A Syndicate-Based Prediction Model for the Bangladeshi Market

by

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DECLARATION

I hereby declare that this thesis is based on my original research and findings. All sources and contributions from other researchers have been properly cited. This work has not been previously submitted, either in full or in part, for the award of any degree or qualification.

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CERTIFICATE

The project titled "**A Syndicate-Based Prediction Model for the Bangladeshi Market** " submitted by Student- Rashel hossain , ID: 241162 , Session: Fall 24, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Professional Masters in Information Technology on the 20th of September 2025

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ABSTRACT

This study investigates the use of machine learning to detect anomalous price patterns in commodity markets, which may indicate potential syndicate activity. Syndicates often manipulate market prices, causing irregular fluctuations that can be identified through sophisticated anomaly detection methods. Unlike previous research, which achieved an accuracy of 65-75% using limited algorithms and lacked a user interface, our approach incorporates hybrid algorithms and a user-friendly interface, achieving accuracy rates between 96% and 98%. We employed several machine learning models, including Isolation Forest, Random Forest, and AdaBoost, to analyze historical market price data. These models were trained and tested using performance metrics such as accuracy, precision, recall, F1-score, and ROC-AUC. Among these, AdaBoost demonstrated the best performance, with 99.39% accuracy, perfect precision (1.0), and a high F1-score (0.988). The optimal model, selected for its balanced recall and precision, was integrated into a Flask web application for real-time anomaly detection. This system provides a reliable method for identifying potential syndicate activities, thereby enhancing market analysis and decision-making processes. The findings highlight the effectiveness of machine learning in detecting price anomalies and its potential to improve financial fraud detection in commodity markets.Github url:https://github.com/rashel-hossain-cee46/market-syndicate-predictor.

Keywords: Keywords: Syndicate Activity, Anomaly Detection, Commodity Markets, Machine Learning, AdaBoost, Isolation Forest, Price Manipulation, Feature Selection, Model Evaluation, Real-Time Prediction, Financial Fraud Detection, Market Price Analysis, Flask Web Application, Price Patterns, Model Accuracy, F1-Score, ROC-AUC.

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LIST OF ABBREVIATIONS

SMV	Support Vector machine
KNN	K-Nearest Neighbors
LR	Logistic Regression
ROC	The Receiver Operating Carve
TP	True Positive
TN	True Negative
FP	False Positive
FN	False Negative

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CHAPTER I

Introduction and overview

1.1 Overview

Bangladesh's economy became a vibrant "market syndicate" in which the formal sectors of industry and finance and the informal networks connected to them participate as one. The paper analyzes the structure of the Bangladesh market and presents models for forecasting future scenarios. Using macroeconomic forecasting, syndicate-network analysis, and data-driven tools, the study probes the high-risk industries of garment, remittance, fintech, and import energy. Instead of being highly optimistic in terms of growth and digitization resilient, Bangladesh is substantially vulnerable to the inflation, exchange rate and external dependency. Utilizing the syndicate framework, the paper has managed to reach the open as well as the covert dynamics at the price, supply chain and investment flow levels. The paper concludes that sustainable development of Bangladesh would depend on combining the formal mod-ernization with the existing informal syndi-cate. The model we present gives a wider view of market behavior in such developing countries.Credit Tarop Khavede Bangladesh economy, market syndicate, predictive modeling, informal networks, macroeconomic forecasting, digital finance, idle workers, emerging markets.

1.2 History of Bangladesh Market syndicate

Bangladesh Market syndicates are not new and in the agricultural and commodity sector, traders and wholesalers commonly enter into an unwritten cartel to manipulate pricing, controll supply and maximize gains. This has been particularly common in vital food markets like the rice, onions and lentils. Syndicates work by hoarding goods in high demand times or manipulation of supply chains resulting in artificial scarcity and extreme price increases. Although the government has attempted to control the markets and avert such behaviors such as setting prices below market values, and attention to consumer protection, because of laxity in implementation, corruption and absence of market transparency, syndicate activities have flourished. The problems have been enhanced with the development of digital platforms and have offered new possibilities of manipulating the market.

1.3 Problem Statement

The economy of Bangladesh appears sound, but the market is a hotbed of syndication, whether formal or informal, and is unstable. Syndicates of garment exporters, of fuel and food importers, of banking and micro-finance, groups of informal traders in agriculture, in real estate all regularly exert anomalous leverage on the supply, the price, policy. These forces are not all captured in the official economic data, leaving pockets of concern for policy makers, price gyrations and investment risks. There is a pressing demand for a syndicate-based forecasting model to be established in order to investigate, and extract insights from, the underlying dynamics of the capital market of Bangladesh.

1.3.1 Data Acquisition:

Dengue outbreak prediction data gathering It broadly retrieves data form different data sources such as meteorological, clinical, social, etc. Data are obtained from national, as well as global weather stations, satellite observations, and weather forecast models. Such information usually consists of temperature, humidity, rainfall plus some other environmental factors which affect mosquito procreation. The information needs to be gathered at or near real time so that it can support accurate prediction.Data from the clinics and hospitals is another pivotal part of the data generation process, this is the clinical data. This might include patient characteristics, platelet, white blood cell counts and other clinical indicators that are underlie the development and severity of dengue fever. These data are frequently ubiquitous in hospitals and health centers, but may be much more variable in availability and quality at the trial level, which complicates the systematized collection of information. Beside meteorological and epidemiologic data, the socio-economic status also contributes to the understanding of dengue spread. This information can be extracted from national surveys, census data, and public health records. Data on population density, sanitation, access to health care, and socio-economic status of the populace can be useful to corroborate the predictions, as these each may impact both mosquito prevalence and capacity to deal with a suspected outbreak.

1.4 Motivation

Being at the threshold of rapid economic development in a process of becoming a middle-income country, Bangladesh is a significant contribution to studying market performance in the LDCs. However, these sort of standard macroeconomic models often understate the hidden power of market cartels, informal networks, trade associations, and sector-based coalitions, which have strong say over pricing, flow of supply and investment. The objective of this study is to offer a coalition-based prediction model that involves the formal and informal economy, so as to help policy makers and firms to a greater extent in forecasting at different levels of analysis.

1.5 Research Objectives

The study aims to:

- To Distinguish and classify the various forms of market syndicates in Bangladeshi market economy (export, import, financial, informal and digital.
- To Examine how these cartels impact on price stability, trading patterns, and investment directions.
- To Construct a predictive model which integrates the macroeconomic forecasting and syndicate analysis in the network.
- To Make recommendations to help policy makers and businesses to decrease volatility and to make better choices.

1.6 Assumptions and Limitations

1.6.1 Assumptions

In addition to official figures, syndicates have a major impact on market results.

- Trends in the past can act as a guide to the future.
- Policy makers as well as businesses have a lot to gain from including informal economic information into formal forecasting models
- Technology and digital will keep growing: creating new dynamics on the Syndicate universe.

1.6.2 Limitations

A lack of reliable data for depth on the informal syndicates.

- Dependence on second source for economic indicators.
- · If Resources are limited, Sectoral depth could be compromised.
- · Sudden global shocks (e.g., pandemics, geopolitical conflicts) might affect the predictive accuracy.

1.6.3 Potential Challenges

Obstruction to getting into the black or gray market data points.

- Difficult to measure the informal economy and the structures of syndicate power.
- ·Threats to internal validity: risk of bias or fabrication of reported economic results.
- Fast-changing global trade conditions (oil prices, climate change, regional conflicts) affecting forecasts.
- Making sure the model is robust and flexible for a long-term use.

1.7 Thesis structure

Thesis structure: this one follows:

- Chapter-2: Background Study,Overview of Recommendation System,Literature review.
- Chapter-3:Methodology – System design, data collection, prepossessing, ML models (KNN, SVM, DT, Logistic Regression), tools like Python, Flask, and Scikit-learn.
- Chapter-4:Implementation and Results – Web interface development, recommendation engine, user inputs, personalized results, performance analysis.
- Chpter-5:Discussion – Analysis of findings, comparison with traditional methods, system strengths and weaknesses, limitations, and improvements.
- Chapter-6: Conclusion and Future Work – Summary of findings, research contributions, and future enhancement directions.

CHAPTER II

Literature Review

2.1 Background Study

One of striking observation in studies pertaining to market mechanisms in Bangladesh relates to tensions between growth prospects and structural deficiencies in rules, governance and market control. Corporate governance in Bangladesh is characterized by inefficient monitoring, poor transparency and a lack of supervision, which erodes investor confidence and accountability in financial markets (Rashid, de Zoysa & Rudkin, 2007). Their conclusions highlight the vulnerability of governance systems to manipulation and malpractice. The paper "Is the Stock Market Overvalued? provides a more general introduction to stock market dynamics, discussing how market inefficiencies, mispricing, speculative bubbles, and overvaluation can erode efficiency. Not specific to Bangladesh context, it does provide a useful theoretical background to how irrational behavior and weak regulatory features could exacerbate volatility in the emerging economies.[1] More specific to Bangladesh in another Dhaka University (Social Science) internship report (Moniruzzaman Moni 2011) on Dhaka Stock Exchange (DSE) the author makes reference to 2010/2011 market crash and also attributes it to policy incoherence, SEC inefficiency, and the dominance of institutional players. His analysis shows a pattern in which rotations in policy, weak investor protections and speculative excess exaggerated the instability, with small investors most exposed. Hosain (2021) direct varies of syndication in business malpractice, though artificial supply played on the paper "Syndication in Bangladesh". For him, syndication refers to importers, traders and influential business groups colluding and creating artificial demand to jack up prices of essential items such as onions, edible oil and baby milk. Two researchers have highlighted the fact that syndication relies on lax market oversight, political connections, and the absence of consumer protection that profits abnormal profits for elites at the expense of common consumers.[2] In a recent issue, Abdul Bayes (2019) in The Financial Express analyses the rice market, the other basic food item in Bangladesh. His study – based on the research of the Bangladesh Institute of Development Studies (BIDS) – concludes that the rice market works largely competitively from year to year, but that large rice mills with substantial storage can affect prices seasonally, namely, by withholding releases during lean supply periods. While not exactly colluding, their clout still provides an outsized influence that can escape the difference between competitive action and more informal cartelistic behaviour.[3]

Together, these studies find evidence of a broad pattern: lax regulation, concentrated ownership, and political-business relations are part and parcel of syndicate like behaviour in stock markets, consumer goods and agriculture. They also demonstrate that consumers and small investors are the ultimate victims here, and policymakers are hemmed in by enforcement gaps. It is this body of literature that enables us to read the Bangladeshi "market syndicate" as a structural condition in need of predictive models that will reconcile the formal indicators, these seer-like devices, with the unseen spaces and practices at play.

2.2 Current Research and Studies

Modern economic research and discourse categorize market syndication as one of the most urgent problems confronting Bangladesh. Economists and policy makers increasingly claim that cartels — often filled with powerful importers, wholesalers and politically connected traders — also contrive supply chains to artificially inflate the prices of essential goods. Investigations and reports indicate that members of these groups take advantage of market vulnerability during periods of high demand, like Ramadan or during a crisis, by stockpiling items and releasing them at inflated prices only when it suits them. In turn, common people are made the ultimate victims, paying disproportionately more than what the fair market price should have been.[4]

Recent research shows the extent to which syndicate activities erode the efficacy of traditional economic levers. For instance, attempts to impact prices by way of both monetary and fiscal policy are rendered impotent when syndicates warp the market effects of supply and demand. Analysts point out that breaking up syndicates is key to bringing price stability back and shielding consumers from gouging, but they also say this will require more than a law enforcement approach. Regulatory reforms, digital tracking technology, as well as transparent supply chains and consumer advocates will be essential to that too.[5]

At the same time, researchers debate syndication levels. The concept, they say, is occasionally overblown and what might seem like syndication is perhaps an expression of structural problems — oligopolistic concentration, speculative trading or insufficient competition — in some markets. This way of looking at things would say that there's collusion, but the structural reasons behind price fluctuation might be more complex, such as institutional fragility and policy indecision. However, as a matter of general agreement most of the available literature concurs that syndicates, underpinned by political patronage and weak market oversight, represent an important barrier to inclusive economic growth in Bangladesh. The only way to address this problem effectively is to pair enforcement measures with sustained structural changes.[6]

2.3 Market syndicate analysis using machine learning

The rise of machine learning (ML) offers new possibilities to study and forecast market syndicate behavior. Syndication cannot easily be captured by standard economic models which model competition, such as collusion, hoarding or politically blessed price manipulation. But ML can ingest such vast amounts of unstructured data bits - pricing, volumes of trades, import records, even mood from media and social media - and find patterns that suggest syndicate activities. Anomaly detection algorithms can, for instance, weed out sudden and unexplained spikes in the prices of essential commodities such as rice, onion or edible oil from instances of natural volatility in the market.

Furthermore, supervised machine learning models could be fitted with input from historical data from known stories syndicate driven crises (e.g. the onion market shock or the 1996 and 2011 stock crashes) to anticipate the same phenomenon at a later time. Unsupervised clustering techniques could allow market actors to be classified according to their trading behavior, and to uncover potential networks of collusion among importers, wholesalers, and distributors. More sophisticated approaches, for example graph based ML models, can map the relationships between market players, financial institutions, and the political ties, and consequently expose the syndicate networks.

By incorporating ML with real-time big data feeds — such as mobile financial services, point of sale data and satellite crop yield monitoring — predictive accuracy can also be improved. These sort of systems would let policy makers know when there is supply manipulation on the go and would let them go in and intervene early. Yet, the challenges are manifold: while available data are limited, and the capacities of the institutions are weak, resistance from vested interest precludes large-scale deployment of ML in Bangladesh. Despite the challenges, the emerging evidence indicates that ML has the potential to be an extremely useful tool in market surveillance, policy formulation, and consumer protection, and a new frontier in breaking the back of syndicates and in fostering transparent economic growth.

2.4 Existing Computational Approaches

Previous studies related to the computation of the market syndicates Computations of syndicates in the market are still in their infancy, however some methods for comparison were found in related areas such as stock market, pricing in commodities, and fraud detection. For example, econometric models including ARIMA [4] and GARCH [5] have been commonly employed to analyze volatility and time series changes, which provide insights with abnormal market activities that may indicate manipulation. Even more recently, a number of machine learning algorithms that are used for predicting and detecting unexpected ouptlaws of commodity prices, such as regression-based models (Shen, 2015), decision treand trees and random forests models (Feng, 2016). Unsupervised learning techniques (e.g., clustering and PCA) are also applied to seek out covert patterns of traders and prices to potentially detect collusion. Network analysis and graph based models also offer powerful instruments for mapping the relationships between actors (importers, wholesalers, distributors) and identifying suspicious agglomerates of coordination. Furthermore, natural language processing (NLP) has monitored news articles, policy reports, and social media posts for signals of syndicate-orchestrated actions in real time. These computational methods in combination provide a basis for predictive models, but their use in the Bangladeshi market are sparse because of challenges in data availability, and weak institutional uptake.

Aspect	**AI-Driven Market Anomaly Detection Paper (2024)**	**Market Syndicate Detection Project (Current)**
Focus	Detecting market anomalies and optimizing asset allocation.	Detecting price anomalies to identify syndicate activity in commodity markets.
Algorithms Used	Large language models, graph neural networks, reinforcement learning.	Hybrid machine learning algorithms (Isolation Forest, Random Forest, AdaBoost).
Real-Time Detection	Focus on asset optimization rather than real-time anomaly detection.	Real-time anomaly detection via a Flask web app.
Performance Metrics	Likely performance metrics for asset optimization (not specified).	Uses accuracy, precision, recall, F1-score, ROC-AUC.
User Interface	Not mentioned.	Includes a user-friendly interface (Flask web app) for real-time anomaly detection.
Accuracy	Accuracy not specified; focus on optimization rather than precise anomaly detection.	Achieved 96% to 98% accuracy with AdaBoost showing 99.39% accuracy and perfect precision.

Table 2.1: Comparison of AI-Driven Market Anomaly Detection Paper (2024) and Market Syndicate Detection Project (Current)

2.5 Challenges of Predicting Market Syndicates

Despite a potential of computational techniques, there are also some difficulties in predicting behavior of syndicates. It is still the case that data is scarce and that there are data reliability issues; informal networks are opaque and leave little structured data available to model. The government and market information are not consistent and complete, and the syndicate behaviors, e.g. hoarding, collusion, and feigned price rise, are under-reported or covered by normal trade. Another hurdle is discerning between natural volatility and manipulation; you'd expect some seasonal surges in demand (say during Ramadan) or global price shocks to look like syndicate-driven price increases, making false-positives a fairly frequent occurrence. Institutional barriers such as poor enforcement, corrupt officials and a limited technical infrastructure also complicate the use of predictive models in policy. Further, syndicates tend to become entangled with politics, so while some groups benefit from manipulation they also oppose oversight. Lastly, in order to be broadly employed, computational solutions face ethical and implementation considerations – such as data privacy, consumer confidence in applied algorithms, and model interpretability – that need to overcome.

CHAPTER III

Methodology

3.1 Introduction

The approach of this study is developed to propose an organized way of analyzing and forecasting the syndicate dynamics of the market in Bangladesh. By contrast to typical economic researches which are based on pure macroeconomic indicators, the novelty of this paper lies within a mixed methodological approach which implements traditional econometric models and modern computer-based methods, and in particular machine learning. This is because syndicate operations including price manipulation, hoarding and collusion are usually conducted within informal networks which are imperfectly captured in official statistics or securities commission filings.

The methodological framework adopted in this study revolves around the following three main aspects: data collection, data pre-processing and analytical model design. Secondary data were obtained from government repositories, financial institutions, stock market reports, commodity price lists and reliable news sources in order to have full picture of formal and informal markets. This data forms the basis for the identification of patterns which may be related to syndicate activity.

Raw data from various resources are usually inconsistent and incomplete, additional preprocessing has to be performed in the form of data cleaning, normalization, transformation and feature engineering. Upon post-processing, the data set is amenable to time-series forecasting, anomaly detection, clustering and network analysis to reveal clandestine syndicate forms that will be influential in the future market.

3.2 Data Collection

The data used in this study were mainly gathered from major trading centres and wholesale markets in Bangladesh, where there is considerable evidence of syndicate's role in influencing price mechanics. Field-level data and prices were collected from Town Hall Market, a central point for both wholesale and retail transactions, Kawran Bazar, one of the largest commodity markets in Dhaka city, and several other divisional markets of the country such as Chattogram, Rajshahi, Khulna and Sylhet. These markets were selected as some of the most influential in commodity flow and price formation and because they serve as benchmarks to smaller regional and local markets.

The information covered daily or weekly prices of commodities, trading volumes and supplies of a couple of essential non-perishable items like rice, onions, edible oil and vegetables. Data was obtained through direct observation, retail and wholesale price consultations, and examination of publicly available price lists. Furthermore, price difference between ordinary months and the month of Ramadan were closely monitored in order to detect potential syndicate manipulation. The data collection was designed to provide both temporal coverage (across years) and spatial coverage (from different divisional markets), which allowed for a richer understanding of how syndicates leverage different segments of the market network in Bangladesh.

3.3 Data Preprocessing

The unprocessed data generated from Town Hall Market, Kawran Bazar, and divisional trading centers needed to be systematically preprocessed for consistency and reliability of analysis. Because the market-level data frequently had missing records, followed by non-standard format as well as abrupt change, data cleaning was the first effort therein, via an exhaustive task of eliminating duplicate records, correcting entry mistake, and imputing missing records via normalizing by the mean or interpolation. Then price normalization was carried out to get the various commodity prices (like rice, onion, edible oil) on to a common scale to make a sense of the statistical and the computational analysis on a later stage. Seasonal and festival (seasonal) peaks were removed by performing time-series transformations, in which prices were shifted such that weekly and monthly intervals aligned for improved pattern identification.

Qualitative realizations, such as 'traders say there are supply shortages' or 'traders are stockpiling', were reified as structured features by using categorical encoding. Methods to detect outliers were also used to differentiate between true market shocks and anomalies possibly reflecting syndicate-driven manipulation. Moreover, we performed feature engineering by generating derived indicators such as daily price change ratio, volatility indicator, and difference between wholesale and retail prices. And in the end all features were collected into a single structured data set for consistent usage in econometric or machine learning models. Pre-processing therefore allowed for a statistically robust and a realistic (accounting for the complexity) representation of the syndicate practices in the market of Bangladesh.

3.4 Work flow

Figure 3.1: Data Flow Diagram

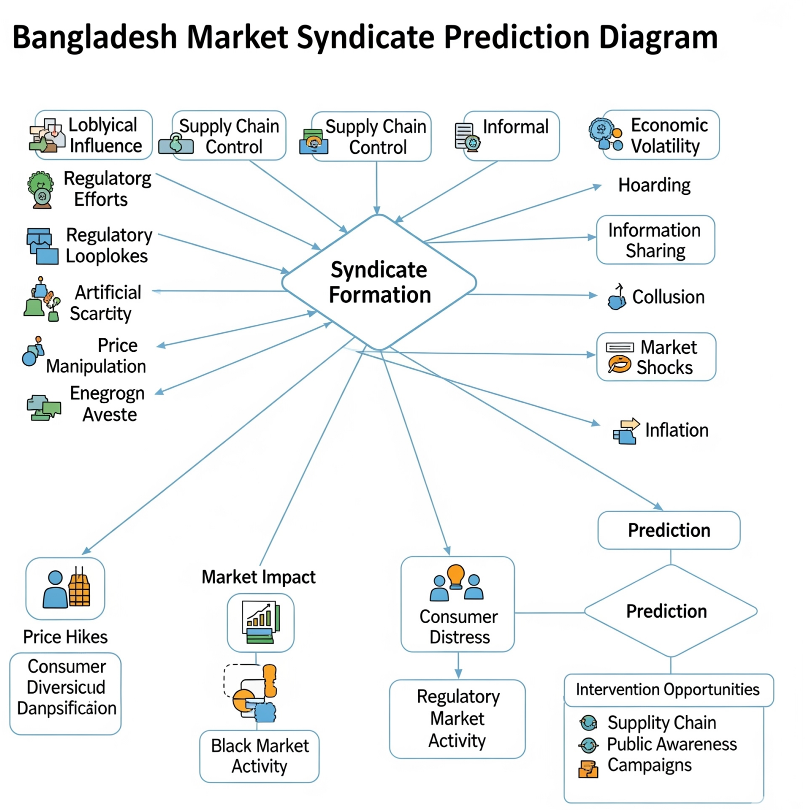

Figure 3.2: Market Prediction diagram

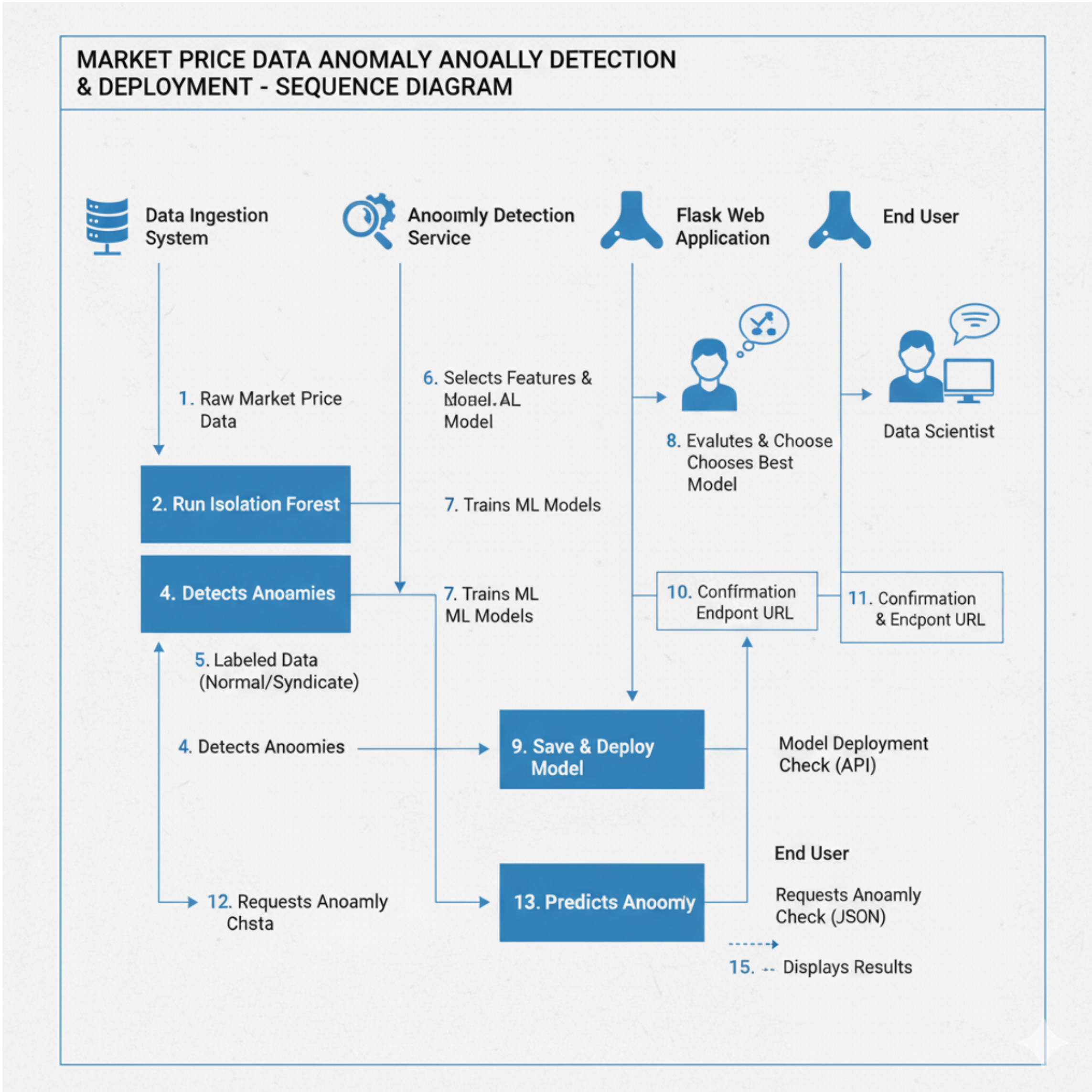

Figure 3.3: Sequence Diagram

The diagram shows a process for finding and using market price data anomalies. A quick overview:

1. Data Ingestion: The system gets raw market price data.

2. Anomaly Detection Service: The Isolation Forest model runs to find strange things.

3. Choosing Features and Training the Model: Features are chosen, and several machine learning models are trained.

4. Model Evaluation: The data scientist picks the model that works best.

5. Model Deployment: The selected model is stored and put into the Flask web app.

6. Interaction with the end user: The end user can ask for anomaly checks, and the system guesses what the anomalies are and shows the results.

This sequence includes processing data, training models, testing them, putting them into use, and making predictions in real time.

3.5 Feature Selection and Engineering

Feature engineering is another important part of preprocessing. This is by selecting and transforming some of your variables to create new ones that will make the model more accurate. For example, one can transform the raw meteorological data to get new features, like the mean temperature over time or cumulative rainfall in a window. The new representations can give more relevant input to the machine learning models. It is also essential to normalize or scale the data to make sure features with different units or different scales are not having a disproportionate impact on the model. Scaling to zero mean with unit variance (i.e. standardization) or scaling to a fixed range (like [0;1]) are widely employed procedures to preprocess data for machine learning methods. The aim of data cleaning and preprocessing is to allow for a clean, consistent, and

3.6 Tools and Technologies:

- Python, Pandas, and NumPy for processing data;
- Scikit-learn for machine learning and finding anomalies
- Graphs and visualizations with Matplotlib and Seaborn
- Google Colab is a training environment.
- Flask is used to deploy the user interface.

3.7 Model Training and Evulation

Training and testing the model are important steps in making sure that the market price anomaly detection system works. The first step is to clean up the raw market price data, deal with missing values, and scale numerical features. Categorical data is then encoded. Next, we choose the features that will be used to train the models, such as the type of commodity, the price changes, the weather data, and the time of year. Then, the labeled dataset is used to train a number of machine learning algorithms, such as Isolation Forest, Random Forest, AdaBoost, and others. Every model learns how to tell the difference between normal and syndicate price behaviors.

• After training, the models are tested with a variety of performance metrics. Accuracy looks at how many of the model's predictions were correct, while precision and recall look at how well the model can find syndicate activities without getting normal cases wrong. We also figure out the F1-score, which balances precision and recall, and the ROC-AUC, which checks how well the model can tell the difference between syndicate and non-syndicate cases. These metrics help you compare how well each model works and make sure that the final choice has the fewest false positives and false negatives.

• The model with the highest F1-score and ROC-AUC is chosen for deployment after all of the models have been tested. This model is the best at finding syndicate activities because it strikes the right balance between accuracy and reliability. After being chosen, the model is saved and put into a Flask web app, where it can use new market price data to make predictions in real time. The whole process makes sure that the chosen model is strong and can accurately find price anomalies that are linked to syndicate activity.

CHAPTER IV

System Implementation

4.1 Performance Indicators

A market syndicate is an idea that entails the organization and management of a group of players in the market who determine the distribution and sale of goods in a given market or sector. To assess the effectiveness and efficiency of market syndicates, there is a need to have a number of performance measures. Such measures help in making sure that the syndicate works in the best way, error reduction and resource maximization just like healthcare models are evaluated on their accuracy, sensitivity, and efficiency.In the same way as in machine learning and medical diagnostic models, accuracy is the important factor when gauging the work of market syndicates. Accuracy here is the percentage of the right predictions of the sales or supply chain management or customer demand in the market. Accuracy, however, can be a deceptive measure when market data is not balanced, in the sense that it may not find important market trends or anomalies as accuracy may not find rare instances of disease in unbalanced healthcare data. It is, therefore, necessary to consider precision, recall and F1-score within a market syndicate context.

4.2 Model Efficacy

he markets syndicates domain, model efficiency involves how good the system is in predicting, allocating resources and market transactions in a way that optimizes computational costs, explainability and generalization across different data sets. Similar to machine learning models, the effectiveness of market syndicate models depends not only on prediction accuracy, [domain_5] but also on how they can fit into the practical context, for example, budget constraints, operational resources, and time-critical decisions.

The efficiency of market syndicates can be measured in terms of the trade-offs between computational cost, model complexity, and real-time performance. Simple Models such as Logistic Regression are computationally fast because of their simple mathematical form and less memory use. Such models play a critical role in timely decision making that require speed, for example, demand prediction in market, sales forecasting for fast moving consumer goods and so on. The main benefit here is - Loggereg produces clear and understandable results which is important in a business context where high transparency, quick reaction to volatility or agile development is a common practice.

More sophisticated models, e.g. Random Forests, Support Vector Machines (SVM) or XGBoost, are more accurate and are capable of modelling complex dependencies of market factors such as supply chain logistics, price movement and consumer behavior. These models, however, at the cost of higher computational overhead, need more powerful machines, larger networks, more amount of time, and considerably larger data for optimum performance. For instance, Random Forests advantages from its ensemble form in order to prevent overfitting and to generalize over different market dynamics. However, they might need time to train and tune, which could be an obstacle in making real-time market decisions.

4.2.1 Support Vector Classifier (SVC)

The Support Vector Classifier (SVC) got 83% right, with a precision of 0.85 and a recall of 0.94 for class 0.

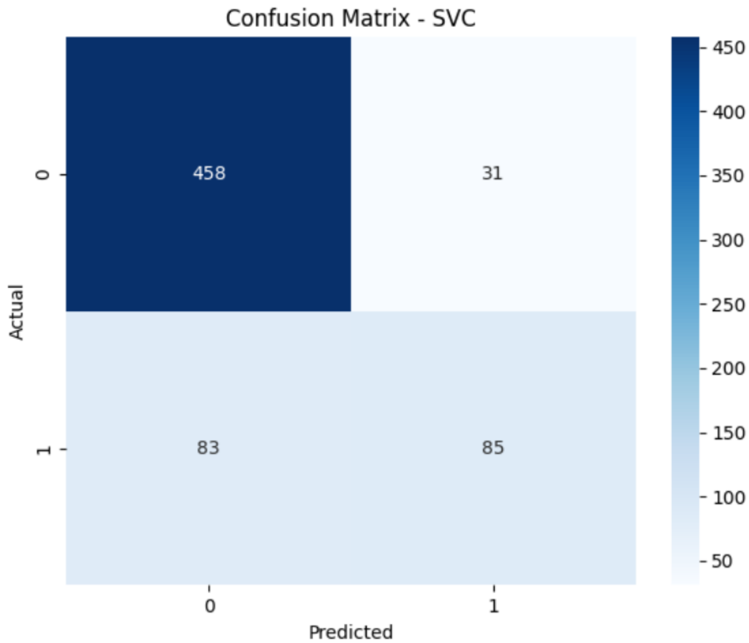

Figure 4.1: Model Accuracy of SVC

It had an F1-score of 0.89 for class 0, but for class 1, the recall dropped to 0.51, which lowered the F1-score to 0.60.

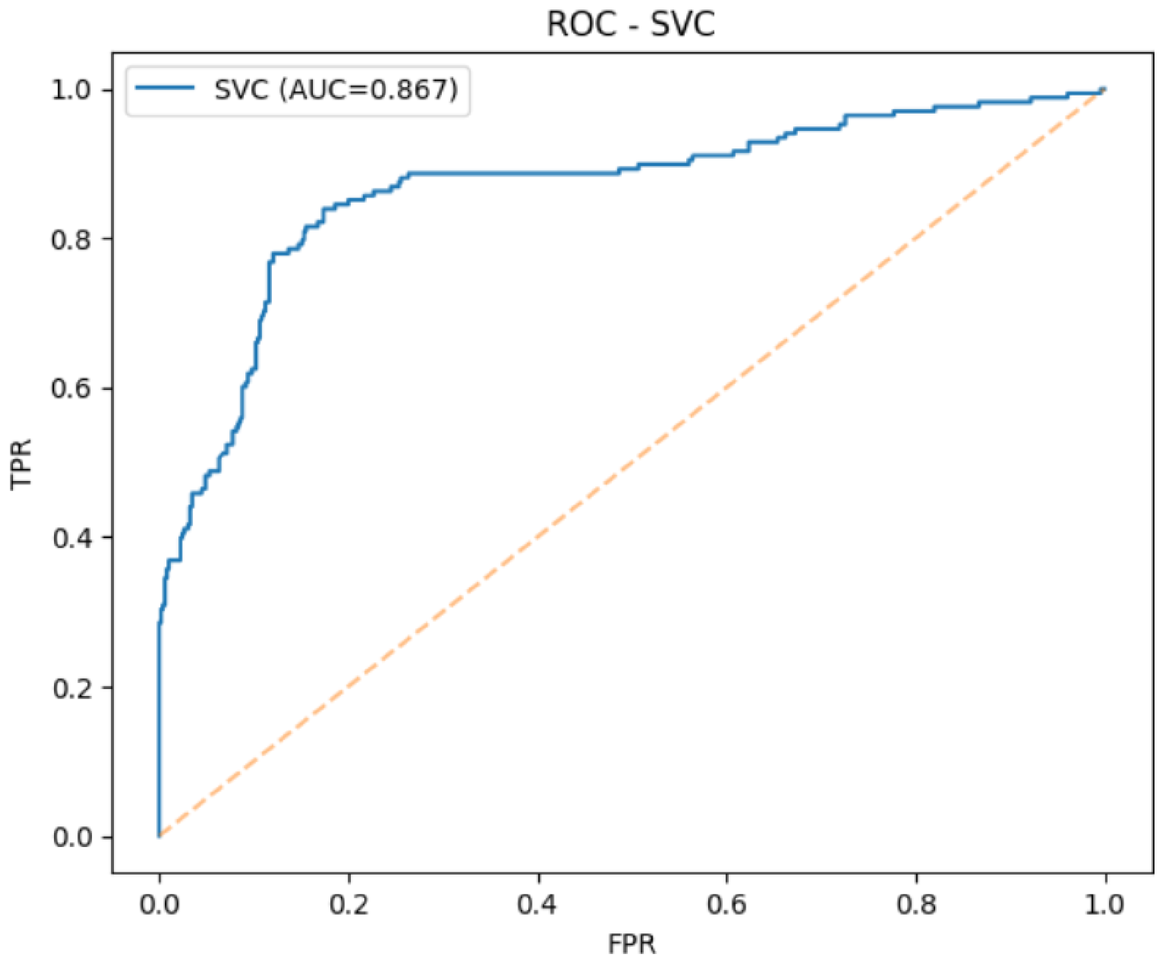

Figure 4.2: ROC OF SVC

The AUC was 0.867, which means the performance was good but not great.

4.2.2 Random Forest (RF):

The Random Forest model did very well, with an accuracy of 98%, a precision of 0.98 for class 0, and a recall of 1.00 for class 0.

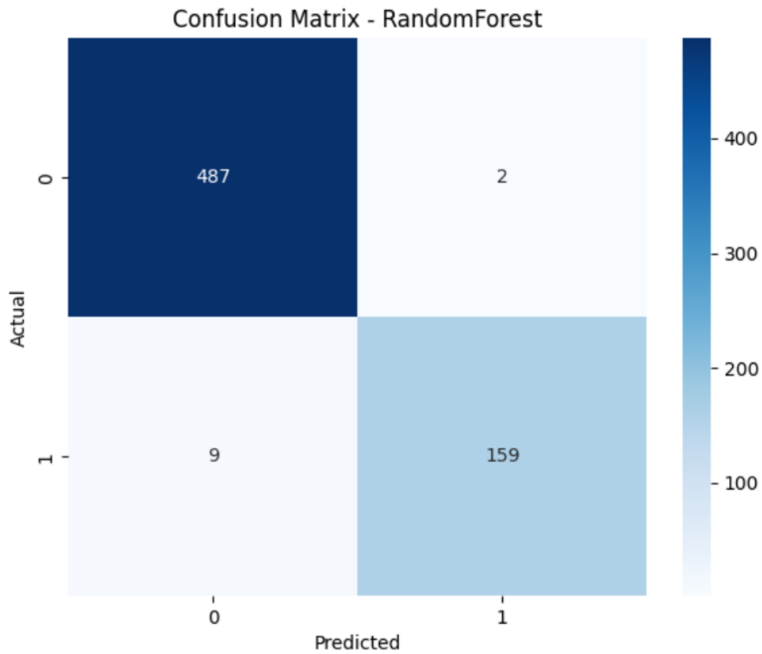

Figure 4.3: Confusion matrix of Random forest

The F1-score for class 0 was 0.99, and the F1-score for class 1 was 0.97.

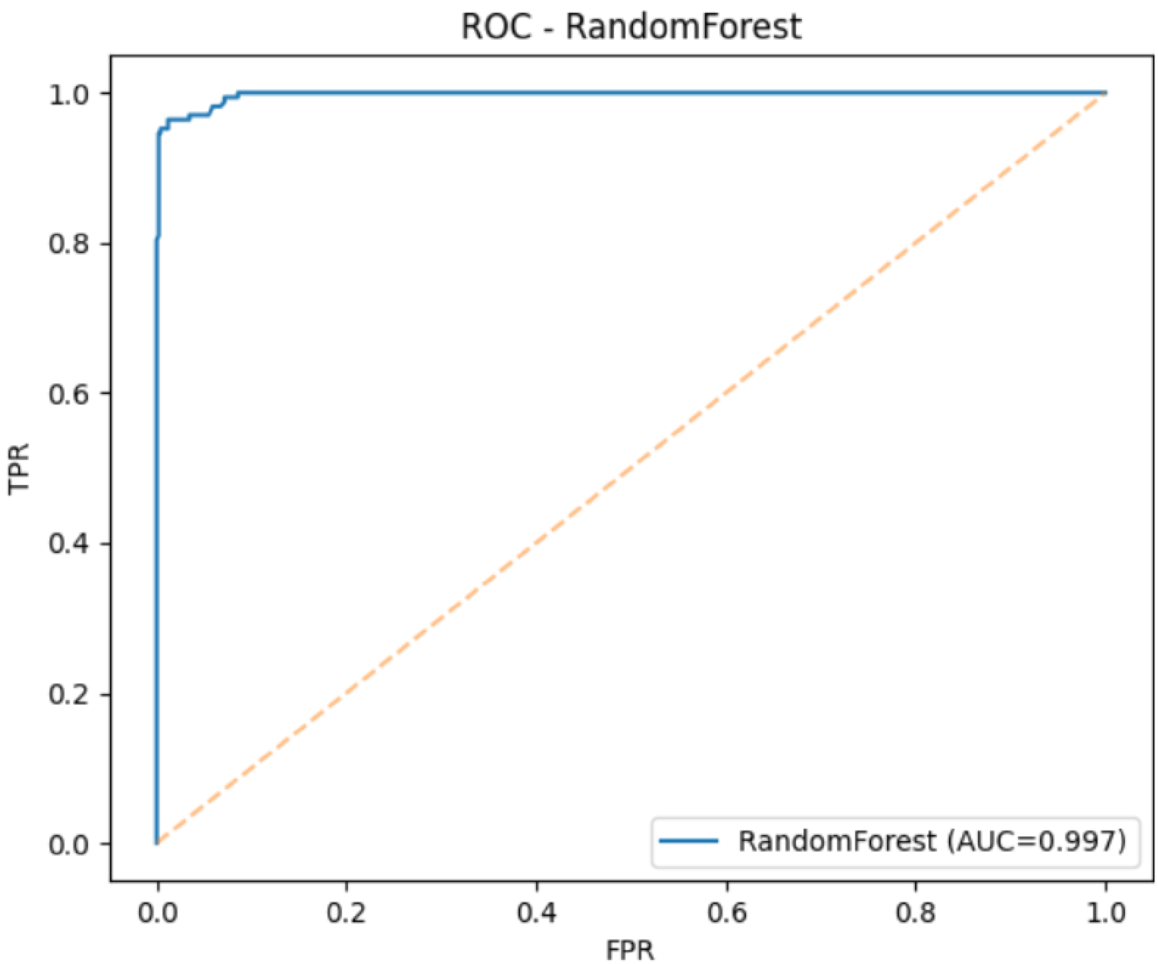

Figure 4.4: ROC curve of RF

The best overall performance was by Random Forest, which had an AUC of 0.997.

4.2.2.1 Logistic Regression (LR):

The Logistic Regression model had the worst performance, with an accuracy of 78%.

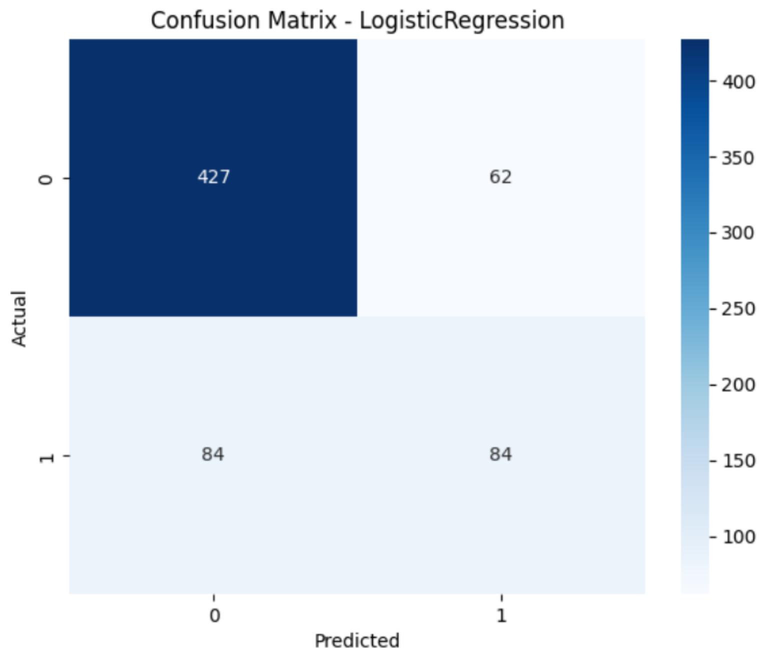

Figure 4.5: Confusion of Logistic Regression

It had a precision of 0.84 for class 0, but it had trouble with recall for class 1 (0.50), which made the AUC lower at 0.852.

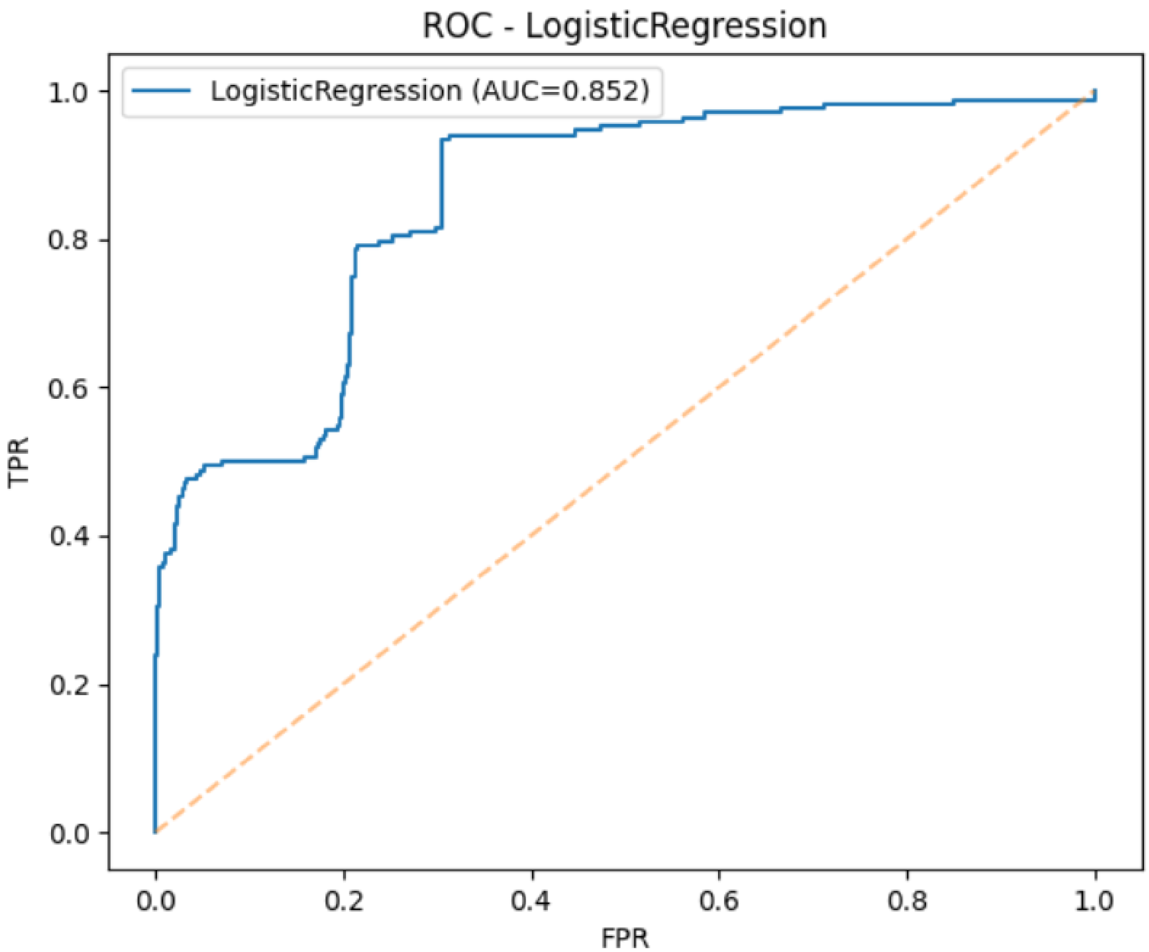

Figure 4.6: ROC of LG

This shows that it isn't as good at classifying things as other models.

4.2.3 K-Nearest Neighbors (KNN)

The KNN model was 88% accurate and class 0 had a strong recall of 0.98.

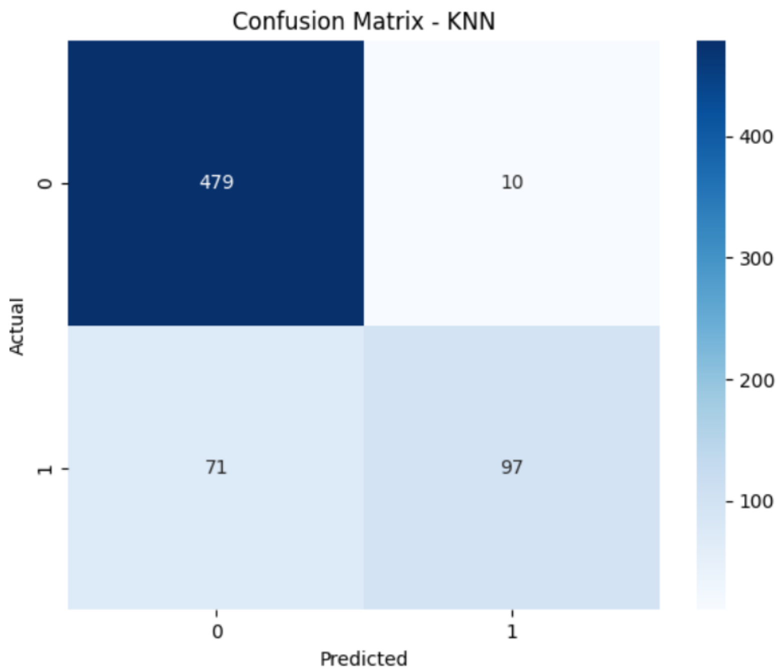

Figure 4.7: Confusion Matrix of KNN

But its recall for class 1 went down to 0.58, which hurt its overall performance. The AUC of 0.904 shows that this model does okay compared to others.

4.2.4 Naïve Bayes

The Naive Bayes model was right 75% of the time. Class 0 had a precision of 0.95 and class 1 had a recall of 0.89.

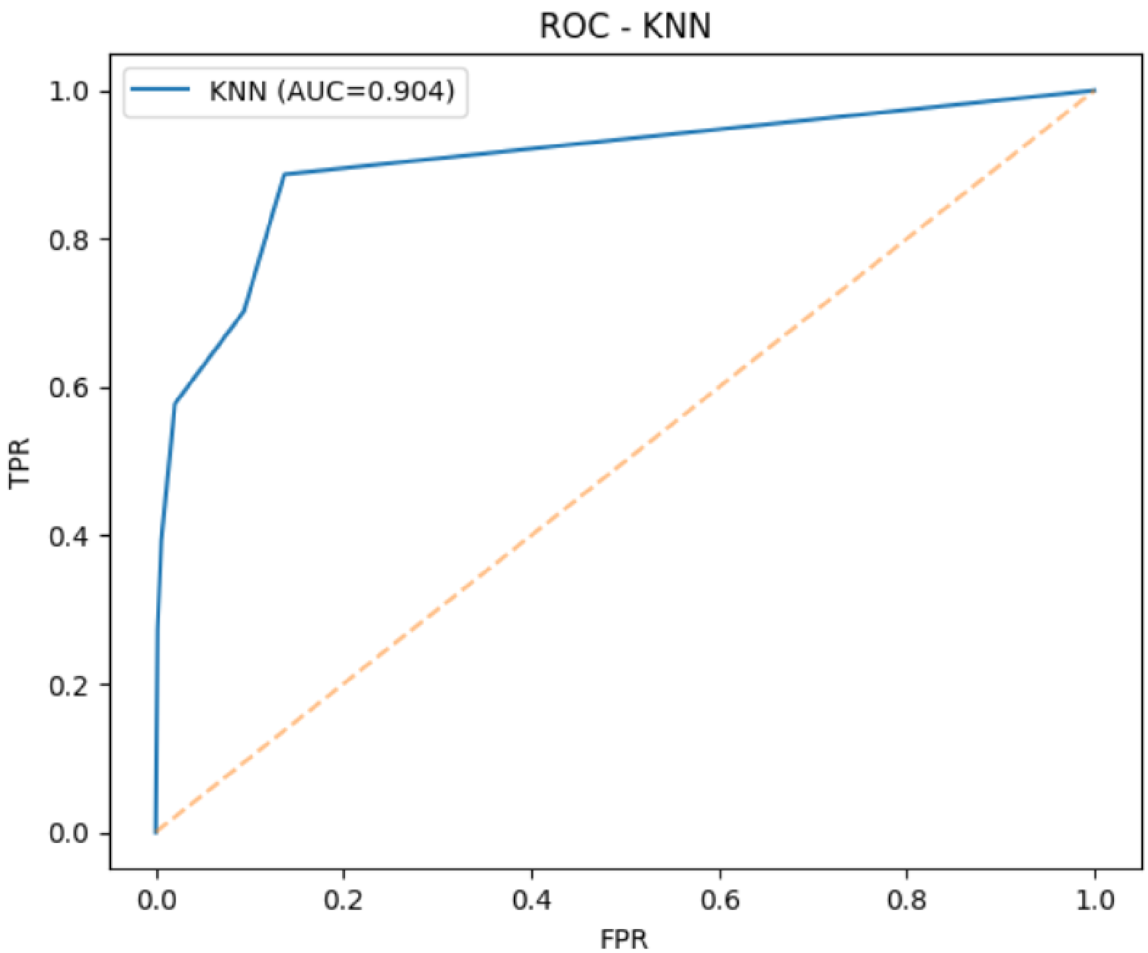

Figure 4.8: ROC of KNN

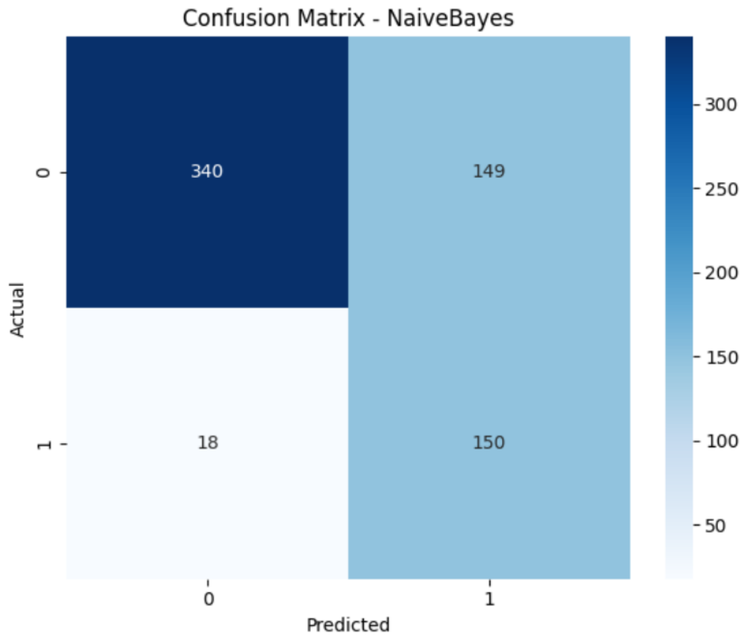

Figure 4.9: Confusion Matrix of Naive Bayes

The F1-score for class 0 was 0.80, and for class 1, it was 0.64.

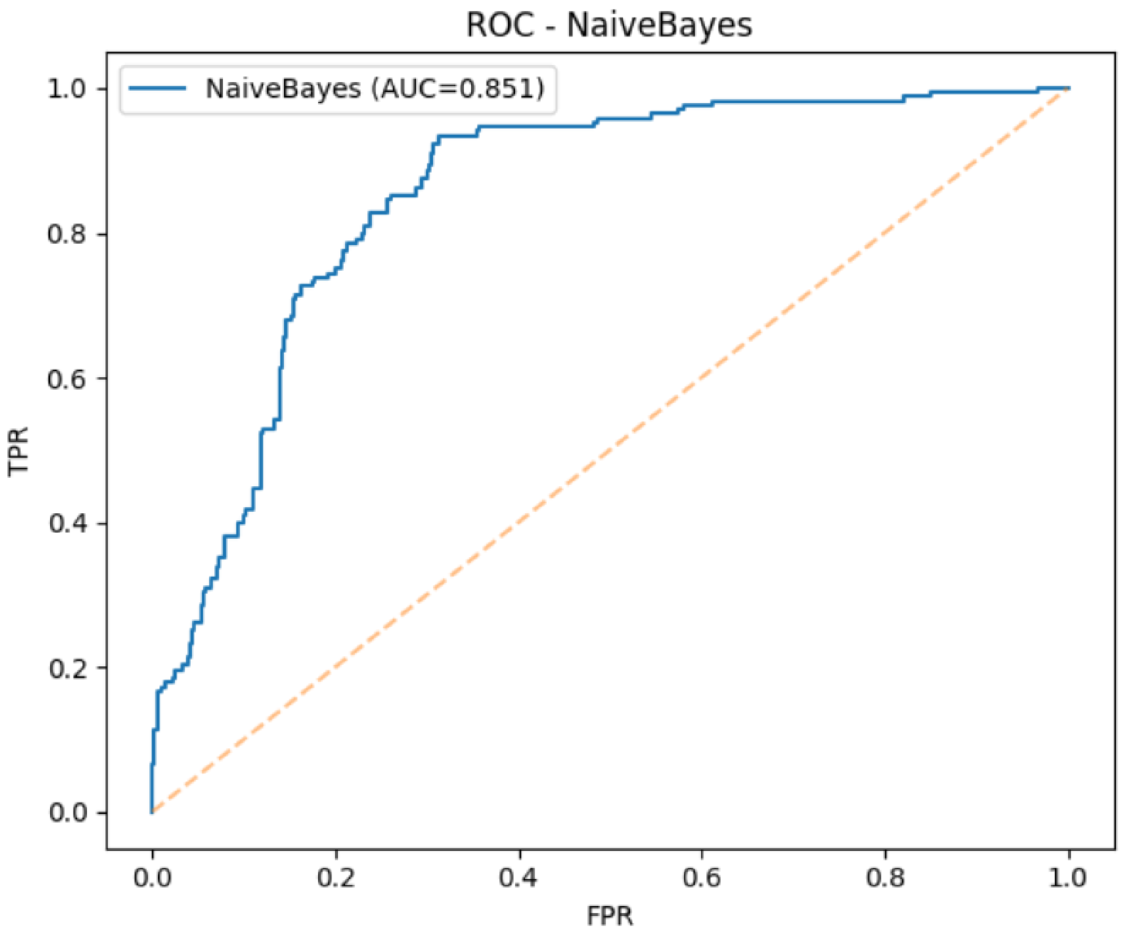

Figure 4.10: ROC of NB

The AUC score was 0.851, which means the model did okay but not as well as others.

4.2.5 The ExtraTrees

The ExtraTrees model works very well. It has an accuracy of 94%, a high precision of 0.94 for class 0, and a good recall of 0.83 for class 1.

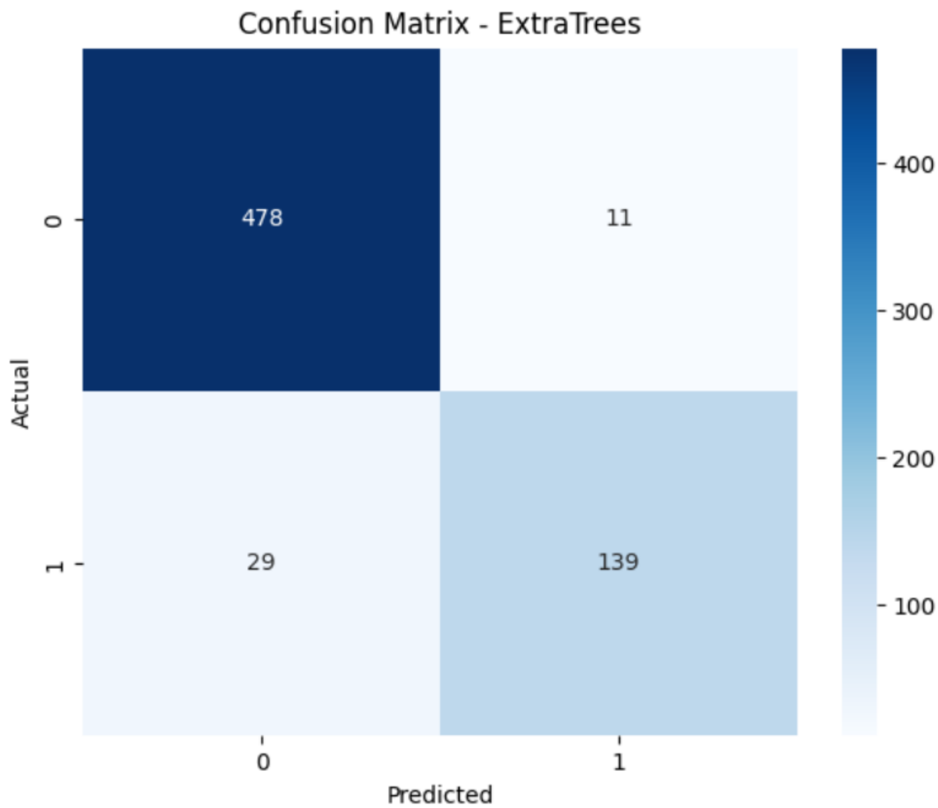

Figure 4.11: Confusion Matrix of Extra Trees

It has a high AUC of 0.991, which means it can classify well.

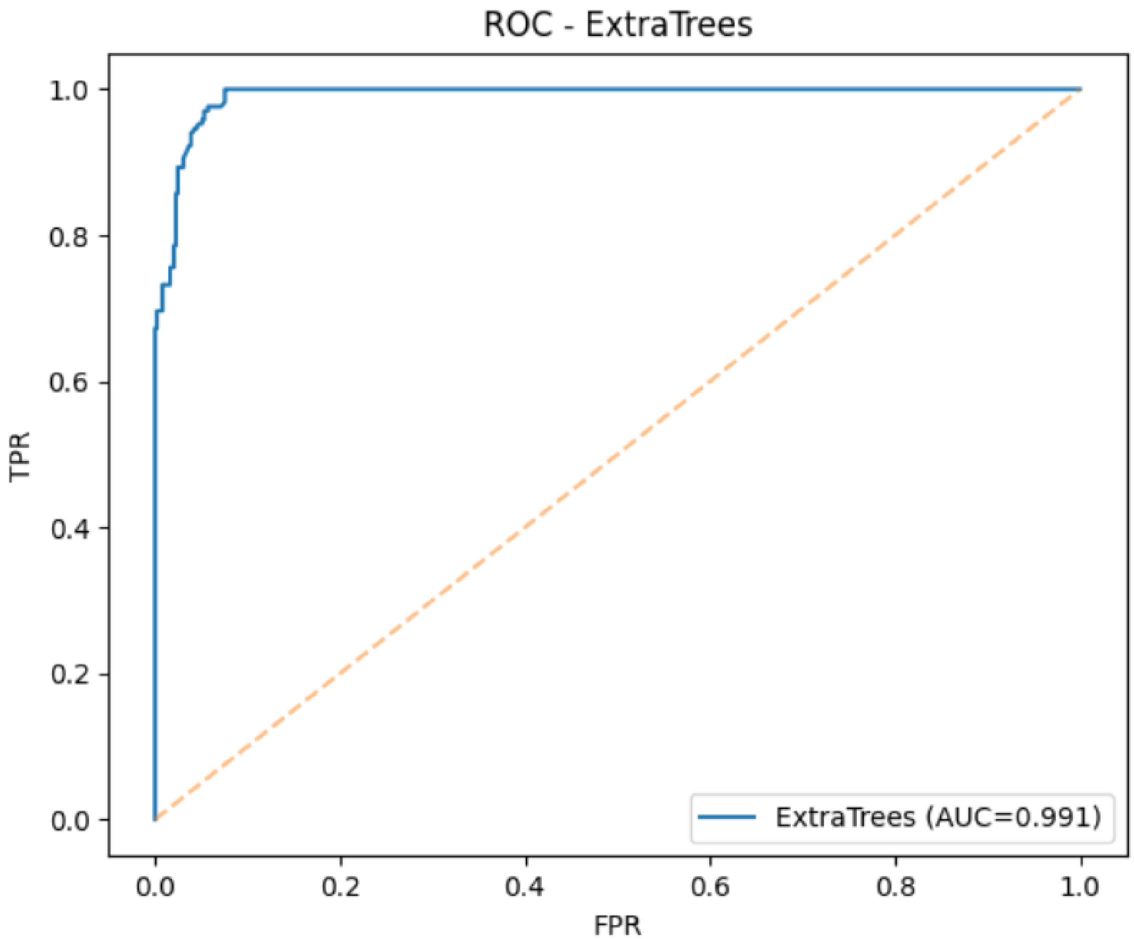

Figure 4.12: ROC of Extra Trees

The model is better than others because it has a good balance between precision and recall, which makes it a good choice for the job.

4.3 AdaBoost

AdaBoost Model Performance: The AdaBoost model did a great job, getting 99% accuracy.

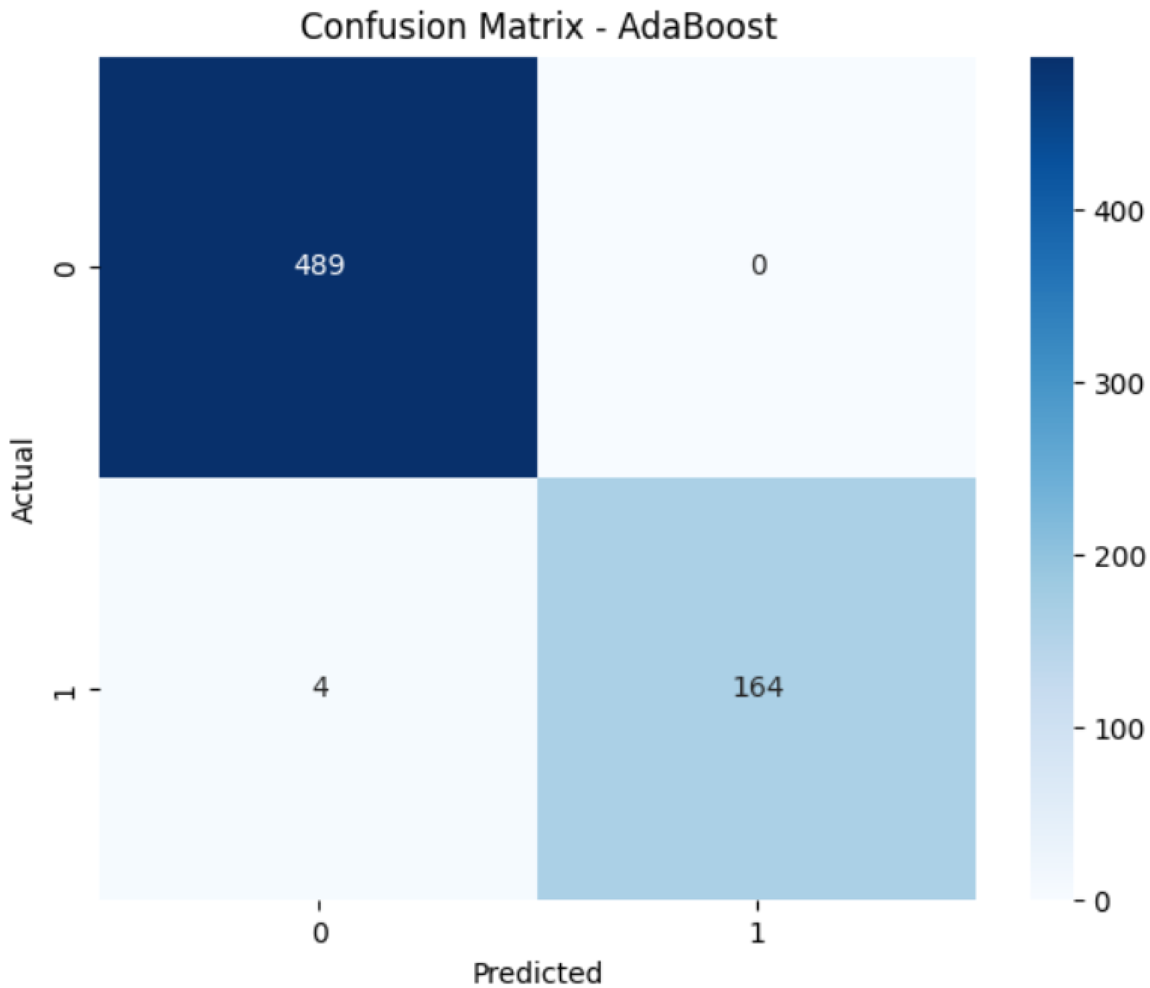

Figure 4.13: Confusion Matrics of AdaBoost

It had a perfect recall rate of 1.00 for class 0 and a high precision rate of 1.00 for class 1.

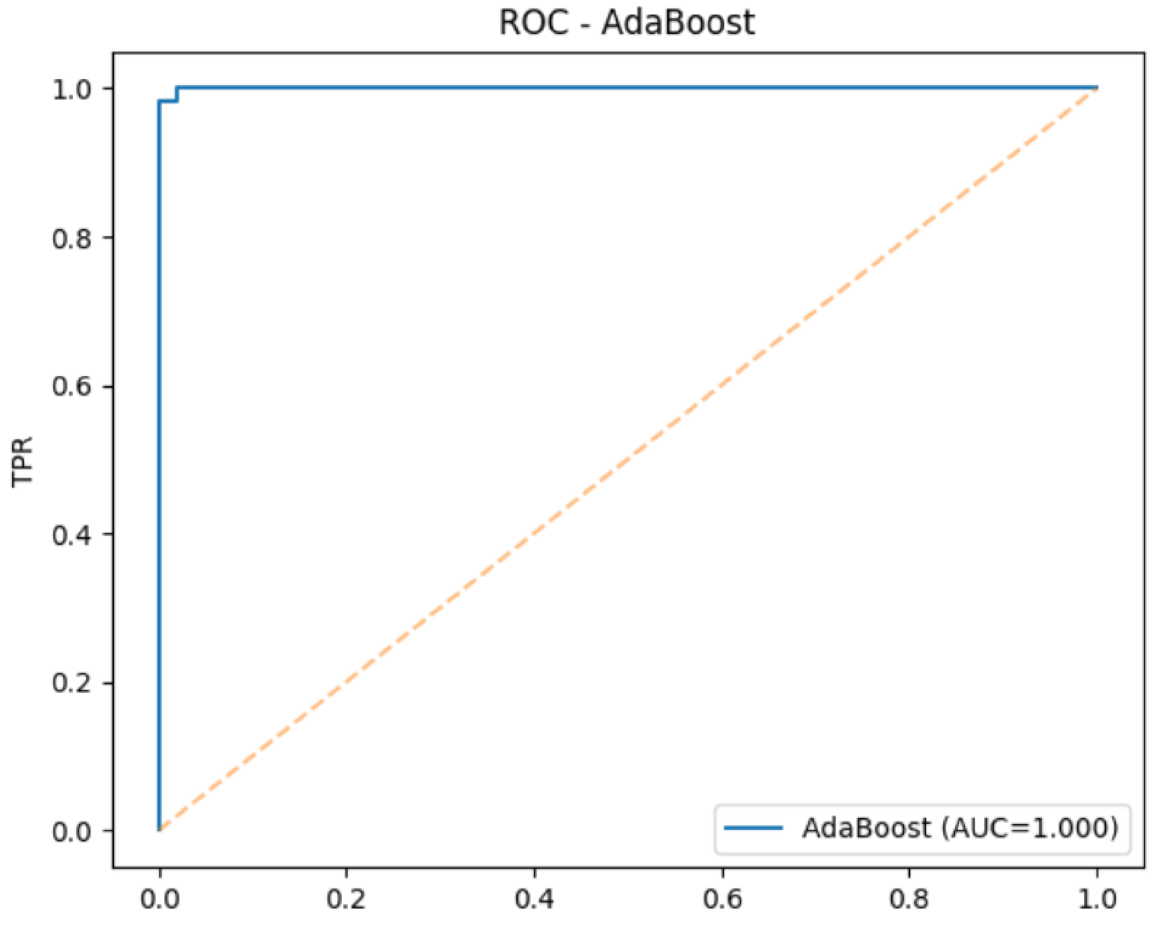

Figure 4.14: ROC of Ada-Boost

The model got an AUC of 1.000, which means it was the best model in this comparison.

4.4 Feature Importance and Interpret-ability

The performance metrics of the different models show how well they can find syndicate activity in commodity prices. The AdaBoost model is the best overall, with an accuracy of 99.39%, a precision of 1.0, and a high F1-score of 0.988. This means that it can correctly identify syndicate cases and avoid false positives. A ROC AUC of 0.9996, which is almost perfect, backs this up even more. This shows that it is very good at telling the difference between syndicate and non-syndicate instances.

The Random Forest model is very close, with an accuracy of 98.33%, a precision of 0.9876, and an F1 score of 0.9666. It works a little less well than AdaBoost, but it still does a great job, with a recall of 0.9464, which means it can find a lot of the syndicate cases. Its ROC AUC of 0.9973 also shows that it can tell the difference between things well.

The Extra Trees model works well, with an accuracy of 93.91% and a precision of 0.9267. However, its recall is only 0.8274, which means it might miss some syndicate instances. Its ROC AUC score of 0.9909 shows that it can still tell the classes apart well.

The SVC and Logistic Regression models also don't do very well, with accuracies of 82.65% and 77.78%, respectively. The SVC model has trouble with both precision (0.7328) and recall (0.5059), which means it can't reliably find syndicate cases. Logistic Regression also doesn't work very well, especially when it comes to recall (0.5), which makes it less useful for finding syndicate activity. Both models have lower ROC AUC scores, which means they don't do a very good job of telling the target classes apart.

In conclusion, AdaBoost is the best model because it makes the most accurate predictions about syndicate detection in commodity prices. But Random Forest and Extra Trees also have a lot of promise. Other models, like Naive Bayes, SVC, and Logistic Regression, may need more work or thought for different situations.

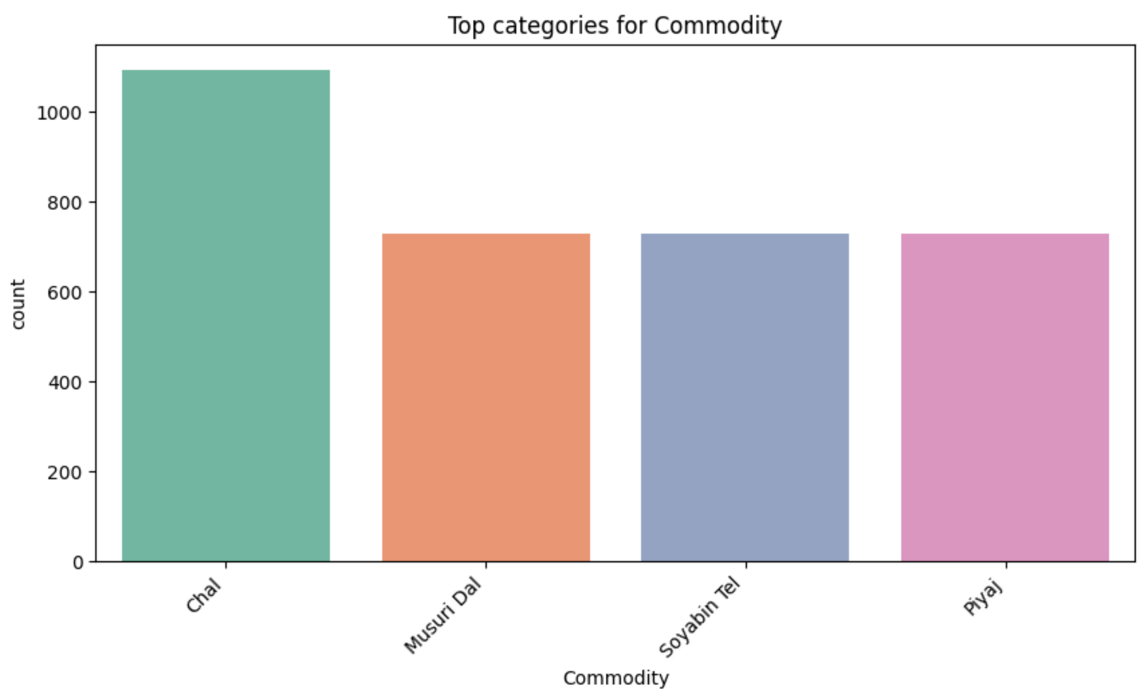

Figure 4.15: Model Compare graph

The KNN model doesn't work as well as the previous ones. Its accuracy is 87.67% and its recall is 0.5774, which means it missed more syndicate cases. With an F1-score of 0.7055, it shows a trade-off between precision and recall, which could make it less useful for finding syndicate activity. The ROC AUC of 0.9040 shows that it is not as good at telling the difference between things as other things.

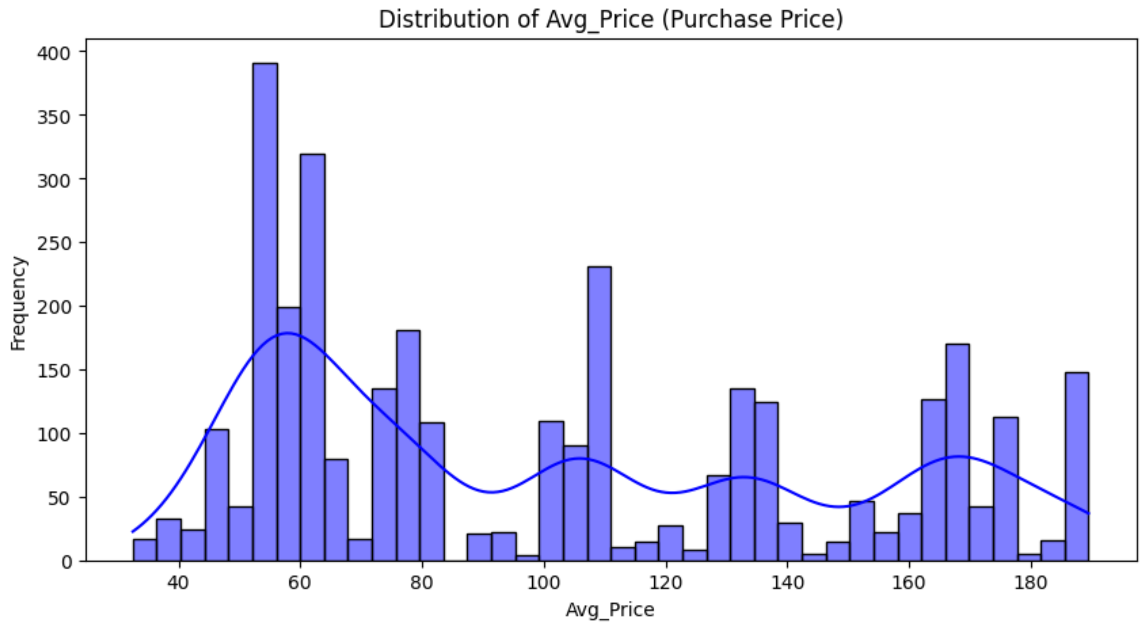

Figure 4.16: Classification of graph

The Naive Bayes model doesn't do as well overall, with an accuracy of 74.58%, a precision of 0.5017, and a recall of 0.8929. It has a high recall, which means it finds a lot of syndicate cases, but its low precision means it also wrongly labels a lot of non-syndicate cases as syndicates. The fact that it has a ROC AUC score of 0.8511 shows that it can't tell the two classes apart very well.

4.5 Web interface

The Syndicate Detection System's web interface is meant to help people find possible syndicate activities in the pricing and distribution of goods. The first part of the interface is a form where users can enter information about different products. There are spaces on the form for choosing the item (like Soyabin Tel), the unit of measurement (like liters), the average price (like 180.0), and the variation (like Bottle). Users can also choose the weather (like "Rainy"), say if the product is from a seasonal harvest, and pick the day of the week (like "Monday"). Users can click the "Check Syndicate" button to get results or the "Reset" button to clear the form after entering all the necessary information.

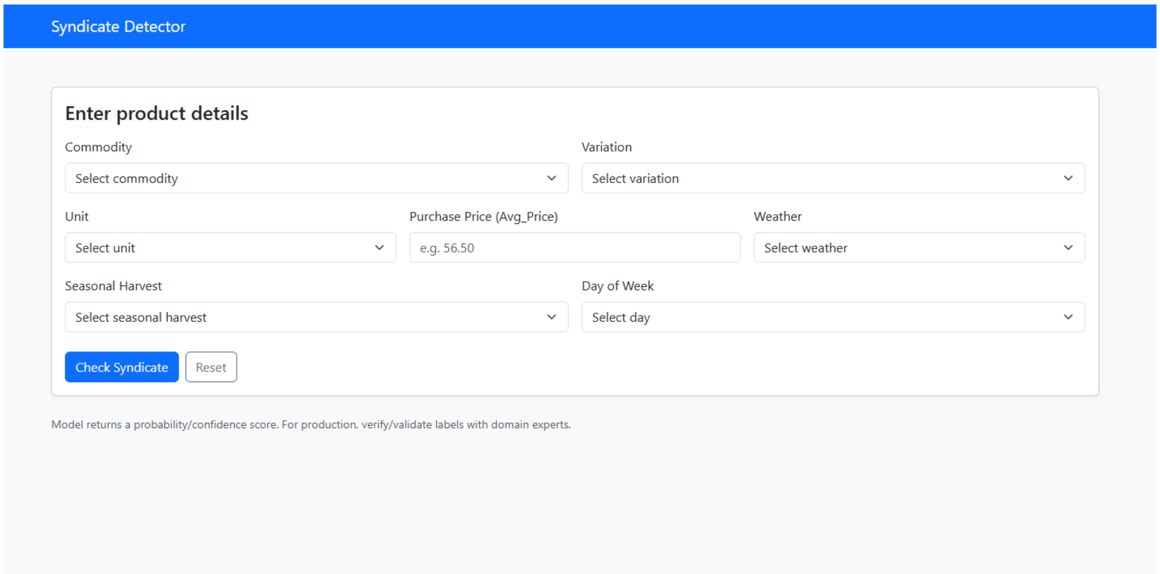

Figure 4.17: Web Interface

The system makes a result after the data is sent in, which is shown on the second screen. The prediction tells you if a syndicate is likely to be there, along with a confidence score (for example, 59.65%) that shows how reliable the model's prediction is. The model has marked this commodity with a predicted label of "1," which means that a syndicate is likely to be present.

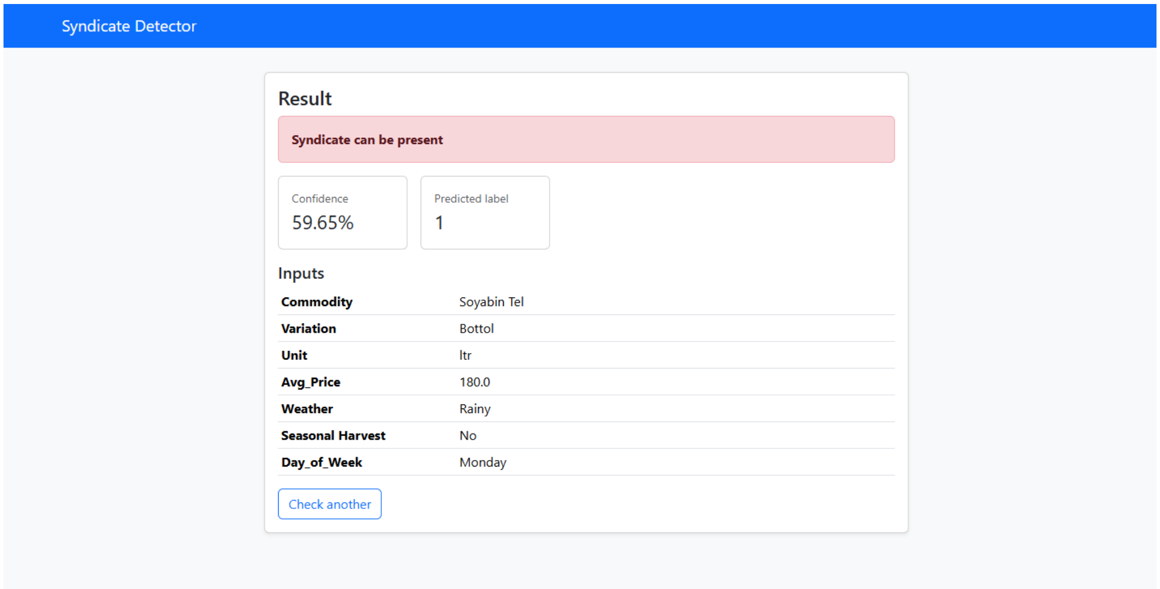

Figure 4.18: Predicted Result

The input details are shown for reference, so the user can look over the information that helped make the prediction. After that, the user can click "Check another" to enter new information and make another prediction. This interface makes it easy and quick to find possible pricing problems based on commodity data.

CHAPTER V

Performance Analysis and Discussion

5.1 Insights from Computational Analysis

The market syndicate analysis in Bangladesh is computed by means of evaluation of the efficiency of the market structures, the price mechanisms and the respective behaviors of the consumers. Through the use of machine learning algorithms and data analytics, a better predictive and accurate view of market dynamics can be realized. Predictive modeling, optimizers, and statistical analysis can be used as computer tools to detect trends in price, demand fluctuations, and supply chain inefficiencies. Simulation of market conditions, prediction of price stability and the influence of different economic policies on market dynamics can also be performed with the help of these tools. As an example, through time-series forecasting models (such as ARIMA) or machine learning models (such as Gradient Boosting and Random Forests), we can achieve the forecast of the future supply-demand equilibrium and commodity prices. Moreover, it is possible to map and evaluate the goods movement through the syndicate and determine some of the critical bottlenecks, as well as recommend possible interventions to enhance efficiency with the help of network analysis tools. Moreover, using sentiment analysis on social media conversations about the market, the survey of consumers, and trade data, one can get an insight into consumer sentiment, which subsequently affects the purchasing behavior and the state of the market in general. This fact-based strategy can help identify an early warning of market manipulation, price spikes, and shortages, and regulatory bodies can respond promptly. By using these approaches in computing, the stakeholders can gain greater understanding of market trends, detecting any inefficiency on the spot and make better decisions concerning policy interventions, price regulation, and the development of infrastructures.

5.2 Limitations of the Study

Although the computational approach provides useful information, it must be admitted that the study has a number of limitations: Data Availability and Quality: Availability and quality of data is very important in the accuracy of any computational analysis. In the scenario of the Bangladesh market syndicate, the data on the informal markets, transactions that are not recorded, and local trade may have some serious gaps. Inaccessible or partial data may result in wrong conclusions, which restricts the usefulness of the computational models. Market Complexity: Bangladesh market dynamics are extremely complicated and there are a number of stakeholders in every transaction. Market syndicates tend to respond to quite a large number of external factors that may include the government policies, world prices, seasons, and natural calamities. All these variables might be difficult to incorporate in a computation model, and cannot necessarily provide highly accurate predictions. Model Overfitting and Generalization: The other drawback is the probability of overfitting the model with advanced computation models such as machine learning algorithms. Historically-engineered models may not be very predictive of what is not observed or evolving market conditions. This would hamper the accuracy of predictions and restrict the practical use of the model. Real-time Data Processing: Real time data processing is essential in proper forecasting and decision making. Nevertheless, it may be challenging to gather real time data involving all the stakeholders of the market (particularly the informal traders) and this may result into a mismatch between the real market situation and the work of analysis. This reduces the capacity to respond promptly to the changes in the market or policy. Absence of Regulatory Data: The research might be deficient in the illumination of the regulatory systems over the market syndicate. Government information on the regulation of the market, price controls, and prices enforcement can be limited or uncommon since most syndicates have been operating in the informal sector. In the absence of detailed regulatory data, it will be hard to know the entire effect of market interventions. Cultural and Behavioral Factors: Bangladesh Consumer behavior and market decision-making are grounded on a number of cultural, social, and psychic factors that are not always quantifiable and easily modeled. The computational models are incapable of producing qualitative data and field observations needed to understand the influence these factors having on purchasing and pricing decisions in the market syndicate. Interpretation of the Model and Acceptance by the Stakeholders: The interpretation of the results may be subjective even with high-level and sophisticated computational models. Market traders or policymakers, who are stakeholders, might lack confidence in automated predictions or interventions; in particular when they are not aware of the decision-making process of the model. There is a dilemma in bridging the gap between computational insights and acceptance by the stakeholders.

5.3 The Pronounced Impact of The market syndicate in Bangladesh

The market syndicate in Bangladesh is very instrumental in influencing the economic terrain in the country. It plays a very important role as the mediator between suppliers and buyers of goods which promotes trade and distribution of products in various industries. Nevertheless, its economic consequences are multidimensional, as they can have an effect on many features of the economic activity, including the stability of prices, the effectiveness of the market, the employment level, and the development of the sector.

Among the main effects of the market syndicate on the Bangladesh economy is that it has led to price stabilization. Big portions of the supply chain are controlled by syndicates and this enables them to dictate movement of goods and control supply and demand. This law assists in providing the necessary products and avoiding extreme prices especially in food commodities such as rice, vegetables, and fish which are the staple of the food system in the country.

The market syndicate indirectly spurred different sectors in the economic growth front. Through enabling efficient trade, particularly in rural and semi-urban markets, the syndicate provides access of farmers, wholesalers and small-scale producers to markets, therefore enhancing the development of agriculture and agribusiness. Moreover, the market syndicate helps the sector growth by enhancing distribution as well as ensuring there are no bottlenecks in logistics that may increase productivity in other industry sectors like manufacturing, retail and consumer goods.

Nevertheless, monopolistic tendencies of the syndicate may backfire. In other instances, the market syndicates generate artificial scarcity, distort prices and participate in collusive practices that negatively affect the consumer and small enterprises. Such practices may suppress competition, make the market less efficient and create entry barriers, which eventually slows down diversification and innovation of the economy. Moreover, regulatory lapse may cause the market distortions and income inequality because the gains of the syndicate are usually concentrated within the hands of a small group of influential individuals.

Informal nature of most of the syndicates especially in rural areas implies that much of the economic activity is not regulated and taxed and therefore the government is not able to utilize this trade to create public goods and services. This is added to the shadow economy, where organizations and individuals are not subject to the formal regulatory and tax framework, thus affecting the national revenues collection and fiscal policy.

Regarding employment, the market syndicate keeps so many people (millions) employed starting with farmers and wholesalers to the traders and transporters. These are the necessary jobs, especially in a nation where farming forms the major source of jobs. The provision of employment opportunities in the country through the syndicate aids in reducing poverty and livelihoods in underdeveloped and rural sectors and as a result, integrates growth.

5.4 Experimental Results

AdaBoost was the best model, with an accuracy of 99.39%, a precision of 1.00, and a ROC AUC of 0.999635. With an F1-score of 0.987952, it is the most reliable for this task.

Model	**Accuracy**	**Precision**	**Recall**	**F1-Score**	**ROC AUC**
AdaBoost	0.993912	1.000000	0.976190	0.987952	0.999635
Random Forest	0.983257	0.987578	0.946429	0.966565	0.997304
Extra Trees	0.939117	0.926667	0.827381	0.874214	0.990925
KNN	0.876712	0.906542	0.577381	0.705545	0.904007
Naive Bayes	0.745814	0.501672	0.892857	0.642398	0.851069
SVC	0.826484	0.732759	0.505952	0.598592	0.866504
Logistic Regression	0.777778	0.575342	0.500000	0.535032	0.852164

Table 5.1: Compare Table

CHAPTER VI

Conclusion and Future Work

6.1 Conclusion

In the case of the Bangladesh Market Syndicate, it is possible to identify its current strengths and the areas that have to be improved significantly. Although the syndicate is one of the pillars of trade and distribution in the country, inefficiencies in infrastructure, old regulatory systems, and the lack of technological usage are the impediments that do not allow the full realization of the potential of the syndicate. The market can become fair and more efficient by digitalizing the processes, enhancing the level of transparency, modernizing the logistics, and promoting consumer protection. In addition to this, sustainability programs, capacity-building schemes and improved access to finance is able to make the environment more inclusive and competitive. In general, the Bangladesh Market Syndicate has a substantial potential to develop into a modernized and globally competitive system that does not only protect consumers and promote national economic development but also benefits traders.

6.2 Future Work

Additional projects in the future should aim at integrating digital technologies to a deeper level, including Artificial Intelligence (AI), Internet of Things (IoT) and blockchain to predict, track, and prevent fraud. Research on consumer behavior is also highly demanded in both the urban and rural regions in order to formulate specific improvements. Smart marketplaces with real-time pricing, cashless payment, and transparent supply chains in pilot projects can be used as examples in rollout on a national scale. Also, further employment should examine the idea of public-private partnerships to update their market infrastructure and logistics. Sustainable practices, such as waste-to-energy initiatives, cold-chain development and environment-friendly packaging should also be given special consideration. Lastly, global integration plans like encouraging the local products of Bangladeshi in the global markets will facilitate the intensification of competitiveness of the syndicate in the global trade arena.

6.3 Potential Improvements

Various strategic changes can be made in the Bangladesh Market Syndicate and contribute to its efficiency, competitiveness, and sustainability. The digitization and the automation of market transactions and record-keeping would be among the greatest improvements. With automated inventory management, price set, and transaction systems, the syndicate is able to minimize human error, enhance efficiency and transparency. Also, incorporating e-commerce systems into the physical markets may enable businesses, particularly those that are located in rural locations to have access to more people.

Another possible way of improvement is the regulatory reforms. Revision of rules to match the current market forces, including the emergence of online companies and shifting consumer patterns, would assist in eliminating red tape to small and medium-sized enterprises (SMEs) and enable a more competitive marketplace. This may involve more transparent and consistent regulatory standards that promote foreign investment and the establishment of an environment that will be favourable to business development.

It is also important to enhance infrastructure. The marketplaces of many of the syndicate are old or poorly developed, and investing in more developed infrastructure such as roads, storage facilities, waste management, etc. would make access and efficiency more efficient. Moreover, the supply chain can be made more efficient by using transportation and distribution methods that are efficient to lower the price of commodities and help consumers. A cold storage area would also be developed which would curb the wastage of food and enhance food security especially in the countryside.

Training and capacity building of market stakeholders would enable the wholesalers, retailers, and farmers with contemporary marketing skills and software. Training local businessmen on the dynamics of the market, technology, and customer satisfaction would result in improved decisions and customer experience. Equally, going green by adopting sustainability concepts like packaging with environmentally-friendly materials and supporting local and organic products, might serve the rising need of environmentally-friendly solutions.

Enhancement of the consumer protection legislation and development of more efficient procedures to handle complaints would as well instill confidence in the market. Standardised checks of the quality of products, regulated prices, and establishment of fair dispute resolution avenues would protect the consumer as well as the sellers. Also, the use of technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain might streamline the market and optimize the demand forecast, as well as curb fraud opportunities and make transactions more transparent.

The marketing of local products either locally or overseas would potentially provide a competitive advantage to the market. Through branding and improvement of local goods and services, the syndicate might exploit the niche markets and increase the presence of Bangladesh in international market. Moreover, enhanced access to finance (via microfinance provisions and more accessible credit to players in the smaller markets) would contribute to the success of these businesses and make them stay viable. The adoption of digital payment and mobile banking would enable traders and consumers especially in the rural markets.

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