

Predictive Analytics in Finance

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ABSTRACT

Predictive analytics leverages statistical techniques, machine learning, and data analysis to help forecast future events by looking at historical and current data. It is widely used to predict future outcomes with better accuracy, especially in situations involving high financial risks. Predictive analytics shifts finance from reactive to proactive decision-making by using AI, machine learning, and real-time data to anticipate risks, customer behavior, and market movements. From detecting fraudulent transactions in real time to forecasting cash flows and personalizing banking experiences, predictive analytics has become crucial for modern finance. Financial institutions use predictive analytics to improve their operations and stay ahead of the competition. The integration of predictive analytics within the finance sector is not just a trend; it is a transformative force driving efficiency, accuracy, and customer satisfaction. This paper provides useful information into how predictive analytic techniques are used in finance sector.

KEYWORDS: *data, data analytics, predictive analytics, finance, finance sector.*

INTRODUCTION

Finance is a broad term associated with activities in capital markets that encompasses intertemporal and portfolio decisions. Financial institutions are constantly seeking new ways to increase accuracy, minimize risk, and improve profitability. Today's financial professionals are forward-looking strategic partners to the business. This shift away from a purely retrospective perspective to proactive value creation has brought about demand for a new set of tools. Among these is predictive analytics. Predictive analytics is transforming the finance sector [1].

The term "predictive analytics" is more commonly applied when moving beyond explanatory statistical models to computational prediction. Predictive analytics is a data science discipline that utilizes predictive models to forecast future outcomes using historical data. Predictive analytics for the finance industry uses machine learning and artificial intelligence to forecast future outcomes, driving financial forecasting and risk management. It allows institutions and investors to make smarter decisions by predicting trends like stock market movements, credit events, and key economic indicators such as

GDP growth, unemployment, and inflation rates. Financial institutions and companies use predictive analytics to accurately forecast revenue streams and cash flows [2].

WHAT IS PREDICTIVE ANALYTICS?

As its name implies, predictive analytics is about predicting future trends such as sales demand, exchange rates, and other important metrics. The technique relies on the application of statistical modeling and regression analysis to historical data to determine and understand trends and formulate future trends. Strictly speaking, predictive analytics does not predict the future, but rather use probability theories to determine what is likely to happen based on patterns and trends revealed by analyzing historical data [3]. Predictive analytics accurately anticipates customer demand, preventing overstocking and stockouts while adapting to market changes. Figure 1 illustrates predictive analytics [4], while Figure 2 show different components of predictive analytics [5].

In general, analytics provides an efficient way to improve planning because it gives you better

How to cite this paper: Matthew N. O. Sadiku | Paul A. Adekunle | Janet O. Sadiku "Predictive Analytics in Finance" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-10 | Issue-2, April 2026, pp.1094-1104, URL: www.ijtsrd.com/papers/ijtsrd101488.pdf



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forecasts. There are different types of data analytics. They are briefly explained as follows [6]:

- *Descriptive Analytics*: Descriptive analytics examines what has happened over the years. They are capable of detecting trends in historical data. Analytics can uncover trends and postulate probable reasons for change by comparing the same data from various periods. It can be seen as the baseline of the industry, which basically assesses past and current data for more meaningful insights and delivers it to the people to use their own intelligence and knowledge to make decisions.
- *Predictive Analytics*: This assists businesses in predicting what might happen and the impact of various situations, such as possible supply chain bottlenecks. Managers can be proactive rather than responsive by pushing them to evaluate these prospective circumstances before they occur. Predictive analytics may be used to identify patterns and trends as well as anticipate breakdowns that may impact suppliers and, consequently, production processes. Predictive analytics for the supply chain leverages data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes.
- *Prescriptive Analytics*: Prescriptive analytics builds on predictive analytics and dives deeper into predicting future insights on what next can be done. Prescriptive analytics uses the findings of descriptive and predictive analytics to recommend what measures a business should take to achieve its objectives. Because prescriptive analytics is increasingly complicated, they need more powerful software capable of rapidly processing and interpreting large amounts of data.
- *Cognitive Analytics*: Cognitive analytics attempts to mimic human thought and behavior, and they can assist companies in answering challenging, complex problems. Cognitive analytics does this by utilizing artificial intelligence (AI), which allows it to be better over time. With the use of AI in the industry, answering complex questions and drawing out contextual conclusions on how humans would have interacted with the situation. It helps with more meaningful data and scale experience and knowledge with better decisions.
- *Diagnostics Analytics*: This gives the ability to identify the root-cause. It is characterized by techniques such as drill-down, data discovery, data mining, and correlations. It involves analyzing overall performance and figuring out

why errors, mistakes, and delays occur. It lets the manager know the delays, breakdowns, and disruptions in the demand and supply processes and the reasons behind them.

Figure 3 shows these major types of data analytics [7]. Unlike diagnostic and descriptive analytics, which were designed to analyze situations after they happened, predictive analytics utilizes advanced data analytics techniques to forecast future outcomes. In the supply chain, the time has come to shift from mere descriptive and diagnostic analytics to predictive and prescriptive analytics. Predictive analytics is a branch of data analytics that makes predictions about future outcomes using historical data combined with statistical modeling, data mining techniques, and machine learning. Figure 4 shows predictive analytics process [8].

PREDICTIVE ANALYTICS IN FINANCE

Increasing digitalization and continuous shifts in customer behavior are making it difficult for finance professionals to plan. What they need is a technology that can help them navigate uncertainties and also empower them to identify potential investment opportunities that yield maximum returns. That is where predictive analytics comes in. Predictive analytics is a broad term that refers to the use of big data mining, statistics, modeling methods, artificial intelligence (AI), and machine learning (ML) algorithms to analyze huge data sets and forecast future outcomes or behaviors. In finance, predictive analytics is employed to enhance decision-making processes across various domains, from banking to investment management. It is used to predict future trends, manage risks, optimize portfolios, and even detect fraud. Corporate finance teams are increasingly turning to predictive analytics to optimize financial operations and achieve strategic business goals. Figure 5 shows a financial analyst [9].

Predictive analytics (PA) is a subset of business analytics that combines statistical analysis and machine learning (ML) to analyze datasets and make predictions about a dependent variable. It can be applied to continuous variables, such as the weight of raw materials ruined during production, or discrete variables, such as the number of unsatisfied customers during a quarter. It can be used to run sophisticated “what-if” scenarios by quickly simulating the financial impact of hundreds of potential business scenarios. As predictive analytics enhances finance processes, it also transforms the skill set required of financial professionals. Predictive analytics can enhance the accuracy of financial forecasts, enabling organizations to make informed decisions regarding budgeting, resource allocation,

and investment strategies [10]. Figure 6 shows predictive analytics in finance [11].

Integrating PA financial operations can lead to improved customer relationship management, targeted marketing, and enhanced decision-making. By leveraging historical data and advanced algorithms, financial institutions can forecast future needs, streamline operations, and make informed decisions that minimize costs while maximizing resource utilization. By utilizing predictive analytics, organizations can improve risk management, optimize pricing strategies, and tailor financial products to meet customer needs, thereby fostering a competitive edge in an increasingly data-driven industry [12].

APPLICATIONS OF PREDICTIVE ANALYTICS IN FINANCE

Predictive analytics is widely used in the financial industry today as banks, insurance companies, credit unions, and other institutions that deal with monetary business on a daily basis. Figure 7 shows how predictive analytics is used in finance [13]. Key applications of predictive analytics include credit risk, fraud detection, compliance, investment optimization, credit scoring, personalized banking, investment analytics, financial forecasting, and portfolio optimization. Common applications of predictive analytics in the financial sector include the following [14-18]:

- *Algorithmic Trading:* Algorithmic trading, commonly referred to as algo trading, is the use of computer programs to automate one or more stages of the trading process. These stages include pre-trade analysis, trading signal generation, and trade execution. Trading strategies increasingly rely on predictive signals drawn from price histories, macroeconomic data, and even sentiment analysis from news or social media. Investment firms use predictive models to develop trading algorithms that predict stock performance based on historical data, social media sentiment, and economic indicators. These algorithms can execute trades at high speeds and with great precision, often outpacing human traders. A key advantage of algorithmic trading is the ability to execute trades in milliseconds, enabling high frequency trading and optimizing market liquidity through smoother trade execution and narrower bid-ask spreads. Algo trading contributes to profitability through its efficiency and data-driven strategies. Algorithms analyze market conditions in real time to execute trades at the most opportune moments, maximizing gains and minimizing losses.
- *Fraud Detection:* Fraud detection is one of the most mature and impactful applications of PA. Predictive analytics plays an important role in detecting fraudulent activities and managing risks. It is an effective method for detecting fraud early. Predictive analytics tools assess data and identify activities that suggest fraudulent patterns. Financial institutions use advanced analytics techniques to monitor transactional data in real-time, identifying unusual patterns and suspicious behavior that may indicate fraud or money laundering. This helps with identifying suspicious patterns and anomalies that may indicate fraud. Certainly, this proactive approach helps in thwarting fraud before it happens. Banks employ predictive analytics models to identify fraudulent transactions by detecting deviations from typical user behavior. For example, if a credit card is used for an unusually large purchase in an atypical location, the model can flag the transaction as suspicious.
- *Risk Management:* One of the key applications of predictive analytics in finance is risk management. Financial institution managers must take appropriate measures to manage risk effectively in today's continuously changing environment. Predictive models help in robust risk management, enabling investors to forecast market volatility and prepare proactive strategies to mitigate risks. Financial institutions use predictive analytics to identify, measure, and manage credit, market, and liquidity risks. By analyzing historical data and stress scenarios, predictive models help estimate potential losses and assess financial stability. Predictive analytics helps identify financial risks proactively before they become serious problems. Banks and financial organizations use predictive analytics models to prevent cyber attacks, detect fraudulent transactions, and assess credit risks. Predictive models assess credit risk by analyzing a borrower's credit history, financial profile, and market conditions. Figure 8 illustrates predictive analytics in financial risk management [19].
- *Financial Forecasting:* In the finance industry, forecasting plays a vital role in helping businesses evaluate risks, predict market trends, and choose where to invest. Financial forecasting is among the most essential use cases of predictive analytics in corporate finance. Accurate cash flow forecasting is essential for maintaining liquidity and financial stability. With predictive analytics, finance professionals can rely on data-driven insights to make proactive decisions. Predictive

analytics helps banking institutions anticipate revenue trends, expense patterns, and funding requirements. Figure 9 displays use cases of predictive analytics in banking [20]. These insights support better budgeting, scenario planning, and decision-making, especially during periods of economic uncertainty.

- *Stock Market Forecasting:* Predictive analytics (PA) is critical for stock market forecasting. Forecasting helps predict stock price movements by analyzing historical price trends, market conditions, and economic indicators, allowing investors to make calculated buy or sell decisions. Finance and investment professionals use it to estimate cash flows, mitigate risks, and make informed decisions by analyzing past trends and patterns. Moreover, PA tools can also assess the risks associated with stocks and their future movements, helping to identify potential investment opportunities.
- *Debt Collection:* Predictive analytics can easily identify the applicants who are more likely to default on their loans and credit card payments by analyzing their past behavior and transaction data. Machine learning algorithms enable financial institutions to develop targeted debt collection strategies and improve recovery rates.
- *Regulatory Compliance:* Compliance functions face growing workloads as transaction volumes rise and regulatory scrutiny tightens. Compliance and regulatory reporting are essential processes in the finance industry, but they can be time-consuming and overwhelming. These processes can be automated using predictive analytics, which analyzes historical data to forecast potential issues. This approach helps reduce costs and minimize the risks of non-compliance. Predictive analytics supports regulatory compliance by identifying high-risk activities and potential compliance breaches before they occur.
- *Portfolio Optimization:* Portfolio optimization in financial markets serves as a cornerstone of effective investment management. Its primary objective is to strike an optimal balance between maximizing returns and minimizing risks. Predictive models are used to forecast optimal outcomes when faced with quadratic problems. Wealth managers and institutional investors are using predictive analytics to balance portfolios more effectively. They use PA to anticipate asset correlations and potential market moves to achieve stronger risk-adjusted returns and personalize client strategies. At the heart of portfolio optimization lies the principle of the risk-return trade-off. Investors aim to attain the highest possible returns for a given level of risk.
- *Earnings Prediction:* Corporate earnings are easier to forecast than the economy, although they too have a high degree of idiosyncratic complexity. As with economic variables, the data has to be sourced from an external vendor. Unlike in economics, however, regressions are not good predictive techniques.
- *Stock Volatility:* The financial markets are inherently volatile, requiring constant monitoring and adjustments to ensure that a portfolio remains aligned with an investor's goals. Volatility forecasting plays an essential role in risk management by helping stakeholders anticipate periods of heightened market instability. The stock-market, because it is considered as important to the process of financial intermediation, is an area which has proved extremely challenging to predict. The stock-market is therefore considered to be efficient if prices would be unaffected by revealing any available information to everyone. Predictive analytics plays a pivotal role in managing market volatility by equipping investors with real-time insights, allowing them to anticipate price swings and implement measures to hedge against downturns.
- *Insurance:* In insurance, predictive analytics enhances underwriting and pricing by estimating risk more accurately. Insurers use predictive models to forecast claim frequency, assess policyholder risk, and detect fraudulent claims, leading to more competitive pricing, reduced losses, and improved overall profitability.
- *Sentiment Analysis:* Market sentiment analysis complements traditional analysis, offering a deeper understanding of market behavior and empowering investors to navigate complexities with precision. Automated trading systems incorporate sentiment insights for real-time decision-making. Market sentiment analysis aids in forecasting market trends, managing risks, and optimizing trading. For example, positive sentiment surges can signal potential bullish trends, guiding market entry points. Predictive models also help detect sentiment changes that may indicate increased volatility, enabling preemptive adjustments to investment strategies.

BENEFITS

Leveraging predictive analytics in the finance sector offers a wide range of measurable business benefits, ranging from proactive decision-making to higher

accuracy, efficiency, better risk control, improved customer experiences, and stronger financial performance. Predictive analytics strengthens risk management by anticipating market fluctuations and mitigating uncertainties posed by economic disruptions or geopolitical changes. It assists companies in increasing productivity and profitability by spotting inefficiencies, anticipating operational bottlenecks, and optimizing workflows. Other benefits of PA in finance include the following [11,17]:

Automation: Automation embedded within predictive systems streamlines resource-intensive processes across finance functions. By embedding intelligence into routine operations, organizations reduce manual intervention while maintaining precision at scale. Automated predictive models analyze large volumes of data with greater speed and consistency than manual processes. These models reduce human error, improve forecast accuracy, and streamline operations across operations such as lending, fraud detection, and financial planning, allowing teams to focus on higher-value strategic activities.

Lower Costs: Efficiency gains achieved through automation, improved risk detection, and streamlined processes lead to meaningful cost reductions. Predictive analytics reduces manual intervention, minimizes fraud-related losses, and optimizes resource utilization across financial operations.

Increased Profitability: By improving targeting, pricing strategies, and investment decisions, predictive analytics directly contributes to revenue growth. Better insights into customer behavior and market trends enable financial institutions to identify new opportunities, optimize margins, and enhance overall profitability.

Proactive Decision-making: Decision-making benefits immensely from forecasting, as it eliminates guesswork and facilitates rational choices regarding asset acquisition, pricing strategies, and expansion plans. Powered by AI, predictive analytics enables financial institutions to move from reactive decision-making to a proactive approach. By anticipating risks, market changes, and customer behavior in advance, organizations can take timely action, reduce uncertainty, and respond more effectively to emerging opportunities and potential threats.

Reduced Loss: By identifying potential credit defaults, fraudulent transactions, and market downturns early, predictive analytics helps institutions minimize losses. These insights enable better risk mitigation strategies, stronger portfolio management, and more resilient financial operations,

particularly in volatile or uncertain economic conditions.

Customer Satisfaction: Predictive models analyze historical patterns and data to gain insights into the current behavior and predict future trends. This helps understand your customer's needs, preferences, and areas of improvement. As a result, you can offer more personalized products or services, leading to an improved customer experience.

Better Resource Allocation: Predictive analytics in finance helps optimize resource allocation strategy by detecting inefficient or underperforming functionalities, identifying areas for improvement, and recommending necessary changes to resolve the issues. This leads to more efficient use of resources, reducing waste and supporting the organization's long-term objectives.

Revenue Growth: Predictive models help identify which products to invest in, leading to increased revenue. Financial analysts and investment professionals can use these models to develop more effective and profitable strategies.

Personalization: Predictive analytics allows financial institutions to understand customer needs, preferences, and behavior. It allows these organizations to offer personalized products, faster approvals, and relevant recommendations, improving customer satisfaction, strengthening loyalty, and building long-term relationships.

Some of the benefits of predictive analytics are shown in Figure 10 [21].

CHALLENGES

Though there are many advantages of using predictive analytics to streamline financial operations and improve efficiency and outcomes, adapting it is not an easy task. Predictive analytics in finance presents several challenges, including data quality, data privacy, availability issues, interpretability, interpretability, regulatory and compliance concerns, problems of algorithm bias, compatibility problems with integrated large traditional systems, and problems of human resources. Other challenges of PA in finance include the following [17,11,22]:

- *Data Quality:* To implement predictive analytics technologies, finance leaders must have access to accurate data. This helps align financial plans with operational plans and improve forecast accuracy. An output is only as good as the input in predictive analytics. The PA tools make forecasts by analyzing accumulated data. If the quality of the data sets feeding the predictive models is poor, the outcomes will also be

unreliable. To ensure better results and accurate predictions, financial forecasting models require high-quality data.

- *Lack of Skilled Professionals:* Lack of skilled professionals is a major challenge in implementing predictive analytics. You need a talented team that can not only perform advanced financial data analytics, but also harness its full potential. Hire data engineers with a strong understanding of ML algorithms, statistical modeling, and data manipulation.
- *Interpretability:* Interpreting predictive models is a complex task. So, understanding how models made the prediction is difficult for finance professionals. It often takes a significant amount of time to analyze the data used by the models and extract valuable insights that explain a specific prediction.
- *Market Complexities:* The complexities of financial decision-making and risk management pose persistent challenges for practitioners. Financial markets are complex because they are influenced by numerous factors, such as geopolitical events, economic indicators, and more. Including all these variables in a predictive model is quite challenging. The skills, tools, and methods associated with predictive analytics are constantly evolving, particularly as AI continues to advance. As such, financial professionals must maintain a mindset of continuous learning to stay current.
- *Cybersecurity:* Managing large volumes of sensitive financial data increases exposure to cybersecurity threats and data privacy breaches. Implement robust cybersecurity measures, encryption standards, and access controls, while aligning data handling practices with privacy regulations such as GDPR and similar frameworks.
- *Integration:* If predictive models cannot easily integrate with your existing finance software system, their value is significantly reduced. A seamless integration between predictive models and your financial system improves operational efficiency and productivity.
- *Training:* Predictive models use big data technologies for efficient data processing and ML algorithms for accurate predictions. Managing these models can be challenging, so you need a skilled staff to perform data analysis and maximize the value of these analytical tools. If your team does not have the required skills, then you have to arrange training sessions that would

help them learn and gain a solid understanding of these models and technologies. Having solutions with predictive features alone will not help unless your employees are trained to use them effectively. Train your employees to help them understand the various scenarios in which predictive analytics helps.

FUTURE OF PREDICTIVE ANALYTICS IN FINANCE

As technology continues to advance and more data becomes available, the applications of predictive analytics in finance are only set to grow. From improving customer experience to enhancing risk management and investment decisions, predictive analytics has the potential to revolutionize the finance industry. Today, predictive analytics in finance has proven to be incredibly valuable.

Predictive analytics is the future of finance. It continues to evolve with the emergence of new technologies. As technologies mature and adoption expands, predictive analytics will continue to shape the future of finance. The future trends of predictive analytics in finance include AI-driven real-time analytics and decision making, integration with blockchain and decentralized finance, and more. Data science and advanced technology are undergoing a revolution that will likely expand the application of predictive analytics' efficacy.

As financial markets continue to evolve, the integration of predictive models drives innovation, adaptability and resilience, ensuring stable and profitable outcomes while advancing a data-driven approach to navigating an increasingly complex financial ecosystem. Finance is moving toward a predictive model of operation. Trends such as real-time analytics, behavioral risk modeling, ESG-integrated predictions, and regulatory compliance will soon be standard practice. Organizations that embrace predictive analytics now will not only manage risk more effectively but also position themselves to capture new opportunities faster than competitors. More advanced financial predictive analytics algorithms will even be able to predict the day or date when a customer can be expected to pay. Ultimately, the most effective use of predictive analytics in finance will involve a combination of data-driven insights and human insight and expertise [23].

CONCLUSION

The ability to predict trends and outcomes has become more and more important in the face of an abundance of data flows. Predicting the future direction of the economy is important to almost all aspects of finance. In the ever-evolving landscape of the business world, predicting the future is tough. For

modern finance leaders, mastering this skill has become indispensable. In the domain of finance, predictive analytics plays a crucial role in decision-making, risk management, and fraud detection.

Predictive analytics is a powerful data analytics technique that uses big data mining, statistics, modeling, machine learning, and artificial intelligence to analyze large volumes of data and make predictions about future events or behaviors. Predictive analytics in finance refers to the use of historical and real-time data and statistical techniques to forecast future financial outcomes, like market trends, customer behavior, and risks. The use of predictive analytics in finance is transforming the industry. Financial institutions use predictive models for various purposes, such as portfolio management and fraud detection. Financial professionals can gain a significant competitive edge by leveraging historical data, machine learning algorithms, and advanced statistical techniques. Predictive analytics in finance equips finance leaders with the ability to manage risks proactively, improve accuracy in planning, optimize investments, and create better customer experiences.

Predictive analytics has redefined financial markets by harnessing the capabilities of big data, artificial intelligence, and machine learning to revolutionize investment strategies, risk management, and market efficiency. Predictive analytics in finance has moved from just being a competitive advantage to a necessity, especially in this digitally proliferating marketplace where customers' expectations continuously change. Understanding predictive analytics models is essential for finance professionals seeking to leverage data-driven insights in their decision-making processes. More information on the use predictive analytics in finance is available from the books in [24-28] and the following related journals:

- The Journal of Finance and Data Science
- Journal of Financial Risk Management

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Figure 1 Predictive analytics [4].



Figure 2 Different components of predictive analytics [5].

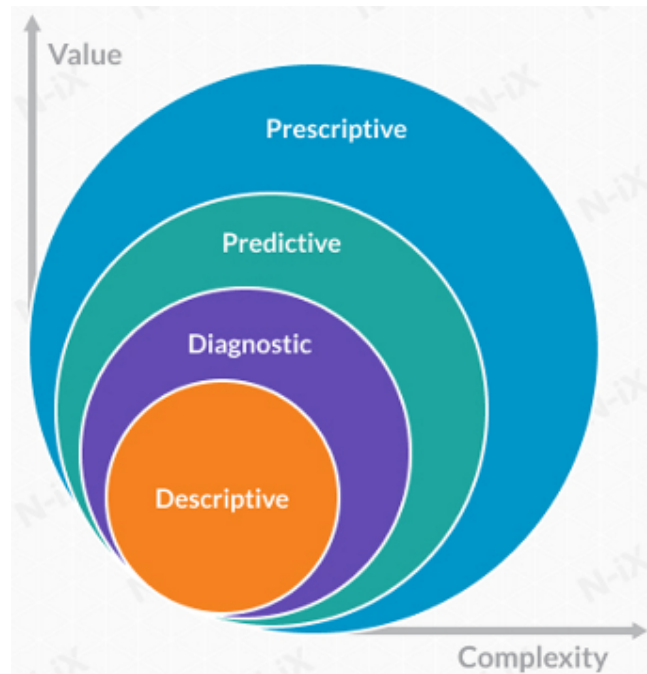


Figure 3 Types of data analytics [7].

Predictive Analytics Process

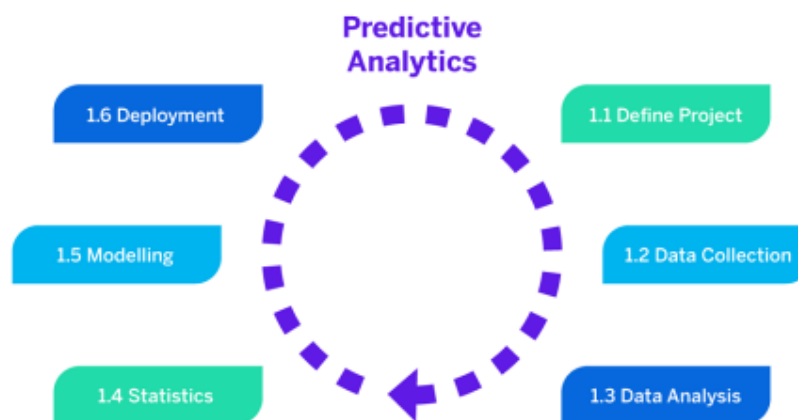


Figure 4 Predictive analytics process [8].



Figure 5 A financial analyst [9].



Figure 6 Predictive analytics in finance [11].

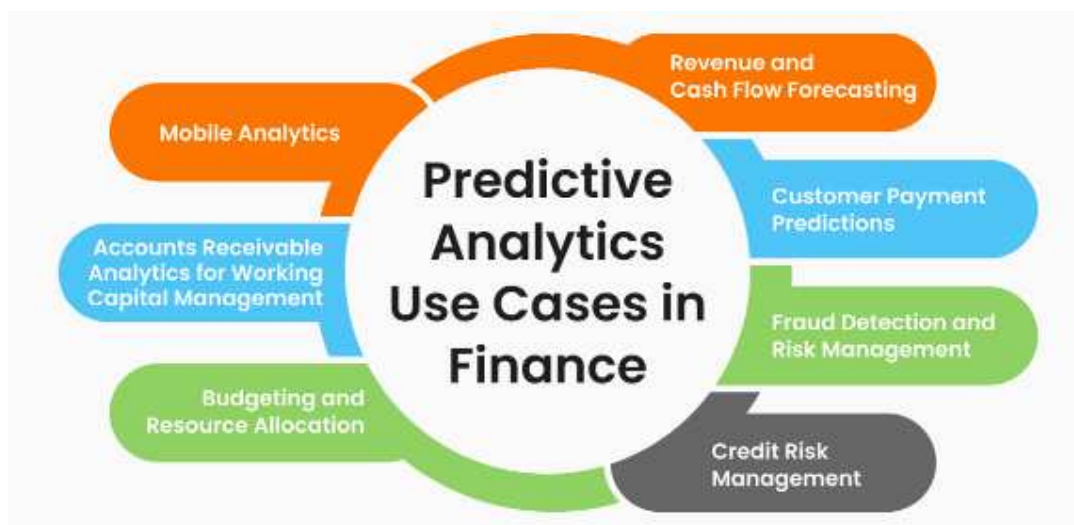


Figure 7 How predictive analytics is used in finance [13].



Figure 8 Predictive analytics in financial risk management [19].

USE CASES OF PREDICTIVE ANALYTICS IN BANKING

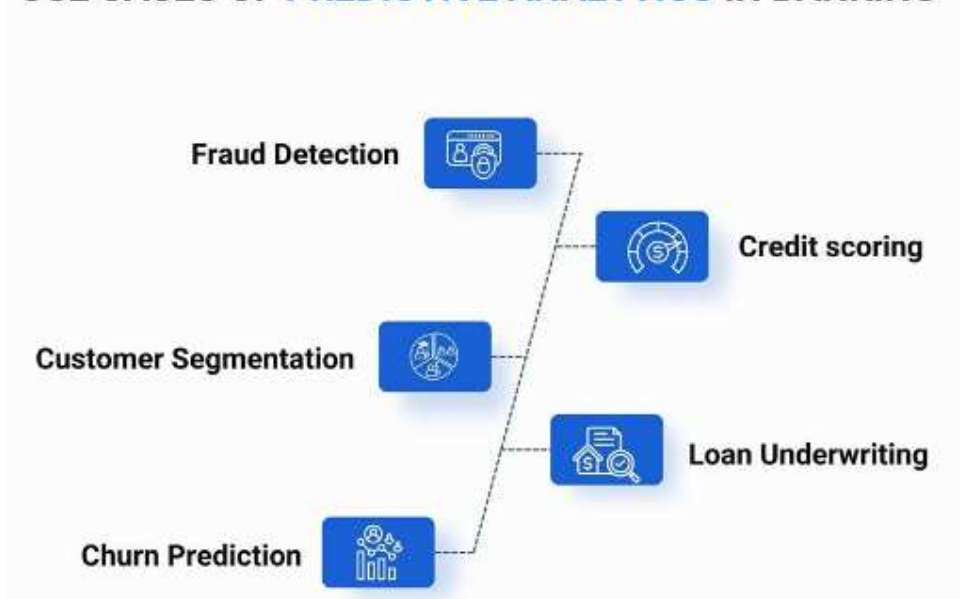


Figure 9 Use cases of predictive analytics in banking [20].

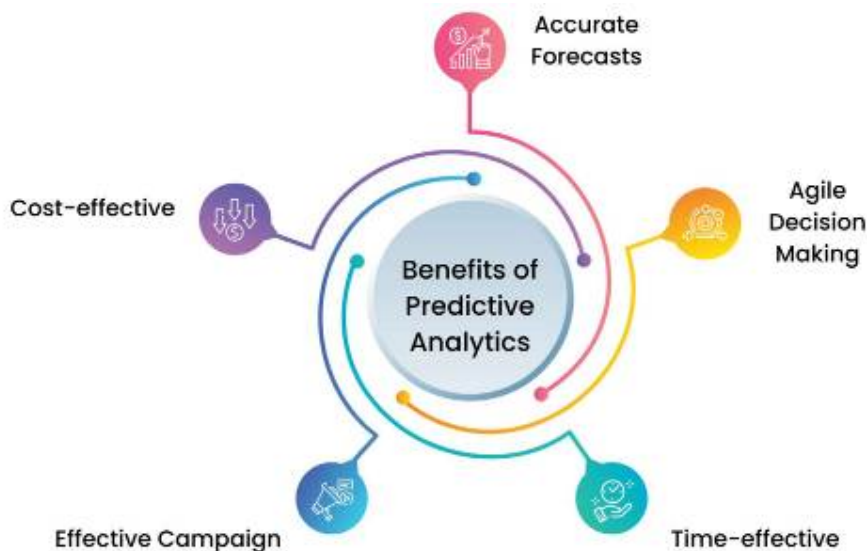


Figure 10 Some of the benefits of predictive analytics [21].