

Predictive Analytics for Human Resources

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ABSTRACT

Predictive modeling is a way to guess what will happen in the future. It looks for patterns from past data and uses those patterns to make predictions. Predictive analytics has become a valuable asset in many industries. It has emerged as a transformative force in the realm of human resources (HR), enabling organizations to make data-driven decisions. It is an important tool for companies who want to stay in the lead. It helps them make smart decisions about the future. Businesses use predictive analytics to manage their products and set good prices. Predictive analytics in HR leverages data and AI to enhance decision-making, identifying at-risk employees and optimizing retention strategies. Through predictive analytics, HR professionals can identify patterns and predict future outcomes based on historical data, allowing for the development of more effective employee retention strategies. This paper explores the role of predictive analytics in human resources.

KEYWORDS: *predictive analytics, human resources, HR, human resources management, HRM.*

INTRODUCTION

Businesses use different types of analytics to work well. Predictive analytics is one of them. Others are descriptive, real-time, diagnostic, and prescriptive analytics. Predictive HR analytics, also known as predictive people analytics or workforce analytics, refers to the use of data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes based on historical data. It uses artificial intelligence to forecast future outcomes and enable more informed decisions about recruiting, staffing, employee development, and other HR functions. By leveraging predictive analytics, HR professionals can move beyond traditional methods and gain insights from historical data on hiring outcomes, employee turnover, and performance. Figure 1 show some HR professionals [1].

New technological tools such as predictive analytics are changing the way companies look at their human resource today. Predictive analytics is an operational analytics method that employs historical information and statistical tools, as well as algorithms to make forecasts of future events. The integration of predictive analytics into HR practices marks a

significant shift from traditional methods that often rely on intuition and anecdotal evidence. HR departments are now equipped to harness vast amounts of information to gain insights into employee behavior, engagement levels, and turnover rates [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 2 illustrates predictive analytics [4], while Figure 3 show different components of predictive analytics [5].

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In general, analytics provides an efficient way to improve planning because it gives you better 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 4 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.

PREDICTIVE ANALYTICS IN HUMAN RESOURCES

Human resource management (HRM) plays a strategic role in enhancing organizational effectiveness, innovation, and competitiveness. Among its core functions, recruitment, employee retention, and performance optimization are critical for maintaining a productive and motivated workforce. Artificial intelligence (AI) and machine learning (ML) have emerged as transformative tools in HRM, offering predictive analytics and automation for critical HR tasks. Artificial intelligence is playing an increasingly strategic role in modern recruitment processes. Organizations that successfully integrate AI technologies into recruitment can reduce time-to-hire, eliminate bias in early screening stages, and offer personalized communication at scale. HR departments increasingly use AI-powered virtual assistants and software bots to support the onboarding process. Artificial intelligence will significantly influence activities within the human resources (HR) department throughout the entire employee lifecycle [8].

Predictive analytics in HR is a set of techniques for analyzing data to predict future events in an organization. It is using data mining, statistics, and machine learning to make more informed decisions about recruiting, staffing, and other HR functions. Figure 5 shows predictive analytics process [9]. By applying predictive analysis to HR data, HR is able to become a strategic partner that relies on proven and data-driven predictive models, instead of relying on gut feeling and soft science. HR predictive analytics enable HR to forecast the impact of people policies on well-being, happiness, and bottom-line performance. For example, Google estimates the probability of people leaving the company by

applying HR predictive analysis. One of Google's findings is that new salespeople, who do not get a promotion within four years, are much more likely to leave the company [10].

To effectively utilize predictive analytics in human resources, it is essential to identify the key metrics that will drive meaningful insights. Commonly analyzed metrics include employee turnover rates, recruitment efficiency, employee engagement scores, and performance ratings. By focusing on these indicators, HR professionals can uncover patterns that reveal underlying issues or opportunities for improvement. The success of predictive analytics in HR hinges on the quality and organization of the data being analyzed. Organizations must ensure that they are capturing comprehensive and accurate data to facilitate meaningful analysis [11].

APPLICATIONS OF PREDICTIVE ANALYTICS IN HUMAN RESOURCES

Predictive HR analytics refers to the use of data, statistical methods, and machine learning to anticipate future trends and outcomes in human resources. It enables HR to optimize recruitment processes by identifying the most effective sources for talent acquisition, improving candidate selection processes, and enhancing overall workforce planning. The application of predictive analytics in recruitment and hiring processes has revolutionized how organizations attract and select talent. Common applications include the following [1,8,11-13]:

- *Healthcare:* Healthcare roles, especially in high-stress environments like emergency and intensive care units, have high rates of burnout and turnover. Predictive analytics can assess risk factors for burnout by monitoring work hours, patient load, and staff wellness reports. Healthcare facilities can use these insights to implement preventative measures, such as adjusting workloads, offering more support, and creating wellness programs tailored to the needs identified through the data. Figure 6 shows the use of predictive analytics in healthcare [14].
- *Restaurants:* In the restaurant industry, staff turnover can peak during high seasons such as holidays and summer months. Predictive analytics can help manage and reduce this turnover. By analyzing historical data on employee shifts, customer volume, and staff feedback, predictive models can identify patterns that lead to high turnover.
- *Talent Acquisition Planning:* HRs are responsible for maintaining an organization's workforce, preventing employee shortages or overstaffing.

Predictive analytics can help HR specialists forecast an organization's talent requirements and workforce needs well in advance to timely address them. This enables HR leaders to make better hiring decisions, ensuring the availability of skilled personnel exactly when and where they are needed to support the company's business outcomes.

- *Employee Engagement:* In the field of human resource management (HRM), successful employee engagement is a primary objective. Employee engagement is key to retaining employees and reducing turnover. It is directly linked to productivity and business success. Employees who are engaged work harder, deliver better quality, are less absent, and less likely to quit. Companies that invest in engagement strategies see higher employee satisfaction and increased performance. Approaches include ensuring workers are actively engaged in their tasks, aligning personal goals with those of the organization and the project, and facilitating quality work while maintaining a healthy work-life balance. Predictive analytics can significantly boost employee engagement. By analyzing data on employee behavior, feedback, and engagement survey results, HR teams can identify trends that lead to disengagement.
- *Employee Performance:* Predictive analytics helps HR professionals identify factors that influence employee performance. It helps employees meet their performance goals and overall corporate objectives. For example, HR specialists can leverage predictive models to understand how different factors, such as employee incentive schemes, will positively or negatively impact different team members' performance.
- *Employee Retention:* Employee retention is a major issue for many companies today. It is a critical concern for organizations seeking to maintain a stable workforce and minimize turnover costs. Numerous organizations are exploring various methods to retain their employees, including generating annual reports through surveys to understand their concerns and needs. HR teams aim to identify company-specific turnover reasons and intervene early to retain employees before it is too late. Predictive analytics plays a vital role in identifying at-risk employees who may be considering leaving the organization. An employee may decide to leave an organization for many reasons. Research shows that the probability of leaving a company

varies and can be calculated based on different characteristics.

- *Performance Management:* Performance management is another area where predictive analytics can yield significant benefits. By analyzing performance data over time, organizations can identify trends that inform talent development strategies and succession planning efforts. Predictive models can help HR professionals forecast future performance outcomes based on historical data, enabling them to make informed decisions about promotions, training needs, and resource allocation.
- *Workforce Planning:* One of the key areas where predictive analytics is making a significant impact is workforce planning. Effective workforce planning is crucial for ensuring an organization has the right number of employees with the right skills and time to meet its operational needs. Predictive analytics enables HR teams to forecast future workforce requirements by analyzing patterns in employee data, such as hiring trends, turnover rates, and productivity metrics. This ability to predict future needs allows organizations to plan more effectively. By using predictive analytics to anticipate customer service challenges and proactively address them through workforce adjustments, organizations can improve the overall customer experience. Predictive analytics has fundamentally transformed the landscape of workforce planning by enabling organizations to forecast future workforce requirements with unprecedented accuracy.

BENEFITS

Predictive analytics can forecast customer behavior, identify potential risks and opportunities, optimize marketing campaigns, and improve operational efficiency. This technology not only forecasts potential employee turnover but also provides actionable insights, enabling companies to proactively address retention challenges. Other benefits include the following [15,16]:

- *Improved Decision-making:* Data-driven decisions are more accurate than those made based on intuition alone. The predictive analytics framework helps HR professionals make better and wiser decisions. Using predictive HR analytics to make better decisions allows businesses to save money, increase productivity, and improve customer satisfaction. Decision-making is a complex task. Using predictive analytics in business intelligence helps ensure the best decision is made. For example, Amazon uses

predictive analytics to help customers make better online shopping decisions. Amazon's recommendations are so good that many people say they are getting personal advice from the site. When decision-making becomes more efficient, productivity increases, and when people are not figuring out what to do, they can spend more time doing the tasks.

- *Fewer Disasters:* Disaster prevention is another reason why the predictive analytics framework is so valuable. It helps prevent disasters by identifying risks early enough to avoid them altogether. Risk reduction is one of any business's primary goals. Data-driven decisions reduce risk by allowing companies to identify potential problems before they occur.
- *Data Acquisition:* The foundation of effective predictive HR analytics lies in establishing a comprehensive data architecture that can seamlessly integrate diverse information sources while maintaining data quality, security, and accessibility standards. This architectural approach addresses the challenges of handling structured and unstructured data from various sources including human resource information systems, performance management platforms, learning management systems, employee surveys, and external market data.
- *Global Adaptation:* The successful deployment of predictive HR analytics models across global organizations requires sophisticated strategies that accommodate diverse cultural contexts, regulatory environments, and business practices while maintaining analytical consistency and accuracy. Workforce behavior and management practices vary significantly across cultures. Cultural adaptation strategies begin with comprehensive assessment of local workforce characteristics, management practices, and regulatory requirements that may impact analytical model performance. Training programs are adapted to local learning preferences and communication styles while maintaining consistent competency standards for analytics usage across global implementations.
- *Scalability:* Scalability mechanisms ensure that implementations can grow with local organizational needs without requiring major system changes. Capacity planning and scalability assessment identify potential system limitations and guide infrastructure improvements to support growing analytical demands. Scalability planning ensures that analytical capabilities can grow and evolve to meet expanding organizational needs

and opportunities. Organizations that plan for scalability from the beginning achieve more cost-effective implementations and better long-term sustainability compared to those that must rebuild capabilities as requirements grow. Scalability best practices include designing flexible architectures that accommodate growth without major redesign.

- *Change Management:* Change management integration ensures that analytical initiatives are effectively incorporated into broader organizational transformation efforts. Organizations that integrate analytics with comprehensive change management programs achieve higher adoption rates and better business outcomes compared to those that treat analytics as purely technical initiatives. Change management best practices include developing comprehensive communication strategies that address employee concerns and expectations.
- *Knowledge Management:* Organizations with strong knowledge management capabilities achieve better consistency and continuity in their analytical programs compared to those that lack systematic knowledge preservation approaches. Knowledge management best practices include documenting analytical models and decision-making processes comprehensively, creating training materials and user guides that facilitate knowledge transfer.
- *Performance Monitoring:* Organizations that establish comprehensive performance monitoring achieve better long-term outcomes and higher return on investment compared to those that lack systematic monitoring capabilities. Performance monitoring best practices include establishing baseline measurements and clear success metrics, implementing automated monitoring systems that track key performance indicators.

Figure 7 shows some benefits of predictive analytics [17].

CHALLENGES

- In spite of its potential benefits, implementing predictive analytics in human resources is not without challenges, such as data quality issues, the need for specialized skills, and ethical considerations related to privacy, and bias. While AI offers transformative opportunities for HRM, its success depends on responsible implementation—guided by theory, supported by transparent models, and aligned with ethical values. To overcome these challenges, organizations must focus on educating employees, transparency, and gradual implementation. Other challenges include the following [8,13,15]:
- *Cost:* The total cost of analytics implementation includes not only technology and consulting expenses but also training costs, ongoing maintenance requirements, and the opportunity cost associated with change management efforts. Cost mitigation strategies include developing a phased implementation approach that spreads costs over time, focusing initial efforts on high-value use cases that demonstrate clear return on investment, and establishing HR services approaches that spread costs across multiple organizational units.
- *Data Privacy:* Employee data must be handled with care. Implementing predictive analytics requires measures and comply with regulations such as GDPR and other data privacy laws. Employee privacy expectations, legal restrictions on data collection, data transfer limitations, and evolving regulatory requirements pose significant challenges to analytical capabilities while increasing implementation complexity.
- *Data Quality:* One of the most significant challenges is data quality. Data governance excellence forms the foundation of effective predictive analytics, requiring comprehensive policies and procedures that ensure data quality, security, and appropriate usage across the organization. Organizations with mature data governance capabilities achieve higher model accuracy, better regulatory compliance, and more effective decision-making compared to those with inadequate governance frameworks. Predictive analytics relies heavily on the accuracy and completeness of data, and HR departments often grapple with fragmented or inconsistent data sources. In many organizations, employee data is spread across different systems, making it difficult to integrate and ensure that the data is clean and reliable. Poor data quality can lead to incorrect predictions.
- *Integration:* Another challenge is the integration of predictive analytics into existing HR processes. Many HR departments still rely on traditional workforce planning methods, which are often manual and reactive. The shift to predictive analytics requires a fundamental change in how data is collected, analyzed, and applied in decision-making. This transition can be complex and resource-intensive, requiring significant investments in technology and training. The integration process may face resistance from HR professionals accustomed to traditional approaches. They may be skeptical of relying on data-driven insights over their experience and intuition.
- *Resistance to Change:* Resistance to change is another critical barrier to successfully adopting predictive analytics in HR. Employees and managers may be hesitant to trust or embrace new technologies, particularly if they perceive them as a threat to their roles or as tools that could increase surveillance. Overcoming this resistance requires clear communication about the benefits of predictive analytics and training programs that empower HR professionals to use these tools effectively. Building a culture that values data-driven decision-making is also essential for ensuring that predictive analytics can be successfully implemented and sustained. Most HR

professionals lack the analytical skills necessary to effectively utilize predictive models, interpret statistical results, or translate analytical insights into appropriate business decisions. Strategic leadership commitment represents the most critical factor in successful predictive HR analytics implementation.

- *Ethical Concerns:* Predictive analytics in HR raises important ethical considerations, particularly privacy and bias. Predictive models often rely on large amounts of personal data, including employee performance metrics, health records, and social media activity. Collecting and analyzing this data can lead to concerns about employee privacy and the potential to misuse sensitive information. Organizations must navigate these concerns carefully, ensuring their data practices comply with legal requirements and ethical standards. Organizations that prioritize ethical considerations build greater trust and acceptance among employees and stakeholders while reducing legal and reputational risks.
- *Bias:* Bias in predictive models is another significant ethical challenge. Predictive models can inadvertently perpetuate biases if they rely on biased historical data. Suppose the data used to train predictive models reflects historical biases or inequalities. In that case, the models may perpetuate or even exacerbate these issues. For example, a predictive model that identifies high-performing employees based on past data may inadvertently favor certain groups over others, leading to biased hiring, promotion, or training decisions. Organizations are leveraging diversity and inclusion metrics to identify biases and ensure fair hiring and promotion practices.
- *Organizational Culture:* In the current economic climate, organizational culture is becoming increasingly critical. Managing a successful organizational culture influences team performance, talent attraction, and retention. While some companies adopt formal or informal work cultures, most integrate a combination of both. The importance of organizational culture in understanding the effectiveness of HR processes is particularly significant. To monitor the dynamics of changes in organizational culture and their impact on employee performance, the use of machine learning models is essential for overall improvement in organizational culture.
- *Transparency:* Transparency about data collection, storage, and use is crucial for maintaining employee trust. Transparency in how HR models operate allows businesses to make

data-driven decisions without inadvertently perpetuating workplace inequalities. Employees may feel uneasy about predictive analytics if they do not understand how their data is used. Clearly communicate the purpose, benefits, and safeguards in place to foster trust.

- *Regulatory Compliance:* Regulatory compliance mechanisms ensure that predictive HR analytics implementations meet legal requirements across different jurisdictions while maintaining consistent analytical capabilities. Data privacy and compliance HR analytics relies on collecting and analyzing sensitive employee data. Regulations such as GDPR and CCPA impose strict guidelines on data handling. Organizations must ensure that employee data is collected with their consent, used only for its intended purpose, and securely stored to prevent breaches. Security and privacy protection measures are integrated to ensure compliance with regulatory requirements and organizational policies across different jurisdictions.
- *Collaboration:* Organizations with strong collaboration between HR professionals, data scientists, IT specialists, and business stakeholders achieve better analytical solutions and higher user adoption rates. Collaboration best practices include establishing cross-functional project teams with clear roles and responsibilities, creating regular communication channels between different functional groups, developing shared understanding of business requirements, and implementing collaborative governance structures that facilitate joint decision-making.

FUTURE OF PREDICTIVE ANALYTICS IN HUMAN RESOURCES

Predictive analytics in HR is a rapidly evolving field that leverages artificial intelligence and data-driven decision-making to revolutionize the way HR decisions are made. Through predictive analytics, HR departments can forecast employee turnover, identify high-potential candidates, and even anticipate future skill gaps within the organization. Looking to the future, predictive analytics in HR offers exciting opportunities for continued innovation and improvement. Emerging trends, such as artificial intelligence and machine learning, also present new opportunities for predictive analytics in HR. Integrating artificial intelligence and machine learning into predictive models will likely enhance their accuracy and reliability as technology advances. These technologies can help HR departments understand complex patterns in employee behavior and customer demand, leading to more effective

workforce planning and improved customer experiences. Predictive analytics is the future. Successful companies, such as Google, Netflix, and Cisco, have already implemented and developed HR predictive analytics tools to drive organizational growth [18].

CONCLUSION

At a time when data is considered synonymous with decision-making, predictive HR analytics could be the differentiating factor between the failure and success of an organization. Predictive analytics is an upcoming trend in human resources (HR). It is in its essence a technology that learns from existing data, and it uses this to forecast individual behavior. It involves a set of various statistical (data mining) techniques that analyze historical data and outcomes. It is an important tool for businesses seeking to make data-driven decisions and gain a competitive edge. It can be used to predict what will happen in the future.

Predictive analytics applications in human resources have gained significant attention as organizations seek to move beyond historical reporting toward forward looking insights. It is helping companies plan their workforce more effectively. Historical data helps to forecast hiring needs, skill gaps, and employee turnover, allowing organizations to prepare for future demands. Predictive analytics supports succession planning by identifying future leaders and ensuring a smooth transition when key employees depart [19]. Studies have demonstrated the effectiveness of predictive models in various HR applications including recruitment optimization, retention prediction, and performance forecasting. More information on the integration of predictive analytics into human resources is available from the books in [20-23] and the following related journals:

- Journal of Human Resource Management Perspectives
- International Journal of Research in Human Resource Management
- German Journal of Human Resource Management
- South Asian Journal of Human Resources Management

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Figure 1 Some HR professionals [1].



Figure 2 Predictive analytics [4].



Figure 3 Different components of predictive analytics [5].

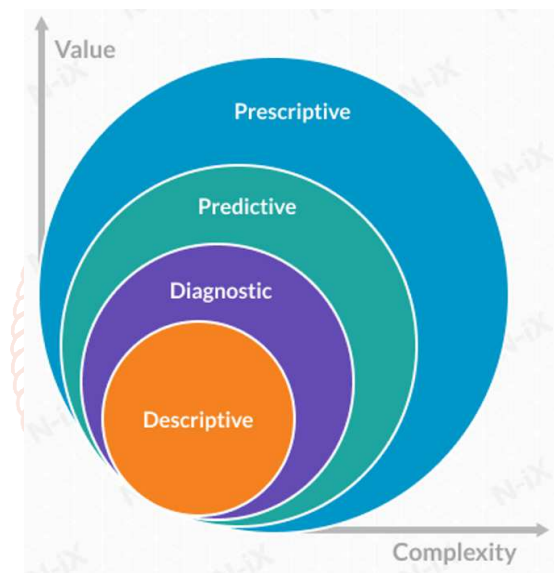


Figure 4 Types of data analytics [7].

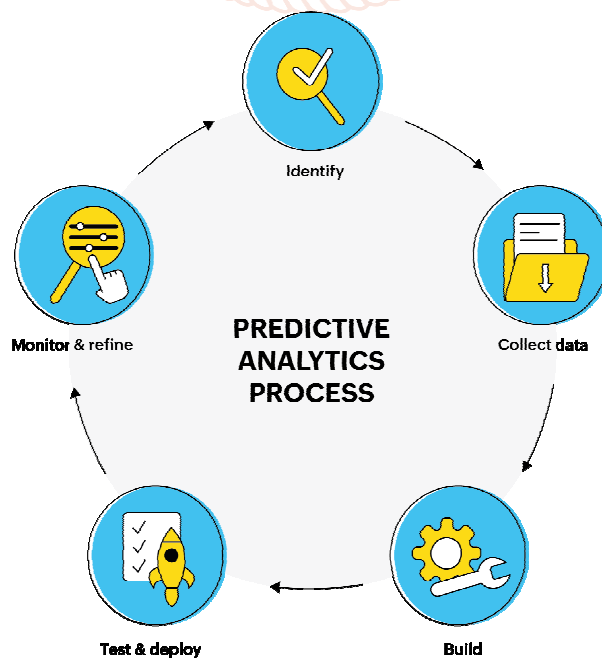


Figure 5 Predictive analytics process [9].



Figure 6 Use of predictive analytics in healthcare [14].

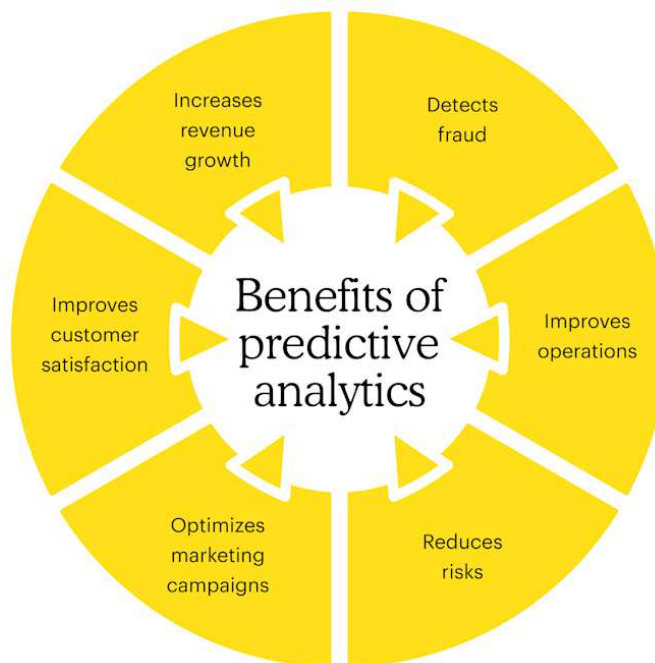


Figure 7 Some benefits of predictive analytics [17].