In [23]:
```python
import pandas as pd
import numpy as np
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
import seaborn as sn
```

In [2]:
```python
wine=pd.read_csv('wine.csv')
wine
```

Out[2]:

	Type	Alcohol	Malic	Ash	Alcalinity	Magnesium	Phenols	Flavanoids	Nonflavanoids	Proanthocyanins	Color	Hue	Dilution	Proline
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	1065
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	1050
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	1185
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	1480
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	735
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74	740
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56	750
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56	835
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62	840
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60	560

178 rows × 14 columns

In [3]:
```python
wine.head()
```

Out[3]:

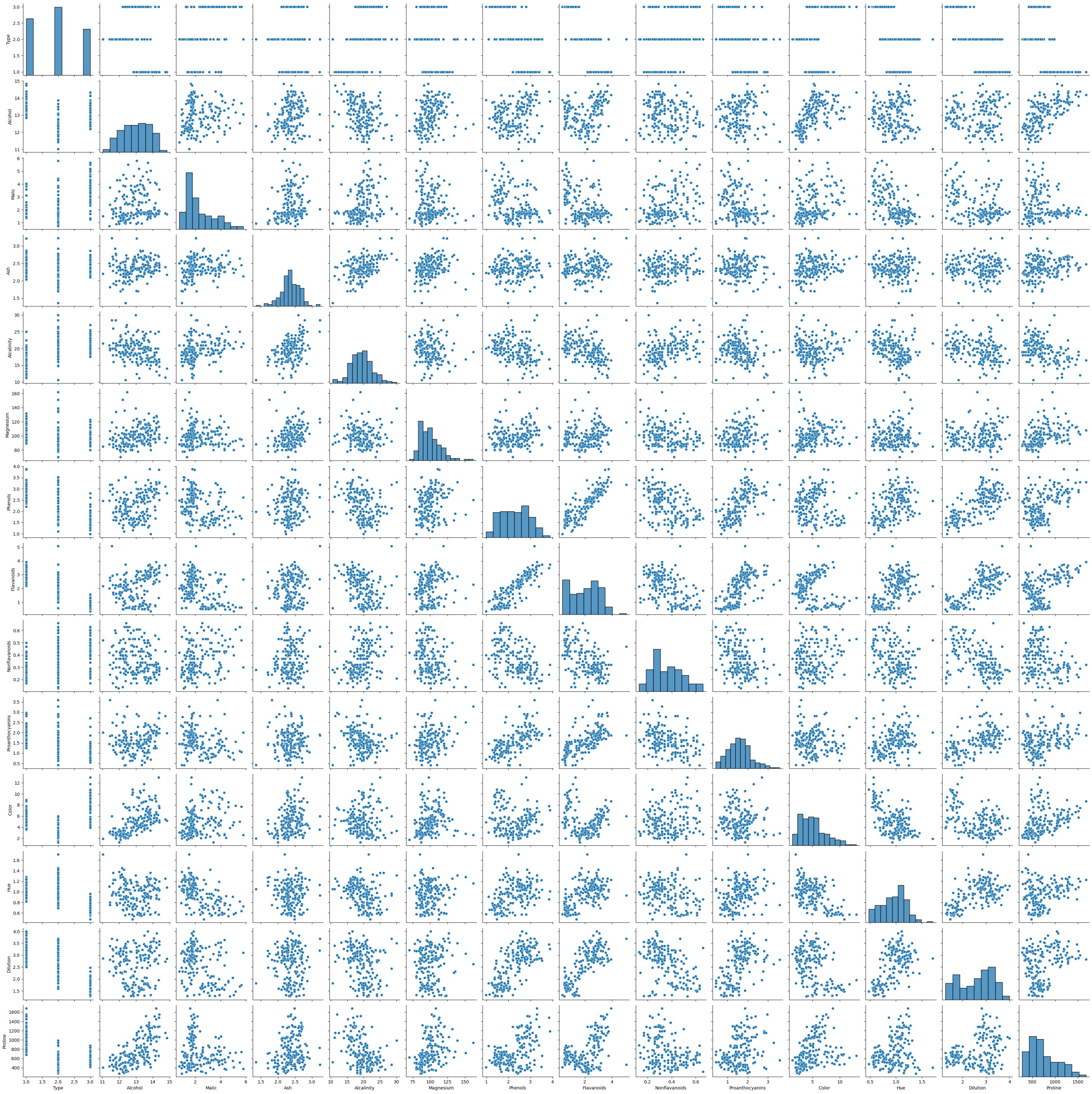
	Type	Alcohol	Malic	Ash	Alcalinity	Magnesium	Phenols	Flavanoids	Nonflavanoids	Proanthocyanins	Color	Hue	Dilution	Proline
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	1065
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	1050
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	1185
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	1480
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	735

In [4]:
```python
wine.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 178 entries, 0 to 177
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Type             178 non-null    int64  
 1   Alcohol          178 non-null    float64
 2   Malic            178 non-null    float64
 3   Ash              178 non-null    float64
 4   Alcalinity       178 non-null    float64
 5   Magnesium        178 non-null    int64  
 6   Phenols          178 non-null    float64
 7   Flavanoids       178 non-null    float64
 8   Nonflavanoids    178 non-null    float64
 9   Proanthocyanins  178 non-null    float64
 10  Color            178 non-null    float64
 11  Hue              178 non-null    float64
 12  Dilution         178 non-null    float64
 13  Proline          178 non-null    int64  
dtypes: float64(11), int64(3)
memory usage: 19.6 KB
```

In [5]:
```python
sn.pairplot(wine)
```

Out[5]:
```
<seaborn.axisgrid.PairGrid at 0x208540e3dc0>
```



In [6]:

```
wine.data = wine.iloc[:,1:]
data =wine.data.values
data
```

```
C:\Users\ROHIT\AppData\Local\Temp\ipykernel_19804\2901724688.py:1: UserWarning: Pandas doesn't allow columns to be created via a new attribute name - see https://pandas.pydata.org/pandas-docs/stable/indexing.html#attribute-access
  wine.data = wine.iloc[:,1:]
```

Out[6]:
```
array([[1.423e+01, 1.710e+00, 2.430e+00, ..., 1.040e+00, 3.920e+00,
        1.065e+03],
       [1.320e+01, 1.780e+00, 2.140e+00, ..., 1.050e+00, 3.400e+00,
        1.050e+03],
       [1.316e+01, 2.360e+00, 2.670e+00, ..., 1.030e+00, 3.170e+00,
        1.185e+03],
       ...,
       [1.327e+01, 4.280e+00, 2.260e+00, ..., 5.900e-01, 1.560e+00,
        8.350e+02],
       [1.317e+01, 2.590e+00, 2.370e+00, ..., 6.000e-01, 1.620e+00,
        8.400e+02],
       [1.413e+01, 4.100e+00, 2.740e+00, ..., 6.100e-01, 1.600e+00,

        5.600e+02]])
```

In [7]:
```
from sklearn.preprocessing import scale
wine_normal = scale(data)
wine_normal
```

Out[7]:
```
array([[ 1.51861254, -0.5622498 ,  0.23205254, ...,  0.36217728,
         1.84791957,  1.01300893],
       [ 0.24628963, -0.49941338, -0.82799632, ...,  0.40605066,
         1.1134493 ,  0.96524152],
       [ 0.19687903,  0.02123125,  1.10933436, ...,  0.31830389,
         0.78858745,  1.39514818],
       ...,
       [ 0.33275817,  1.74474449, -0.38935541, ..., -1.61212515,
        -1.48544548,  0.28057537],
       [ 0.20923168,  0.22769377,  0.01273209, ..., -1.56825176,
        -1.40069891,  0.29649784],
       [ 1.39508604,  1.58316512,  1.36520822, ..., -1.52437837,
        -1.42894777, -0.59516041]])
```

In [8]:
```
pca = PCA(n_components = 13)
pca_values = pca.fit_transform(wine_normal)
pca_values
```

Out[8]:
```
array([[ 3.31675081e+00, -1.44346263e+00, -1.65739045e-01, ...,
        -4.51563395e-01,  5.40810414e-01, -6.62386309e-02],
       [ 2.20946492e+00,  3.33392887e-01, -2.02645737e+00, ...,
        -1.42657306e-01,  3.88237741e-01,  3.63650247e-03],
       [ 2.51674015e+00, -1.03115130e+00,  9.82818670e-01, ...,
        -2.86672847e-01,  5.83573183e-04,  2.17165104e-02],
       ...,
       [-2.67783946e+00, -2.76089913e+00, -9.40941877e-01, ...,
         5.12492025e-01,  6.98766451e-01,  7.20776948e-02],
       [-2.38701709e+00, -2.29734668e+00, -5.50696197e-01, ...,
         2.99821968e-01,  3.39820654e-01, -2.18657605e-02],
       [-3.20875816e+00, -2.76891957e+00,  1.01391366e+00, ...,
        -2.29964331e-01, -1.88787963e-01, -3.23964720e-01]])
```

In [9]:
```
pca.components_
```

Out[9]:
```
array([[ 0.1443294 , -0.24518758, -0.00205106, -0.23932041,  0.14199204,
         0.39466085,  0.4229343 , -0.2985331 ,  0.31342949, -0.0886167 ,
         0.29671456,  0.37616741,  0.28675223],
       [-0.48365155, -0.22493093, -0.31606881,  0.0105905 , -0.299634  ,
        -0.06503951,  0.00335981, -0.02877949, -0.03930172, -0.52999567,
         0.27923515,  0.16449619, -0.36490283],
       [-0.20738262,  0.08901289,  0.6262239 ,  0.61208035,  0.13075693,
         0.14617896,  0.1506819 ,  0.17036816,  0.14945431, -0.13730621,
         0.08522192,  0.16600459, -0.12674592],
       [-0.0178563 ,  0.53689028, -0.21417556,  0.06085941, -0.35179658,
         0.19806835,  0.15229479, -0.20330102,  0.39905653,  0.06592568,
        -0.42777141,  0.18412074, -0.23207086],
       [-0.26566365,  0.03521363, -0.14302547,  0.06610294,  0.72704851,
        -0.14931841, -0.10902584, -0.50070298,  0.13685982, -0.07643678,
        -0.17361452, -0.10116099, -0.1578688 ],
       [-0.21353865, -0.53681385, -0.15447466,  0.10082451, -0.03814394,
         0.0841223 ,  0.01892002,  0.25859401,  0.53379539,  0.41864414,
        -0.10598274, -0.26585107, -0.11972557],
       [-0.05639636,  0.42052391, -0.14917061, -0.28696914,  0.3228833 ,
        -0.02792498, -0.06068521,  0.59544729,  0.37213935, -0.22771214,
         0.23207564, -0.0447637 ,  0.0768045 ],
       [-0.39613926, -0.06582674,  0.17026002, -0.42797018,  0.15636143,
         0.40593409,  0.18724536,  0.23328465, -0.36822675,  0.03379692,
        -0.43662362,  0.07810789, -0.12002267],
       [ 0.50861912, -0.07528304, -0.30769445,  0.20044931,  0.27140257,
         0.28603452,  0.04957849,  0.19550132, -0.20914487,  0.05621752,
         0.08582839,  0.1372269 , -0.57578611],
       [ 0.21160473, -0.30907994, -0.02712539,  0.05279942,  0.06787022,
        -0.32013135, -0.16315051,  0.21553507,  0.1341839 , -0.29077518,
        -0.52239889,  0.52370587,  0.162116  ],
       [-0.22591696,  0.07648554, -0.49869142,  0.47931378,  0.07128891,
         0.30434119, -0.02569409,  0.11689586, -0.23736257,  0.0318388 ,
        -0.04821201,  0.0464233 ,  0.53926983],
       [-0.26628645,  0.12169604, -0.04962237, -0.05574287,  0.06222011,
        -0.30388245, -0.04289883,  0.04235219, -0.09555303,  0.60422163,
         0.259214  ,  0.60095872, -0.07940162],
       [ 0.01496997,  0.02596375, -0.14121803,  0.09168285,  0.05677422,
        -0.46390791,  0.83225706,  0.11403985, -0.11691707, -0.0119928 ,
        -0.08988884, -0.15671813,  0.01444734]])
```

In [10]:
```python
var = pca.explained_variance_ratio_
var
```

Out[10]:
```
array([0.36198848, 0.1920749 , 0.11123631, 0.0706903 , 0.06563294,
       0.04935823, 0.04238679, 0.02680749, 0.02222153, 0.01930019,
       0.01736836, 0.01298233, 0.00795215])
```

In [12]:
```python
var1 = np.cumsum(np.round(var,decimals = 4)*100)
var1
```

Out[12]:
```
array([ 36.2 ,  55.41,  66.53,  73.6 ,  80.16,  85.1 ,  89.34,  92.02,
        94.24,  96.17,  97.91,  99.21, 100.01])
```

In [13]:
```python
plt.plot(var1,color="red")
```

Out[13]:
```
[<matplotlib.lines.Line2D at 0x20864cc4af0>]
```

In [14]:
```python
pca_values[:,0:1]
```

Out[14]:
```
array([[ 3.31675081],
       [ 2.20946492],
       [ 2.51674015],
       [ 3.75706561],
       [ 1.00890849],
       [ 3.05025392],
       [ 2.44908967],
       [ 2.05943687],
       [ 2.5108743 ],
       [ 2.75362819],
       [ 3.47973668],
       [ 1.7547529 ],
       [ 2.11346234],
       [ 3.45815682],
       [ 4.31278391],
       [ 2.3051882 ],
       [ 2.17195527],
       [ 1.89897118],
       [ 3.54198508],
       [ 2.0845222 ],
       [ 3.12440254],
       [ 1.08657007],
       [ 2.53522408],
       [ 1.64498834],
       [ 1.76157587],
       [ 0.9900791 ],
       [ 1.77527763],
       [ 1.23542396],
       [ 2.18840633],
       [ 2.25610898],
```

```
[ 2.50022003],
[ 2.67741105],
[ 1.62857912],
[ 1.90269086],
[ 1.41038853],
[ 1.90382623],
[ 1.38486223],
[ 1.12220741],
[ 1.5021945 ],
[ 2.52980109],
[ 2.58809543],
[ 0.66848199],
[ 3.07080699],
[ 0.46220914],
[ 2.10135193],
[ 1.13616618],
[ 2.72660096],
[ 2.82133927],
[ 2.00985085],
[ 2.7074913 ],
[ 3.21491747],
[ 2.85895983],
[ 3.50560436],
[ 2.22479138],
[ 2.14698782],
[ 2.46932948],
[ 2.74151791],
[ 2.17374092],
[ 3.13938015],
[-0.92858197],
[-1.54248014],
[-1.83624976],
[ 0.03060683],
[ 2.05026161],
[-0.60968083],
[ 0.90022784],
[ 2.24850719],
[ 0.18338403],
[-0.81280503],
[ 1.9756205 ],
[-1.57221622],
[ 1.65768181],
[-0.72537239],
[ 2.56222717],
[ 1.83256757],
[-0.8679929 ],
[ 0.3700144 ],
[-1.45737704],
[ 1.26293085],
[ 0.37615037],
[ 0.7620639 ],
[ 1.03457797],
[-0.49487676],
[-2.53897708],
[ 0.83532015],
[ 0.78790461],
[-0.80683216],
[-0.55804262],
[-1.11511104],
[-0.55572283],
[-1.34928528],
[-1.56448261],
[-1.93255561],
[ 0.74666594],
[ 0.95745536],
[ 2.54386518],
[-0.54395259],
[ 1.03104975],
[ 2.25190942],
[ 1.41021602],
[ 0.79771979],
[-0.54953173],
[-0.16117374],
[-0.65979494],
[ 0.39235441],
[-1.77249908],
[-0.36626736],
[-1.62067257],
[ 0.08253578],
[ 1.57827507],
[ 1.42056925],
[-0.27870275],
[-1.30314497],
[-0.45707187],
[-0.49418585],
[ 0.48207441],
[-0.25288888],
[-0.10722764],
[-2.4330126 ],
```

```
       [-0.55108954],
       [ 0.73962193],
       [ 1.33632173],
       [-1.177087  ],
       [-0.46233501],
       [ 0.97847408],
       [-0.09680973],
       [ 0.03848715],
       [-1.5971585 ],
       [-0.47956492],
       [-1.79283347],
       [-1.32710166],
       [-2.38450083],
       [-2.9369401 ],
       [-2.14681113],
       [-2.36986949],
       [-3.06384157],
       [-3.91575378],
       [-3.93646339],
       [-3.09427612],
       [-2.37447163],
       [-2.77881295],
       [-2.28656128],
       [-2.98563349],
       [-2.3751947 ],
       [-2.20986553],
       [-2.625621  ],
       [-4.28063878],
       [-3.58264137],
       [-2.80706372],
       [-2.89965933],
       [-2.32073698],
       [-2.54983095],
       [-1.81254128],
       [-2.76014464],
       [-2.7371505 ],
       [-3.60486887],
       [-2.889826  ],
       [-3.39215608],
       [-1.0481819 ],
       [-1.60991228],
       [-3.14313097],
       [-2.2401569 ],
       [-2.84767378],
       [-2.59749706],
       [-2.94929937],
       [-3.53003227],
       [-2.40611054],
       [-2.92908473],
       [-2.18141278],
       [-2.38092779],
       [-3.21161722],
       [-3.67791872],
       [-2.4655558 ],
       [-3.37052415],
       [-2.60195585],
       [-2.67783946],
       [-2.38701709],
       [-3.20875816]])
```

In [15]:

```
final_df = pd.concat([pd.DataFrame(pca_values[:,0:3],columns=['pc1','pc2','pc3']),wine['Type']], axis=1)
final_df
```

Out[15]:

	pc1	pc2	pc3	Type
0	3.316751	-1.443463	-0.165739	1
1	2.209465	0.333393	-2.026457	1
2	2.516740	-1.031151	0.982819	1
3	3.757066	-2.756372	-0.176192	1
4	1.008908	-0.869831	2.026688	1
...	...	...	...	...
173	-3.370524	-2.216289	-0.342570	3
174	-2.601956	-1.757229	0.207581	3
175	-2.677839	-2.760899	-0.940942	3
176	-2.387017	-2.297347	-0.550696	3
177	-3.208758	-2.768920	1.013914	3

178 rows × 4 columns

In [16]:

```
sn.scatterplot(data=final_df,x='pc1',y='pc2',hue='Type',s = 100)
```

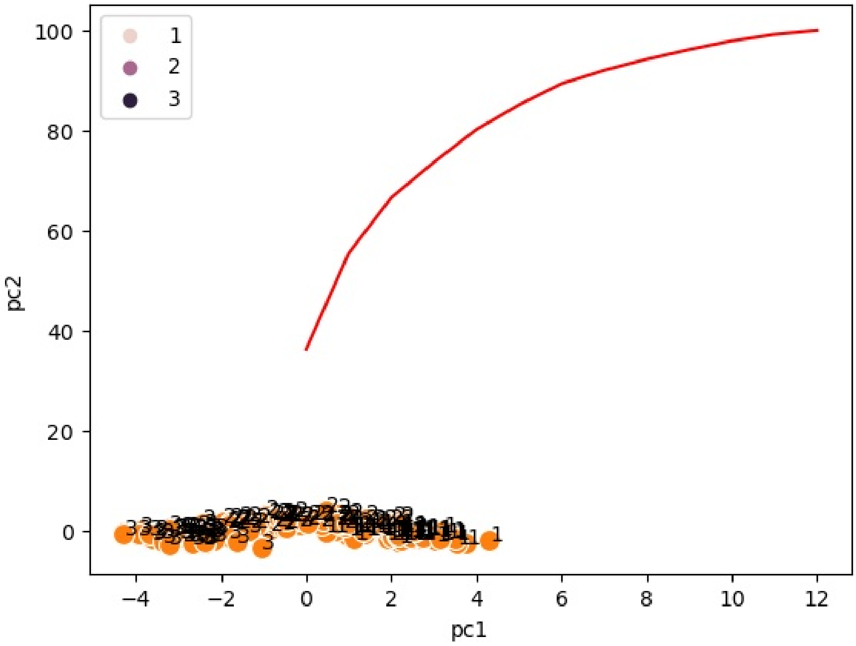
Out[16]: <AxesSubplot:xlabel='pc1', ylabel='pc2'>

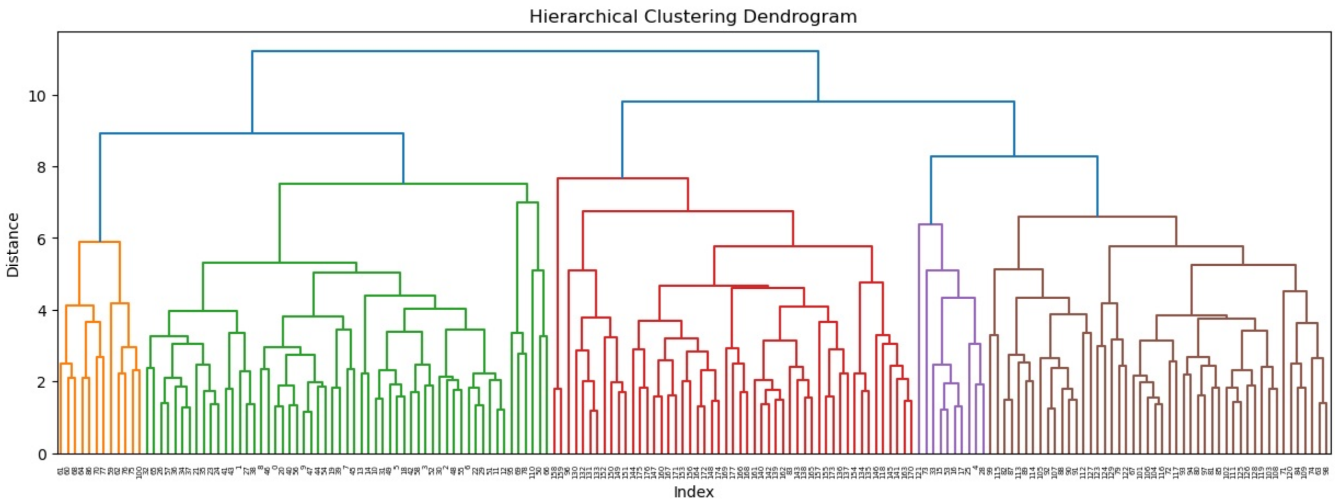
In [17]:
```
p1 = sn.scatterplot(data=final_df,x='pc1',y='pc2',s = 100)
for line in range(0,final_df.shape[0]):
     p1.text(final_df.pc1[line], final_df.pc2[line], final_df.Type[line], horizontalalignment='left', size='med
```

In [18]:
```
from sklearn.cluster import KMeans
from scipy.cluster.hierarchy import linkage
import scipy.cluster.hierarchy as sch
from sklearn.cluster import AgglomerativeClustering
import warnings
warnings.filterwarnings('ignore')
```

In [ ]:

In [20]:
```
p = np.array(wine_normal)
z = linkage(wine_normal, method="complete",metric="euclidean")
plt.figure(figsize=(15, 5))
plt.title('Hierarchical Clustering Dendrogram')
plt.xlabel('Index')
plt.ylabel('Distance')
sch.dendrogram(z,)
plt.show()
```





In [24]:
```
h_complete = AgglomerativeClustering(n_clusters=3, linkage='complete',affinity = "euclidean").fit(wine_normal)
cluster_labels=pd.Series(h_complete.labels_)
cluster_labels
wine['clust']=cluster_labels # creating a  new column and assigning it to new column
wine
```

Out[24]:

	Type	Alcohol	Malic	Ash	Alcalinity	Magnesium	Phenols	Flavanoids	Nonflavanoids	Proanthocyanins	Color	Hue	Dilution	Proline
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	1065
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	1050
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	1185
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	1480
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	735
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74	740
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56	750
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56	835
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62	840
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60	560

178 rows × 15 columns

In [25]:

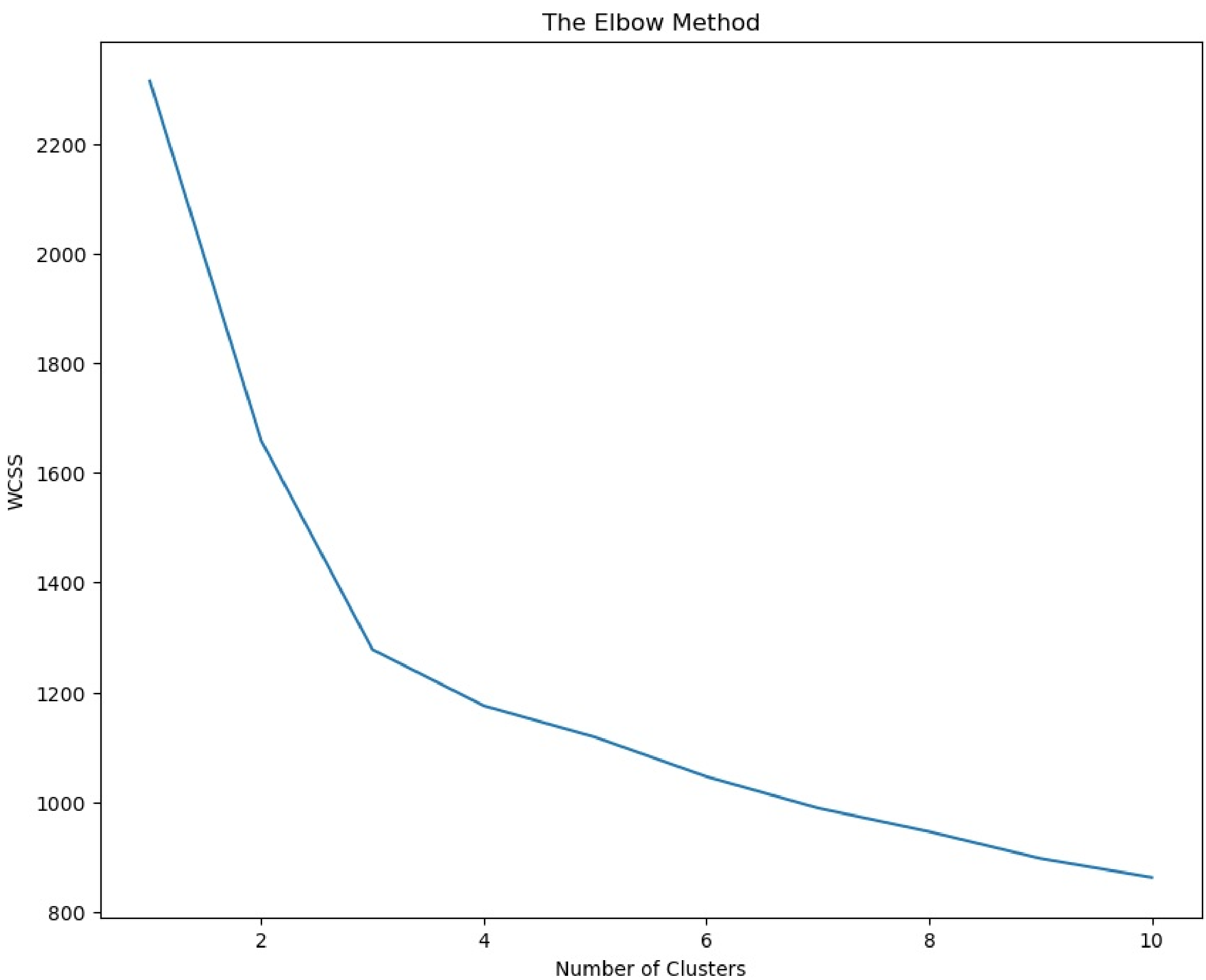
```
data = wine[(wine.clust==3)]
data
```

Out[25]:

Type	Alcohol	Malic	Ash	Alcalinity	Magnesium	Phenols	Flavanoids	Nonflavanoids	Proanthocyanins	Color	Hue	Dilution	Proline	clu

In [26]:

```
fig = plt.figure(figsize=(10, 8))
WCSS = []
for i in range(1, 11):
    clf = KMeans(n_clusters=i)
    clf.fit(wine_normal)
    WCSS.append(clf.inertia_)
plt.plot(range(1, 11), WCSS)
plt.title('The Elbow Method')
plt.ylabel('WCSS')
plt.xlabel('Number of Clusters')
plt.show()
```



In [27]:

```
WCSS
```

Out[27]:
```
[2314.0,
 1659.0079672511501,
 1277.928488844642,
 1175.428333103347,
 1118.3178115480703,
 1046.3669940024863,
 989.1916562037078,
 946.1044545256149,
 897.1892832593963,
 862.6305523869835]
```

In [28]:
```
clf = KMeans(n_clusters=3)
y_kmeans = clf.fit_predict(wine_normal)
```

In [29]:
```
y_kmeans
clf.labels_
```

Out[29]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 2, 1, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 1, 2, 2, 0, 2, 2, 2, 2, 2, 2, 2, 2, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1])
```

In [30]:
```
clf.cluster_centers_
```

Out[30]:
```
array([[ 0.83523208, -0.30380968,  0.36470604, -0.61019129,  0.5775868 ,
         0.88523736,  0.97781956, -0.56208965,  0.58028658,  0.17106348,
         0.47398365,  0.77924711,  1.12518529],
       [ 0.16490746,  0.87154706,  0.18689833,  0.52436746, -0.07547277,
        -0.97933029, -1.21524764,  0.72606354, -0.77970639,  0.94153874,
        -1.16478865, -1.29241163, -0.40708796],
       [-0.92607185, -0.39404154, -0.49451676,  0.17060184, -0.49171185,
        -0.07598265,  0.02081257, -0.03353357,  0.0582655 , -0.90191402,
         0.46180361,  0.27076419, -0.75384618]])
```

In [31]:
```
clf.inertia_
```

Out[31]:
```
1277.928488844642
```

In [32]:
```
md=pd.Series(y_kmeans)
wine['clust']=md
wine
```

Out[32]:

	Type	Alcohol	Malic	Ash	Alcalinity	Magnesium	Phenols	Flavanoids	Nonflavanoids	Proanthocyanins	Color	Hue	Dilution	Proline
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	1065
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	1050
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	1185
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	1480
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	735
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74	740
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56	750
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56	835
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62	840
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60	560

178 rows × 15 columns

In [33]:
```
WCSS
```

Out[33]:

```
[2314.0,
 1659.0079672511501,
 1277.928488844642,
 1175.428333103347,
 1118.3178115480703,
 1046.3669940024863,
 989.1916562037078,
 946.1044545256149,
 897.1892832593963,
 862.6305523869835]
```


In [ ]: