OTT REVENUE PREDICTION MODEL

A model to predict the revenue in million dollars based on the number of scubscribers.

Data set:

Independant variable X: Subscribers/Year/Content Spend/Profit
Dependant variable Y: Overall revenue generated in dollars

In [1]:
```
#import required libraries
import numpy as np
import pandas as pd
import os
import seaborn as sns
import matplotlib.pyplot as plt
```

In [2]:
```
#List all files used
for dirname, _, filenames in os.walk(r"C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel"):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\ContentSpend.csv
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\NumSubscribers.csv
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\NumSubscribersByRegion.csv
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\Profit.csv
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\Revenue.csv
C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\RevenueByRegion.csv
```

In [3]:
```
#import datset
df_profit = pd.read_csv(r"C:\Users\vdp10002\OneDrive - Advanced Micro Devices Inc\IISC_project\MainProject_OTTRe
df_subscribers = pd.read_csv(r"C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\NumSubscr
df_revenue = pd.read_csv(r"C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\Revenue.csv")
df_ContentSpend=pd.read_csv(r"C:\Users\vdp10002\Desktop\MainProject_OTTRevenuePredictionModel\Netflix\ContentSpe
#initial exploration of data
df_profit
```

Out[3]:

	Year	Profit
0	2012	0.050
1	2013	0.228
2	2014	0.403
3	2015	0.306
4	2016	0.379
5	2017	0.839
6	2018	1.600
7	2019	2.600
8	2020	4.500

In [4]:
```
df_subscribers
```

Out[4]:

	Year	Subscribers
0	2011	21.5
1	2012	25.7
2	2013	35.6
3	2014	47.9
4	2015	62.7
5	2016	79.9
6	2017	99.0
7	2018	124.3
8	2019	151.5
9	2020	192.9

In [5]:
```
df_revenue
```

Out[5]:

	Year	Revenue
0	2011	3.1
1	2012	3.5
2	2013	4.3
3	2014	5.4
4	2015	6.7
5	2016	8.8
6	2017	11.6
7	2018	15.7
8	2019	20.1
9	2020	24.9

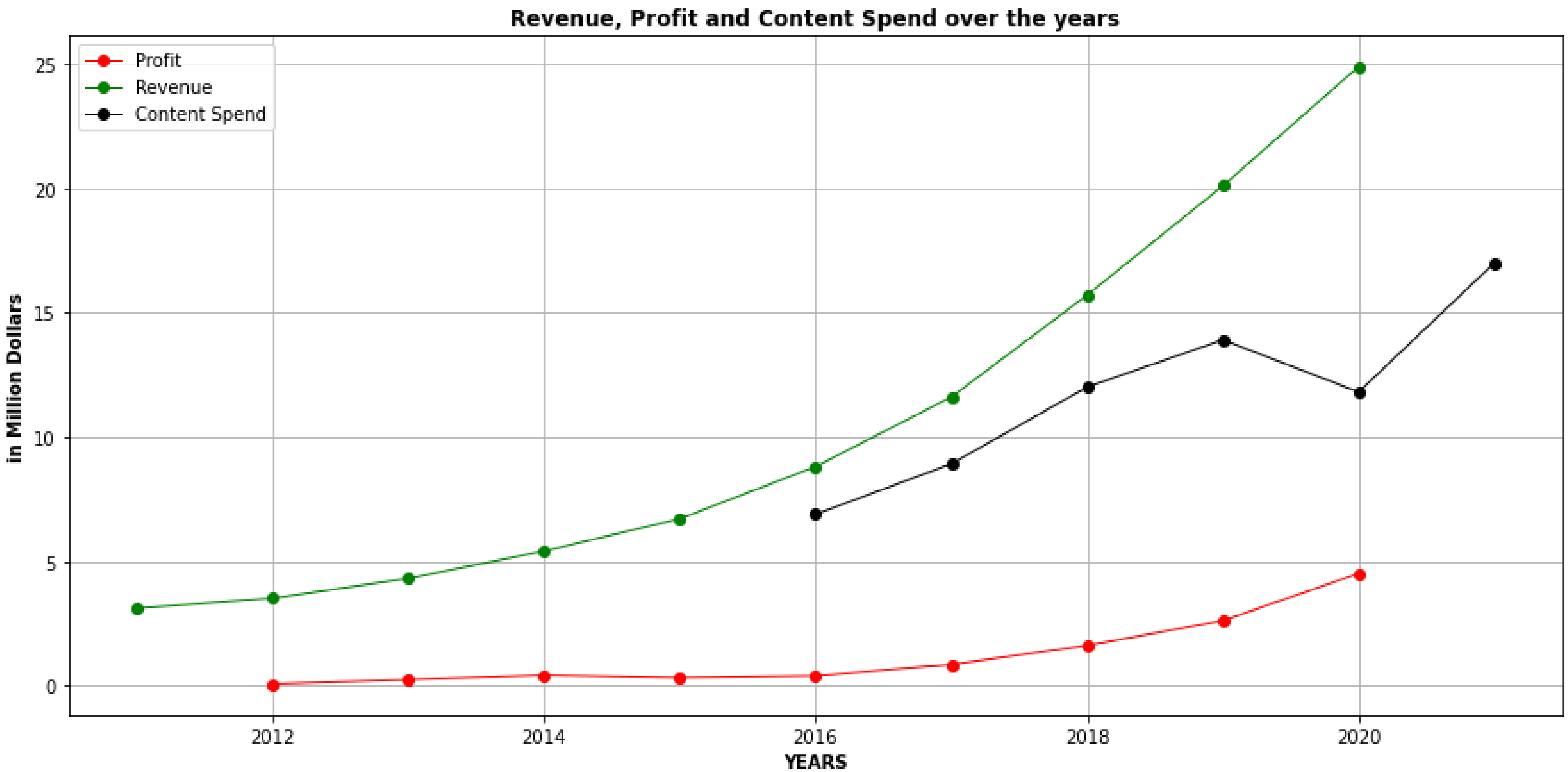
In [6]:
```
df_ContentSpend
```

Out[6]:

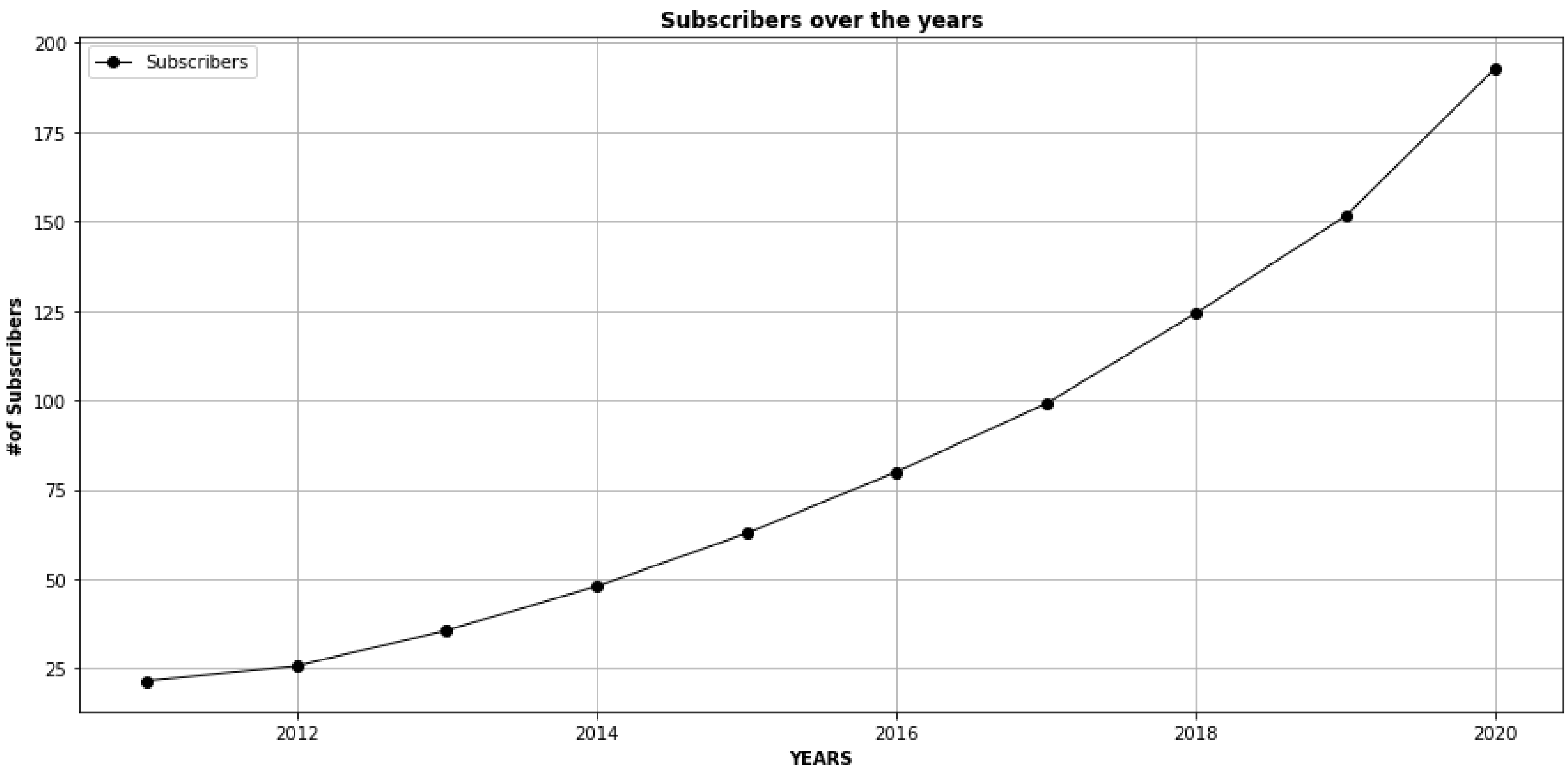
	Year	Content_spend
0	2016	6.88
1	2017	8.91
2	2018	12.00
3	2019	13.90
4	2020	11.80
5	2021	17.00

VISUALIZE DATSET

In [7]:
```
#understanding the trend of Revenue over the years, profit and content spend
x1 = df_profit['Year'].values
y1 = df_profit['Profit'].values

x2=df_subscribers['Year'].values
y2=df_subscribers['Subscribers'].values

x3=df_revenue['Year'].values
y3=df_revenue['Revenue'].values

x4=df_ContentSpend['Year'].values
y4=df_ContentSpend['Content_spend'].values

plt.rcParams["figure.figsize"] = (15,7)

plt.plot(x1, y1, 'red', label='Profit',  marker='o', linestyle='-', linewidth='1')
#plt.plot(x2, y2, 'blue', label='Subscribers')
plt.plot(x3, y3, 'green', label='Revenue',  marker='o', linestyle='-', linewidth='1')
plt.plot(x4, y4, 'black', label='Content Spend',  marker='o', linestyle='-', linewidth='1')

plt.grid()
plt.xlabel('YEARS', fontweight="bold")
plt.ylabel('in Million Dollars', fontweight="bold")
plt.title('Revenue, Profit and Content Spend over the years', fontweight="bold")
plt.legend()
plt.show()
```

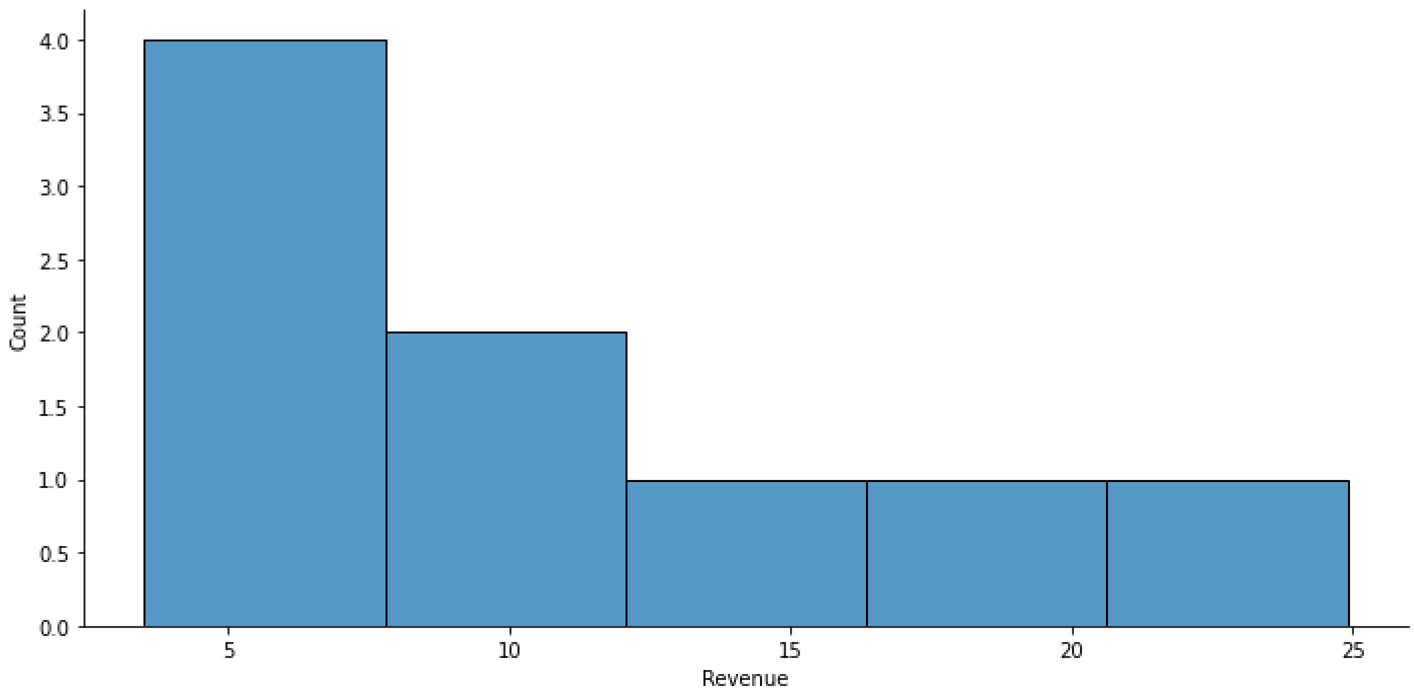

Revenue, Profit and Content Spend over the years
Profit
Revenue
Content Spend
25
20
15
10
5
0
in Million Dollars
2012
2014
2016
2018
2020
YEARS

In [8]:
```
#understanding the trend of Revenue wrt # of Subscribers
x5=df_subscribers['Year'].values
y5=df_subscribers['Subscribers'].values

plt.rcParams["figure.figsize"] = (15,7)

plt.plot(x5, y5, 'black', label='Subscribers', marker='o', linestyle='-', linewidth='1')

plt.grid()
plt.xlabel('YEARS', fontweight="bold")
plt.ylabel('#of Subscribers', fontweight="bold")
plt.title('Subscribers over the years', fontweight="bold")
plt.legend()
plt.show()
```



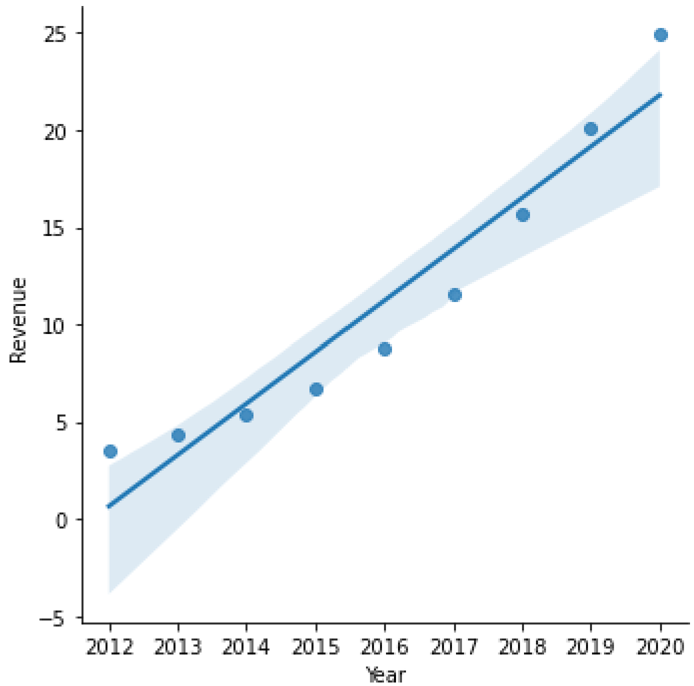
In [9]:
```
df_new = pd.merge(pd.merge(df_profit,df_revenue,on='Year'),df_subscribers,on='Year', how='right')
df_new1 = pd.merge(df_new, df_ContentSpend, on='Year', how='outer')
```

In [10]:
```
# developing a histogram using DISPLOT
sns.displot(data   = df_new1,
            x      = 'Revenue',
            height = 5,
            aspect = 2)


plt.show()
```



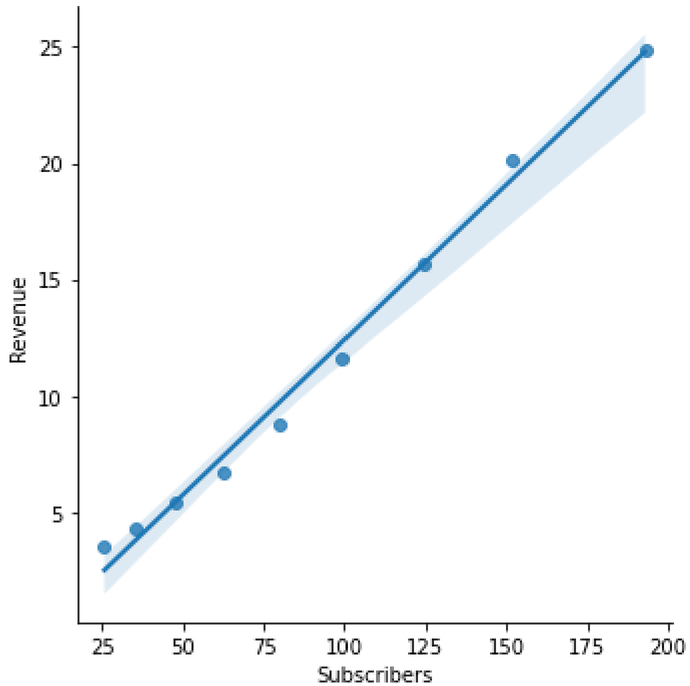
In [11]:
```
sns.lmplot(x='Year', y='Revenue', data=df_new1)
```

Out[11]: <seaborn.axisgrid.FacetGrid at 0x2d69d675f70>



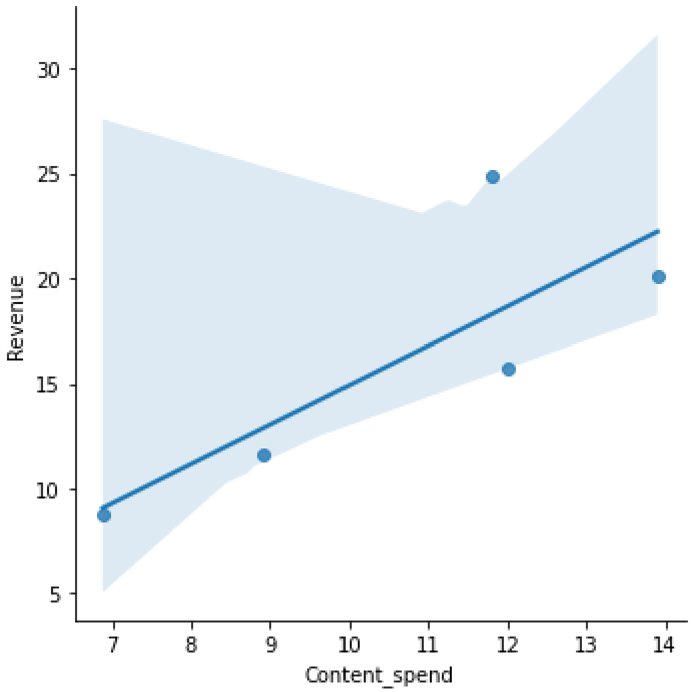
In [12]:
```
sns.lmplot(x='Subscribers', y='Revenue', data=df_new1)
```

Out[12]:
```
<seaborn.axisgrid.FacetGrid at 0x2d69db47190>
```



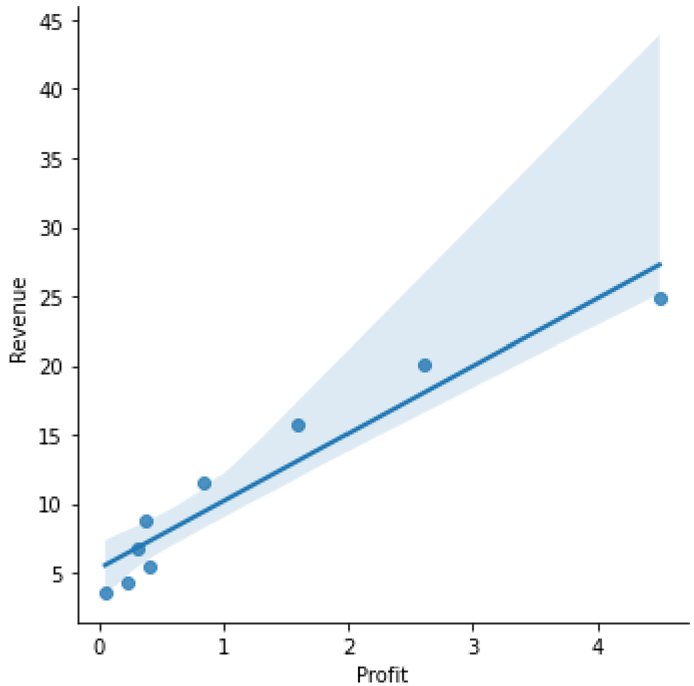
In [13]:
```
sns.lmplot(x='Content_spend', y='Revenue', data=df_new1)
```

Out[13]: <seaborn.axisgrid.FacetGrid at 0x2d69e488c10>



In [14]:
```
sns.lmplot(x='Profit', y='Revenue', data=df_new1)
```

Out[14]:
```
<seaborn.axisgrid.FacetGrid at 0x2d69e4faf10>
```



MISSING VALUE ANALYSIS AND IMPUTATION

In [15]:
```
df_new1.isnull()
```

Out[15]:

	Year	Profit	Revenue	Subscribers	Content_spend
0	False	True	True	False	True
1	False	False	False	False	True
2	False	False	False	False	True
3	False	False	False	False	True
4	False	False	False	False	True
5	False	False	False	False	False
6	False	False	False	False	False
7	False	False	False	False	False
8	False	False	False	False	False
9	False	False	False	False	False
10	False	True	True	True	False

In [16]:
```
df_new1
```

Out[16]:

	Year	Profit	Revenue	Subscribers	Content_spend
0	2011	NaN	NaN	21.5	NaN
1	2012	0.050	3.5	25.7	NaN
2	2013	0.228	4.3	35.6	NaN
3	2014	0.403	5.4	47.9	NaN
4	2015	0.306	6.7	62.7	NaN
5	2016	0.379	8.8	79.9	6.88
6	2017	0.839	11.6	99.0	8.91
7	2018	1.600	15.7	124.3	12.00
8	2019	2.600	20.1	151.5	13.90
9	2020	4.500	24.9	192.9	11.80
10	2021	NaN	NaN	NaN	17.00

In [17]:
```
## Replace all NaN values with 0
#df_new2= df_new1.fillna(0)
#df_new2
df_new2=df_new1
from sklearn.impute import SimpleImputer
imputer = SimpleImputer(missing_values=np.NaN, strategy='median')
print(imputer)
df_new2.Profit = imputer.fit_transform(df_new2['Profit'].values.reshape(-1,1))
df_new2.Revenue = imputer.fit_transform(df_new2['Revenue'].values.reshape(-1,1))
df_new2.Subscribers = imputer.fit_transform(df_new2['Subscribers'].values.reshape(-1,1))
df_new2.Content_spend = imputer.fit_transform(df_new2['Content_spend'].values.reshape(-1,1))
df_new2
```

```
SimpleImputer(strategy='median')
```

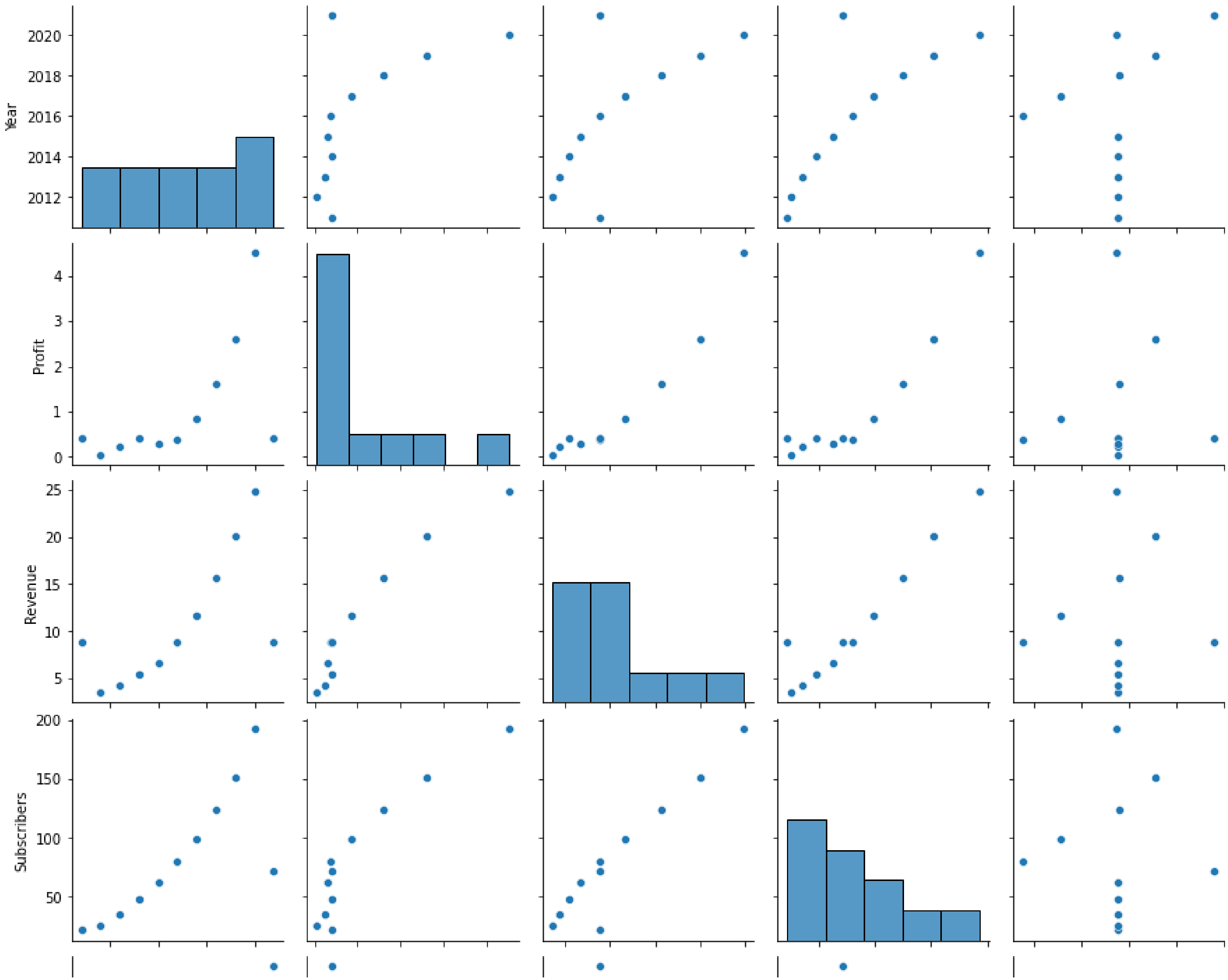
Out[17]:

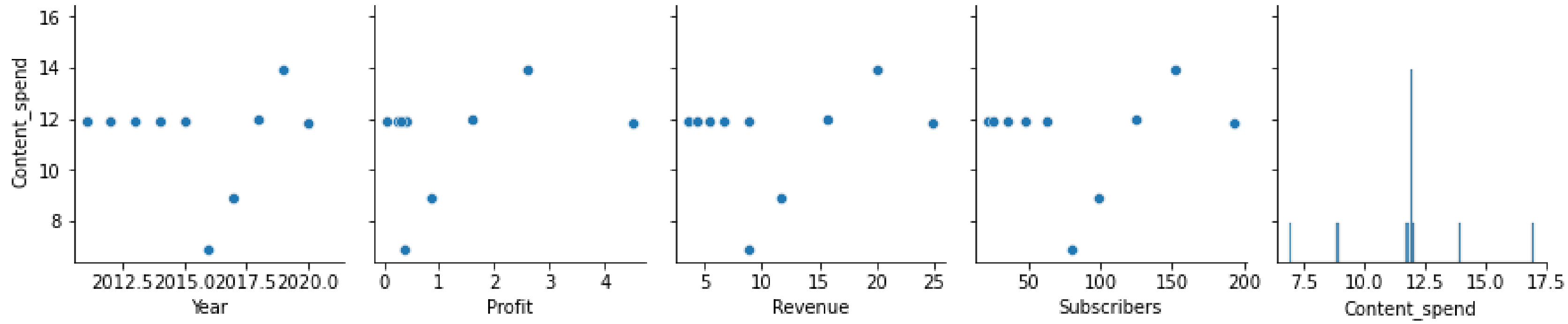
	Year	Profit	Revenue	Subscribers	Content_spend
0	2011	0.403	8.8	21.5	11.90
1	2012	0.050	3.5	25.7	11.90
2	2013	0.228	4.3	35.6	11.90
3	2014	0.403	5.4	47.9	11.90
4	2015	0.306	6.7	62.7	11.90
5	2016	0.379	8.8	79.9	6.88
6	2017	0.839	11.6	99.0	8.91
7	2018	1.600	15.7	124.3	12.00
8	2019	2.600	20.1	151.5	13.90
9	2020	4.500	24.9	192.9	11.80
10	2021	0.403	8.8	71.3	17.00

Understand the relationship between variables

In [18]:
```
sns.pairplot(df_new2)
```

Out[18]: <seaborn.axisgrid.PairGrid at 0x2d69f927be0>





OLS results interpretation

In [19]:
```
from sklearn import linear_model
import statsmodels.api as sm

x = df_new2[['Year','Subscribers','Profit','Content_spend']]
y = df_new2['Revenue']

# adding a constant as an intercept is not included by default and has to be added manually
x = sm.add_constant(x)

model = sm.OLS(y, x).fit()

print_model = model.summary()
print(print_model)
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                Revenue   R-squared:                       0.951
Model:                            OLS   Adj. R-squared:                  0.919
Method:                 Least Squares   F-statistic:                     29.37
Date:                Tue, 29 Nov 2022   Prob (F-statistic):           0.000442
Time:                        22:31:32   Log-Likelihood:                -19.549
No. Observations:                  11   AIC:                             49.10
Df Residuals:                       6   BIC:                             51.09
Df Model:                           4
Covariance Type:            nonrobust
=================================================================================
                    coef    std err          t      P>|t|      [0.025      0.975]
---------------------------------------------------------------------------------
const           513.1137   1205.304      0.426      0.685   -2436.158    3462.385
Year             -0.2550      0.602     -0.424      0.686      -1.727       1.217
Subscribers       0.0908      0.072      1.266      0.252      -0.085       0.266
Profit            1.7554      1.979      0.887      0.409      -3.087       6.598
Content_spend     0.1979      0.399      0.496      0.638      -0.779       1.174
==============================================================================
Omnibus:                        4.600   Durbin-Watson:                   1.356
Prob(Omnibus):                  0.100   Jarque-Bera (JB):                1.808
Skew:                           0.959   Prob(JB):                        0.405
Kurtosis:                       3.513   Cond. No.                     4.16e+06
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
[2] The condition number is large, 4.16e+06. This might indicate that there are
strong multicollinearity or other numerical problems.

C:\Users\vdp10002\Anaconda3\lib\site-packages\scipy\stats\stats.py:1541: UserWarning: kurtosistest only valid
for n>=20 ... continuing anyway, n=11
  warnings.warn("kurtosistest only valid for n>=20 ... continuing "
```

Linear Regression Model

In [20]:

```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error
from sklearn import preprocessing
from sklearn.metrics import r2_score
```

In [21]:
```
#split features: recognising dependent and independent variables
y=df_new2[['Revenue']]
print(y)
x=df_new2.drop(['Revenue'], axis=1)
print(x)
```

```
    Revenue
0       8.8
1       3.5
2       4.3
3       5.4
4       6.7
5       8.8
6      11.6
7      15.7
8      20.1
9      24.9
10      8.8
    Year  Profit  Subscribers  Content_spend
0   2011   0.403         21.5          11.90
1   2012   0.050         25.7          11.90
2   2013   0.228         35.6          11.90
3   2014   0.403         47.9          11.90
4   2015   0.306         62.7          11.90
5   2016   0.379         79.9           6.88
6   2017   0.839         99.0           8.91
7   2018   1.600        124.3          12.00
8   2019   2.600        151.5          13.90
9   2020   4.500        192.9          11.80
10  2021   0.403         71.3          17.00
```

In [22]:
```
#preparing training and test dataset
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25)
x_train.shape
print(x_train)
```

```
    Year  Profit  Subscribers  Content_spend
2   2013   0.228         35.6          11.90
3   2014   0.403         47.9          11.90
9   2020   4.500        192.9          11.80
0   2011   0.403         21.5          11.90
6   2017   0.839         99.0           8.91
8   2019   2.600        151.5          13.90
5   2016   0.379         79.9           6.88
10  2021   0.403         71.3          17.00
```

In [23]:
```
x_test
```

Out[23]:

	Year	Profit	Subscribers	Content_spend
4	2015	0.306	62.7	11.9
7	2018	1.600	124.3	12.0
1	2012	0.050	25.7	11.9

In [24]:
```
y_test
```

Out[24]:

	Revenue
4	6.7
7	15.7
1	3.5

In [25]:
```
y_train
```

Out[25]:

	Revenue
2	4.3
3	5.4
9	24.9
0	8.8
6	11.6
8	20.1
5	8.8
10	8.8

In [26]:
```
%%time
#instantiating linear regression model and fitting it to the training data
LR = LinearRegression()
LR.fit(x_train,y_train)
```

```
CPU times: total: 0 ns
Wall time: 2 ms
```

Out[26]:
```
LinearRegression()
```

In [27]:
```
print('Intercept (c): ', LR.intercept_)
print('Coefficient (m): ', LR.coef_)
#scoring the model based on training and testing data
LR_test_score=LR.score(x_test, y_test)
LR_train_score=LR.score(x_train, y_train)
print('LR Testing Score: ', LR_test_score)
print('LR Trainig Score: ', LR_train_score)
```

```
Intercept (c):  [887.60609464]
Coefficient (m):  [[-0.44146596  1.38906515  0.10234273  0.29715788]]
LR Testing Score:  0.9041527270851477
LR Trainig Score:  0.9524730521774123
```

In [28]:
```
#predicting on test data
y_predict = LR.predict(x_test)
print(y_predict)
```

```
[[ 8.43031193]
 [15.23739231]
 [ 5.61242811]]
```

In [29]:
```
#evaluating Linear Regression model
MSE_LR=mean_squared_error(y_test,y_predict)
RMSE_LR=np.sqrt(mean_squared_error(y_test,y_predict))
print("LR mean_sqrd_error is==", MSE_LR)
print("LR root_mean_squared error of is==",RMSE_LR)
```

```
LR mean_sqrd_error is== 2.5567792534886373
LR root_mean_squared error of is== 1.598993199950718
```

In [30]:
```
#evaluating feature YEAR
x_yr=df_new2[['Year']]
y_yr=df_new2[['Revenue']]
x_yr_train, x_yr_test, y_yr_train, y_yr_test = train_test_split(x_yr, y_yr, test_size=0.25)
print('Shape of X_Year_TrainingData:', x_yr_train.shape)
LR_yr = LinearRegression()
LR_yr.fit(x_yr_train,y_yr_train)
y_yr_predict = LR_yr.predict(x_yr_test)
print(y_yr_predict)
print('Test Score:',LR_yr.score(x_yr_test, y_yr_test))
print('Train Score:', LR_yr.score(x_yr_train, y_yr_train))
print('Linear Model Coefficient (m): ', LR_yr.coef_)
print('Linear Model Coefficient (b): ', LR_yr.intercept_)
MSE_LR_yr=mean_squared_error(y_yr_test,y_yr_predict)
print("mean_sqrd_error is==", MSE_LR_yr)
```

```
Shape of X_Year_TrainingData: (8, 1)
[[12.29598145]
 [ 5.56615147]
 [13.41761978]]
Test Score: 0.5909239486505122
Train Score: 0.34682159254801936
Linear Model Coefficient (m):  [[1.12163833]]
Linear Model Coefficient (b):  [-2251.17017002]
mean_sqrd_error is== 20.170176505205415
```

In [31]:
```
#evaluating feature CONTENT SPEND
x_cont=df_new2[['Content_spend']]
y_cont=df_new2[['Revenue']]
#print(x_sub)
#print(y_sub)
x_cont_train, x_cont_test, y_cont_train, y_cont_test = train_test_split(x_cont, y_cont, test_size=0.25)
#print('Shape of X_Subscribers_TrainingData:', x_sub_train.shape)
#print(x_sub_train)
LR_cont = LinearRegression()
LR_cont.fit(x_cont_train,y_cont_train)
y_cont_predict = LR_cont.predict(x_cont_test)
print(y_cont_predict)
print('Test Score:',LR_cont.score(x_cont_test, y_cont_test))
print('Train Score:', LR_cont.score(x_cont_train, y_cont_train))
print('Linear Model Coefficient (m): ', LR_cont.coef_)
print('Linear Model Coefficient (b): ', LR_cont.intercept_)
MSE_LR_cont=mean_squared_error(y_cont_test,y_cont_predict)
print("mean_sqrd_error is==", MSE_LR_cont)
```

```
[[11.33250145]
 [12.01163664]
 [10.89434971]]
Test Score: 0.014016633999728856
Train Score: 0.0037949537333521466
Linear Model Coefficient (m):  [[0.21907587]]
Linear Model Coefficient (b):  [8.28734688]
mean_sqrd_error is== 43.55636296159866
```

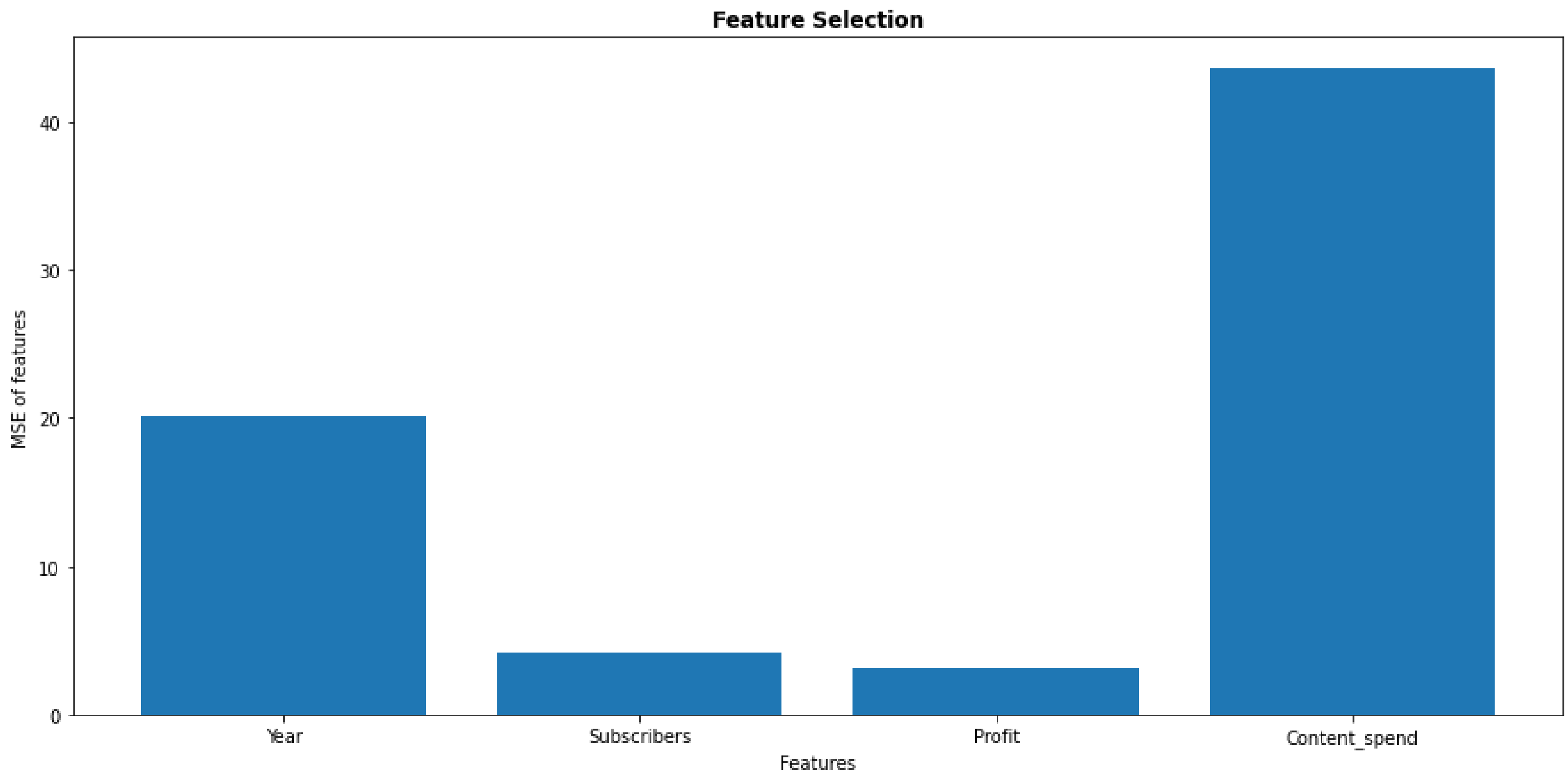
In [32]:
```
#evaluating feature PROFIT
x_prof=df_new2[['Profit']]
y_prof=df_new2[['Revenue']]
#print(x_sub)
#print(y_sub)
x_prof_train, x_prof_test, y_prof_train, y_prof_test = train_test_split(x_prof, y_prof, test_size=0.25)
#print('Shape of X_Subscribers_TrainingData:', x_sub_train.shape)
#print(x_sub_train)
LR_prof = LinearRegression()
LR_prof.fit(x_prof_train,y_prof_train)
y_prof_predict = LR_prof.predict(x_prof_test)
print(y_prof_predict)
print('Test Score:',LR_prof.score(x_prof_test, y_prof_test))
print('Train Score:', LR_prof.score(x_prof_train, y_prof_train))
print('Linear Model Coefficient (m): ', LR_prof.coef_)
print('Linear Model Coefficient (b): ', LR_prof.intercept_)
MSE_LR_prof=mean_squared_error(y_prof_test,y_prof_predict)
print("mean_sqrd_error is==", MSE_LR_prof)
```

```
[[7.53681973]
 [7.65074992]
 [6.82000896]]
Test Score: 0.31356701329992187
Train Score: 0.9229748831552983
Linear Model Coefficient (m):  [[4.74709117]]
Linear Model Coefficient (b):  [5.73767217]
mean_sqrd_error is== 3.0889484401503524
```

In [33]:
```
#evaluating feature SUBSCRIBER
x_sub=df_new2[['Subscribers']]
y_sub=df_new2[['Revenue']]
#print(x_sub)
#print(y_sub)
x_sub_train, x_sub_test, y_sub_train, y_sub_test = train_test_split(x_sub, y_sub, test_size=0.25)
#print('Shape of X_Subscribers_TrainingData:', x_sub_train.shape)
#print(x_sub_train)
LR_sub = LinearRegression()
LR_sub.fit(x_sub_train,y_sub_train)
y_sub_predict = LR_sub.predict(x_sub_test)
print(y_sub_predict)
print('Test Score:',LR_sub.score(x_sub_test, y_sub_test))
print('Train Score:', LR_sub.score(x_sub_train, y_sub_train))
print('Linear Model Coefficient (m): ', LR_sub.coef_)
print('Linear Model Coefficient (b): ', LR_sub.intercept_)
MSE_LR_sub=mean_squared_error(y_sub_test,y_sub_predict)
print("mean_sqrd_error is==", MSE_LR_sub)
```

```
[[7.39251431]
 [6.00928999]
 [9.05688178]]
Test Score: -3.31178195960747
Train Score: 0.9057944001433338
Linear Model Coefficient (m):  [[0.11245726]]
Linear Model Coefficient (b):  [2.00581147]
mean_sqrd_error is== 4.148892418911189
```

In [34]:
```
plt.bar(["Year", "Subscribers","Profit","Content_spend"],[MSE_LR_yr,MSE_LR_sub,MSE_LR_prof,MSE_LR_cont])
plt.title("Feature Selection", fontweight='bold')
plt.ylabel("MSE of features")
plt.xlabel("Features")
plt.show()
```



In [35]:
```
# predict revenue with #ofSubscribers
y_predict_1 = LR_sub.predict([[200]])
y_predict_1
```

```
C:\Users\vdp10002\Anaconda3\lib\site-packages\sklearn\base.py:450: UserWarning: X does not have valid feature
names, but LinearRegression was fitted with feature names
  warnings.warn(
```

Out[35]:
```
array([[24.49726383]])
```

In [36]:
```
# predict revenue for a particular year
y_predict_2 = LR_yr.predict([[2030]])
print(y_predict_2)
```

```
[[25.75564142]]
```

```
C:\Users\vdp10002\Anaconda3\lib\site-packages\sklearn\base.py:450: UserWarning: X does not have valid feature
names, but LinearRegression was fitted with feature names
  warnings.warn(
```

Random Forest Regression Model

In [37]:
```
from sklearn.ensemble import RandomForestRegressor
```

In [38]:
```
%%time
#instantiating Random Forest regression model and fitting it to the training data
RF = RandomForestRegressor(n_jobs=-1)
RF.fit(x_sub_train, y_sub_train)
```

```
CPU times: total: 109 ms
Wall time: 85 ms
```

```
<timed exec>:3: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please chang
e the shape of y to (n_samples,), for example using ravel().
```

Out[38]:
```
RandomForestRegressor(n_jobs=-1)
```

In [39]:
```
# Calculate R2
RF_train_score=RF.score(x_sub_train, y_sub_train)
RF_test_score=RF.score(x_sub_test, y_sub_test)
print('RF Testing Score:',RF_test_score)
print('RF Taining Score:',RF_train_score)
```

```
RF Testing Score: -0.8282682448036791
RF Taining Score: 0.968001770168733
```

In [40]:
```
#predicting on test data
y_predict_RF = RF.predict(x_sub_test)
print(y_predict_RF)
```

```
[5.514 5.514 8.647]
```

In [41]:
```
#evaluating Random Forest regression model
score_RF=RF.score(y_sub_test,y_predict_RF)
MSE_RF=mean_squared_error(y_sub_test,y_predict_RF)
RMSE_RF=np.sqrt(mean_squared_error(y_sub_test,y_predict_RF))
print("RF r2 socre is ",score_RF)
print("RF mean_sqrd_error is==", MSE_RF)
print("RF root_mean_squared error of is==",RMSE_RF)
```

```
RF r2 socre is  -0.6401499171377567
RF mean_sqrd_error is== 1.7592003333333206
RF root_mean_squared error of is== 1.3263484961854184

C:\Users\vdp10002\Anaconda3\lib\site-packages\sklearn\base.py:493: FutureWarning: The feature names should mat
ch those that were passed during fit. Starting version 1.2, an error will be raised.
Feature names unseen at fit time:
- Revenue
Feature names seen at fit time, yet now missing:
- Subscribers

  warnings.warn(message, FutureWarning)
```

KNN Regression Model

In [42]:
```
from sklearn.neighbors import KNeighborsRegressor
```

In [43]:
```
%%time
#instantiating KNN regression model and fitting it to the training data
KNN = KNeighborsRegressor(n_neighbors=2)
KNN.fit(x_sub_train,y_sub_train)
```

```
CPU times: total: 0 ns
Wall time: 2 ms
```

Out[43]:
```
KNeighborsRegressor(n_neighbors=2)
```

In [44]:
```
KNN_test_score=KNN.score(x_sub_test, y_sub_test)
KNN_train_score=KNN.score(x_sub_train, y_sub_train)
print('KNN Testing Score:',KNN_test_score)
print('KNN Taining Score:',KNN_train_score)
```

```
KNN Testing Score: -1.9081986143187066
KNN Taining Score: 0.9104524248986294
```

In [45]:
```
y_predict_knn = KNN.predict(x_sub_test)
print(y_predict_knn)
```

```
[[6.15]
 [6.15]
 [8.8 ]]
```

In [47]:
```
score_KNN=KNN.score(y_sub_test,y_predict_RF)
MSE_KNN=mean_squared_error(y_sub_test,y_predict_knn)
RMSE_KNN=np.sqrt(mean_squared_error(y_sub_test,y_predict_knn))
print("r2 socre is ",score_KNN)
print("MSE is ",MSE_KNN)
print("RMSE is ",RMSE_KNN)
```

```
r2 socre is  -0.07644012559892577
MSE is  2.7983333333333342
RMSE is  1.6728219670166142

C:\Users\vdp10002\Anaconda3\lib\site-packages\sklearn\base.py:493: FutureWarning: The feature names should mat
ch those that were passed during fit. Starting version 1.2, an error will be raised.
Feature names unseen at fit time:
- Revenue
Feature names seen at fit time, yet now missing:
- Subscribers

  warnings.warn(message, FutureWarning)
```

Decision Tree Regression Model

In [48]:
```
from sklearn.tree import DecisionTreeRegressor
```

In [49]:
```
%%time
#instantiating Decision Tree regression model and fitting it to the training data
DT = DecisionTreeRegressor(random_state = 0)
DT.fit(x_sub_train,y_sub_train)
```

```
CPU times: total: 0 ns
Wall time: 4.04 ms
```

Out[49]:
```
DecisionTreeRegressor(random_state=0)
```

In [50]:
```
DT_test_score=DT.score(x_sub_test, y_sub_test)
DT_train_score=DT.score(x_sub_train, y_sub_train)
print('DT Testing Score:',DT_test_score)
print('DT Taining Score:',DT_train_score)
```

```
DT Testing Score: -2.0000000000000004
DT Taining Score: 1.0
```

In [51]:
```
y_predict_DT = DT.predict(x_sub_test)
print(y_predict_DT)
```

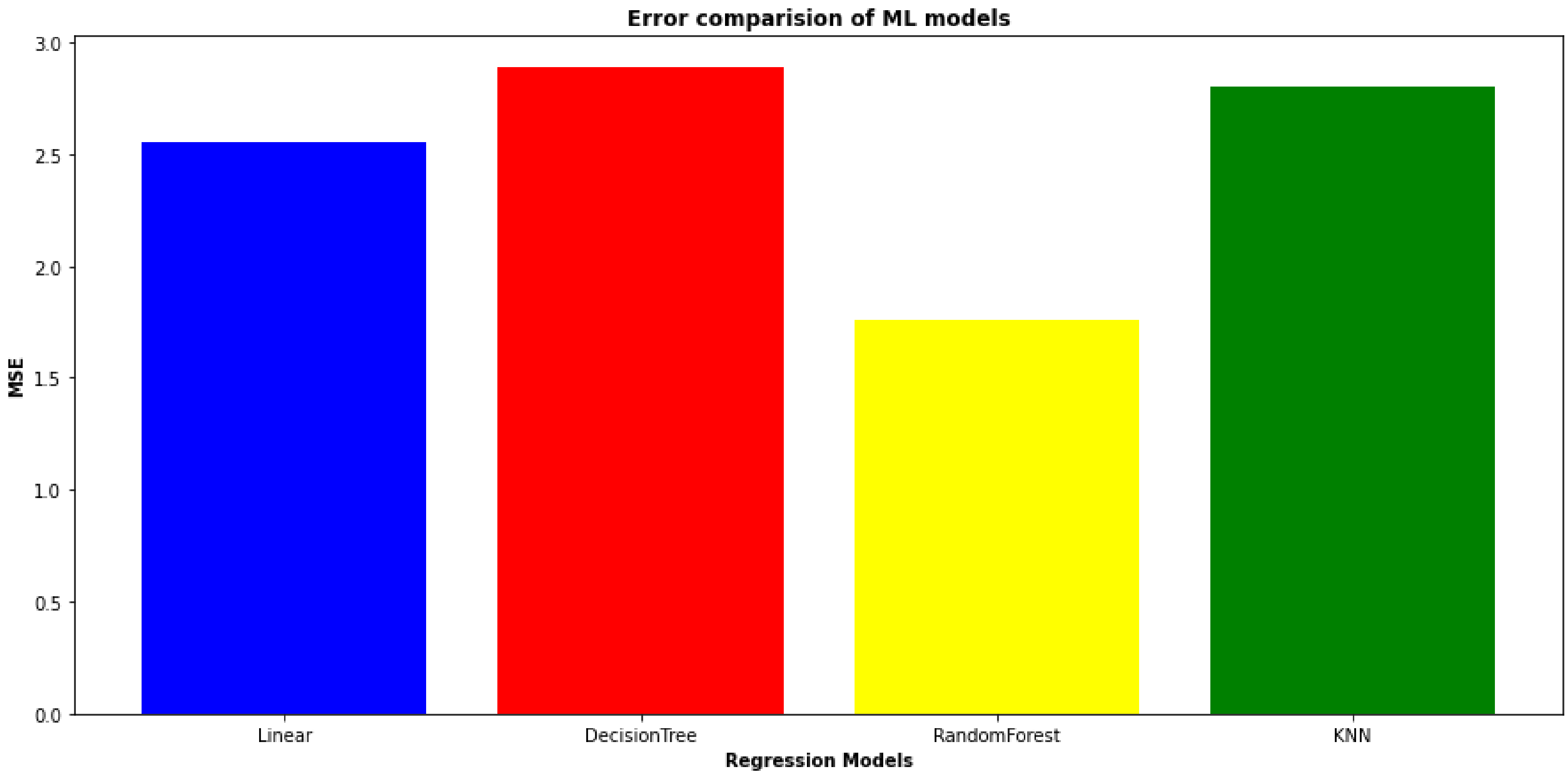
```
[3.5 3.5 8.8]
```

In [52]:
```
score_DT=DT.score(y_sub_test,y_predict_knn)
MSE_DT=mean_squared_error(y_sub_test,y_predict_DT)
RMSE_DT=np.sqrt(mean_squared_error(y_sub_test,y_predict_DT))
print("r2 socre is ",score_DT)
print("MSE is ",MSE_DT)
print("RMSE is ",RMSE_DT)
```

```
r2 socre is  -1.9999999999999996
MSE is  2.886666666666668
RMSE is  1.6990193249832881

C:\Users\vdp10002\Anaconda3\lib\site-packages\sklearn\base.py:493: FutureWarning: The feature names should mat
ch those that were passed during fit. Starting version 1.2, an error will be raised.
Feature names unseen at fit time:
- Revenue
Feature names seen at fit time, yet now missing:
- Subscribers

  warnings.warn(message, FutureWarning)
```

Comparing Models

In [53]:
```
plt.bar(["Linear", "DecisionTree","RandomForest","KNN"],[MSE_LR,MSE_DT,MSE_RF,MSE_KNN], color=['blue', 'red', 'y
plt.title("Error comparision of ML models", fontweight="bold")
plt.ylabel("MSE", fontweight="bold")
plt.xlabel("Regression Models", fontweight="bold")
plt.show()
```



In [ ]: