape after removing duplicates: {df.shape}")

```

Number of duplicate IDs found: 0

Dataframe shape after removing duplicates: (594, 14)

```

[8]: model_df = df.drop(columns=['Descripción', 'Facilities', 'ID', 'Estado'])

```

```

[9]: model_df.head()

```

```

[9]: Tipo de inmueble  Precio (admin_included)  Estrato  Baños  Habitaciones \
0 Apartaestudio      1800000.0          4.0    1.0           NaN
1 Apartaestudio      3500000.0          4.0    1.0           1.0
2 Apartamento        1050000.0          4.0    1.0           1.0
3 Apartamento        3500000.0          4.0    2.0           2.0
4 Apartamento        1281000.0          4.0    1.0           1.0

Parqueaderos  Area  Area Privada  Piso  Antigüedad
0 NaN      22.0      22.0    2.0    9 a 15 años
1 NaN      31.0      31.0    0.0    menor a 1 año
2 NaN      45.0      45.0    2.0    1 a 8 años

```

3	1.0	68.2	68.2	14.0	menor a 1 año
4	1.0	17.0	17.0	0.0	menor a 1 año

```
[10]: model_df['Tipo de inmueble'].value_counts()
```

```
[10]: Tipo de inmueble
Apartamento      253
Apartaestudio     143
Casa              103
Habitación        95
Name: count, dtype: int64
```

```
[11]: model_df['Antigüedad'].value_counts()
```

```
[11]: Antigüedad
más de 30 años    137
1 a 8 años       130
16 a 30 años     122
9 a 15 años       77
menor a 1 año     69
Name: count, dtype: int64
```

```
[12]: model_df['Tipo de inmueble'] = model_df['Tipo de inmueble'].replace({
        'Apartaestudio': 'Apartamento',
        'Habitación': 'Apartamento'
    })
```

```
[13]: null_counts = model_df.isnull().sum()
print(null_counts)
```

```
Tipo de inmueble      0
Precio (admin_included) 0
Estrato               3
Baños                 15
Habitaciones          44
Parqueaderos         342
Area                  0
Area Privada          113
Piso                  0
Antigüedad            59
dtype: int64
```

```
[14]: model_df['Parqueaderos'] = model_df['Parqueaderos'].fillna(0)
model_df['Baños'] = model_df['Baños'].fillna(0)
model_df['Estrato'] = model_df['Estrato'].fillna(model_df['Estrato'].mode()[0])
model_df['Antigüedad'] = model_df['Antigüedad'].fillna(model_df['Antigüedad'].
    ↪mode()[0])
model_df['Habitaciones'] = model_df['Habitaciones'].fillna(1)
```

```
model_df['Area Privada'] = model_df['Area Privada'].fillna(model_df['Area'].
↳iloc[0])
```

```
[15]: # Add price per square meter as a feature
model_df['Precio_por_m2'] = model_df['Precio (admin_included)'] /_
↳model_df['Area']

# Add bedroom-to-bathroom ratio
model_df['Bedroom_Bath_Ratio'] = model_df['Habitaciones'] / model_df['Baños'].
↳replace(0, 0.5)

# Add categorical features for property size
model_df['Size_Category'] = pd.cut(
    model_df['Area'],
    bins=[0, 30, 60, 120, 500, float('inf')],
    labels=['Tiny', 'Small', 'Medium', 'Large', 'Huge']
)
model_df = pd.get_dummies(model_df, columns=['Size_Category'], drop_first=True)
```

```
[16]: model_df_original = model_df.copy()
model_df
```

```
[16]:
```

	Tipo de inmueble	Precio (admin_included)	Estrato	Baños	Habitaciones	\
0	Apartamento	1800000.0	4.0	1.0	1.0	
1	Apartamento	3500000.0	4.0	1.0	1.0	
2	Apartamento	1050000.0	4.0	1.0	1.0	
3	Apartamento	3500000.0	4.0	2.0	2.0	
4	Apartamento	1281000.0	4.0	1.0	1.0	
..	
679	Apartamento	3500000.0	4.0	1.0	2.0	
681	Apartamento	1600000.0	5.0	1.0	1.0	
682	Apartamento	4000000.0	4.0	2.0	4.0	
683	Casa	7000000.0	4.0	0.0	1.0	
684	Apartamento	1550000.0	4.0	1.0	1.0	

	Parqueaderos	Area	Area Privada	Piso	Antigüedad	Precio_por_m2	\
0	0.0	22.0	22.0	2.0	9 a 15 años	81818.181818	
1	0.0	31.0	31.0	0.0	menor a 1 año	112903.225806	
2	0.0	45.0	45.0	2.0	1 a 8 años	23333.333333	
3	1.0	68.2	68.2	14.0	menor a 1 año	51319.648094	
4	1.0	17.0	17.0	0.0	menor a 1 año	75352.941176	
..	
679	0.0	90.0	90.0	0.0	1 a 8 años	38888.888889	
681	0.0	18.0	16.0	2.0	1 a 8 años	88888.888889	
682	1.0	168.0	22.0	4.0	más de 30 años	23809.523810	
683	0.0	600.0	600.0	0.0	más de 30 años	11666.666667	
684	0.0	39.0	39.0	1.0	más de 30 años	39743.589744	

	Bedroom_Bath_Ratio	Size_Category_Small	Size_Category_Medium	\
0	1.0	False	False	
1	1.0	True	False	
2	1.0	True	False	
3	1.0	False	True	
4	1.0	False	False	
..	
679	2.0	False	True	
681	1.0	False	False	
682	2.0	False	False	
683	2.0	False	False	
684	1.0	True	False	

	Size_Category_Large	Size_Category_Huge
0	False	False
1	False	False
2	False	False
3	False	False
4	False	False
..
679	False	False
681	False	False
682	True	False
683	False	True
684	False	False

[594 rows x 16 columns]

```
[17]: model_df = pd.get_dummies(model_df, columns=['Tipo de inmueble'],
↳ drop_first=True)
model_df = pd.get_dummies(model_df, columns=['Antigüedad'], drop_first=True)
```

```
[18]: from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
features = ['Precio (admin_included)', 'Area Privada', 'Area', 'Estrato',
↳ 'Baños', 'Habitaciones', 'Piso'] # incluye todas las variables numéricas
model_df[features] = scaler.fit_transform(model_df[features])
```

```
[19]: from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
# from sklearn.metrics import silhouette_score

# # Determinación del número óptimo de clusters con el método del codo
# wcss = []
# for k in range(2, 10):
#     kmeans = KMeans(n_clusters=k, random_state=42)
```

```

#     kmeans.fit(model_df[features])
#     wcss.append(kmeans.inertia_)

# plt.plot(range(2, 10), wcss, marker='o')
# plt.xlabel('Número de clusters')
# plt.ylabel('WCSS')
# plt.title('Método del Codo')
# plt.show()

# # Selección de k basado en el método del codo y cálculo de la silueta

# k_opt = 2 # por ejemplo, si el codo es en 3
# kmeans = KMeans(n_clusters=k_opt, random_state=42)
# clusters = kmeans.fit_predict(model_df[features])
# score = silhouette_score(model_df[features], clusters)
# print("Silhouette Score:", score)

# model_df['Cluster'] = clusters

from sklearn.metrics import silhouette_samples, silhouette_score
import numpy as np

# Compute silhouette scores for different k values
silhouette_scores = []
k_range = range(2, 10)

for k in k_range:
    kmeans = KMeans(n_clusters=k, random_state=42, n_init=10)
    clusters = kmeans.fit_predict(model_df[features])
    silhouette_avg = silhouette_score(model_df[features], clusters)
    silhouette_scores.append(silhouette_avg)
    print(f"For n_clusters = {k}, the silhouette score is {silhouette_avg}")

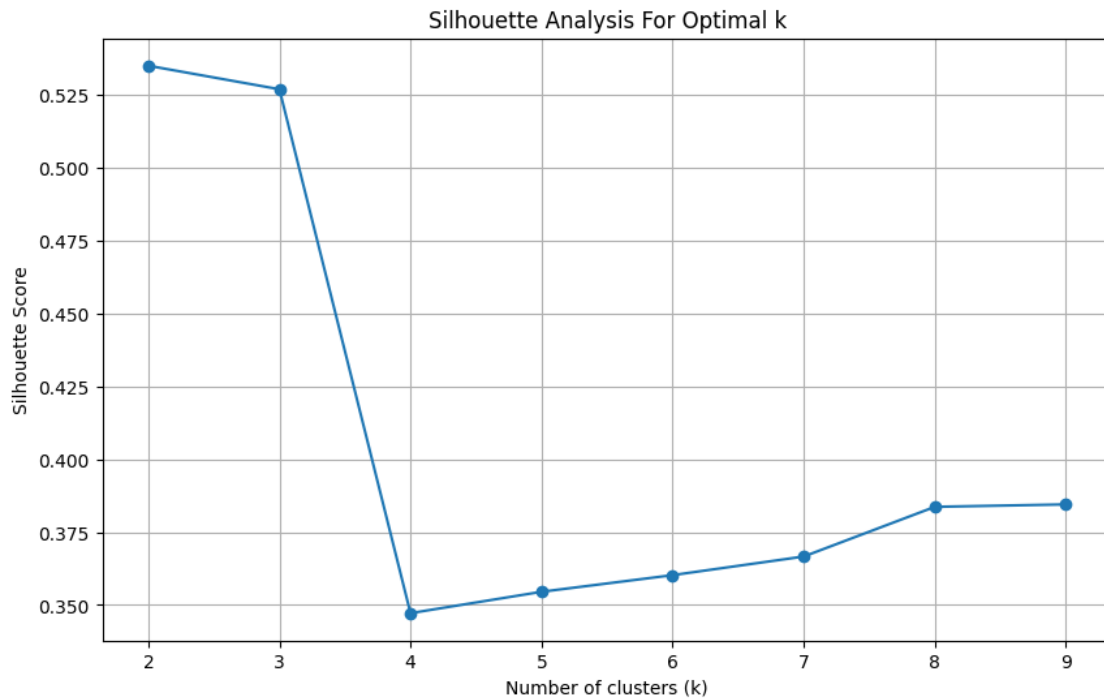
# Plot silhouette scores
plt.figure(figsize=(10, 6))
plt.plot(k_range, silhouette_scores, 'o-')
plt.xlabel('Number of clusters (k)')
plt.ylabel('Silhouette Score')
plt.title('Silhouette Analysis For Optimal k')
plt.grid(True)
plt.show()

# Choose optimal k (highest silhouette score)
optimal_k = k_range[np.argmax(silhouette_scores)]
print(f"Optimal number of clusters: {optimal_k}")

```

For n_clusters = 2, the silhouette score is 0.5350571570008068

For n_clusters = 3, the silhouette score is 0.5269820745184624
 For n_clusters = 4, the silhouette score is 0.34717431807636123
 For n_clusters = 5, the silhouette score is 0.3545222439692743
 For n_clusters = 6, the silhouette score is 0.3602321823810078
 For n_clusters = 7, the silhouette score is 0.36662295544876755
 For n_clusters = 8, the silhouette score is 0.3836718232550033
 For n_clusters = 9, the silhouette score is 0.38450713069750936



Optimal number of clusters: 2

```
[20]: # Imprimir el DataFrame completo en la consola
model_df_original['Cluster'] = clusters
model_df_original
# Si prefieres guardar el DataFrame con los clusters en un CSV:
# model_df.to_csv("df_with_clusters.csv", index=False)
```

```
[20]:
```

	Tipo de inmueble	Precio (admin_included)	Estrato	Baños	Habitaciones	\
0	Apartamento	1800000.0	4.0	1.0	1.0	
1	Apartamento	3500000.0	4.0	1.0	1.0	
2	Apartamento	1050000.0	4.0	1.0	1.0	
3	Apartamento	3500000.0	4.0	2.0	2.0	
4	Apartamento	1281000.0	4.0	1.0	1.0	
..	
679	Apartamento	3500000.0	4.0	1.0	2.0	
681	Apartamento	1600000.0	5.0	1.0	1.0	

682	Apartamento	4000000.0	4.0	2.0	4.0
683	Casa	7000000.0	4.0	0.0	1.0
684	Apartamento	1550000.0	4.0	1.0	1.0

	Parqueaderos	Area	Area Privada	Piso	Antiguedad	Precio_por_m2 \
0	0.0	22.0	22.0	2.0	9 a 15 años	81818.181818
1	0.0	31.0	31.0	0.0	menor a 1 año	112903.225806
2	0.0	45.0	45.0	2.0	1 a 8 años	23333.333333
3	1.0	68.2	68.2	14.0	menor a 1 año	51319.648094
4	1.0	17.0	17.0	0.0	menor a 1 año	75352.941176
..
679	0.0	90.0	90.0	0.0	1 a 8 años	38888.888889
681	0.0	18.0	16.0	2.0	1 a 8 años	88888.888889
682	1.0	168.0	22.0	4.0	más de 30 años	23809.523810
683	0.0	600.0	600.0	0.0	más de 30 años	11666.666667
684	0.0	39.0	39.0	1.0	más de 30 años	39743.589744

	Bedroom_Bath_Ratio	Size_Category_Small	Size_Category_Medium \
0	1.0	False	False
1	1.0	True	False
2	1.0	True	False
3	1.0	False	True
4	1.0	False	False
..
679	2.0	False	True
681	1.0	False	False
682	2.0	False	False
683	2.0	False	False
684	1.0	True	False

	Size_Category_Large	Size_Category_Huge	Cluster
0	False	False	0
1	False	False	0
2	False	False	0
3	False	False	2
4	False	False	0
..
679	False	False	0
681	False	False	8
682	True	False	5
683	False	True	6
684	False	False	0

[594 rows x 17 columns]

```
[21]: import pandas as pd
import numpy as np
```

```

import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans, DBSCAN, AgglomerativeClustering
from sklearn.mixture import GaussianMixture
from sklearn.metrics import silhouette_score

# Assuming model_df and features are already defined

# 1. Gaussian Mixture Models
gmm = GaussianMixture(n_components=3, random_state=42)
gmm_clusters = gmm.fit_predict(model_df[features])
gmm_score = silhouette_score(model_df[features], gmm_clusters)
print(f"GMM Silhouette Score: {gmm_score}")

# 2. DBSCAN - density-based clustering
dbscan = DBSCAN(eps=0.5, min_samples=5)
dbscan_clusters = dbscan.fit_predict(model_df[features])
# Only calculate silhouette score if there's more than one cluster and no noise
# points (-1)
if len(set(dbscan_clusters)) > 1 and -1 not in dbscan_clusters:
    dbscan_score = silhouette_score(model_df[features], dbscan_clusters)
    print(f"DBSCAN Silhouette Score: {dbscan_score}")
else:
    print("DBSCAN produced noise points or a single cluster. Adjust parameters.")

# 3. Hierarchical Clustering
hc = AgglomerativeClustering(n_clusters=3)
hc_clusters = hc.fit_predict(model_df[features])
hc_score = silhouette_score(model_df[features], hc_clusters)
print(f"Hierarchical Clustering Silhouette Score: {hc_score}")

# Visualization of different clustering results using PCA
from sklearn.decomposition import PCA

pca = PCA(n_components=2)
principal_components = pca.fit_transform(model_df[features])

# Create a figure with multiple subplots
fig, axes = plt.subplots(2, 2, figsize=(15, 12))

# KMeans plot
axes[0, 0].scatter(principal_components[:, 0], principal_components[:, 1],
    c=clusters, cmap='viridis')
axes[0, 0].set_title('KMeans Clustering')

```

```

# GMM plot
axes[0, 1].scatter(principal_components[:, 0], principal_components[:, 1],
                  c=gmm_clusters, cmap='viridis')
axes[0, 1].set_title('Gaussian Mixture Model')

# DBSCAN plot
axes[1, 0].scatter(principal_components[:, 0], principal_components[:, 1],
                  c=dbscan_clusters, cmap='viridis')
axes[1, 0].set_title('DBSCAN')

# Hierarchical clustering plot
axes[1, 1].scatter(principal_components[:, 0], principal_components[:, 1],
                  c=hc_clusters, cmap='viridis')
axes[1, 1].set_title('Hierarchical Clustering')

plt.tight_layout()
plt.show()

# Compare the performance of different algorithms
algorithms = ['KMeans', 'GMM', 'Hierarchical']
scores = [silhouette_score(model_df[features], clusters),
          gmm_score,
          hc_score]

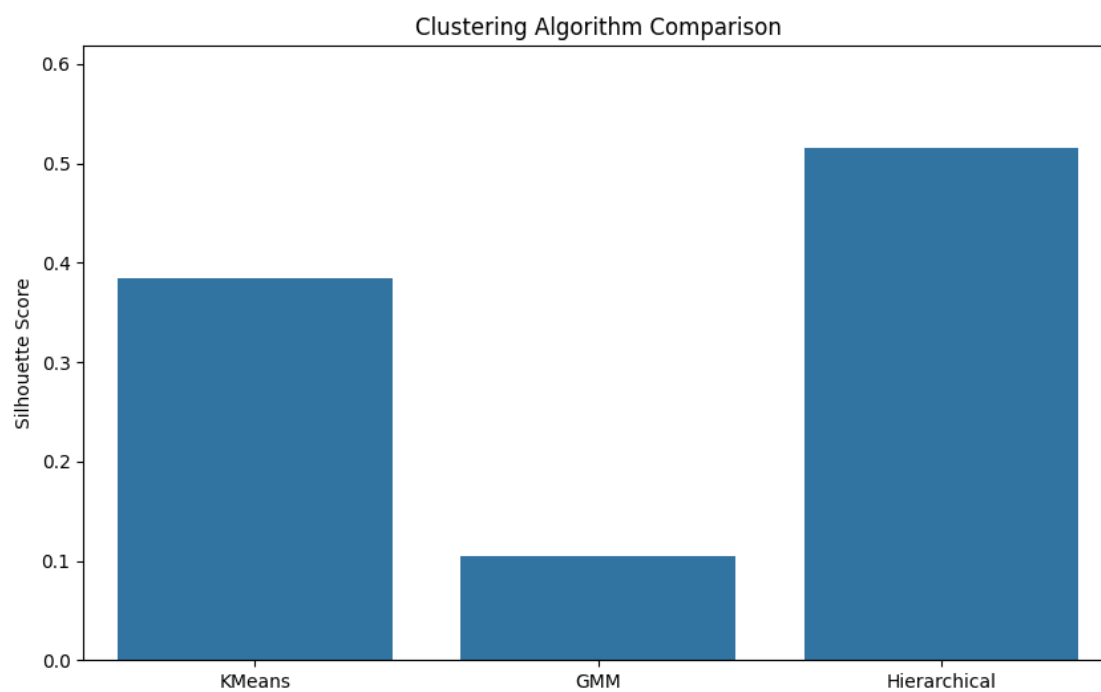
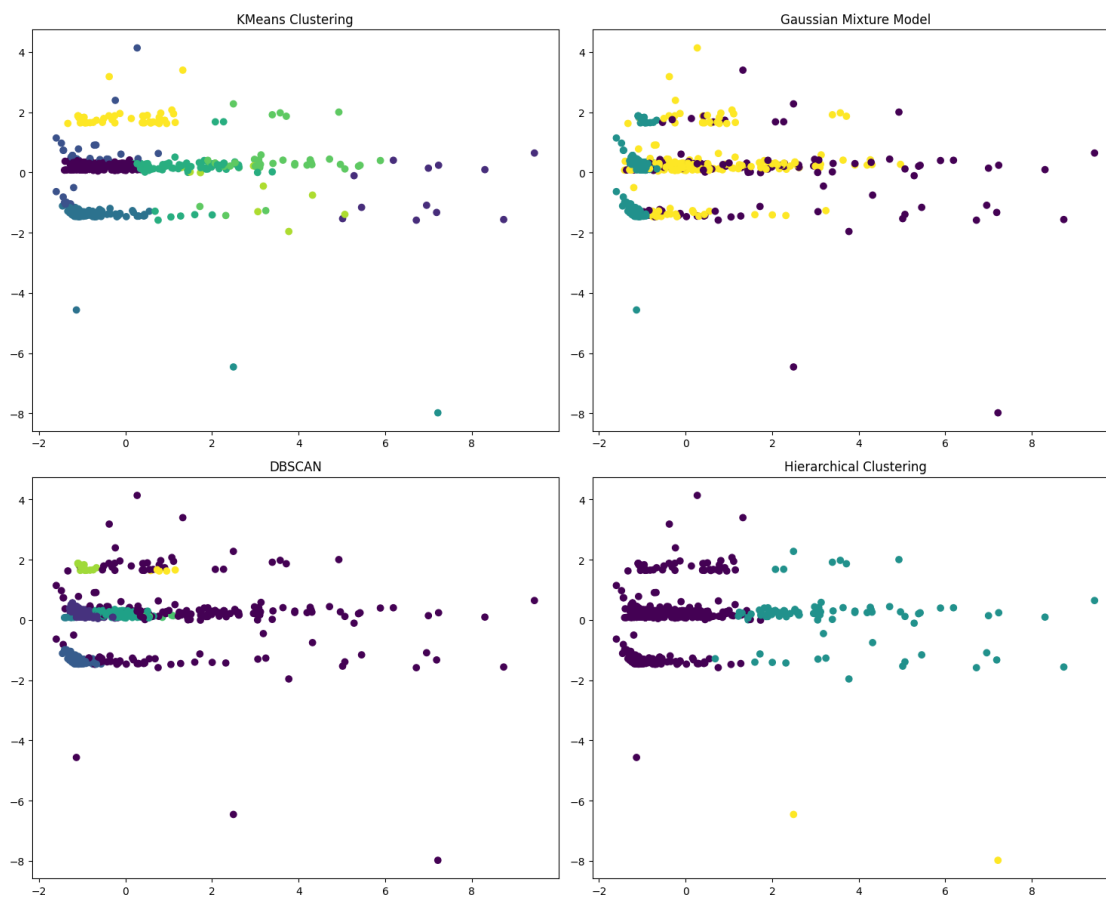
plt.figure(figsize=(10, 6))
sns.barplot(x=algorithms, y=scores)
plt.ylabel('Silhouette Score')
plt.title('Clustering Algorithm Comparison')
plt.ylim(0, max(scores) * 1.2)
plt.show()

```

GMM Silhouette Score: 0.1049937464367089

DBSCAN produced noise points or a single cluster. Adjust parameters.

Hierarchical Clustering Silhouette Score: 0.5152151913113655



```

[22]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats

# Assuming model_df_original now has the 'Cluster' column

# Add the clusters back to the original dataframe for analysis
# model_df_original['Cluster'] = best_model_clusters # (use the clusters from
↳ your best model)

# 1. Detailed cluster profiling
def analyze_clusters(df, cluster_column='Cluster'):
    """Analyze the characteristics of each cluster"""

    # Number of properties in each cluster
    cluster_counts = df[cluster_column].value_counts().sort_index()
    print(f"Number of properties in each cluster:\n{cluster_counts}")

    # Create a profile for each numeric column
    numeric_cols = ['Precio (admin_included)', 'Area', 'Area Privada',
                    'Estrato', 'Baños', 'Habitaciones', 'Parqueaderos', 'Piso']

    profile = df.groupby(cluster_column)[numeric_cols].agg(['mean', 'median',
↳ 'min', 'max', 'std'])
    print("\nCluster Profiles:")
    print(profile)

    # Distribution of categorical variables across clusters
    categorical_cols = ['Tipo de inmueble', 'Antigüedad']
    for col in categorical_cols:
        if col in df.columns:
            print(f"\nDistribution of {col} across clusters:")
            print(pd.crosstab(df[cluster_column], df[col], normalize='index'))

    return profile

profile = analyze_clusters(model_df_original)

# 2. Visualize the cluster profiles
def plot_cluster_profiles(df, numeric_cols, cluster_col='Cluster'):
    """Plot radar charts to visualize cluster profiles"""

```

```

# Get the number of clusters
n_clusters = df[cluster_col].nunique()

# Calculate the mean of each feature for each cluster
means = df.groupby(cluster_col)[numeric_cols].mean()

# Scale the data between 0 and 1 for radar chart
scaler = StandardScaler()
means_scaled = pd.DataFrame(
    scaler.fit_transform(means),
    index=means.index,
    columns=means.columns
)

# Create a radar chart for each cluster
fig, axes = plt.subplots(1, n_clusters, figsize=(15, 5),
    ↪subplot_kw=dict(polar=True))
if n_clusters == 1:
    axes = [axes]

for i, ax in enumerate(axes):
    values = means_scaled.iloc[i].values
    angles = np.linspace(0, 2*np.pi, len(numeric_cols), endpoint=False).
    ↪tolist()
    values = np.concatenate((values, [values[0]])) # Close the loop
    angles = np.concatenate((angles, [angles[0]])) # Close the loop

    ax.plot(angles, values, 'o-', linewidth=2)
    ax.fill(angles, values, alpha=0.25)
    ax.set_thetagrids(np.degrees(angles[:-1]), numeric_cols)
    ax.set_title(f'Cluster {i}')

plt.tight_layout()
plt.show()

# Plot radar charts for key numeric features
plot_features = ['Precio (admin_included)', 'Area', 'Estrato', 'Baños',
    ↪'Habitaciones', 'Parqueaderos']
plot_cluster_profiles(model_df_original, plot_features)

# 3. Box plots for key variables by cluster
def plot_boxplots(df, features, cluster_col='Cluster'):
    """Create boxplots for each feature by cluster"""

    n_features = len(features)
    fig, axes = plt.subplots(n_features, 1, figsize=(10, 4*n_features))

```

```

if n_features == 1:
    axes = [axes]

for i, feature in enumerate(features):
    sns.boxplot(x=cluster_col, y=feature, data=df, ax=axes[i])
    axes[i].set_title(f'Distribution of {feature} by Cluster')

plt.tight_layout()
plt.show()

# Create boxplots for key features
key_features = ['Precio (admin_included)', 'Area', 'Habitaciones', 'Estrato']
plot_boxplots(model_df_original, key_features)

# 4. Scatter plot matrix for visual cluster inspection
sns.pairplot(model_df_original,
              vars=['Precio (admin_included)', 'Area', 'Habitaciones', 'Baños'],
              hue='Cluster',
              palette='viridis')
plt.suptitle('Scatter Plot Matrix by Cluster', y=1.02)
plt.show()

# 5. Statistical tests to confirm cluster differences
def test_cluster_differences(df, features, cluster_col='Cluster'):
    """Run statistical tests to confirm differences between clusters"""

    results = {}
    n_clusters = df[cluster_col].nunique()

    for feature in features:
        # For features with 2 clusters, use t-test
        if n_clusters == 2:
            cluster_0 = df[df[cluster_col] == 0][feature]
            cluster_1 = df[df[cluster_col] == 1][feature]
            t_stat, p_val = stats.ttest_ind(cluster_0, cluster_1,
            equal_var=False)
            results[feature] = {'test': 't-test', 'statistic': t_stat,
            'p_value': p_val}
            # For more than 2 clusters, use ANOVA
        else:
            groups = [df[df[cluster_col] == i][feature] for i in
            range(n_clusters)]
            f_stat, p_val = stats.f_oneway(*groups)
            results[feature] = {'test': 'ANOVA', 'statistic': f_stat, 'p_value':
            p_val}

    return pd.DataFrame(results).T

```

```

# Run statistical tests
stat_results = test_cluster_differences(model_df_original, key_features)
print("\nStatistical Tests for Cluster Differences:")
print(stat_results)

# 6. Market segment labeling based on cluster characteristics
def label_clusters(profile):
    """Assign business-friendly labels to clusters based on their
    ↪ characteristics"""

    cluster_labels = {}

    # Calculate average price and area across all clusters to use as thresholds
    avg_price = profile[('Precio (admin_included)', 'mean')].mean()
    avg_area = profile[('Area', 'mean')].mean()

    for cluster in profile.index:
        # Extract key metrics for this cluster
        price = profile.loc[cluster, ('Precio (admin_included)', 'mean')]
        area = profile.loc[cluster, ('Area', 'mean')]
        rooms = profile.loc[cluster, ('Habitaciones', 'mean')]

        # Logic to assign labels based on property characteristics
        if price > avg_price:
            price_label = "Premium"
        else:
            price_label = "Budget"

        if area > avg_area:
            size_label = "Spacious"
        else:
            size_label = "Compact"

        cluster_labels[cluster] = f"{price_label} {size_label} Properties"

    return cluster_labels

# Generate business-friendly cluster labels
cluster_labels = label_clusters(profile)
print("\nCluster Market Segments:")
for cluster, label in cluster_labels.items():
    print(f"Cluster {cluster}: {label}")

# Add the labels to the original dataframe
model_df_original['Market_Segment'] = model_df_original['Cluster'].
    ↪map(cluster_labels)

```



```
# Display sample of final dataset with clusters and labels
print("\nSample of segmented properties:")
print(model_df_original[['Tipo de inmueble', 'Precio (admin_included)', 'Area',
                        'Habitaciones', 'Cluster', 'Market_Segment']].head(10))
```

Number of properties in each cluster:

Cluster

```
0    274
1     12
2     34
3    106
4      2
5     71
6     38
7      9
8     48
```

Name: count, dtype: int64

Cluster Profiles:

	Precio (admin_included)			
	mean	median	min	max
Cluster				
0	1.814757e+06	1650000.0	300000.0	6500000.0
1	1.239167e+07	13500000.0	5500000.0	20000000.0
2	2.240324e+06	2000000.0	977000.0	5500000.0
3	1.597577e+06	1470000.0	460000.0	7500000.0
4	6.175000e+08	617500000.0	465000000.0	770000000.0
5	5.337694e+06	4800000.0	480000.0	18500000.0
6	8.356184e+06	6500000.0	500000.0	25000000.0
7	1.285333e+07	5500000.0	50000.0	60000000.0
8	2.679319e+06	2175000.0	470000.0	8000000.0

	Area						
	std	mean	median	min	max	std	...
Cluster							...
0	9.678014e+05	44.002555	35.0	1.0	250.0	31.210277	...
1	4.473652e+06	568.333333	600.0	321.0	960.0	154.937133	...
2	1.040361e+06	44.676471	32.5	6.0	144.0	31.030543	...
3	1.000685e+06	41.042453	31.5	1.0	200.0	33.429394	...
4	2.156676e+08	255.000000	255.0	108.0	402.0	207.889394	...
5	3.173229e+06	214.647887	220.0	6.0	680.0	116.997082	...
6	5.588132e+06	406.368421	387.0	12.0	780.0	136.810467	...
7	1.916127e+07	63.444444	10.0	1.0	320.0	115.520681	...
8	1.738182e+06	67.322917	47.8	6.0	450.0	72.319940	...

Parqueaderos					Piso				
	mean	median	min	max		mean	median	min	max

Cluster									
0	0.335766	0.0	0.0	2.0	0.517494	1.558394	1.0	0.0	5.0
1	3.833333	4.0	0.0	9.0	2.552479	1.333333	1.0	0.0	4.0
2	0.911765	1.0	0.0	10.0	1.747165	9.411765	8.0	6.0	18.0
3	0.273585	0.0	0.0	10.0	1.028480	1.811321	2.0	0.0	6.0
4	2.000000	2.0	1.0	3.0	1.414214	1.500000	1.5	1.0	2.0
5	1.450704	1.0	0.0	5.0	1.251156	1.084507	1.0	0.0	6.0
6	2.210526	2.0	0.0	5.0	1.662917	1.105263	0.0	0.0	6.0
7	4.000000	3.0	0.0	10.0	4.387482	1.666667	2.0	0.0	4.0
8	0.854167	1.0	0.0	5.0	1.031206	1.770833	1.5	0.0	7.0

	std
Cluster	
0	1.575413
1	1.497473
2	3.602336
3	1.690946
4	0.707107
5	1.295558
6	1.502961
7	1.414214
8	1.859302

[9 rows x 40 columns]

Distribution of Tipo de inmueble across clusters:

Tipo de inmueble	Apartamento	Casa
Cluster		
0	0.981752	0.018248
1	0.000000	1.000000
2	1.000000	0.000000
3	0.971698	0.028302
4	0.500000	0.500000
5	0.422535	0.577465
6	0.078947	0.921053
7	0.444444	0.555556
8	0.979167	0.020833

Distribution of Antigüedad across clusters:

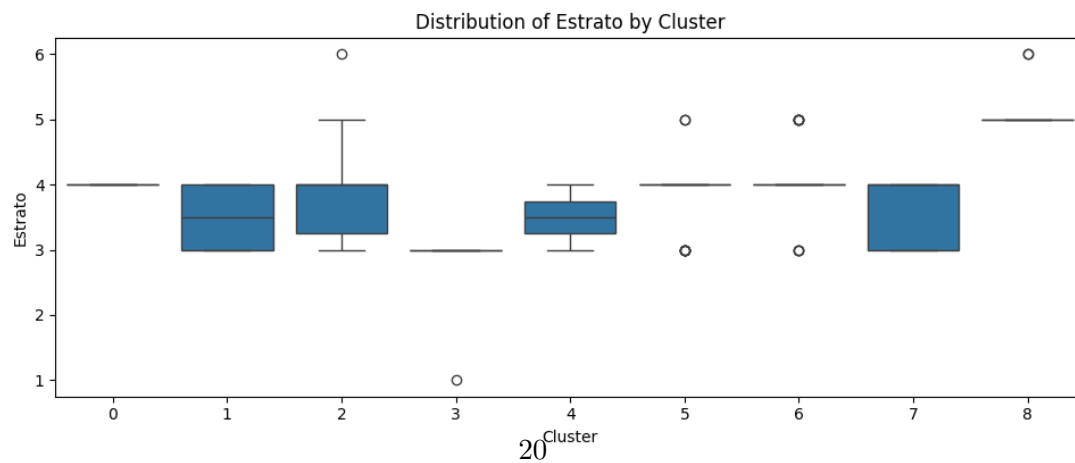
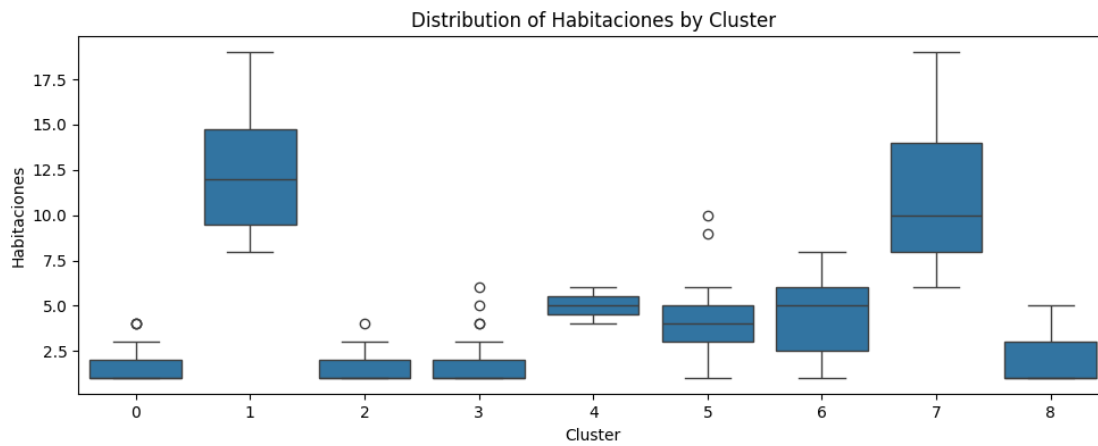
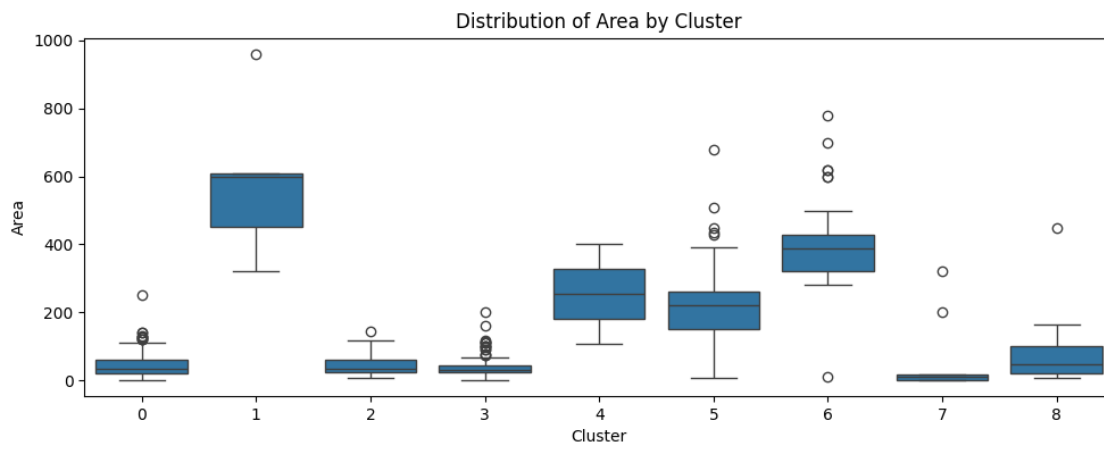
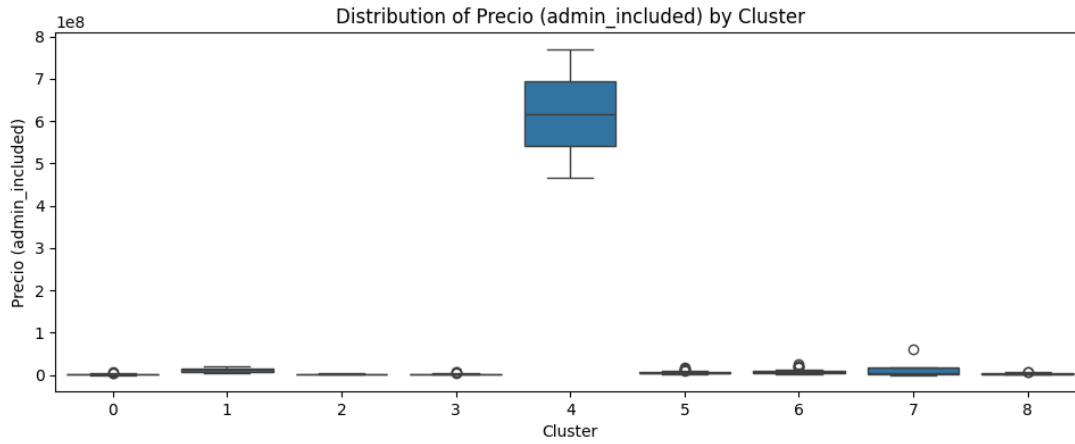
Antigüedad	1 a 8 años	16 a 30 años	9 a 15 años	menor a 1 año \
Cluster				
0	0.248175	0.200730	0.164234	0.131387
1	0.000000	0.250000	0.083333	0.000000
2	0.382353	0.058824	0.088235	0.323529
3	0.245283	0.188679	0.122642	0.150943
4	0.000000	0.000000	0.500000	0.000000
5	0.056338	0.295775	0.056338	0.042254

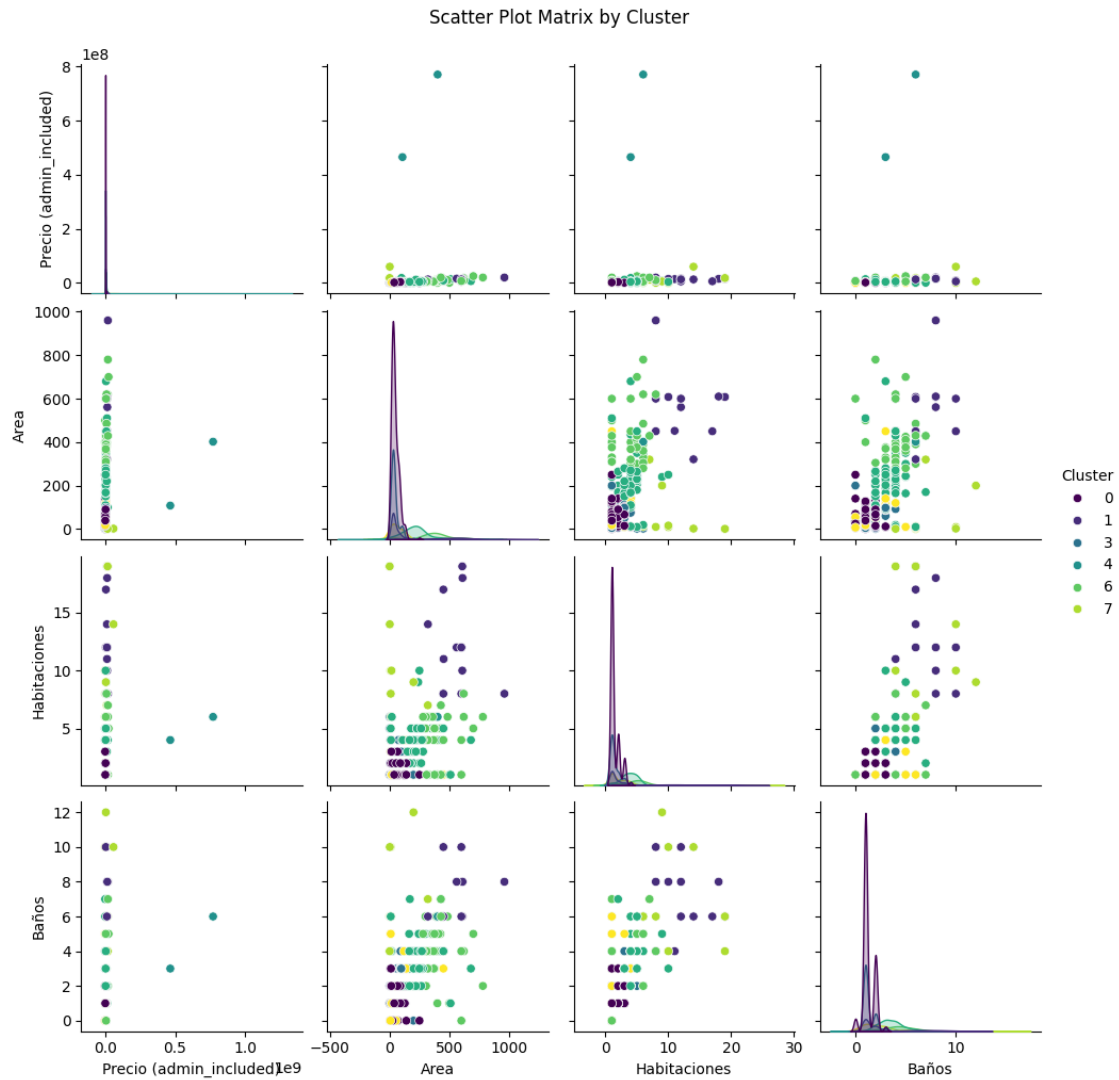
6	0.026316	0.210526	0.105263	0.000000
7	0.222222	0.111111	0.000000	0.111111
8	0.333333	0.250000	0.125000	0.041667

Antigüedad más de 30 años
Cluster

0	0.255474
1	0.666667
2	0.147059
3	0.292453
4	0.500000
5	0.549296
6	0.657895
7	0.555556
8	0.250000

Cluster0 Cluster1 Cluster2 Cluster3 Cluster4 Cluster5 Cluster6 Cluster7 Cluster8
 Problem_included Problem_included Problem_included Problem_included Problem_included Problem_included Problem_included Problem_included Problem_included
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Statistical Tests for Cluster Differences:

	test	statistic	p_value
Precio (admin_included)	ANOVA	1062.379206	0.0
Area	ANOVA	230.053209	0.0
Habitaciones	ANOVA	193.548594	0.0
Estrato	ANOVA	289.443731	0.0

Cluster Market Segments:

Cluster 0: Budget Compact Properties
Cluster 1: Budget Spacious Properties
Cluster 2: Budget Compact Properties

Cluster 3: Budget Compact Properties
 Cluster 4: Premium Spacious Properties
 Cluster 5: Budget Spacious Properties
 Cluster 6: Budget Spacious Properties
 Cluster 7: Budget Compact Properties
 Cluster 8: Budget Compact Properties

Sample of segmented properties:

	Tipo de inmueble	Precio (admin_included)	Area	Habitaciones	Cluster	\
0	Apartamento	1800000.0	22.0	1.0	0	
1	Apartamento	3500000.0	31.0	1.0	0	
2	Apartamento	1050000.0	45.0	1.0	0	
3	Apartamento	3500000.0	68.2	2.0	2	
4	Apartamento	1281000.0	17.0	1.0	0	
6	Apartamento	1450000.0	26.0	1.0	3	
8	Casa	6000000.0	380.0	5.0	6	
9	Apartamento	2300000.0	19.0	1.0	0	
10	Casa	15000000.0	608.0	19.0	1	
11	Apartamento	550000.0	70.0	1.0	0	

	Market_Segment
0	Budget Compact Properties
1	Budget Compact Properties
2	Budget Compact Properties
3	Budget Compact Properties
4	Budget Compact Properties
6	Budget Compact Properties
8	Budget Spacious Properties
9	Budget Compact Properties
10	Budget Spacious Properties
11	Budget Compact Properties

```
[23]: from sklearn.model_selection import GridSearchCV
      from sklearn.cluster import KMeans
      from sklearn.metrics import make_scorer, silhouette_score

      # Define parameter grid
      param_grid = {
          'n_clusters': range(2, 10),
          'init': ['k-means++', 'random'],
          'n_init': [10, 15, 20],
          'max_iter': [300, 500]
      }

      # Create a custom scorer
      silhouette_scorer = make_scorer(silhouette_score, greater_is_better=True)
```

```

# Initialize GridSearchCV
grid_search = GridSearchCV(
    KMeans(),
    param_grid,
    scoring=silhouette_scorer,
    cv=5 # Using 5-fold cross-validation
)

# Fit the model
grid_search.fit(model_df[features])

# Get the best parameters
print("Best parameters:", grid_search.best_params_)
print("Best silhouette score:", grid_search.best_score_)

# Use the best model for final clustering
best_kmeans = grid_search.best_estimator_
final_clusters = best_kmeans.predict(model_df[features])

```

/home/manolo/2024-II/REDES/entregable/env/lib/python3.12/site-packages/sklearn/model_selection/_validation.py:960: UserWarning: Scoring failed. The score on this train-test partition for these parameters will be set to nan. Details:

Traceback (most recent call last):

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File "/home/manolo/2024-II/REDES/entregable/env/lib/python3.12/site-
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    scores = scorer(estimator, X_test, **score_params)
            ~~~~~

```

TypeError: _BaseScorer.__call__() missing 1 required positional argument: 'y_true'

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```

        scores = scorer(estimator, X_test, **score_params)
        ~~~~~~
TypeError: _BaseScorer.__call__() missing 1 required positional argument:
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warnings.warn(
Best parameters: {'init': 'k-means++', 'max_iter': 300, 'n_clusters': 2,
'n_init': 10}
Best silhouette score: nan

/home/manolo/2024-II/REDES/entregable/env/lib/python3.12/site-
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warnings.warn(
/home/manolo/2024-II/REDES/entregable/env/lib/python3.12/site-
packages/sklearn/model_selection/_search.py:1108: UserWarning: One or more of
the test scores are non-finite: [nan nan nan nan nan nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan
nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan
nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan nan
nan nan nan nan nan nan]
warnings.warn(

```

```

[24]: from sklearn.metrics import davies_bouldin_score, calinski_harabasz_score

# Davies-Bouldin Index (lower is better)
db_score = davies_bouldin_score(model_df[features], final_clusters)
print(f"Davies-Bouldin Score: {db_score}")

# Calinski-Harabasz Index (higher is better)
ch_score = calinski_harabasz_score(model_df[features], final_clusters)
print(f"Calinski-Harabasz Score: {ch_score}")

```

```

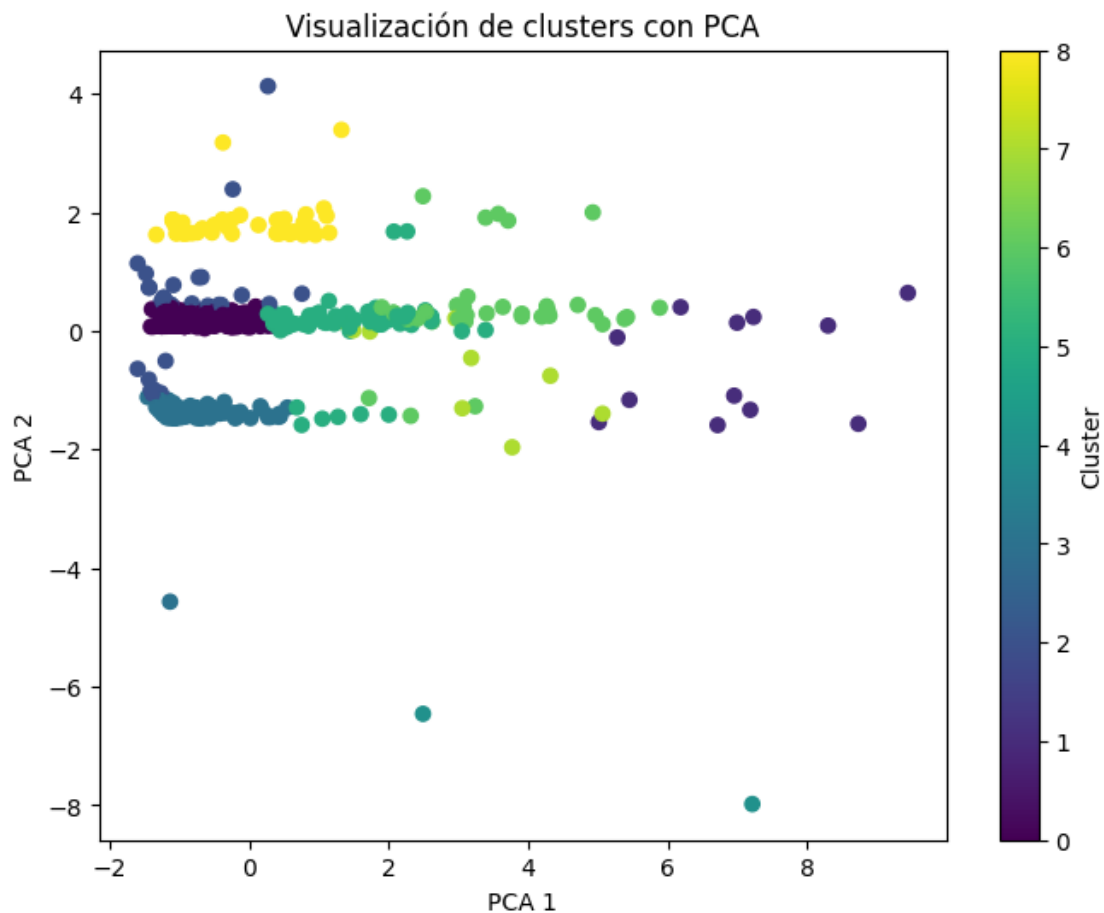
Davies-Bouldin Score: 1.0839082064066552
Calinski-Harabasz Score: 267.89173546375105

```

```
[25]: from sklearn.decomposition import PCA

pca = PCA(n_components=2)
principal_components = pca.fit_transform(model_df[features])

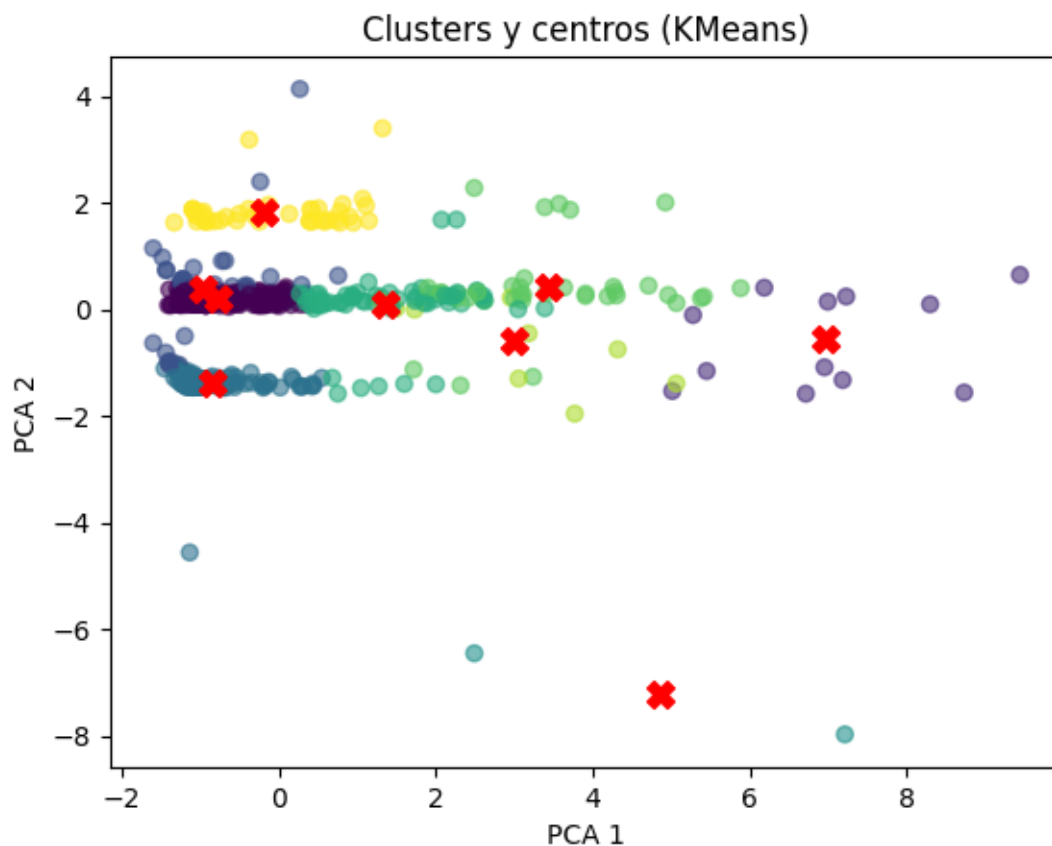
plt.figure(figsize=(8,6))
plt.scatter(principal_components[:, 0], principal_components[:, 1], c=clusters, cmap='viridis')
plt.xlabel('PCA 1')
plt.ylabel('PCA 2')
plt.title('Visualización de clusters con PCA')
plt.colorbar(label='Cluster')
plt.show()
```



```
[26]: centers = kmeans.cluster_centers_
centers_pca = pca.transform(centers)
```

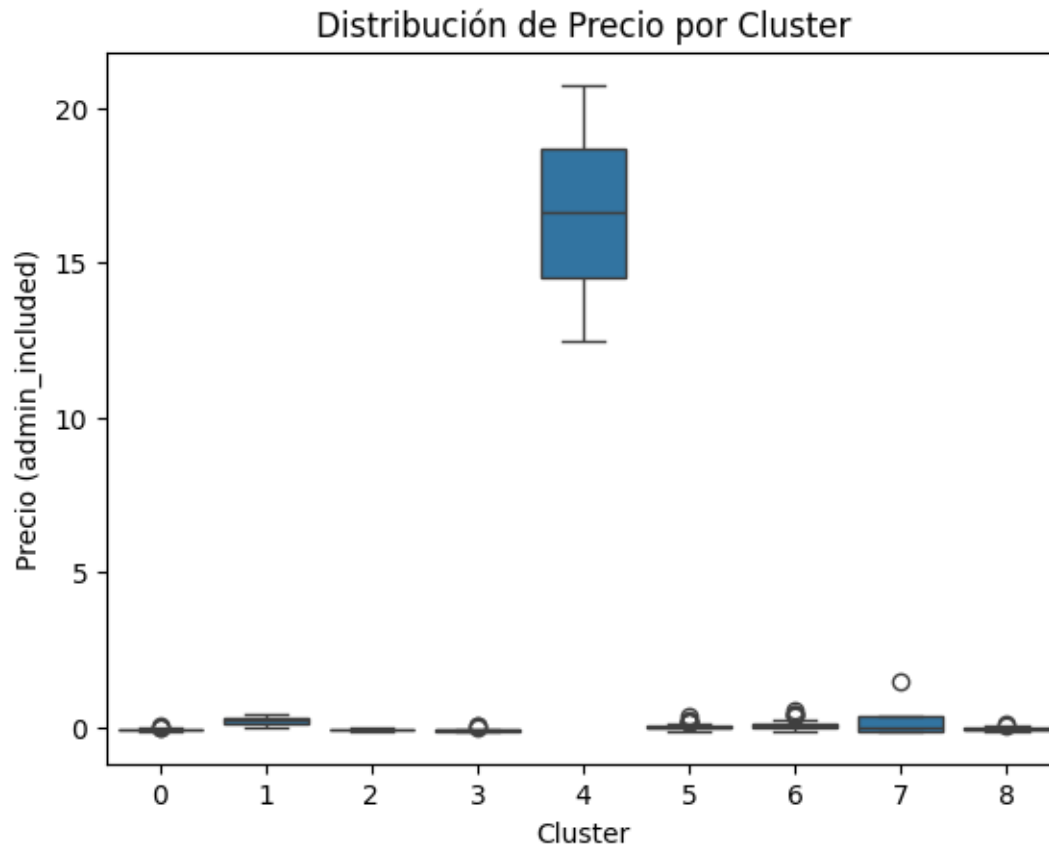
```
plt.scatter(principal_components[:, 0], principal_components[:, 1], c=clusters, cmap='viridis', alpha=0.6)
plt.scatter(centers_pca[:, 0], centers_pca[:, 1], c='red', s=100, marker='X')
plt.xlabel('PCA 1')
plt.ylabel('PCA 2')
plt.title('Clusters y centros (KMeans)')
plt.show()
```

/home/manolo/2024-II/REDES/entregable/env/lib/python3.12/site-packages/sklearn/utils/validation.py:2739: UserWarning: X does not have valid feature names, but PCA was fitted with feature names
warnings.warn(



```
[27]: import seaborn as sns

model_df['Cluster'] = clusters
sns.boxplot(x='Cluster', y='Precio (admin_included)', data=model_df)
plt.title('Distribución de Precio por Cluster')
plt.show()
```



```
[28]: corr_matrix = model_df.corr()
print("Correlación de las variables con el Precio:")
print(corr_matrix['Precio (admin_included)'].sort_values(ascending=False))
```

Correlación de las variables con el Precio:

Precio (admin_included)	1.000000
Baños	0.162788
Precio_por_m2	0.154236
Area Privada	0.150954
Area	0.145256
Habitaciones	0.135333
Tipo de inmueble_Casa	0.134625
Parqueaderos	0.132018
Size_Category_Large	0.100710
Cluster	0.067231
Antigüedad_más de 30 años	0.061318
Size_Category_Huge	0.039059
Antigüedad_9 a 15 años	0.032484
Size_Category_Medium	0.028027
Bedroom_Bath_Ratio	0.017675

```

Estrato -0.015514
Piso -0.017593
Antigüedad_menor a 1 año -0.029270
Antigüedad_16 a 30 años -0.029851
Size_Category_Small -0.051850
Name: Precio (admin_included), dtype: float64

```

```

[29]: plt.figure(figsize=(10,8))
      sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
      plt.title('Matriz de correlación')
      plt.show()

```

