In [1]:
```python
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, MinMaxScaler
from sklearn.feature_extraction.text import CountVectorizer
import random
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA
from sklearn.mixture import GaussianMixture
from sklearn.cluster import KMeans
import pickle
from gensim.parsing.preprocessing import remove_stopwords
from sklearn.feature_extraction.text import TfidfVectorizer
```

In [27]:
```python
path = '/Data/contents_dict.txt'
with open(path, "rb") as fp:
  contents_load = pickle.load(fp)
```

In [28]:
```python
n = len(list(contents_load.keys()))
df = pd.DataFrame(columns=['content', 'class'], index=range(0, n))
for i in range(0, n):
  df['content'].iloc[i] = remove_stopwords(contents_load[i][0]).replace('said', '').replace('year', '') #Clean the stopwords
  df['class'].iloc[i] = contents_load[i][1]
df
```

Out[28]:

	content	class
0	Ask Jeeves tips online ad revival Ask Jeeves l...	business
1	UK economy facing 'major risks' The UK manufac...	business
2	US rate rise expected US rates expected rise f...	business
3	US Ahold suppliers face charges US prosecutors...	business
4	Egypt sell state-owned bank The Egyptian gover...	business
...	...	...
2220	Confusion high-definition TV Now critical mass...	tech
2221	'No re-draft' EU patent law A proposed Europea...	tech
2222	Hollywood sue net film pirates The US movie in...	tech
2223	Lifestyle 'governs mobile choice' Faster, bett...	tech
2224	US peer-to-peer pirates convicted The convicti...	tech

2225 rows × 2 columns

In [29]:
```python
text_data = np.array(df['content'])
count = CountVectorizer(stop_words='english')
count.fit(text_data)
bag_of_words = count.fit_transform(text_data)
X = bag_of_words.toarray()
X.shape
```

Out[29]: (2225, 29123)

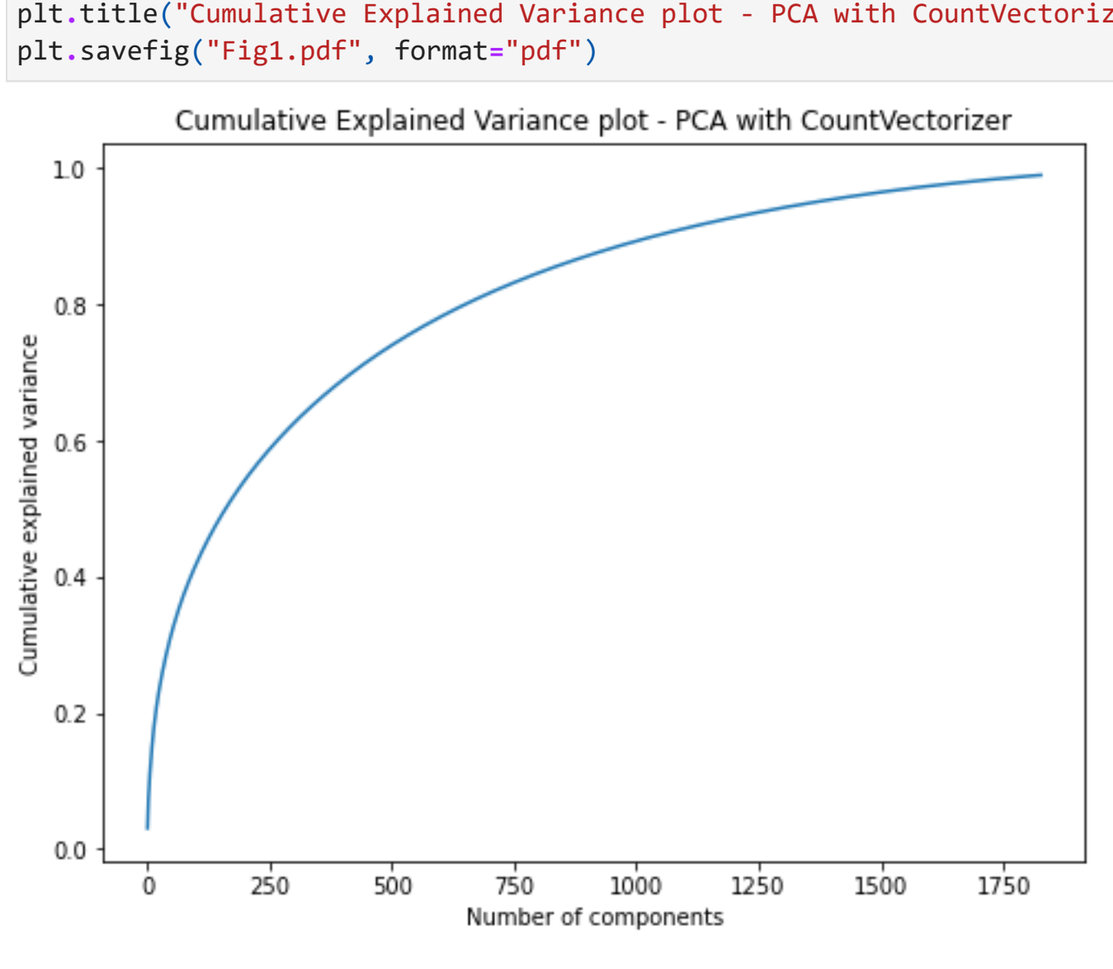
In [30]:
```python
y = list(df['class'])
def encode(item):
  label_dict = {'business': 0, 'entertainment': 1, 'politics': 2, 'sport': 3, 'tech': 4}
  return label_dict[item]
y = list(map(encode, y))
y = np.array(y)
y
```

Out[30]: array([0, 0, 0, ..., 4, 4, 4])

In [31]:
```python
print(X.shape)
print(y.shape)
```

```
(2225, 29123)
(2225,)
```

In [32]:
```python
plt.figure(figsize=(8,6))
plt.plot(np.cumsum(PCA(.99).fit(X).explained_variance_ratio_))
plt.xlabel('Number of components')
plt.ylabel('Cumulative explained variance')
plt.title("Cumulative Explained Variance plot - PCA with CountVectorizer")
plt.savefig("Fig1.pdf", format="pdf")
```

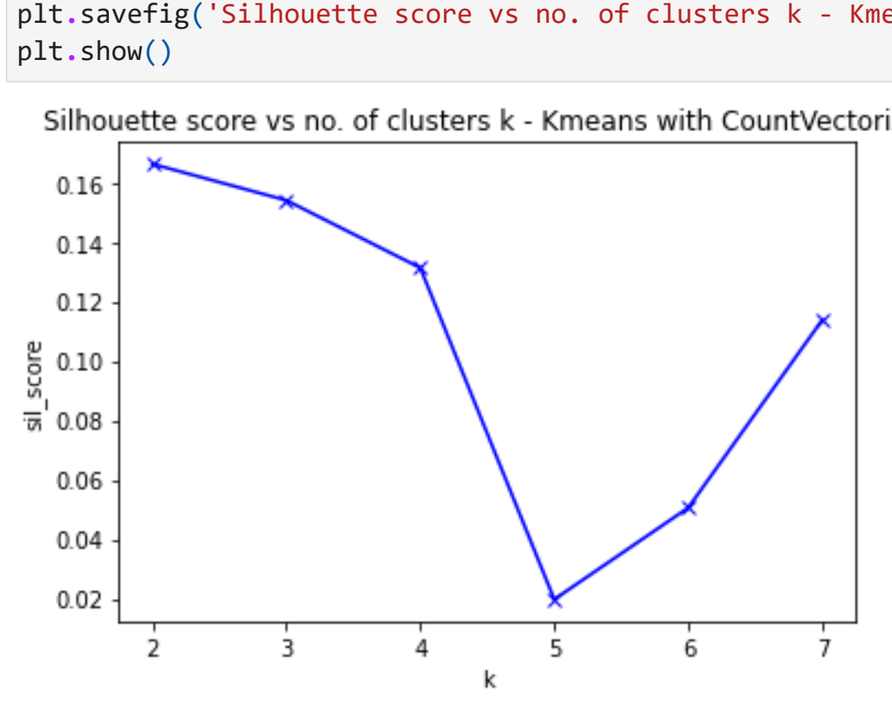


In [33]:
```python
pca = PCA(.90)
pca.fit(X)
X = pca.transform(X)
pca.n_components_
```

Out[33]: 1036

In [37]:
```python
from sklearn import metrics
list_sil = []
K = range(2,8)
for k in K:
  kmeanModel = KMeans(n_clusters=k)
  kmeanModel.fit(X)
  labels = kmeanModel.predict(X)
  sil = metrics.silhouette_score(X, labels, metric = 'euclidean')
  list_sil.append(sil)
```

In [38]:
```python
plt.plot(K, list_sil, 'bx-')
plt.xlabel('k')
plt.ylabel('sil_score')
plt.title('Silhouette score vs no. of clusters k - Kmeans with CountVectorizer')
plt.savefig('Silhouette score vs no. of clusters k - Kmeans with CountVectorizer.pdf', format='pdf')
plt.show()
```



In [41]:
```python
kmeanModel = KMeans(n_clusters=5)
kmeanModel.fit(X)
gmmModel = GaussianMixture(n_components = 5)
gmmModel.fit(X)
```

Out[41]: GaussianMixture(n_components=5)

In [42]:
```python
y_pred_kMean = kmeanModel.predict(X)
y_pred_gmm = gmmModel.predict(X)
from sklearn.metrics import accuracy_score
```

In [43]:
```python
y_pred_kMean = list(y_pred_kMean)
y_pred_gmm = list(y_pred_gmm)
```

In [44]:
```python
df_result = df
df_result['class_pred'] = y_pred_kMean #Experiments using wordcloud with results from Kmeans and GMM shows that KMean isolated topics much better
```

In [45]:
```python
from wordcloud import WordCloud
```

In [46]:
```python
for c in [0, 1, 2, 3, 4]:
  text = ''
  for i in range(0, n):
    if df_result['class_pred'].iloc[i] == c:
      text += ' ' + df_result['content'].iloc[i].strip()
  # Create and generate a word cloud image:
  wordcloud = WordCloud(background_color="white").generate(text)

  # Display the generated image:
  plt.imshow(wordcloud, interpolation="bilinear")
  plt.axis("off")
  plt.title(f"Wordcloud_cat {c}_kmeansModel")
  plt.savefig(f"Wordcloud_cat {c}_kmeansModel.pdf", format='pdf')
  plt.show()
```

In [47]:
```python
label_dict_pred = {'business': 1, 'entertainment': 3, 'politics': 2, 'sport': 0, 'tech': 4} #Interpret the topic of each cluster from wordcloud
def convert_class(cl):
  return label_dict_pred[cl]
initial_class_converted = list(map(convert_class, list(df_result['class'])))
```

In [48]:
```python
df_result['class_converted'] = initial_class_converted
df
```

Out[48]:

	content	class	class_pred	class_converted
0	Ask Jeeves tips online ad revival Ask Jeeves l...	business	1	1
1	UK economy facing 'major risks' The UK manufac...	business	1	1
2	US rate rise expected US rates expected rise f...	business	1	1
3	US Ahold suppliers face charges US prosecutors...	business	0	1
4	Egypt sell state-owned bank The Egyptian gover...	business	1	1
...	...	...	...	...
2220	Confusion high-definition TV Now critical mass...	tech	1	4
2221	'No re-draft' EU patent law A proposed Europea...	tech	1	4
2222	Hollywood sue net film pirates The US movie in...	tech	1	4
2223	Lifestyle 'governs mobile choice' Faster, bett...	tech	1	4
2224	US peer-to-peer pirates convicted The convicti...	tech	1	4

2225 rows × 4 columns

In [49]:
```python
y_true = np.array(df['class_converted'])
y_pred = np.array(df['class_pred'])
accuracy_score(y_true, y_pred)
```

Out[49]: 0.5186516853932585

CountVectorizer is not effective --> Let's try TFIDF

In [50]:
```python
#rebuilt data
n = len(list(contents_load.keys()))
df = pd.DataFrame(columns=['content', 'class'], index=range(0, n))
for i in range(0, n):
  df['content'].iloc[i] = remove_stopwords(contents_load[i][0]).replace('said', '').replace('year', '') #Clean the stopwords
  df['class'].iloc[i] = contents_load[i][1]
df
```

Out[50]:

	content	class
0	Ask Jeeves tips online ad revival Ask Jeeves l...	business
1	UK economy facing 'major risks' The UK manufac...	business
2	US rate rise expected US rates expected rise f...	business
3	US Ahold suppliers face charges US prosecutors...	business
4	Egypt sell state-owned bank The Egyptian gover...	business
...	...	...
2220	Confusion high-definition TV Now critical mass...	tech
2221	'No re-draft' EU patent law A proposed Europea...	tech
2222	Hollywood sue net film pirates The US movie in...	tech
2223	Lifestyle 'governs mobile choice' Faster, bett...	tech
2224	US peer-to-peer pirates convicted The convicti...	tech

2225 rows × 2 columns

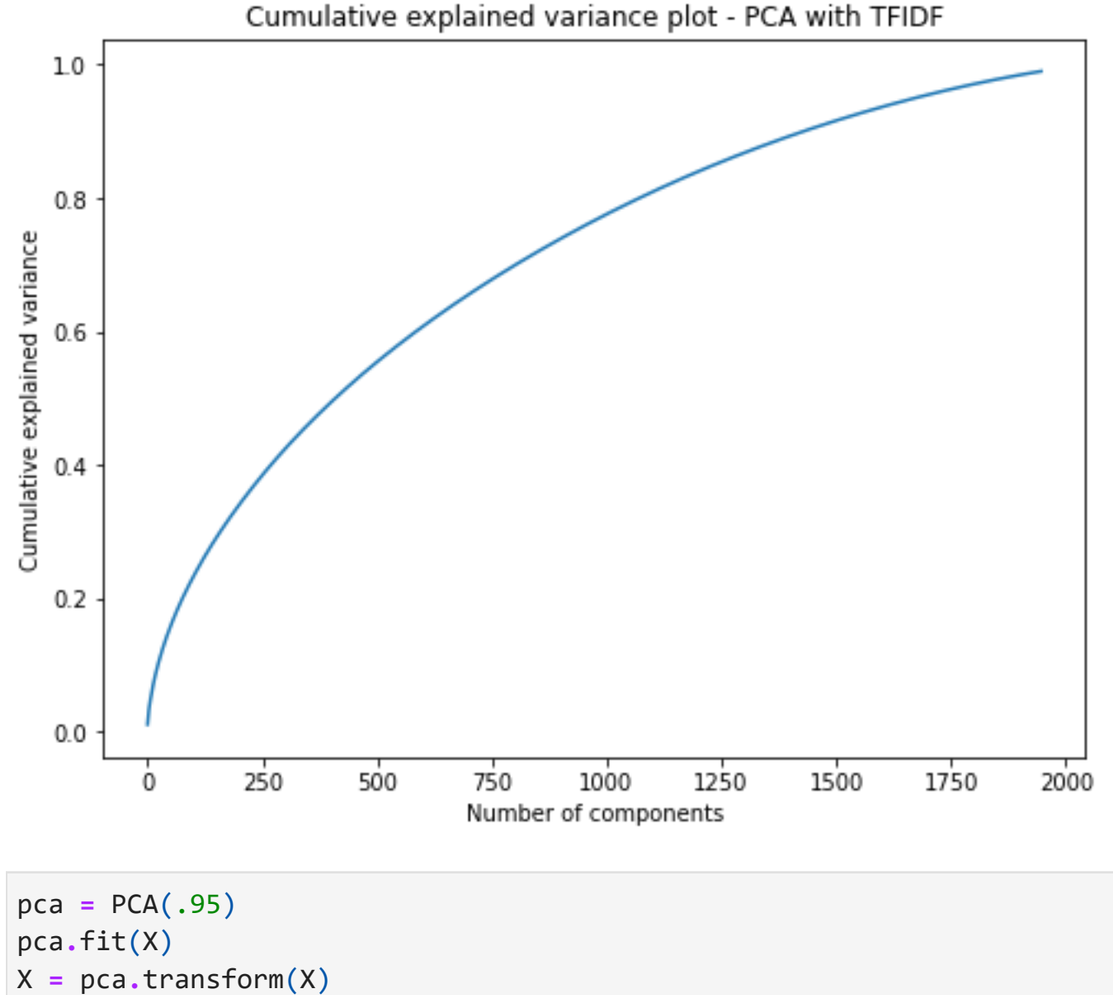
In [51]:
```python
text_data = np.array(df['content'])
count = TfidfVectorizer()
count.fit(text_data)
bag_of_words = count.fit_transform(text_data)
X = bag_of_words.toarray()
X.shape
```

Out[51]: (2225, 29396)

In [52]:
```python
y = list(df['class'])
def encode(item):
  label_dict = {'business': 0, 'entertainment': 1, 'politics': 2, 'sport': 3, 'tech': 4}
  return label_dict[item]
y = list(map(encode, y))
y = np.array(y)
y
```

Out[52]: array([0, 0, 0, ..., 4, 4, 4])

In [53]:
```python
plt.figure(figsize=(8,6))
plt.plot(np.cumsum(PCA(.99).fit(X).explained_variance_ratio_))
plt.xlabel('Number of components')
plt.ylabel('Cumulative explained variance')
plt.title("Cumulative explained variance plot - PCA with TFIDF")
plt.savefig("Cumulative explained variance plot - PCA with TFIDF.pdf", format="pdf")
plt.show()
```



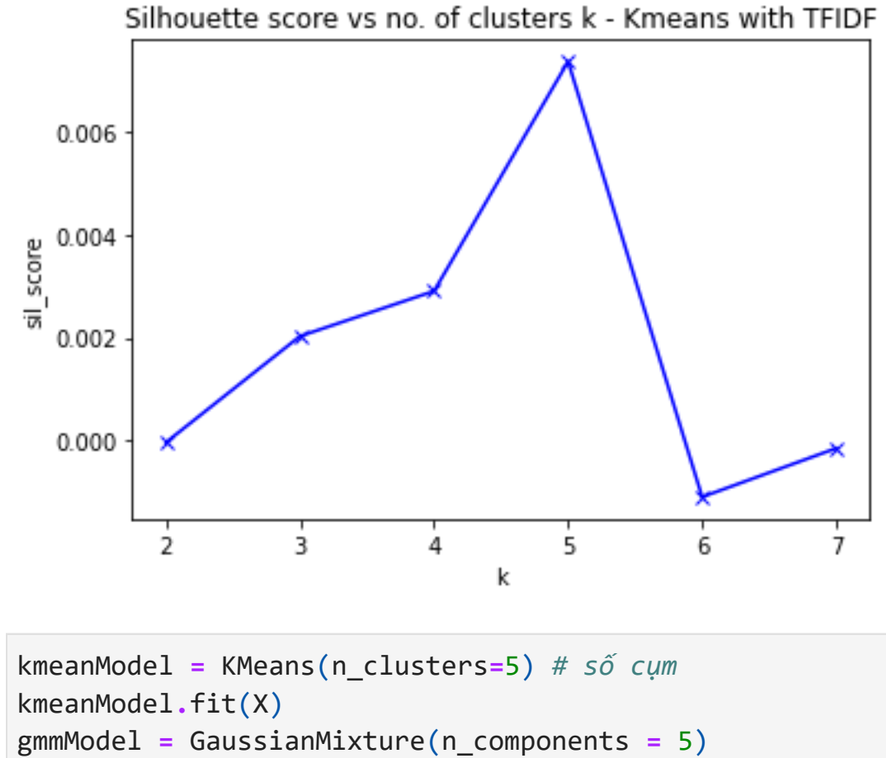
In [54]:
```python
pca = PCA(.95)
pca.fit(X)
X = pca.transform(X)
pca.n_components_
```

Out[54]: 1673

In [59]:
```python
from sklearn import metrics
list_sil = []
K = range(2,8)
for k in K:
  kmeanModel = KMeans(n_clusters=k)
  kmeanModel.fit(X)
  labels = kmeanModel.predict(X)
  sil = metrics.silhouette_score(X, labels, metric = 'euclidean')
  list_sil.append(sil)

plt.plot(K, list_sil, 'bx-')
plt.xlabel('k')
plt.ylabel('sil_score')
plt.title('Silhouette score vs no. of clusters k - Kmeans with TFIDF')
plt.savefig('Silhouette score vs no. of clusters k - Kmeans with TFIDF.pdf', format='pdf')

plt.show()
```



In [60]:
```python
kmeanModel = KMeans(n_clusters=5) # số cụm
kmeanModel.fit(X)
gmmModel = GaussianMixture(n_components = 5)
gmmModel.fit(X)
```

Out[60]: GaussianMixture(n_components=5)

In [61]:
```python
y_pred_kMean = kmeanModel.predict(X)
y_pred_gmm = gmmModel.predict(X)

y_pred_kMean = list(y_pred_kMean)
y_pred_gmm = list(y_pred_gmm)

df_result = df
df_result['class_pred'] = y_pred_kMean #Similar to what said before, Kmeans isolated topics much better at this point
```

In [63]:
```python
from wordcloud import WordCloud

for c in [0, 1, 2, 3, 4]:
  text = ''
  for i in range(0, n):
    if df_result['class_pred'].iloc[i] == c:
      text += ' ' + df_result['content'].iloc[i].strip()
  # Create and generate a word cloud image:
  wordcloud = WordCloud(background_color="white").generate(text)

  # Display the generated image:
  plt.imshow(wordcloud, interpolation="bilinear")
  plt.axis("off")
  plt.title(f"Wordcloud_cat {c}_TFIDFModel")
  plt.savefig(f"Wordcloud_cat {c}_TFIDFModel.pdf", format='pdf')
  plt.show()
```

In [64]:
```python
label_dict_pred = {'business': 0, 'entertainment': 3, 'politics': 1, 'sport': 4, 'tech': 2} #Interpret the topic of each cluster from wordcloud
def convert_class(cl):
  return label_dict_pred[cl]
initial_class_converted = list(map(convert_class, list(df_result['class'])))

df_result['class_converted'] = initial_class_converted

from sklearn.metrics import accuracy_score
y_true = np.array(df_result['class_converted'])
y_pred = np.array(df_result['class_pred'])
accuracy_score(y_true, y_pred)
```

Out[64]: 0.8844943820224719

--> The result of TFIDF is clearly better