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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Why E-Commerce Startups Fail: Can machine learning provide solution?

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Abstract

E-commerce has transformed how businesses operate, providing customers with convenience and companies with access to global markets. However, despite its vast potential, many e-commerce initiatives have failed due to either external conditions such as local or global market fluctuations or internal conditions such as a mixture of poor planning, financial mismanagement, operational inefficiencies, and cybersecurity risks. Focusing on the market fluctuations which is a key component for external conditions. A simulative dataset that mimics real-world market conditions is used to present contribution of machine learning to decision making stages. The usage of informatics could help mitigate these risks by improving decision-making, security, and operational efficiency, and in turn could prevented many of the failures.

Keywords: e-commerce, failure, informatics, XGBost, ML

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INTRODUCTION

E-commerce heavily relies on accessibility, speed in delivery, and sharing and exchanging goods, services and information on demand [1], [2], [3]. The rise of e-commerce has been fueled by advances in technology, growing internet accessibility, and changing consumer habits [4] [5]. While some businesses thrive in this digital landscape, many others struggle to survive [6], [7]. Researches suggests that a significant percentage of e-commerce startups fail within their first few years [8]. Understanding why these failures occur is essential for businesses looking to create sustainable and successful online ventures.

The collapse of companies like Webvan, Boo.com, Etoys, Flooz.com and Quibi highlights the consequences of poor planning and execution [9], [10]. Among them, Webvan was founded in 1996, with $1.2 billion funding, a startup that aimed to transform the grocery industry by offering online ordering and home delivery. Unfortunately, neglecting crucial factors such as not having a viable business model, avoiding sustainable cost management, and comply with market dynamics contributed to the failure in 2001 [11], [12]. Similarly, Boo.com was a promising online fashion retailer, launched in 1999. A cutting-edge online shopping experience for high-end consumers was in the plan. Unrealistic spending and unclear direction gradually steered to its failure in 2000 [13], [14].

Multiple studies present post-mortem analysis about the reasons of failure [10], [15]. Some of the emerging common threads can be outlines as follows; an inability to generate sustainable revenue due to ignoring the market dynamics, bad product-market fit due to not conducting any market research, losing to competitors as a result of lacking market oriented management, and simply running out of money because of unnecessary or misguided expansion or expenditure.

Through the manuscript, the cause of failure split into two main groups; external conditions such as local or global market fluctuations etc. and internal conditions such as a mixture of poor planning, financial mismanagement, operational inefficiencies, and cybersecurity risks etc. These are groups usually includes country-specific conditions and can be expanded without any restriction.

The initial aim of this manuscript is to outline internal conditions from the literature review. The second aim is to demonstrate how the inability to utilize informatics and data-driven decision-making can result in business failure and then use of Machine learning (ML) to help overcome some of these challenges.

A condense literature review presented in the following sections. Key Reasons for E-Commerce Failure are abstracted from references given in the text. Then, a microdata set that is artificially generated that mimics market conditions is used to present contribution of ML to decision making stage. Some suggestions are outlined for future e-commerce attempts.

The Role of Informatics in E-Commerce

In the context of this study, the term, informatics refers to the collection large volume of the data, processing them for multi-purpose, and application of the findings to elevate business via using in decision-making and also operations [16], [17], [18]. In simple terms, informatics helps e-commerce companies to analyze consumer behavior, optimize inventory, enhance cybersecurity, and personalize marketing strategy [19].

One of the most impactful applications of informatics is in big data analytics [20]. At this stage ML applications come into use, as it happens in different scientific applications [21], [22], [23], [24]. ML and big data can evaluate customer preferences and predict tendency of buying in future, and then modify inventory requests accordingly. As a result, the usage of the informatics helps companies to avoid both stock shortages of highly demanded products and also overstocking low demanded goods.

Addition to managing the market, cybersecurity is another vital area where informatics comes into play [25], [26]. Advanced encryption, artificial intelligent (AI) driven fraud detection [27], and

blockchain technology [28] help protect sensitive customer information from cyber threats which also uses similar technology [29].

Note that informatics enables seamless integration of different e-commerce functions, such as payment processing, customer relationship management, and supply chain tracking [30], [31]. By automating and optimizing these processes, both conventional and online businesses can reduce operational costs and improve efficiency.

Key Reasons for E-Commerce Failure

A quote attributed to Benjamin Franklin states that. "If You Fail to Plan, You Are Planning to Fail". It is still valid axiom. Regardless of being conventional or e-commerce initiative all commercial activities require careful planning ahead. This actions requires knowledge. Lack of knowledge or misinterpretation of the data drags the company to unwanted locations. The following compilations from literature summarizes some of the reasons for failure. Note that this list is not exhausted list and can be extend beyond the limit of the manuscript.

A) Pre- launching period;

Inadequate Market Research, many e-commerce ventures fail because they don't understand their audience or industry well enough. Entrepreneurs sometimes launch platforms without fully grasping market demand, consumer behavior, or competitive landscapes [32]. Without this critical knowledge, businesses often invest resources in the wrong places and struggle to attract customers.

Poor User Experience (UX) and Website Design, customers expect a seamless and intuitive online shopping experience. Issues such as slow loading times, confusing navigation, and a lack of mobile optimization can frustrate users and lead to high bounce rates and abandoned carts [33]. A lack of personalization and poor customer support further deter potential buyers.

B) Operational period

Security and Privacy Concerns, consumers need to trust an e-commerce platform before making a purchase. Security breaches, weak encryption, and unprotected payment gateways expose businesses and customers to fraud [34]. Failing to implement strong security measures can result in financial losses and a damaged reputation.

Logistical and Supply Chain Challenges, timely and reliable order fulfillment is a crucial part of e-commerce success. Businesses that struggle with inventory management, shipping delays, or inefficient return policies risk losing customer trust [35]. Without streamlined logistics, even the best products can fail to reach the right customers at the right time.

C) Management issues

Financial Mismanagement, many startups overestimate their potential revenue while underestimating operational costs [36]. Poor budgeting, unsustainable pricing models, and cash flow problems can quickly sink a business. Without a solid financial plan, even promising e-commerce ventures can run out of resources before they gain traction.

Ineffective Digital Marketing Strategies, in a highly competitive online space, businesses need strong digital marketing strategies to attract and retain customers. A lack of SEO optimization, weak social media presence, and poorly targeted advertisements result in low visibility and poor sales [37]. Simply having a website is not enough, businesses must actively engage their audience.

D) Site-depended problem

Regulatory and Compliance Issues, ignoring legal and regulatory requirements of where seller or buyer are located, such as tax laws, consumer protection rules, and data privacy policies, can lead to serious consequences [38]. Businesses that fail to comply with these regulations risk lawsuits, fines, and even shutdowns.

Figure 1 illustrate the relation between key reasons and failure. Similar to conventional usage of Venn diagram which usually address the recipe for success, the startups are expected to cover red zone to survive.

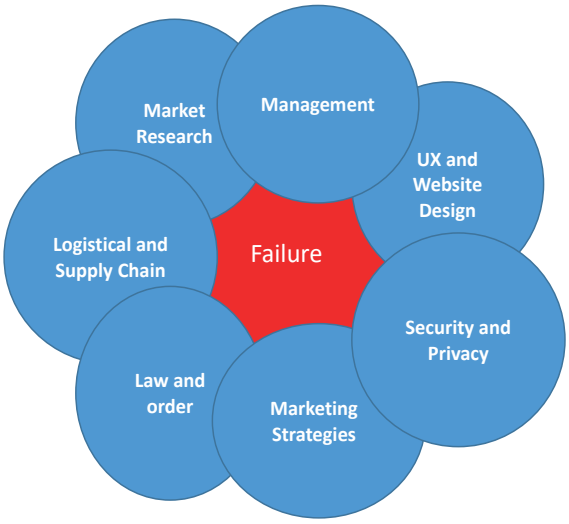

Figure 1. Simplified relation between key reasons and failure. The smaller the red zone, the higher the probability of the company's survival

The area of red zone in Figure 1 should be next to none to increase the survival rate. This can be achieved via improving either or multiple keys. Aforementioned issues are the recipes to doom even once-successful companies. Integrating informatics into e-commerce operations can help businesses prevent many of the common pitfalls that lead to failure. Data-driven decision-making allows businesses to anticipate market trends, streamline logistics, and adjust strategies in real time.

Data driven decision maker

The external conditions are usually seen as out-of-control situations but also accepted that the occurrence can be predicted up to certain level [39]. Traditionally, over simplified approach uses stock market data to guide the investment decision. Two periods outlines the approach; Bull and Bear cycles (Figure 2). A bull market refers to a period of rising stock prices. It is assumed that increasing investor confidence, strong economic growth, and low unemployment rates occur in this period. On the other hand, a bear market is about the declining stock prices, economic contraction, and reduced investor confidence. Hence, it represent macroeconomic downturns, high inflation, or financial crises [40].

Numerically, the threshold is about 20% or more change from their previous period [41]. Bull markets represent the upward change, while bear markets shows a decline [42].

Strategic decisions should be in accord with these cycles. Bull markets states that companies may expand their investment in research and development, acquire competitors, and upscale their operations. While bear markets are the periods when firms are forced to cut costs, to preserve liquidity, and downsize their operations so that they can survive through economic

Figure 2. Variations and market definitions [43].

declines [44], [45].

Regardless of the size of the company, relying on single data is not viable. Multiple criteria, such as stock returns, inflation rates, interest rates, etc., must always be employed for holistic approach [46].

A simplified ML application can be explain throug a scenario. Note that this neither final recommendation not optimum solution, It is just an example using financial indicators to predict optimal investment time, i.e., Bull cycle. According to result, the decision makers may take action to expand or shrink a business.

Scenario: using a data set covering over approximately 15 years, can we guide the investment strategy in March 2025?

The solution requires internal i.e., key performance indicators (KPIs) and external data i.e., major indicators of economic conditions. Ahmed et al [47] states that the success of an e-commerce company can be measured using KPIs across different areas, including financial health, customer engagement, and operational efficiency. In the frame of this study only financial performance and customer acquisition were taken into consideration. Marketing performance and operational efficiency and many other possible indicators were left out for the sake of the simplicity.

Selected financial performance indicators are as follows. Revenue growth which represent variations in sales over the time. Profit margins measures the health of profitability. Average Order Value (AOV) means spending per purchase. Customer Lifetime Value (CLV) is a measurement of the loyalty of customer and repeatability of business.

Indicators for customer acquisition & retention will be defined under the three basic definitions. Customer acquisition cost (CAC) together with CLV measures the sustainability of business. Repeat purchase rate indicates strong brand loyalty. Conversion rate is the percentage of visitors who make a purchase.

For this purposes I generated a random dataset that mimics real-world market conditions via simulating selected KPIs and also stock returns together with changes in both inflation rates and interest rates. Needlessly to say that the business owners can use real data according to country of origin and also increase the number of criteria in accordance with the availability of data.

To make this decision, the proposed algorithm (Figure 3) uses *XGBoost*, a widely recognized gradient boosting algorithm known for its efficiency in financial time-series predictions [48]. A simple code was developed in Python, with the help of AI applications, is given in Amendment.

In general, XGBoost uses gradient boosting tree mode, the model follows an additive approach, combining multiple decision trees:

$$\tilde{y} = \sum_i^N f_i(X) \tag{1}$$

Where X type of the data available, N number of trees f_i (X) the prediction of the i-th tree, and finally $\tilde{y}$, predicted values of y. The development and evaluation of Equation 1 can be found literature and web pages and will not be repeated here (please see [48], [49]). For clarity, X contains KPIs, stock returns, and changes in both inflation rates and interest rates in this scenario while y-values are 0 or 1 along the coverage period (15 years). y-values controls the success of the approach and should be selected with caution. Murphy [48] suggested that stock market trends can be used to predict possible investment time.

If the 50-day simple moving average (SMA) crosses above the 200-day SMA (y=1), it often signals a good time to invest. Otherwise, it is time to act conservatively and wait (y=0). Figure 4 shows real stock market data obtained from yahoo finance. Comparison of SMA_50 and SMA_200 suggests that 2024 presents a favorable opportunity for business expansion, particularly if the interest rates are low, provided that key performance indicators remain aligned.

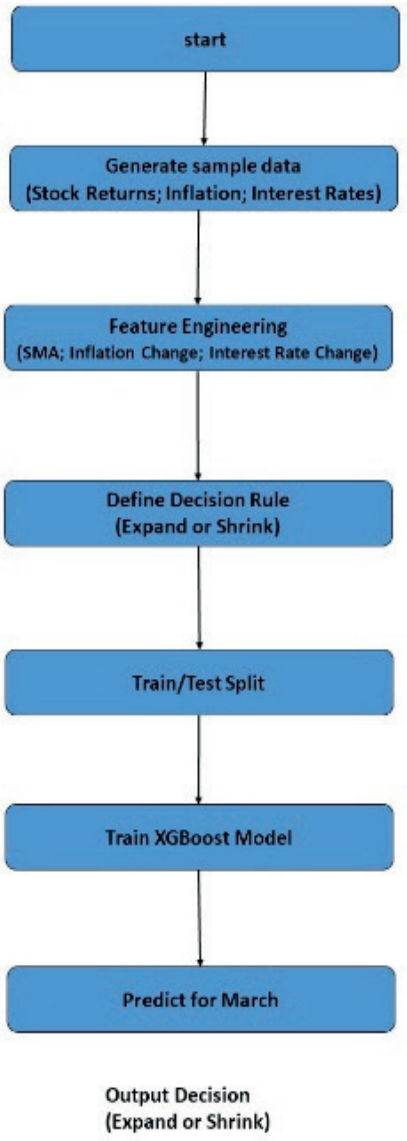

Figure 3. algorithm of the decision making

The algorithm trained the model using 80% of the data set and then the rest of the data were used to test for accuracy. The model learned to predict whether market conditions suggest favorable expansion time ($\tilde{y} = 1$) or staying steady or shrinking time ($\tilde{y} = 0$). This approach aligns with prior research on economic cycle forecasting [50]. As a next stage, the trained model evaluates data and determine whether economic conditions in expected time (e.g. March 2025) favor business expansion or contraction. The result was positive ($\tilde{y} = 1$) for this scenario but irrelevant since it was based on random data set. Real-life example should include company-specific KPI and external data for meaningful result.

This approach would allow for a robust dynamic, data-driven, decision-making process rather than relying solely on intuition or traditional analysis.

DISCUSSION

The result of the ML applications are heavily rely on the data. The consistency of the data set controls the output. Figure 5 shows the actual (y) and predicted ($\tilde{y}$) decision over Last 100 Days.

There was one incidence that result was false i.e., actual decision is 0 but predicted is 1. Number of tests with various random data set pointed out that any unusual fluctuation in stock market could easily cause such false result. Thus, multiple decision criteria should be tested before taking any action. In addition to guiding investment strategy, ML can be used for management purposes and enhances operational efficiency. Automated inventory management, real-time order tracking, and AI-powered pricing adjustments help businesses stay competitive [51]. By reducing human errors and improving response times, e-commerce companies can improve both their internal processes and customer satisfaction [52].

As an example, considering the predictive analytics, and through the examination of historical sales data, companies are able to make decisions regarding inventory management, thereby ensuring that they maintain appropriate stock levels of the correct products [53]. This approach mitigates the potential for lost sales resulting from stock shortages or the necessity to offer significant discounts on surplus inventory.

Security threats are another major concern for e-commerce businesses. Informatics-driven security systems, such as AI-powered fraud detection and multi-factor authentication, help protect against cyberattacks and fraudulent transactions [54]. These technologies help businesses maintain customer trust and prevent financial losses.

Customer experience is also greatly enhanced by informatics. Personalized recommendations, automated chatbots, and AI-driven customer support improve engagement and satisfaction

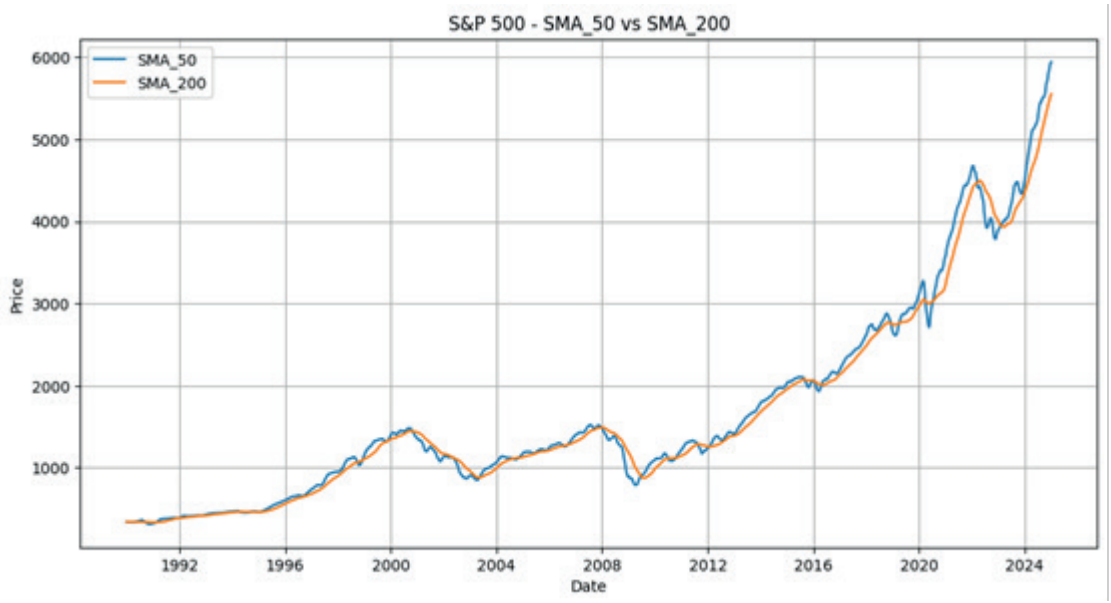

Figure 4. Comparison of SMA_50 and SMA_200 for stock market data obtained from Yahoo finance web site.

[55]. Businesses that understand and anticipate their customers' needs are more likely to build long-term relationships and foster brand loyalty. Informatics-driven e-commerce has transformed the retail landscape, offering numerous benefits such as increased efficiency and personalized shopping experiences. However, it also presents several challenges [56], [57], [58], [59].

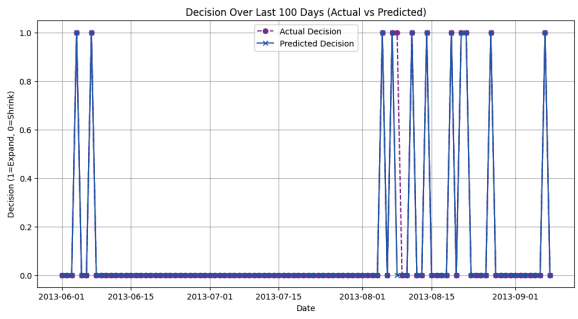

Figure 5. Comparison of decisions; actual (y) with solid line and predicted (ỹ) with dashed line

Establishing and maintaining advanced e-commerce systems require significant investments in infrastructure, software, and cybersecurity measures, contributing to increased operational expenses. Technical glitches, server crashes, or software bugs can lead to operational disruptions. Providing accessibility around the clock and along the year is a major concern to keep e-business in business [60].

While automation enhances efficiency, excessive dependence on AI-driven customer service may lack the personal touch, potentially leading to customer frustration. Talking to Chabot is not pleasant experience especially non-native speakers and elderlies. In addition, AI algorithms in e-commerce can unintentionally perpetuate biases present in their training data, leading to discriminatory practices or unfair pricing strategies.

As stated above, e-commerce businesses must navigate complex regulations related to data protection, taxation, consumer rights and environmental regulations. As an example, the rise of e-commerce has led to increased packaging waste and carbon emissions from shipping, raising concerns about its environmental sustainability.

A simple real-life example can simulate the some of the major issues mentioned above. If an entrepreneur starting a business in the Middle East to sell her art globally, even within her own country. A product will cost only $20, but a 25% tax must be added for the government and then an average 18% fee for the e-commerce platform will elevate the price. In addition, the cost of the cargo fee makes the final cost undesirable and ultimately leads the entrepreneur towards failure.

Alternatively, considering the same entrepreneur is trying an international platform to reach the global market, where there are no visible taxes involved. However, the shipping costs are three times higher than the product itself and the high custom fee depending on the country of arrival will cost fortune to buyer. After all, additional taxing for transferring of the money to country of the origin will make the commercial attempt sink into dark hole of failure.

It is worth to mention that the security breach is another problem for e-commerce businesses. The extensive collection of personal data in e-commerce platforms makes their database prime targets for cyberattacks, leading to potential financial losses for both parties. Nalla and Reddy [61] compared modern and conventional database solutions and stated that a security breach rates are 15% and 25% respectively.

As a summary, regular problems related to conventional business operation require management skill which can be enhanced via analyzing the data and utilizing knowledge.

E-commerce challenges outlined above underscored the importance of implementing robust security measures, ethical AI practices, and inclusive strategies to mitigate the all impacts of informatics-driven e-commerce.

RESULTS

The E-Commerce Performance Model provides a systematic framework for analyzing the reasons behind the failure of e-commerce businesses by evaluating KPIs [62], [63]. Table 1 summaries the some of the common indicators that may lead to an undesired point. These indicators can be extend according to industry, local law and regulations and geographic location.

By leveraging data analytics and performance models, e-commerce businesses can diagnose failures in advance, optimize processes accordingly, and implement corrective measures to enhance overall performance [64].

Through the manuscript only one numerical example was presented in order to fit the frame of the publication. With the selection of appropriate data set and decision criteria, the code presented here can be altered to serve to predict future of any KPIs.

CONCLUSION

The e-commerce businesses keep failing due to skipping or doing poorly market research, not responding and heal the bad user experiences on time, being open to security breaches, logistical inefficiencies, and most important overlooking the market dynamics and financial mismanagement.

Table 1. Some of the indicators to foresee the future

Indicators	Sustainable	Unsustainable
Marketing strategies	CAC<CLV	CAC>CLV
Long-Term Investment	Data-driven	Intuitive
Conversion rates	High	Low
Operational efficiency	Fast	Slow
Return rates	Low	High
Inventory Turnover*	High	Low
Cost saving	High	low
Supply Chain	High percentage of suppliers	Struggling to find suppliers
Digital Transformation	In pace with development	Only basic usage

*The optimum turnover ratio varies by industry. High-Turnover Industries focuses on regular products aiming for daily needs. Low-Turnover Industries are for the niche products such as luxury goods, heavy machinery, and specialty items.

However, many of these failures can be mitigated with the right application of informatics and usage of the data-driven actions providing that the data the decision are appropriate and consistent.

Informatics frameworks, particularly Big Data Analytics and AI-driven market prediction, provide robust tools for market forecasting and business decision-making. By leveraging data analytics, enhancing cybersecurity, optimizing operations, and improving customer engagement, businesses can avoid common pitfalls and increase their chances of long-term success.

In harsh competitive environment, e-commerce companies must not only embrace informatics but also integrate it into every aspect of their strategy and operations to thrive in the digital age.

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Amendment

```
import pandas as pd
import numpy as np
import xgboost as xgb
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt

# Sample data - Replace with real data
# Define the data set
np.random.seed(42)
date_range = pd.date_range(start="2000-01-01",
periods=5000, freq='D')
data = pd.DataFrame(index=date_range)

# Financial Performance Indicators
data['Revenue_Growth'] = np.random.uniform(0.95,
1.05, size=len(date_range))
data['Profit_Margin'] = np.random.uniform(5, 30,
size=len(date_range))
data['AOV'] = np.random.uniform(50, 500,
size=len(date_range))
data['CLV'] = np.random.uniform(100, 2000,
size=len(date_range))

# Customer Acquisition & Retention
data['CAC'] = np.random.uniform(5, 50,
size=len(date_range))
data['Repeat_Purchase_Rate'] =
np.random.uniform(0.1, 0.5, size=len(date_range))
data['Conversion_Rate'] = np.random.uniform(0.01,
0.2, size=len(date_range))

# Generate a linear trend with breaks represent bears
and bulls
def linear_trend_with_breaks(length, breaks, slopes):
    trend = np.zeros(length)
    start = 0
    for i, (break_point, slope) in enumerate(zip(breaks,
slopes)):
        end = break_point if i < len(breaks) - 1 else
length
        trend[start:end] = np.arange(0, end - start) *
slope + trend[start - 1] if start > 0 else np.arange(0,
end - start) * slope
        start = end
    return trend

breaks = [1250, 2000, 2500, 2700, 3750]  # Define
the break points
slopes = [0.01, -0.05, 0.01, -0.1, 0.02]  # Define the
slopes for each segment, negative values means
downturns
data['Linear_Trend'] =
linear_trend_with_breaks(len(date_range), breaks,
slopes)

# Add random noise to the linear trend to create the
'Return' column
data['Return'] = data['Linear_Trend'] +
np.random.normal(-50, 50, size=len(date_range))
+100 # Random noise added

# External indicators
data['Inflation'] = np.random.uniform(1.5, 3.5,
size=len(date_range))
```

```
data['InterestRate'] = np.random.uniform(0.5, 5.0,
size=len(date_range))
data['Inflation_Change'] =
data['Inflation'].pct_change().fillna(0)
data['InterestRate_Change'] =
data['InterestRate'].pct_change().fillna(0)
# End data definition to be replace with real data

# Decision Criteria
data['SMA_50'] =
data['Return'].rolling(window=50).mean().fillna(0)
data['SMA_200'] =
data['Return'].rolling(window=200).mean().fillna(0)
data['Decision'] = np.where(
    (data['SMA_50'] > data['SMA_200']) &
(data['InterestRate'] < 2.5) &
(data['Conversion_Rate'] > 0.05), 1, 0
)

# Train/Test Split
features = ['Return', 'SMA_50', 'SMA_200',
'Inflation_Change', 'InterestRate_Change',
            'Revenue_Growth', 'Profit_Margin', 'AOV',
'CLV', 'CAC', 'Repeat_Purchase_Rate',
'Conversion_Rate']
X = data[features]
y = data['Decision']
X_train, X_test, y_train, y_test = train_test_split(X,
y, test_size=0.2, random_state=42)

# Train XGBoost Model
model =
xgb.XGBClassifier(use_label_encoder=False,
eval_metric='logloss')
model.fit(X_train, y_train)

# Plot SMA_50 and SMA_200
plt.figure(figsize=(12, 6))
plt.plot(data.index, data['SMA_50'], label='SMA_50')
plt.plot(data.index, data['SMA_200'],
label='SMA_200')
plt.title('SMA_50 vs SMA_200')
plt.xlabel('Date')
plt.ylabel('Value')
plt.legend()
plt.grid(True)
plt.show()

# Select the Prediction month (March=3)
march_data = data.loc[data.index.month == 3,
X.columns]
prediction = model.predict(march_data)
result = "Expand" if prediction[-1] == 1 else "Shrink"
print(f'Decision for March: {result}')

# Plot Decision Over Last 100 Values with Model
Prediction
plt.figure(figsize=(12, 6))
plt.plot(data.index[-100:], data['Decision'][-100:],
label='Actual Decision', color='purple', linestyle='--',
marker='o')
predicted_decisions = model.predict(X.iloc[-100:])
plt.plot(data.index[-100:], predicted_decisions,
label='Predicted Decision', color='blue', linestyle='-',
marker='x')
plt.title('Decision Over Last 100 Days (Actual vs
Predicted)')
plt.xlabel('Date')
plt.ylabel('Decision (1=Expand, 0=Shrink)')
plt.legend()
plt.grid(True)
plt.show()
```