In [6]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.metrics import pairwise_distances_argmin_min

data = {
    'X': [1.0, 1.5, 5.0, 8.0, 1.0, 9.0, 8.0, 10.0, 9.0, 2.0],
    'Y': [2.0, 1.8, 8.0, 8.0, 0.6, 11.0, 2.0, 2.0, 3.0, 2.5]
}
df = pd.DataFrame(data)
df.to_csv("kmeans_performance_data.csv", index=False)
df = pd.read_csv("kmeans_performance_data.csv")
features = df[['X', 'Y']].values
performance_results = []
k_values = range(1, 11)

for k in k_values:
    kmeans = KMeans(n_clusters=k, random_state=0)
    kmeans.fit(features)
    closest, distances = pairwise_distances_argmin_min(features, kmeans.clus
    total_distance = np.sum(distances)
    performance_results.append((k, total_distance))
    print(f'k={k} -> Sum of Euclidean Distances: {total_distance:.4f}')

ks, distances = zip(*performance_results)
plt.figure(figsize=(8, 6))
plt.plot(ks, distances, marker='o')
plt.title('Performance vs. Number of Clusters (k)')
plt.xlabel('Number of Clusters (k)')
plt.ylabel('Total Euclidean Distance to Cluster Centers')
plt.grid(True)
plt.show()
```

```
C:\ProgramData\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:141
2: FutureWarning: The default value of `n_init` will change from 10 to 'au
to' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\ProgramData\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:143
6: UserWarning: KMeans is known to have a memory leak on Windows with MKL,
when there are less chunks than available threads. You can avoid it by set
ting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(

k=1 -> Sum of Euclidean Distances: 47.3263

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k=2 -> Sum of Euclidean Distances: 25.0268
```

```
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k=3 -> Sum of Euclidean Distances: 11.9110

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k=4 -> Sum of Euclidean Distances: 8.5671

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k=5 -> Sum of Euclidean Distances: 5.5671

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k=6 -> Sum of Euclidean Distances: 4.2251

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k=7 -> Sum of Euclidean Distances: 2.8644
```

```
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k=8 -> Sum of Euclidean Distances: 1.4502

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k=9 -> Sum of Euclidean Distances: 0.5385

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k=10 -> Sum of Euclidean Distances: 0.0000
```

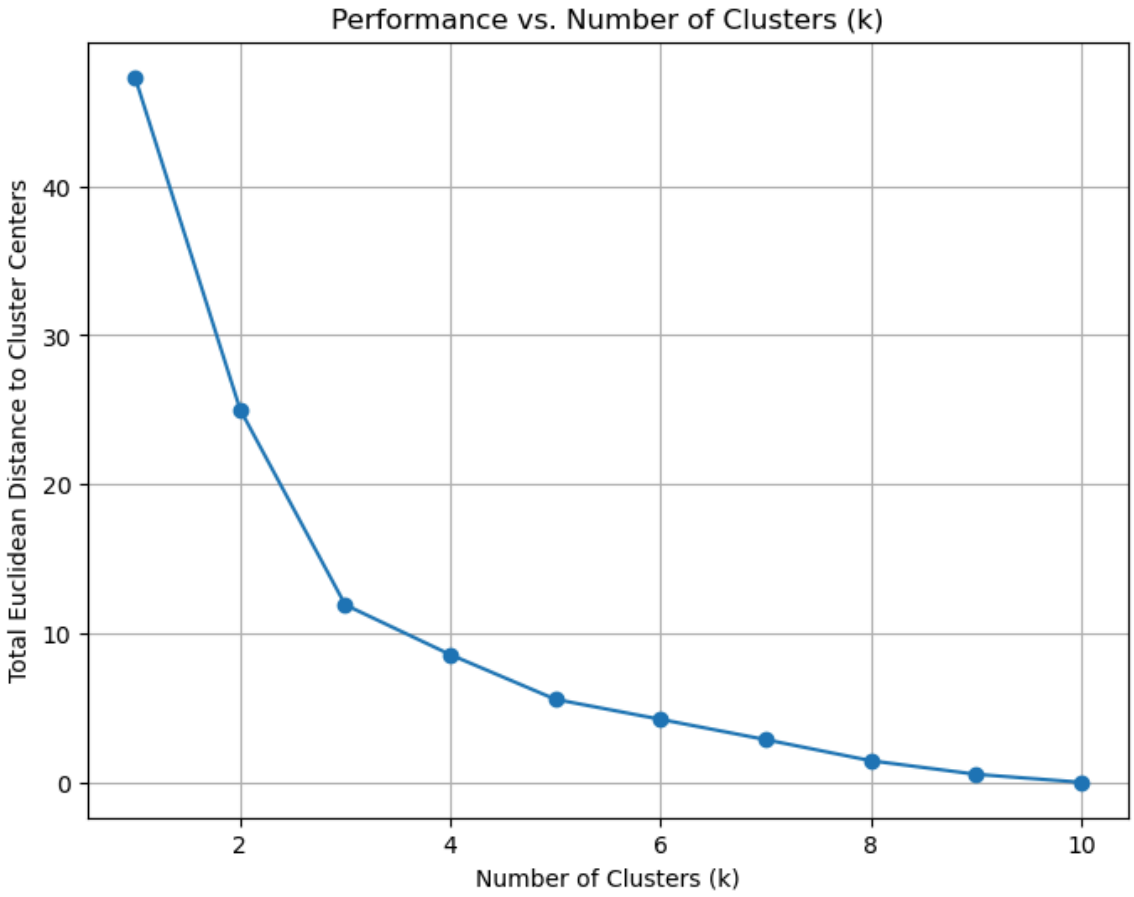
Performance vs. Number of Clusters (k)
Total Euclidean Distance to Cluster Centers
Number of Clusters (k)
0
10
20
30
40
2
4
6
8
10

In [ ]:

In [ ]: