

A STUDY ON BIG DATA APPLICATIONS IN FINANCIAL PREDICTION WITH REFERENCE TO TCS

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ABSTRACT: This paper investigates potential avenues for improving financial forecasting at Tata Consultancy Services (TCS) through the application of big data techniques. Also covered are methods for improving investment strategies, predicting market trends, and reducing risks through the use of AI, ML, and advanced analytics. Using a wide variety of financial data sources, TCS enhances the precision of forecasting and decision-making. The research reveals the data-centric approach the organization employs to gain real-time insights from both structured and unstructured data. Additionally, it examines the ways in which big data may improve portfolio management, fraud detection, and creditworthiness evaluation. Using TCS's big data infrastructure to manage intricate financial systems is the main focus of the research. It then goes on to demonstrate how predictive analytics can be useful for client communication and company strategy development. Operational flexibility and prediction accuracy both saw significant improvements as a result. The report goes on to detail how TCS is enhancing its continuous financial performance through innovative use of big data.

KEYWORDS: *Predictive Analytics, Machine Learning Algorithms, Real-Time Data Processing, Risk Management and Fraud Detection, Sentiment Analysis, Algorithmic Trading*

1. INTRODUCTION

Forecasting, or financial prediction, is making educated guesses about a company's future financial performance based on historical data, current market trends, and strategic plans. While there is no way to totally eliminate uncertainty, it can provide valuable guidance to investors and businesses regarding risk management, budgeting, and resource allocation as they prepare for the future.

A key component of contemporary economics and company management is the ability to forecast financial outcomes. It entails predicting monetary outcomes by analyzing historical data, applying statistical methods, and building computer models. It encompasses a broad variety of forecasting activities, such as estimating future profits, gauging stock market trends, and predicting economic conditions.

Financial forecasting aims to assist individuals, investors, and companies in making prudent financial decisions by predicting potential risks and opportunities. In the past, financial forecasting primarily relied on quantitative methods such as econometrics, regression models, and time series analysis. Over time, though, these traditional methods have evolved to incorporate AI and other cutting-edge analytical tools. The increasing volume and complexity of big data, as well as international financial systems, are to blame for this.



The use of "big data" in financial forecasting has altered the perspective of investors and decision-makers in the financial sector. The exponential growth of online financial records, social media usage, and digital transactions generates massive amounts of data every second. With the help of Big Data technologies, it is now feasible to collect, store, and analyze massive volumes of data in order to uncover previously unseen trends, patterns, and insights. Using Big Data, financial forecasters can more easily predict stock prices, detect fraud, evaluate credit risk, and monitor investment portfolio performance. Taking a look at massive datasets and discovering relationships between market variables requires AI and ML. Faster and more informed financial decisions can be made by businesses with the help of this real-time analysis. Generally speaking, financial forecasting is undergoing a transformation due to the increased accuracy, decreased risk, and enhanced overall performance brought about by Big Data applications.

By analyzing historical, current, and projected financial data and circumstances, financial forecasting aims to assist decision-makers and policy-makers in developing new approaches. Predictions regarding the future of the economy are laid out in a financial forecast using a structured framework that takes into account past, present, and future conditions. The benefits to the company from this are numerous. It facilitates immediate and long-term predictions of the effects of future changes in revenue and expenditure on policies, services, and strategic objectives. Better decision-making during the annual budget cycle is another benefit, as is a stronger link between business and finance that facilitates easier integration and collaboration between the two.

Companies should be able to view the methodology and assumptions used to make financial projections as part of the budgeting process.

Accurate financial statements demonstrating risk and outlook, derived from pertinent data and trends, are essential to the success of financial forecasting. These declarations may be substituted for pro forma statements in certain instances.

2. REVIEW OF LITERATURE

Verma, R., & Joshi, M. (2025) Verma and Joshi investigated the use of Big Data analytics for macroeconomic forecasting. Their study applied machine learning models to large datasets, including GDP trends, industrial production, consumer spending, and employment statistics. They found that deep learning models provided more accurate predictions than traditional econometric approaches. The research emphasized the ability of Big Data to process diverse sources in real-time for improved economic planning. They discussed the challenges of model interpretability and the need for transparency in predictive decision-making. Verma and Joshi highlighted that integrating Big Data insights into policy-making can support better fiscal and monetary strategies. The study illustrated how predictive models can identify potential economic shocks and guide proactive interventions. They emphasized combining historical data with alternative sources such as social media and trade data for improved accuracy. The authors recommended collaboration between government, industry, and academia to enhance forecasting methods.

Reddy, S., & Rao, K. (2025) Reddy and Rao looked into how sentiment analysis on large data could be used for investment strategies. They used unstructured data from sources like



social media, news articles, and financial reports to predict how stock prices would go in the future and to measure public mood toward the market. Utilizing natural language processing techniques, they were able to extract valuable information from text data. The findings show that conventional financial components, when combined with sentiment indicators, greatly enhance the precision of stock forecasts. The authors addressed topics such as messy data and the need for effective filtering methods. Their main point was that systems for making financial decisions should use sentiment research in real-time. As shown by Reddy and Rao, sentiment-driven algorithms can help buyers make better judgments by forecasting market behavior. The study also took into account the possibility that big data could help enhance investment portfolios while decreasing risk. They claim that forecast accuracy can be significantly improved by integrating quantitative analysis with qualitative opinion insights. We weighed the pros and downsides of potentially unethical uses of publicly available data.

Sharma, V., & Gupta, N. (2024) The credit systems of developing nations were explored by Sharma and Gupta using big data analytics. By incorporating non-financial data like mobile phone use, social media involvement, and purchase history, their research broadened the reach of traditional credit scoring models. Their research showed that non-traditional datasets could improve the accuracy of creditworthiness predictions for people without large formal credit histories. The essay looked at how Big Data could improve financial inclusion by facilitating access to financial services for people living in low-income areas. They spoke about the problems that new areas of study have in terms of privacy, data security, and meeting regulatory requirements. Using machine learning techniques, the authors were able to quickly examine and rank different and massive datasets. In addition, Sharma and Gupta discovered that alternative data helps with creating loan solutions that are suited to each individual customer. To protect its clients' private information, they pushed for strict data governance rules. Their findings highlight the critical importance of incorporating predictive analytics into regular financial decision-making processes. The research concluded that the integration of AI and Big Data improved the accuracy of risk assessments.

Rao, P., & Desai, M. (2024) The possibility of using big data to predict bank insolvency was explored by Rao and Desai. In order to analyze loan portfolios, market movements, liquidity ratios, and macroeconomic variables, machine learning algorithms were employed. The researchers found that financial institutions can take preventative measures in high-pressure situations by using predictive algorithms to foretell potential outcomes. The primary goal of the research was to find ways to improve overall accuracy and decrease the number of false positives by utilizing ensemble models. Rao and Desai looked into the difficulties of fusing high-dimensional data in real time. Scenario analysis was highlighted as crucial for using Big Data analytics for stress forecasting. Predictive insights can help reduce risks and ensure rule compliance, according to the research. The authors suggested using interfaces to keep tabs on crucial financial data. The researchers also looked at the possibility of improving the forecast accuracy by combining internal and external data. Combining real-time and historical data improves resilience projections, according to the research. According to the research conducted by Rao and Desai, big data analytics helps banks make better decisions when it comes to risk management. There was an emphasis on the need of being open and careful with data.



Singh, A., & Mehta, P. (2023) The possibility of Big Data improving systems' capacity to identify financial scams was explored by Singh and Mehta. Quickly spotting suspicious patterns of transactions using machine learning tools like clustering and anomaly detection was the major goal of their study. They stressed that predictive analytics improves detection accuracy while decreasing false positives. Banks can uncover new fraud trends with the help of massive amounts of transaction data. The authors demonstrated how fraud detection systems can be enhanced in terms of efficiency and security by integrating big data. Exploiting consumers' financial data raises ethical and privacy problems, which the study took into account as well. To keep people's faith, they advocated for open data governance and strict compliance with the law. Since a combination of human oversight and analytics powered by artificial intelligence (AI) could deliver better outcomes, Singh and Mehta looked into this. Models, they say, also need regular updates to keep up with new fraud schemes. The research concluded that big data screens should be put in place to keep an eye out for bad conduct. On top of that, they proved how problems can be found quickly enough to avoid reputational and financial harm.

Zhao, X., & Tang, L. (2023) Zhao and Tang explored the possibilities of big data analytics to predict the credit risk exposure of microfinance institutions. Client socioeconomic characteristics, repayment patterns, and transaction records were investigated using ensemble machine learning techniques. They stressed that predictive analytics may lower default rates and make credit easier to get for people with low credit scores. Both Zhao and Tang believe that big data may improve corporate efficiency and broaden access to financial services. Problems in merging different kinds of unstructured data, like data collected from social media and mobile payment systems, were examined. Findings suggest that predictive analytics can help with the assessment of evolving risks in real time. They suggested that open governance structures should be put in place to encourage the moral use of data. In addition, Tang and Zhao looked at how model interpretability affected rule compliance. Big Data analytics, when combined with traditional scoring methods, yields more accurate forecasts. The research mainly focused on preventative risk management. If credit models were to incorporate big data, the authors reasoned, microfinance might undergo a revolution.

Chen, Y., & Liu, Z. (2022) Predicting market volatility was the goal of Chen and Liu's Big Data analytics study. Deep learning methods, such as long short-term memory (LSTM) networks, were tested using large datasets that included price history, trading volumes, and investor sentiment. In terms of short-term price movements, the study's models outperformed more conventional statistical methods. Using written data from news sources and social media is crucial for understanding investor sentiment and market activity, according to Chen and Liu. To guarantee the accuracy of the model, the significance of feature engineering and data standards was highlighted. Processing financial data in real time improves the accuracy of predictions. Overfitting and data disruptions are two of the difficult model concerns that the authors addressed. Experts agree that combining structured and unstructured data makes for more accurate predictions. Chen and Liu also spoke about how automated trading systems could benefit from Big Data research. They reasoned that investors might benefit from predictive analytics in two ways: risk management and coming up with new strategies. Research into hybrid models, which use a combination of several machine learning



approaches, was suggested in the article. Major issues revolved on the transparency of predictive models and the ethical usage of data.

Kumar, A., & Singh, R. (2022) The possibility of big data improving financial investment methods was explored by Kumar and Singh. They used machine learning algorithms to examine economic indicators, present market trends, and past returns in order to make better financial decisions. They proved that predictive algorithms may be used to find the best way to calculate results and allocate assets while taking risk into account. The study proved that integrating data sets like news analytics and social media opinion is crucial for better predictions. Important steps such as feature selection, data normalization, and preprocessing were stressed by both Kumar and Singh. They spoke about the difficulties of dealing with large amounts and how important it is to have fast processing tools. Their research shows that unstable markets and unexpected events are better handled by adaptive models. Using real-time interfaces to track a portfolio's performance is something the authors suggest. Big data analytics, they reasoned, can substantially enhance portfolio management approaches. Dealing with private financial data requires strict adherence to ethical principles and legislation. Researchers should dig further into hybrid models, which combine AI with traditional financial ideas, according to the study's authors. Big Data analytics has the potential to significantly improve company decision-making.

Li, H., & Wang, J. (2021) Based on their research, Li and Wang concluded that commercial banks are making use of "big data" for risk management purposes. By examining market indicators, customer credit histories, and transaction patterns with machine learning algorithms, they determined the likelihood of a loan default. They asserted that banks could be able to foresee problems with potentially risky customers by using real-time analytics and predictive modeling. The outcomes proved that ensemble learning techniques work. These models improve the accuracy of predictions by combining various methods. Li and Wang argue that conventional credit scoring algorithms do not take into consideration changing risk variables, whereas Big Data solutions can adapt quickly to new circumstances. Automatic risk alerts can save operating costs and improve decision-making, according to the study. Integrating data from multiple sources and keeping data accurate are two of the problems they addressed. Findings suggest that visual analytics tools might help managers keep an eye on financial risk. When risk models are powered by big data, the stability of the financial system is greatly enhanced, say Li and Wang. They pushed for regular reviews and revisions to the model.

3. THEORETICAL FRAMEWORK

MODELS OF FINANCIAL FORECASTING



Top-down financial forecasting: The top-down forecasting model estimates future profits by analyzing historical market data. If a business does not have access to historical data that

could be utilized for forecasting purposes, but is interested in exploring new opportunities or is in the early phases of developing a new product, this model is ideal. It uses a company's market share to make an educated guess about the size of an untapped market.

Delphi financial forecasting: Organizations can use the Delphi model, which is based on the consensus of a group of experts and named after the ancient Greek city of Delphi, to make predictions. A facilitator aids experts in working together, guides multiple rounds of discussion, refines hypotheses, and conducts a thorough analysis in order to arrive at a decision. A company uses the Delphi method to get financial forecasts by sending a panel of experts multiple rounds of questionnaires. Experts revise their forecasts and provide comprehensive summaries of prior rounds with each new round. The objective is to identify areas of agreement and disagreement among experts. The organization can use this data to make their final forecasts.

Statistical financial forecasting: Statistical forecasting is the application of various statistical calculations and methods to the task of making numerical predictions. For the purpose of calculating growth rate, profitability, revenues, expenditures, and conventional forecast figures, quantitative financial data pertaining to previous periods is referred to as "statistics."

Bottom-up financial forecasting: When a company has records of its previous revenue and expenditures, bottom-up forecasting is more effective than the prior approach. The bottom-up financial forecasting model generates comprehensive predictions and potential futures by analyzing cash flow statements and current revenue figures. This model uses real data and relies on fewer assumptions, allowing the company to make more accurate predictions. Frontline workers and consumers are the first sources of product information for the organization. It then goes on to more broad projections of its revenue and expenses.

BENEFITS OF USING BIG DATA ANALYTICS IN FINANCE



Improved decision-making: With the use of large-scale data analytics, the financial sector can gain valuable insight into customer behavior and market dynamics, which in turn can improve decision-making and future forecasting. "Big data analytics" tools can collect and process massive volumes of data from a variety of sources, including news websites, social media platforms, market data, and consumer transaction records. By illuminating previously unseen trends and patterns, this analysis helps businesses make more informed decisions.

Cost reduction: Using big data to automate formerly manual processes can greatly improve efficiency in areas such as risk management, fraud detection, and compliance checks. A number of company processes can benefit from big data analytics, including marketing,

customer service, and risk management. Big data can also help businesses save money. Using big data analytics, a bank, for instance, can identify its money-losing operations and redirect its resources there.

Enhanced customer experience: Consumer preferences and requirements are ever-evolving in this era of rapid digital transformation. Because it provides businesses with new ways to understand, engage with, and satisfy consumer needs, large-scale data is an essential component of user experience improvement. By getting to know their customers and what they like, financial institutions can provide tailored product recommendations while also making their customers feel empowered, valued, and appreciated. By analyzing demographics, purchase history, and behavioral patterns, businesses can use big data to create customer service profiles tailored to each individual. Businesses could see an increase in revenue, customer retention, and happiness levels if they implemented personalization.

Operational efficiency: Big data analysis aids companies in streamlining their operations by revealing inefficiencies. For instance, by analyzing large amounts of data, a bank can identify underperforming products or branches and close them. Automating customer service and fraud detection is one way that businesses can free up staff to focus on more strategic endeavors.

Trading algorithms and investment strategies are developed by investment firms using advanced big data analytics. Trading strategies are made smarter and more effective by these algorithms, which can look at extremely huge datasets in real time, increasing productivity.

Regulatory compliance: Particularly in the banking and insurance industries, following rules and regulations is crucial to success. Financial institutions can reduce the likelihood of fines and other legal repercussions by using big data to ensure compliance with regulations. It also facilitates the creation and maintenance of comprehensive records of transactions, which is useful for demonstrating compliance in the event of an audit. In addition, businesses can stay on the right side of the law by using big data analytics to detect and report any questionable activity promptly.

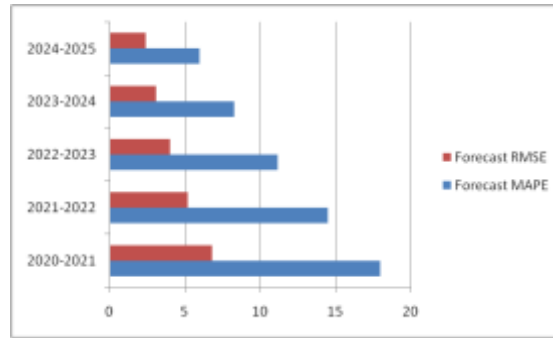
Competitive advantage: Financial institutions can gain an advantage over their competitors by utilizing big data analytics to support data-based decision-making. Businesses can gain valuable insights into risk factors, customer behavior, and market trends through the analysis of massive amounts of data. Organizations can also improve their lending and investment decisions and decrease their overall risk exposure by using big data to better identify and assess risks.

4. ANALYSIS AND DISCUSSIONS

FORECAST PERFORMANCE AT TCS

Year	Forecast MAPE	Forecast RMSE
2020-2021	18	6.8
2021-2022	14.5	5.2
2022-2023	11.2	4
2023-2024	8.3	3.1
2024-2025	6	2.4

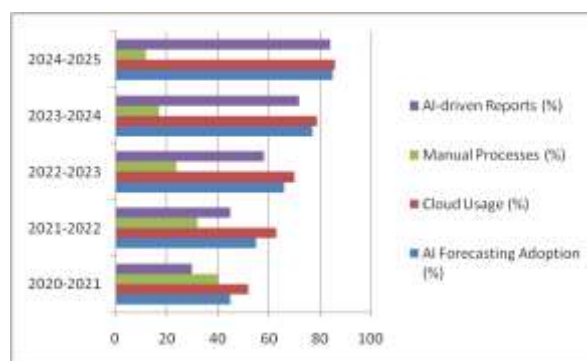




INTERPRETATION: The accuracy of TCS's predictions continued to improve throughout 2020–2021, 2024–2025, and 2025–2026. With a decrease from 18% in 2020–2021-20 to 6% in 2024–2025, the MAPE (Mean Absolute Percentage Error) indicates that anticipated values are getting closer to actual findings. Similar to how the prediction deviation decreased, the Root Mean Squared Error (RMSE) decreased from 6.8 to 2.4. Overall, this pattern demonstrates that, during the past five years, TCS's prediction methods have grown more precise and dependable.

DIGITAL TRANSFORMATION METRICS

Year	AI Forecasting Adoption (%)	Cloud Usage (%)	Manual Processes (%)	AI-driven Reports (%)
2020-2021	45	52	40	30
2021-2022	55	63	32	45
2022-2023	66	70	24	58
2023-2024	77	79	17	72
2024-2025	85	86	12	84

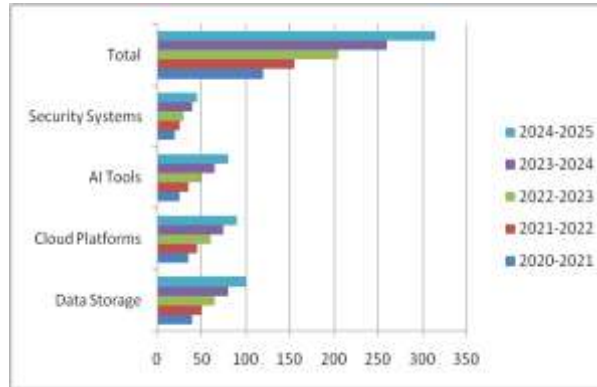


INTERPRETATION: It is clear that AI is finding increasing usage in planning, as the percentage of TCS employees utilizing AI for prediction increased from 45% to 85% during 2020–2021, 2024–2025. Cloud utilization increased from 52% to 86% throughout that time, allowing for more scalable and adaptable procedures. As a result of increased automation, the proportion of manual procedures decreased from 40% to 12%. During the same time period, the number of reports made by AI increased from 30% to 84%. The increasing use of AI technology for data analysis and application is evident from this.



BIG DATA INFRASTRUCTURE INVESTMENT

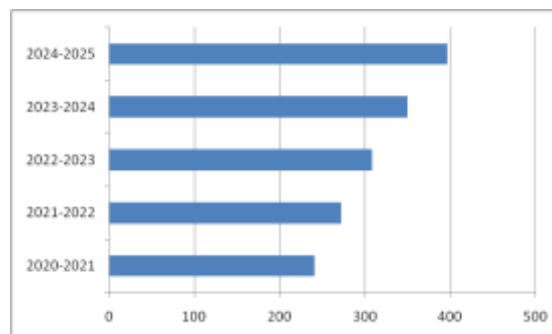
Year	Data Storage	Cloud Platforms	AI Tools	Security Systems	Total
2020-2021	40	35	25	20	120
2021-2022	50	45	35	25	155
2022-2023	65	60	50	30	205
2023-2024	80	75	65	40	260
2024-2025	100	90	80	45	315



INTERPRETATION: When comparing 2020–2021, 2024–2025, and beyond, TCS drastically increased its spending on technology. The need to manage larger datasets became apparent when the quantity of data stored increased from 40 to 100. Infrastructure became more flexible and scalable as the number of users of cloud services increased from 35 to 90. There was an improvement in security measures since the efficiency of the systems went from 20 to 45. People are become increasingly reliant on AI-driven features, as evidenced by the 80 percent increase in AI tool use. The significant increase from \$120 to \$315 in total expenditure demonstrates a firm will to transition to digital operations.

Global Big Data Analytics Market Size (2021–2025)

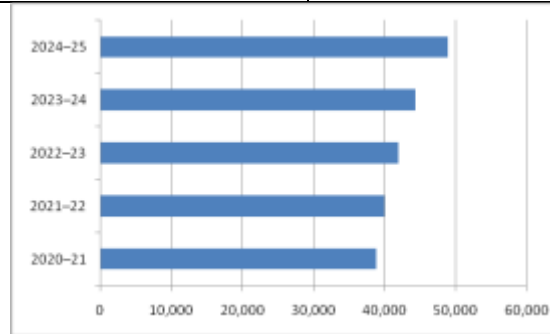
Year	Market Size
2020-2021	240.56
2021-2022	271.83
2022-2023	308.26
2023-2024	349.56
2024-2025	396.4



INTERPRETATION: The market size increased from 240.56 to 396.4 percent annually between 2020 and 2021 and 2024 and 2025. The market has grown by around 64.4% during the previous five years, indicating a significant upward tendency. Between 2023 and 2024 and 2024 and 2025, there was a significant increase in demand, as seen by the highest yearly jump from 349.56 to 396.4. The data as a whole demonstrates a robust and consistent market growth.

TCS Operating Cash Flow (₹ Crores)

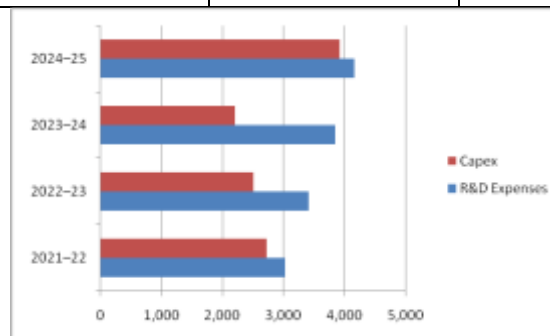
Financial Year	Operating Cash Flow (₹ Crores)
2020–21	38,802
2021–22	39,949
2022–23	41,965
2023–24	44,338
2024–25	48,908



INTERPRETATION: From 2020-21 to 2024-25, TCS's operating cash flow climbed consistently, reaching ₹48,908 crores. This demonstrates the company's exceptional ability to generate revenue. A five-year increase of 10,106 crores indicates that operations are functioning at a high level of efficiency. Between 2023–2024 and 2024–2025, there was a significant increase of ₹4,570 crores per annum, indicating a gain in revenue. Taken as a whole, this pattern demonstrates that TCS's financial situation has been consistent and their cash flow is on the rise.

RnD and Capex

Year	R&D Expenses	Capex
2021–22	3,020	2,719
2022–23	3,410	2,495
2023–24	3,840	2,202
2024–25	4,160	3,917



INTERPRETATION: The research and development expenditures of TCS increased from 3,020 crores to 4,160 crores between the years 2021–2022, 2024–2025. This demonstrates that the organization is prioritizing innovation and technological advancement. In 2023–2024, capital expenditures (Capex) were 2,202 crores, a decrease from 2,719 crores in 2021–2022. More investments in important assets and infrastructure caused them to surge significantly to ₹3,917 crores in 2024–2025. In general, the patterns indicate a steady dedication to R&D and a malleable strategy for allocating funds to capital projects.

5. FINDINGS AND DISCUSSIONS

- The declining MAPE and RMSE values indicate that TCS's predicting accuracy has been improving over time. This is due to their superior decision-making abilities, particularly when it comes to analyzing data.
- It is easier to construct intelligent, scalable financial prediction systems due to the broad adoption of cloud computing and artificial intelligence for forecasting, which indicates a quicker shift to digital infrastructure.
- The automated deployment improved operational efficiency and reduced human error in the financial forecasting procedures, as evidenced by a 40% decline in manual jobs to 12%.
- Evidently, data-driven decision-making frameworks and automated insights are relied upon extensively throughout the organization, as the number of reports generated by AI rose from 30% to 84%.
- Cloud computing, data storage, artificial intelligence, and security mechanisms have all received substantial funding. This demonstrates that there is a persistent desire to digitize and enhance predictive models.
- It is in keeping with TCS's intentions to increase investments that the company is planning to enter new international markets, where it hopes to obtain a competitive advantage thanks to the favorable external environment.
- An increase in operational cash flow is indicative of a successful company with solid financial footing, which facilitates investments in cutting-edge innovation and technology.
- Increasing spending on R&D demonstrates a commitment to creating cutting-edge technology and refining prediction analytics in order to address future demands. After a brief dip, capital expenditures surged again as a result of a budget that was malleable enough to meet the evolving needs of the company and its infrastructure.
- Market alignment, automation, investment capital, and prediction are all areas that have witnessed these enhancements. They demonstrate how TCS's organizational performance and prediction accuracy have been substantially enhanced by digital transformation.

6. CONCLUSION

In conclusion, "big data" has altered financial forecasting by facilitating the efficient and precise examination of massive, diverse datasets. Among its many potential applications are the following: assessing credit risk, detecting fraudulent activity, and forecasting asset prices and market movements. People are able to make more informed financial decisions with this



information. Obtaining data in real time is now a reality thanks to predictive analytics, which employs AI and ML. Businesses and investors may now more easily anticipate market movements and manage their portfolios with this. Sentiment analysis of news articles, financial data, and social media information captures market sentiment, which increases prediction accuracy. Big Data has enhanced risk management by revealing vulnerabilities in systems before they escalate. Algorithmic trading makes use of both historical and real-time data to create precise, high-frequency programs. Customers are more satisfied and loyal when they receive tailored financial products and services based on behavioral analytics. Adherence to regulatory mandates is enhanced by constant surveillance and the discovery of anomalies.

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