EMAIL SPAM DETECTION WITH MACHINE LEARNING

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Importing Data Manipulation Libraries

In [2]:
```
#Importing data manipulation and visualization libraries

import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

In [3]:
```
#Reading the CSV file containing the datasets
spam_mail = pd.read_csv('spam.csv', encoding = 'latin')
```

In [4]:
```
#Viewing the first 5 and last 5 rows from the dataset
spam_mail
```

Out[4]:

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN
...	...	...	...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...	NaN	NaN	NaN
5568	ham	Will Ì_ b going to esplanade fr home?	NaN	NaN	NaN
5569	ham	Pity, * was in mood for that. So...any other s...	NaN	NaN	NaN
5570	ham	The guy did some bitching but I acted like i'd...	NaN	NaN	NaN
5571	ham	Rofl. Its true to its name	NaN	NaN	NaN

5572 rows × 5 columns

In [5]:
```
spam_mail.columns
```
Out[5]:
```
Index(['v1', 'v2', 'Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], dtype='object')
```

In [6]:
```
spam_mail.isna().sum()
```
Out[6]:
```
v1                0
v2                0
Unnamed: 2     5522
Unnamed: 3     5560
Unnamed: 4     5566
dtype: int64
```

In [7]:
```
spam_mail.describe()
```
Out[7]:

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
count	5572	5572	50	12	6
unique	2	5169	43	10	5
top	ham	Sorry, I'll call later	bt not his girlfrnd... G o o d n i g h t . . .@"	MK17 92H. 450Ppw 16"	GNT:-)"
freq	4825	30	3	2	2

In [8]:
```
spam_mail = spam_mail.drop(columns = ["Unnamed: 2","Unnamed: 3","Unnamed: 4"], axis = 1, errors = 'ignore')
```

In [9]:
```
spam_mail
```

Out[9]:

	v1	v2
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...
...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...
5568	ham	Will Ì_ b going to esplanade fr home?
5569	ham	Pity, * was in mood for that. So...any other s...
5570	ham	The guy did some bitching but I acted like i'd...
5571	ham	Rofl. Its true to its name

5572 rows × 2 columns

```
In [10]: df = spam_mail.rename(columns = {'v1': 'Class', 'v2': 'Text'})

         df
```

Out[10]:

	Class	Text
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...
...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...
5568	ham	Will Ì_ b going to esplanade fr home?
5569	ham	Pity, * was in mood for that. So...any other s...
5570	ham	The guy did some bitching but I acted like i'd...
5571	ham	Rofl. Its true to its name

5572 rows × 2 columns

```
In [11]: df.duplicated().sum()

Out[11]: 403
```

In [12]:
```
df = df.drop_duplicates()
df
```

Out[12]:

	Class	Text
0	ham	Go until jurong point, crazy.. Available only ...
1	ham	Ok lar... Joking wif u oni...
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...
3	ham	U dun say so early hor... U c already then say...
4	ham	Nah I don't think he goes to usf, he lives aro...
...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...
5568	ham	Will Ì_ b going to esplanade fr home?
5569	ham	Pity, * was in mood for that. So...any other s...
5570	ham	The guy did some bitching but I acted like i'd...
5571	ham	Rofl. Its true to its name

5169 rows × 2 columns

In [13]:
```
#df['Class'].replace({"ham": 0, "spam": 1}, inplace=True)
#df
```

In [14]:
```
df.duplicated().sum()
```

Out[14]:
```
0
```

Training & Evaluation

- Importing all Necessary Machine Learning Models & Libraries

In [15]:
```python
# Import necessary libraries

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import classification_report, accuracy_score, confusion_matrix
```

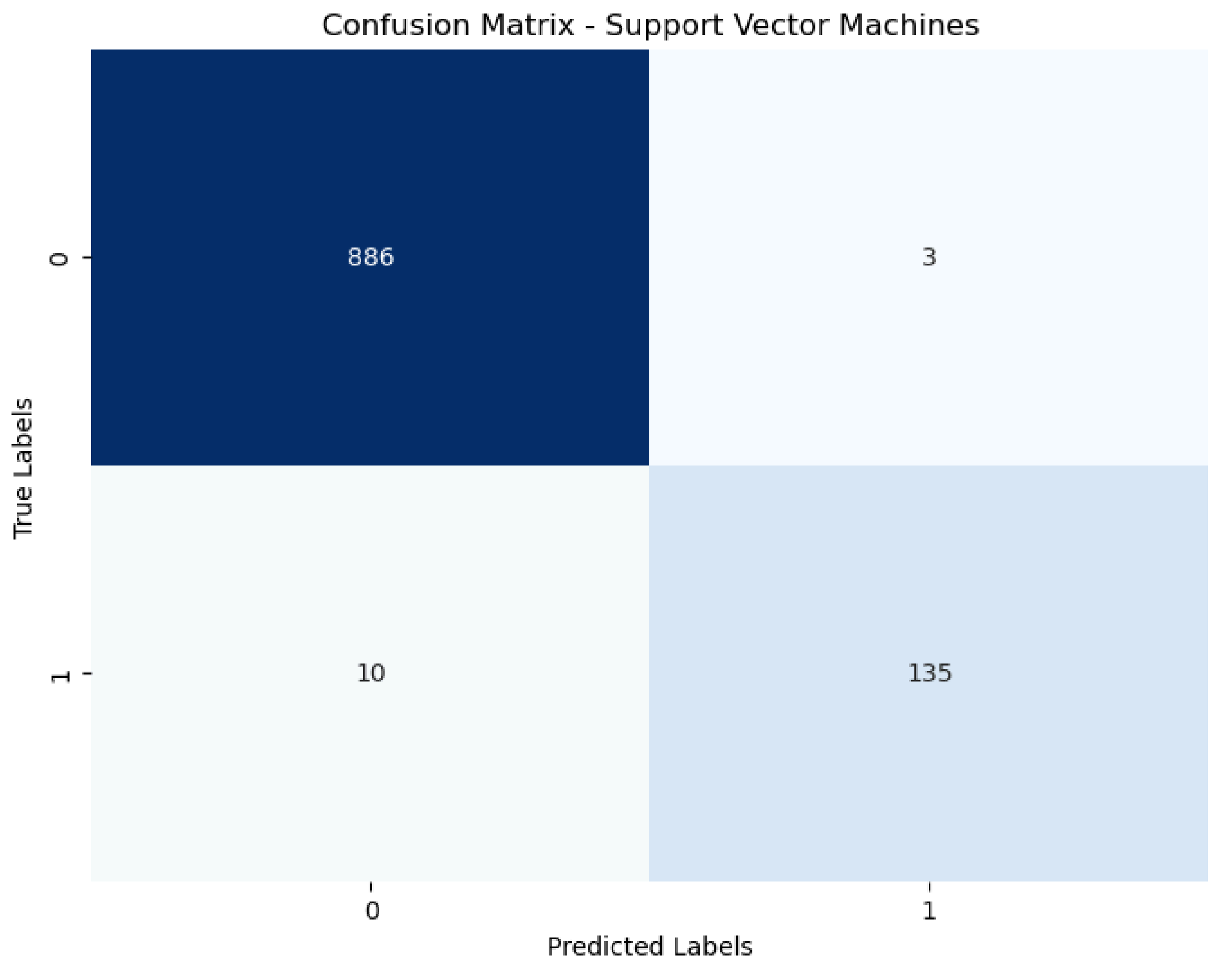
- Using Support Ventor Machine Model

In [16]:

```python
# Assigning the feature and target columns from the datasets
X = df['Text']  # Feature
y = df['Class']  # Target

# Split the data into training and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 42)

# Convert text data into TF-IDF vectors
vectorizer = TfidfVectorizer(max_features=1000)  # You can adjust the max_features
X_train_tfidf = vectorizer.fit_transform(X_train)
X_test_tfidf = vectorizer.transform(X_test)

# Train an SVM model
clf = SVC(kernel='linear', C=1.0, probability=True)
clf.fit(X_train_tfidf, y_train)

# Make predictions on the test data
y_pred = clf.predict(X_test_tfidf)

# Evaluate the model
print("Accuracy:", accuracy_score(y_test, y_pred))
print("\nClassification Report:\n", classification_report(y_test, y_pred))
```

```
Accuracy: 0.9874274661508704

Classification Report:
               precision    recall  f1-score   support

         ham       0.99      1.00      0.99       889
        spam       0.98      0.93      0.95       145

    accuracy                           0.99      1034
   macro avg       0.98      0.96      0.97      1034
weighted avg       0.99      0.99      0.99      1034
```

In [17]:
```python
# Assuming you already have 'y_test' (true labels) and 'y_pred' (predicted labels)
conf_matrix = confusion_matrix(y_test, y_pred)

# Create a heatmap for the confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', cbar=False)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix - Support Vector Machines')
plt.show()
```



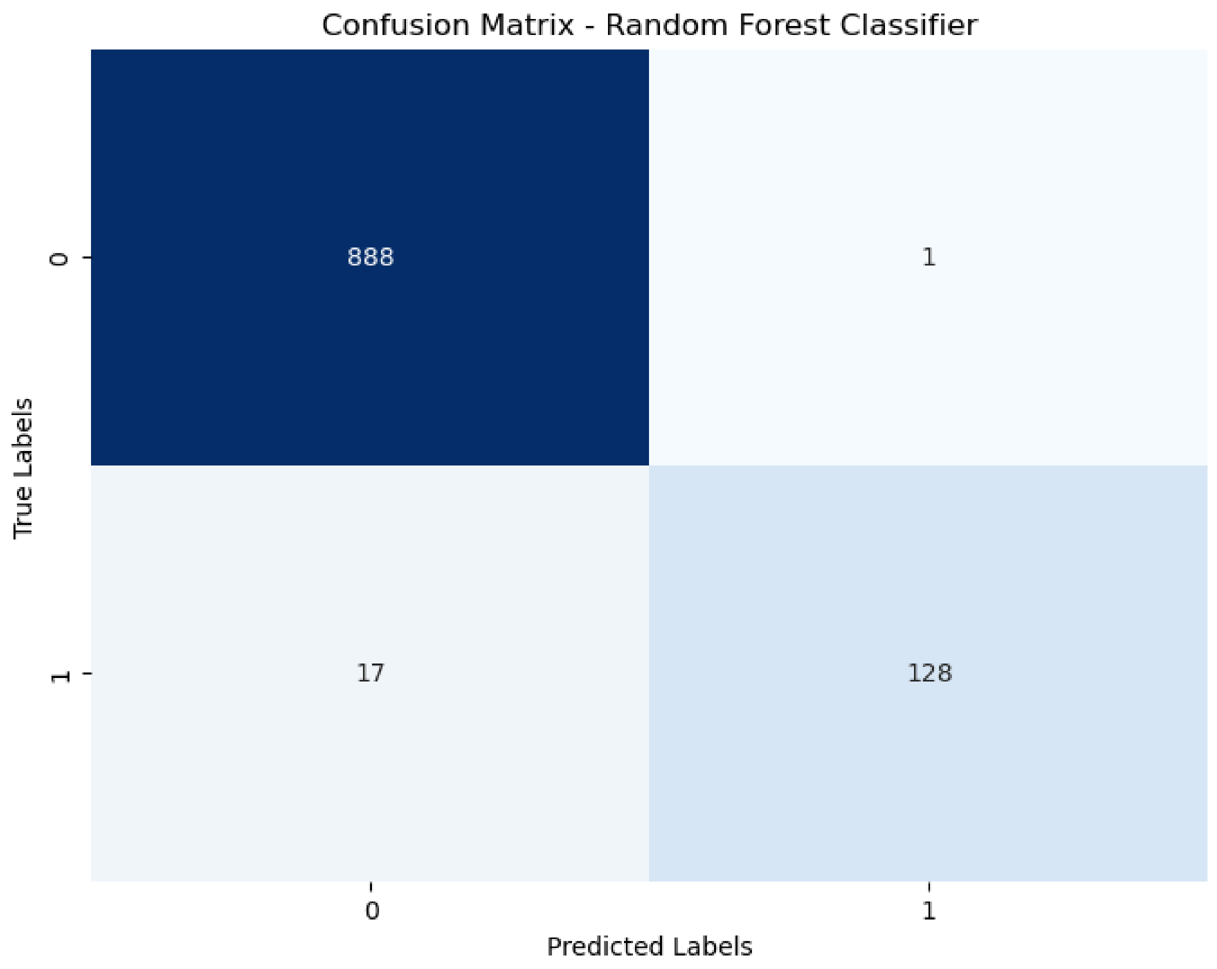
- Using Random Forest Classifier

In [18]:
```
# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(df['Text'], df['Class'], test_size = 0.2, random_state = 42)

# Create a TF-IDF vectorizer
vectorizer = TfidfVectorizer(max_features = 1000)  # The max_features can be adjusted as deem fit by users

# Transform text data into numerical features
X_train_tfidf = vectorizer.fit_transform(X_train)
X_test_tfidf = vectorizer.transform(X_test)

# Initialize and train the Random Forest classifier
rf_classifier = RandomForestClassifier(n_estimators=100, random_state=42)
rf_classifier.fit(X_train_tfidf, y_train)

# Predictions on the test set
y_pred = rf_classifier.predict(X_test_tfidf)
```

In [19]:
```
# Accuracy
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.4f}")

# Classification report (precision, recall, F1-score)
print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.9826
              precision    recall  f1-score   support

         ham       0.98      1.00      0.99       889
        spam       0.99      0.88      0.93       145

    accuracy                           0.98      1034
   macro avg       0.99      0.94      0.96      1034
weighted avg       0.98      0.98      0.98      1034
```

In [20]:
```python
# Assuming you already have 'y_test' (true labels) and 'y_pred' (predicted labels)
conf_matrix = confusion_matrix(y_test, y_pred)

# Create a heatmap for the confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', cbar=False)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix - Random Forest Classifier')
plt.show()
```

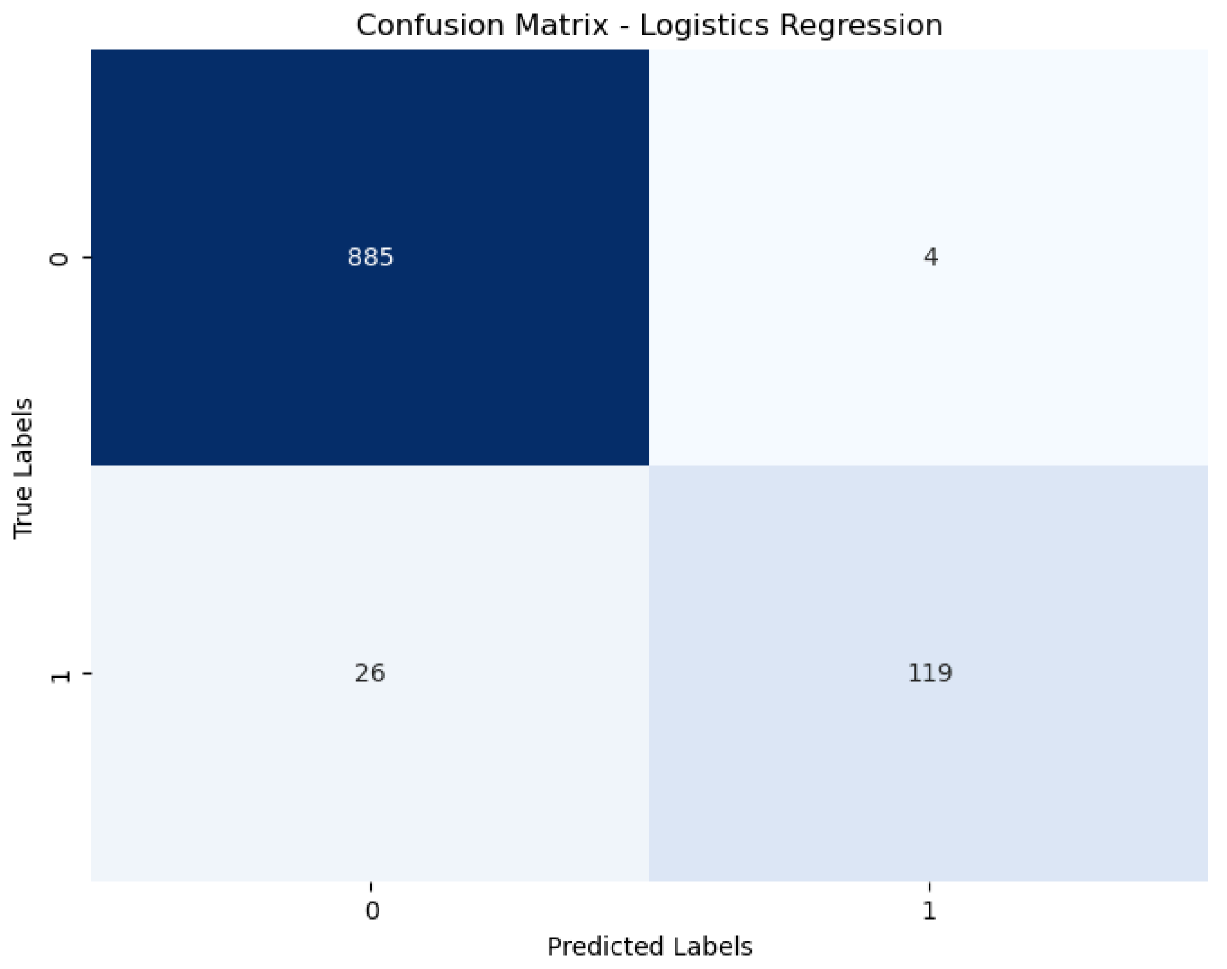


- Using Logistics Regression Model

In [21]:
```python
# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(df['Text'], df['Class'], test_size=0.2, random_state=42)

# Create a TF-IDF vectorizer
vectorizer = TfidfVectorizer(max_features = 4000)  # Adjust max_features as needed

# Transform text data into numerical features
X_train_tfidf = vectorizer.fit_transform(X_train)
X_test_tfidf = vectorizer.transform(X_test)

# Initialize and train the logistic regression model
logreg_model = LogisticRegression()
logreg_model.fit(X_train_tfidf, y_train)

# Predictions on the test set
y_pred = logreg_model.predict(X_test_tfidf)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.4f}")

print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.9710
              precision    recall  f1-score   support

         ham       0.97      1.00      0.98       889
        spam       0.97      0.82      0.89       145

    accuracy                           0.97      1034
   macro avg       0.97      0.91      0.94      1034
weighted avg       0.97      0.97      0.97      1034
```

In [22]:
```python
# Assuming you already have 'y_test' (true labels) and 'y_pred' (predicted labels)
conf_matrix = confusion_matrix(y_test, y_pred)

# Create a heatmap for the confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', cbar=False)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix - Logistics Regression')
plt.show()
```

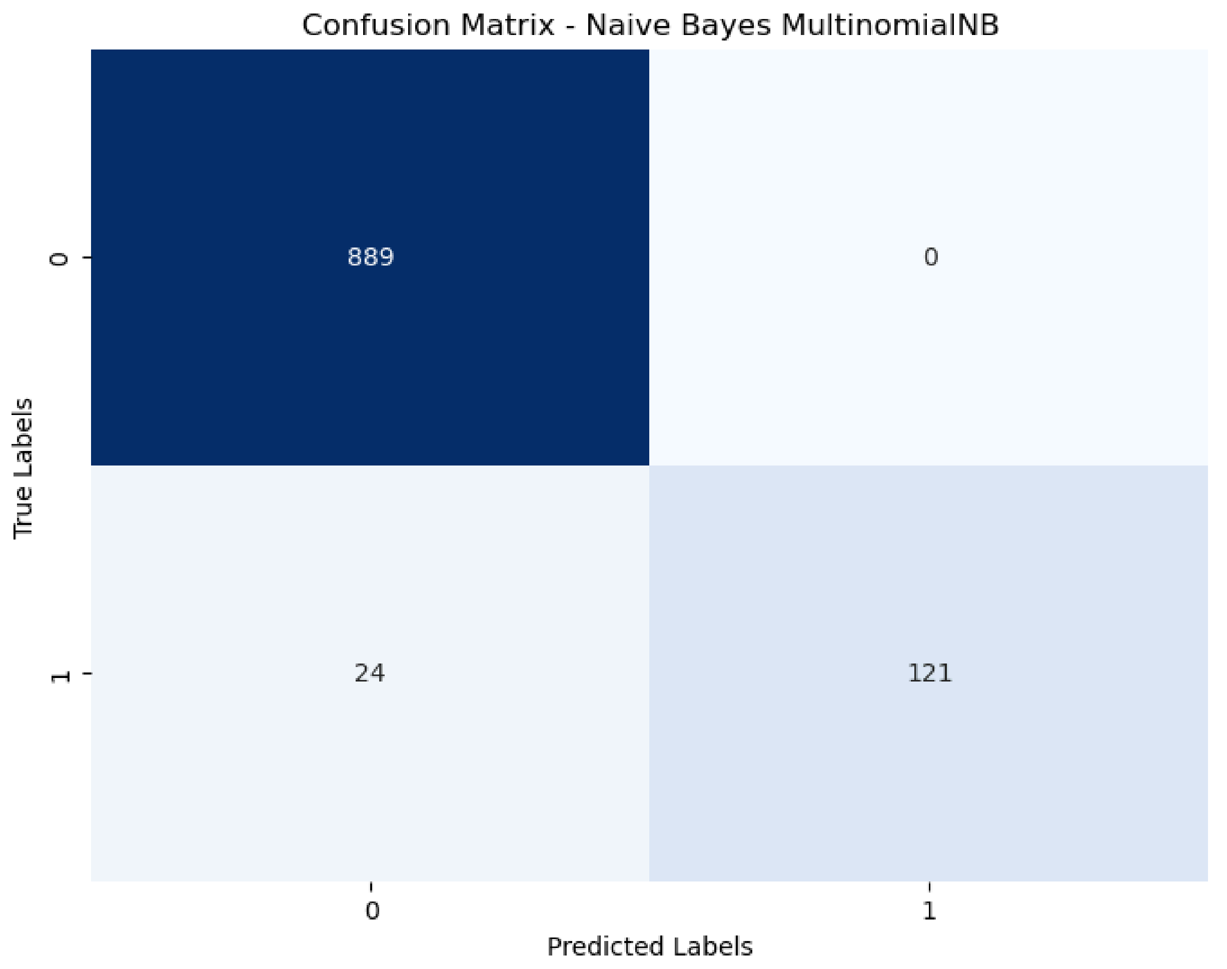


- Using Naive Bayes - MultinomialNB Model

In [23]:
```
# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(df['Text'], df['Class'], test_size = 0.2, random_state = 42)

# Create a TF-IDF vectorizer
vectorizer = TfidfVectorizer(max_features=1000)  # Adjust max_features as needed

# Transform text data into numerical features
X_train_tfidf = vectorizer.fit_transform(X_train)
X_test_tfidf = vectorizer.transform(X_test)

# Initialize and train the Naive Bayes classifier
nb_classifier = MultinomialNB()
nb_classifier.fit(X_train_tfidf, y_train)

# Predictions on the test set
y_pred = nb_classifier.predict(X_test_tfidf)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.4f}")

print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.9768
              precision    recall  f1-score   support

         ham       0.97      1.00      0.99       889
        spam       1.00      0.83      0.91       145

    accuracy                           0.98      1034
   macro avg       0.99      0.92      0.95      1034
weighted avg       0.98      0.98      0.98      1034
```

In [24]:
```
# Compute the confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)

# Plot the confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', cbar=False)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix - Naive Bayes MultinomialNB')
plt.show()
```



Testing the Model Using Unseen Text & Text From the Training Datasets

- Using Unseen Text to Test the Prediction of the Model

In [25]:
```
#Using unseen text to test the models prediction

# Example text for prediction
new_text = input("Please type a word here: ")

# Transform the new text into numerical features
new_text_tfidf = vectorizer.transform([new_text])

# Make predictions
predicted_class = nb_classifier.predict(new_text_tfidf)

print(f"Predicted class: {predicted_class[0]}")
```

```
Please type a word here: ghgf hfdhd
Predicted class: ham
```

The model was tested with a completetely different text that is not on the training data set and it with key words like "Won", "20000 dollar" and a hyperlink "www.dajah.com" (http://www.dajah.com") and the model correctly predicted the text as Spam

- Randomly Sampling Text from the Datase to Test the Prediction of the Model

In [27]:
```
import random

# Sample 10 random indices from the test set
sample_indices = random.sample(range(len(X_test)), 10)

# Initialize lists to store results
sample_texts = []
true_labels = []
predicted_labels = []

for idx in sample_indices:
    sample_text = X_test.iloc[idx]
    sample_text_tfidf = vectorizer.transform([sample_text])
    predicted_class = nb_classifier.predict(sample_text_tfidf)[0]
    true_label = y_test.iloc[idx]

    sample_texts.append(sample_text)
    true_labels.append(true_label)
    predicted_labels.append(predicted_class)

# Create a DataFrame to display the results
results_df = pd.DataFrame({
    'Sample Text': sample_texts,
    'True Label': true_labels,
    'Predicted Label': predicted_labels
})

# Display the results
print(results_df)
```

```
                                         Sample Text True Label  \
0  Sometimes Heart Remembrs someone Very much... ...        ham
1  Ok lor but not too early. Me still having proj...        ham
2  * Was thinking about chuckin ur red green n bl...        ham
3  Pick you up bout 7.30ish? What time are  and t...        ham
4          Aight will do, thanks again for comin out        ham
5            Cool, I'll text you when I'm on the way        ham
6  How's it feel? Mr. Your not my real Valentine ...        ham
7         I'm not sure if its still available though        ham
8               Thts wat Wright Brother did to fly..        ham
9              That seems unnecessarily affectionate        ham

  Predicted Label
0             ham
1             ham
2             ham
3             ham
4             ham
5             ham
6             ham
7             ham
8             ham
9             ham
```