```
In [ ]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler, MinMaxScaler
from sklearn.cluster import KMeans
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor, GradientBoostingRegressor,
from sklearn.tree import DecisionTreeRegressor
from sklearn.preprocessing import PolynomialFeatures
from sklearn.metrics import mean_squared_error, r2_score
import warnings
warnings.filterwarnings('ignore')
```

```
In [ ]: financial = pd.read_csv('/content/financial_management_dataset.csv')
financial.head()
```

Out[ ]:

	revenue	expenditure	funding_stability	operational_costs	transparency_s
0	54967141.53	27829731.98	0.536	22843223.08	
1	48617356.99	37256534.90	0.448	21914608.55	
2	56476885.38	41277550.20	0.519	28132153.67	
3	65230298.56	61989188.92	0.425	21180215.32	
4	47658466.25	50008978.12	0.931	18069886.01	

Financial Performance Analysis

```
In [ ]: financial['Net_Income'] = financial['revenue'] - financial['expenditure']
financial['Operating_Margin'] = financial['Net_Income'] / financial['revenue']
financial['Cost_to_Revenue_Ratio'] = financial['expenditure'] / financial['rev
financial['Operational_Cost_Efficiency'] = financial['revenue'] / financial['c
financial.head()
```

Out[ ]:

	revenue	expenditure	funding_stability	operational_costs	transparency_s
0	54967141.53	27829731.98	0.536	22843223.08	
1	48617356.99	37256534.90	0.448	21914608.55	
2	56476885.38	41277550.20	0.519	28132153.67	
3	65230298.56	61989188.92	0.425	21180215.32	
4	47658466.25	50008978.12	0.931	18069886.01	

```
In [ ]: financial_cleaned = financial.drop(columns=['revenue', 'expenditure', 'operati
display(financial_cleaned.head())
```

	funding_stability	transparency_score	risk_tolerance	fund_utilization_efficiency
0	0.536	7.20	0.406	0.648
1	0.448	4.42	0.606	0.917
2	0.519	6.55	0.439	0.583
3	0.425	3.40	0.934	0.527
4	0.931	3.23	0.535	0.596

In [ ]:
```
financial_cleaned.isnull().sum()
```

Out[ ]:

	0
funding_stability	0
transparency_score	0
risk_tolerance	0
fund_utilization_efficiency	0
predicted_trend	0
anomaly_label	0
Net_Income	0
Operating_Margin	0
Cost_to_Revenue_Ratio	0
Operational_Cost_Efficiency	0

dtype: int64

In [ ]:
```
financial_cleaned.info()
```

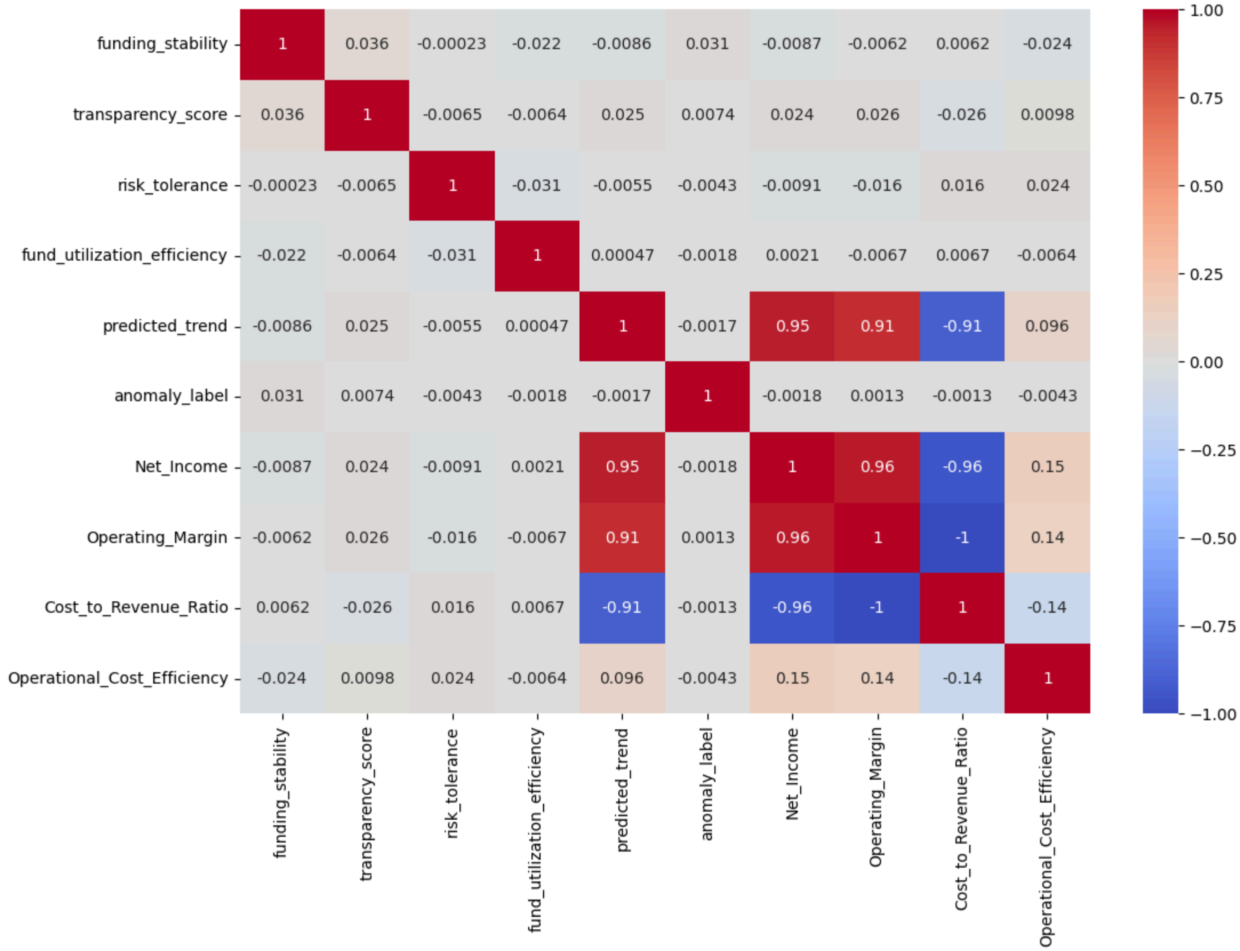
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3000 entries, 0 to 2999
Data columns (total 10 columns):
 #   Column                       Non-Null Count  Dtype  
---  ------                       --------------  -----  
 0   funding_stability            3000 non-null   float64
 1   transparency_score           3000 non-null   float64
 2   risk_tolerance               3000 non-null   float64
 3   fund_utilization_efficiency  3000 non-null   float64
 4   predicted_trend              3000 non-null   float64
 5   anomaly_label                3000 non-null   int64  
 6   Net_Income                   3000 non-null   float64
 7   Operating_Margin             3000 non-null   float64
 8   Cost_to_Revenue_Ratio        3000 non-null   float64
 9   Operational_Cost_Efficiency  3000 non-null   float64
dtypes: float64(9), int64(1)
memory usage: 234.5 KB
```

In [ ]:
```
financial_cleaned.describe()
```

Out[ ]:

	funding_stability	transparency_score	risk_tolerance	fund_utilization_effi
count	3000.000000	3000.00000	3000.000000	3000.0
mean	0.644883	5.06369	0.509347	0.7
std	0.199003	2.86339	0.287039	0.1
min	0.300000	0.00000	0.001000	0.5
25%	0.476750	2.59750	0.269000	0.6
50%	0.644000	5.14000	0.508000	0.7
75%	0.813000	7.53000	0.752000	0.8
max	1.000000	10.00000	1.000000	1.0

In [ ]:
```
financialcorr = financial_cleaned.corr()
plt.figure(figsize=(12, 8))
sns.heatmap(financialcorr, annot=True, cmap='coolwarm')
plt.show()
```



K-Means Cluster Analysis

In [ ]:

```
kmeans = KMeans(n_clusters=5, random_state=42)
kmeans.fit(financial_cleaned)
kmeans.labels_
```

Out[ ]:

```
array([2, 1, 1, ..., 4, 4, 1], dtype=int32)
```

In [ ]:

```
financial_cleaned['cluster'] = kmeans.labels_
financial_cleaned.head()
```

Out[ ]:

	funding_stability	transparency_score	risk_tolerance	fund_utilization_efficien
0	0.536	7.20	0.406	0.6
1	0.448	4.42	0.606	0.9
2	0.519	6.55	0.439	0.5
3	0.425	3.40	0.934	0.5
4	0.931	3.23	0.535	0.5

In [ ]:
```
plt.figure(figsize=(12, 8))
```

Out[ ]: <Figure size 1200x800 with 0 Axes>

<Figure size 1200x800 with 0 Axes>

In [ ]:
```
X_transparency_risk = financial_cleaned[['transparency_score', 'risk_tolerance

scaler_tr = MinMaxScaler()
X_transparency_risk_scaled = scaler_tr.fit_transform(X_transparency_risk)

kmeans_tr = KMeans(n_clusters=2, random_state=42, n_init=10)
financial_cleaned['transparency_risk_cluster'] = kmeans_tr.fit_predict(X_trans

cluster_centers_original = scaler_tr.inverse_transform(kmeans_tr.cluster_cente

heuristic_score_0 = cluster_centers_original[0, 0] - cluster_centers_original[
heuristic_score_1 = cluster_centers_original[1, 0] - cluster_centers_original[

label_mapping = {
    0: 'High transparency & low risk' if heuristic_score_0 > heuristic_score_1
    1: 'Low transparency & high risk' if heuristic_score_0 > heuristic_score_1
}
financial_cleaned['transparency_risk_label'] = financial_cleaned['transparency

print("Cluster Centers (Original Scale):")
display(pd.DataFrame(cluster_centers_original, columns=['transparency_score',

print("\nFirst 5 rows with new cluster labels:")
display(financial_cleaned[['transparency_score', 'risk_tolerance', 'transparen
```

Cluster Centers (Original Scale):

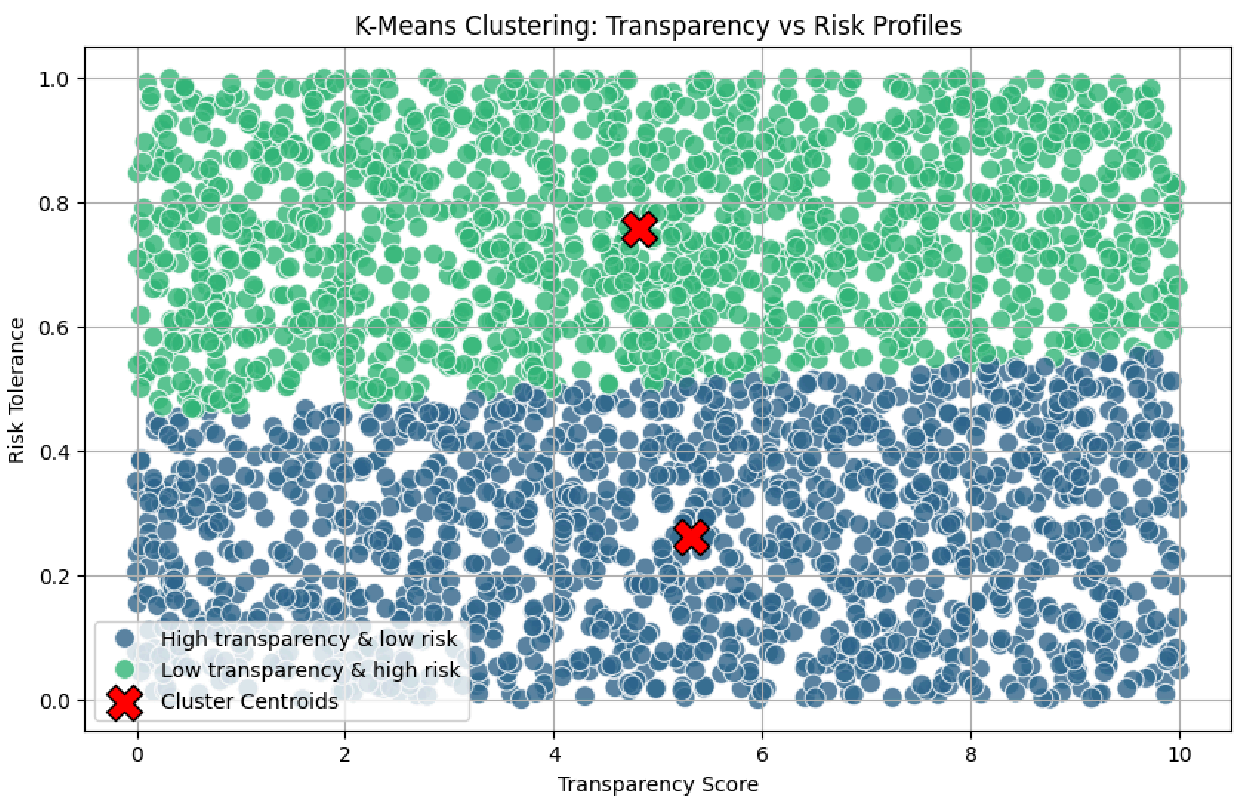
	transparency_score	risk_tolerance
Cluster 0	5.310501	0.262061
Cluster 1	4.817537	0.755974

First 5 rows with new cluster labels:

	transparency_score	risk_tolerance	transparency_risk_cluster	transparency_risl
0	7.20	0.406	0	High transparenc
1	4.42	0.606	1	Low transparency
2	6.55	0.439	0	High transparenc
3	3.40	0.934	1	Low transparency
4	3.23	0.535	1	Low transparency

In [ ]:

```
plt.figure(figsize=(10, 6))
sns.scatterplot(
    x='transparency_score',
    y='risk_tolerance',
    hue='transparency_risk_label',
    data=financial_cleaned,
    palette='viridis',
    s=100,
    alpha=0.8
)
plt.scatter(
    cluster_centers_original[:, 0],
    cluster_centers_original[:, 1],
    marker='X',
    s=300,
    color='red',
    label='Cluster Centroids',
    edgecolors='black'
)
plt.title('K-Means Clustering: Transparency vs Risk Profiles')
plt.xlabel('Transparency Score')
plt.ylabel('Risk Tolerance')
plt.legend()
plt.grid(True)
plt.show()
```



In [ ]:

```
financial_cleaned = financial_cleaned.drop(columns=['cluster','transparency_ri
financial_cleaned.head()
```

Out[ ]:

	funding_stability	transparency_score	risk_tolerance	fund_utilization_efficienc
0	0.536	7.20	0.406	0.64
1	0.448	4.42	0.606	0.91
2	0.519	6.55	0.439	0.58
3	0.425	3.40	0.934	0.52
4	0.931	3.23	0.535	0.59

Linear Regression

In [ ]:
```
X = financial_cleaned.drop(columns=['Cost_to_Revenue_Ratio'])
y = financial_cleaned['Cost_to_Revenue_Ratio']
```

In [ ]:
```
financiallin = LinearRegression()
financiallin.fit(X, y)
```

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

In [ ]:
```
y_pred = financiallin.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 1.3086188619187216e-25
R-squared: 1.0
```

Polynominal Regression

In [ ]:
```
financialpoly = PolynomialFeatures(degree=2)
X_poly = financialpoly.fit_transform(X)
```

In [ ]:
```
polynomial_regressor = LinearRegression()
polynomial_regressor.fit(X_poly, y)

y_pred = polynomial_regressor.predict(X_poly)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 0.00023673409524684034
R-squared: 0.9971220575364617
```

Decision Tree Regressor

In [ ]:
```
financialdec = DecisionTreeRegressor(max_depth = 4, random_state=42)
financialdec.fit(X, y)
```

Out[ ]:
```
DecisionTreeRegressor
DecisionTreeRegressor(max_depth=4, random_state=42)
```

In [ ]:
```
y_pred = financialdec.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 0.00094624706455113
R-squared: 0.9884966100669583
```

Random Forest Regressor

In [ ]:
```
financialrandom = RandomForestRegressor(n_estimators=140, random_state=42)
financialrandom.fit(X, y)
```

Out[ ]:
```
RandomForestRegressor
RandomForestRegressor(n_estimators=140, random_state=42)
```

In [ ]:
```
y_pred = financialrandom.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 4.0566188928483925e-05
R-squared: 0.9995068426557675
```

Gradient Boost Regressor

In [ ]:
```
financialgradient = GradientBoostingRegressor(n_estimators=200, learning_rate=
financialgradient.fit(X, y)
```

Out[ ]:
```
GradientBoostingRegressor
GradientBoostingRegressor(learning_rate=0.01, n_estimators=200, rando
m_state=42)
```

In [ ]:
```
y_pred = financialgradient.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 0.0019081519859643196
R-squared: 0.9768028698123697
```

Adaboost Regressor

In [ ]:
```
financialada = AdaBoostRegressor(n_estimators=100, learning_rate=0.01, loss='l
financialada.fit(X, y)
```

Out[ ]:

AdaBoostRegressor

```
AdaBoostRegressor(learning_rate=0.01, n_estimators=100, random_stat
e=42)
```

In [ ]:
```
y_pred = financialada.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 0.0016694364968763767
R-squared: 0.9797048997968305
```

Bagging Regressor

In [ ]:
```
financialbag = BaggingRegressor(n_estimators=150, max_samples=0.7, max_feature
financialbag.fit(X, y)
```

Out[ ]:

BaggingRegressor

```
BaggingRegressor(max_features=0.5, max_samples=0.7, n_estimators=150,
                 random_state=42)
```

In [ ]:
```
y_pred = financialbag.predict(X)
```

In [ ]:
```
print("Mean Squared Error:", mean_squared_error(y, y_pred))
print("R-squared:", r2_score(y, y_pred))
```

```
Mean Squared Error: 0.0007335176064548764
R-squared: 0.9910827315973714
```

Citations

https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.PolynomialFeatures.html

https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeRegressor.html

https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.RandomForestRegressor.html

https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.GradientBoostingRegressor.html

https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.AdaBoostRegressor.html

https://scikit-learn.org/stable/modules/generated/sklearn.ensemble.BaggingRegressor.html

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