Opportunities and Challenges of Implementing Predictive Analytics for Competitive Advantage

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Opportunities and Challenges of Implementing Predictive Analytics for Competitive Advantage

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ABSTRACT

The past few years have seen an explosion in the business use of analytics. Corporations around the world are using analytical tools to gain a better understanding of their customer's needs and wants. Predictive analytics has become an increasingly hot topic in analytics landscape as more companies realize that predictive analytics enables them to reduce risks, make intelligent decisions, and create differentiated customer experiences. As a result, predictive analytics deployments are gaining momentum. Yet, the adoption rate is slow, and organizations are only beginning to scratch the surface in regards to the potential applications of this technology. Implemented properly, the business benefits can be substantial. However, there are strategic pitfalls to consider. The key objective of this article is to propose a conceptual model for successful implementation of predictive analytics in organizations. This article also explores the changing dimensions of analytics, highlights the importance of predictive analytics, identifies determinants of implementation success, and covers some of the potential benefits of this technology. Furthermore, this study reviews key attributes of a successful predictive analytics platform and illustrates how to overcome some of the strategic pitfalls of incorporating this technology in business. Finally, this study highlights successful implementation of analytics solutions in manufacturing and service industry.

KEYWORDS

Big Data, Business Intelligence, Cognitive Analytics, Data Mining, Descriptive Analytics, Diagnostic Analytics, Embedded Analytics, Predictive Analeptics, Prescriptive Analytics

1. INTRODUCTION

Data is growing faster than ever before from a variety of sources including social media, mobile devices, and the Internet of Things (IOT). According to Gartner Research, data volume will grow 800 percent over the next 5 years and 80 percent of that data will be unstructured (Feki et al., 2016). Several trends have contributed to this data explosion including massive growth in video and photo data, staggering usage of smart phones, 50 billion smart connected devices in the world, widespread usage of CRM, ERP, and product/service logs (Marr, 2015; Perrin, 2015). Additionally, growing numbers of companies are collecting data from their customers. This trend will continue in the future. By the year 2020, about 1.7 megabytes of new information will be created every second for every human being on the planet. By then, our accumulated universe of data will reach 44 trillion gigabytes (McAfee and Brynjolfsson, 2012).

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The majority of Big Data (unstructured data) doesn't offer a lot of value in its unprocessed state. Of course, one can pull powerful insights from this stockpile of data by applying the right set of tools and analytics. One can also see patterns and build a model of how these data work. Once you build a model, you can predict. The right use of Big Data can enable analysts to find trends and give big insights that help create value and drive operational efficiencies for the enterprise. Moreover, Big Data can bring other important benefits to organizations such as: enabling new products and services, helping to better meeting customer demands, and facilitating growth and analytics use. Insights hidden previously by data too costly to process can help in the creation of new products and in the discovery of ways to gain competitive advantages. Similarly, the ability to process every item of data in reasonable time and successfully exploiting the value in Big Data removes the troublesome need for sampling and promotes an investigative approach to data.

After years of slow adoption, Big Data and business analytics solutions have finally hit mainstream. Among all analytics tools, Predictive Analytics (PA) has become an increasingly hot topic in analytics circle as more organizations realize that predictive modeling of customer behavior and business scenarios is the big way to gain insights out of Big Data. Predictive Analytics is also considered as one of the key pillars of enabling digital transformation efforts across industries and business processed globally. Furthermore, heightened development and commercialization of analytics tools by IT vendors has also helped expand predictive analytics capabilities. As a result, there has been an increase in adoption levels.

When implemented properly, the technology can enable organizations to tap their collection of data to gain business benefits. Although the current users of predictive analytics are primarily large corporations, there are numerous additional industries and organizations where predictive analytics tools could advantageously assist decision makers.

In spite of the apparent advantages of using predictive analytics, a 2015 study by the MHI/Deloitte revealed that less than one-quarter of companies surveyed have adopted predictive analytics, though that number is expected to climb to nearly 70 percent by 2020 (DeAngelis, 2015). Therefore, it is important to explore the opportunities and challenges of implementing predictive analytics into the core business applications of businesses, and present the findings for enterprise leaders, administrators, managers, and policymakers to consider.

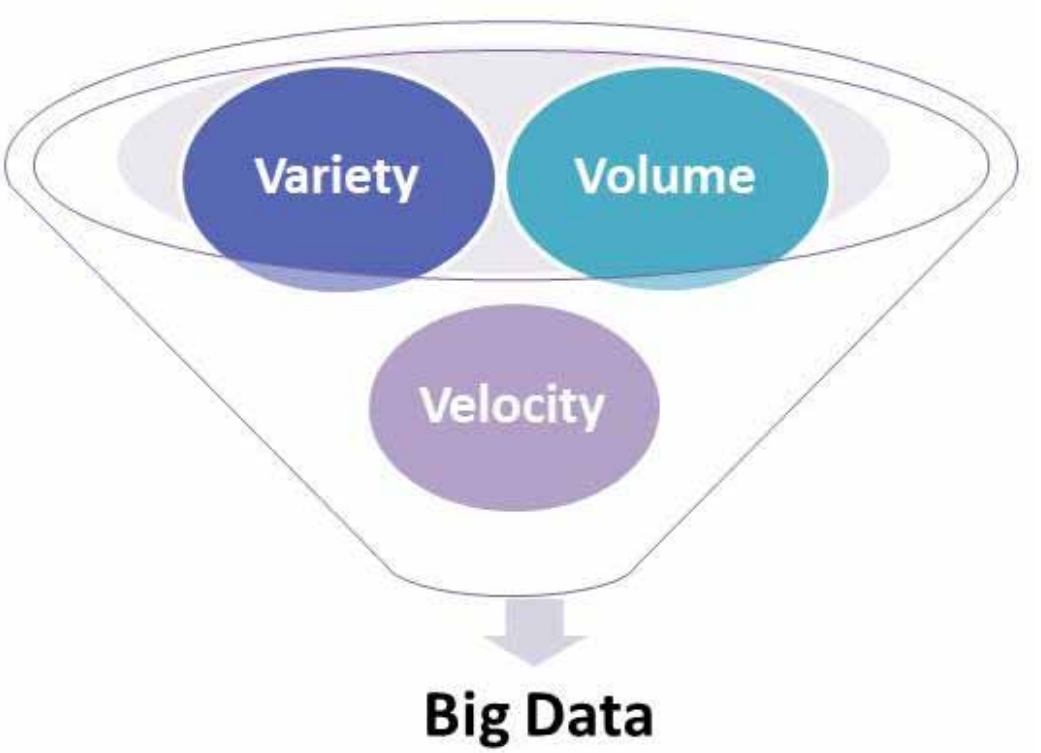
2. THE EVOLUTION OF BIG DATA AND ANALYTICS

2.1. The Rise of Big Data

The term "Big Data" was coined in mid 1990s and is defined as data that is too large, complex, and dynamic, and exceeds the processing capacity of conventional database architectures of an organization (Weiss and Indurkhya, 1998). According to Gartner, Big Data is comprised of high Volume, high Velocity, and high Variety data, which he calls 3V's. The data is too big and cannot be handled easily, it moves with excessive speed flowing in and out, making it difficult to analyze. Finally, the range and type of data sources are too great to assimilate (Figure 1). (Diebold, 2012)

The act of gathering and storing large amounts of data for eventual analysis is not new. Since 1950s, businesses were using basic analytics to uncover hidden patterns and trends, show changes over time, and confirm or challenge theories. As enterprises have amassed broader pools of data in big data platforms, it has created increased opportunities for them to mine that data for predictive insights. Typically, organizations cannot manage the data effectively with current database architectures rather they should choose an alternative way to process Big Data to gain value from it. A well-defined data management strategy is essential to successfully utilize Big Data in corporations around the world. Data and analytics are playing important roles in improving competitive advantage. (Taylor, 2012).

Figure 1. 3 V's of big data



2.2. The Rise of Business Analytics

Analytics, in the form of business intelligence, is defined as a set of technologies, processes, and tools that use data to predict likely behavior by individuals, machinery or other entities.

By using the right analytics, Big Data can deliver richer insights and uncover hidden patterns and relationships. More data could translate into more possibilities for a business only if it can discover the meaning inside of it (Minelli, et al., 2013).

Since the 1950s, decades before anyone used the term "Big Data," businesses were using basic analytics to uncover hidden patterns and trends, show changes over time, and confirm or challenge theories. The new benefits that modern data analytics brings to the table are speed and efficiency. The ability to work faster – and stay agile – gives organizations a competitive edge that they didn't have before. Over the past decade data exploded and became big, and business intelligence has been revolutionized. Widespread access to the Cloud, insightful data visualizations, interactive business dashboards, and rise of self-service analytics made the technology available and affordable for businesses of all sizes. Suddenly advanced analytics is not just for the analysts (Gaitho, 2017). Analytics is commonly used in Finance, Marketing, Human Resources, Health Care, Government Policies and every possible industry where data is generated (Analytics Vidhya Content Team, 2015).

The past few years have seen an explosion in business use of analytics. Corporations around the world are using analytical tools, including business intelligence (BI), dashboards and data mining to gain a better understanding of their present customers and to predict who will potentially become customers, and what their needs are. With the help of new analytics tools, enterprises can leverage Big Data analytics to drive a host of business objectives, from streamlined operations to improved customer relations (Henke, et al, 2016). In fact, Big Data analytics will transform virtually every

Table 1. Categories of Business Analytics

Business Analytics	Questions	Tools	Outcomes	Focus
Prescriptive (Automation)	• What should I do? • Why should I do it?	• Decision modeling • Optimization • Simulation • Expert systems	• Optimization-Best possible business decisions	• Focus on decision making and efficiency
Predictive (Foresight)	• What is likely to happen? • What will happen? • Why will it happen	• Data mining • Text/media mining • Predictive modeling • Artificial Neural Networks (ANN)	• Accurate projections of the future conditions and states	• Identify past patterns to predict the future
Diagnostic (Insight)	• Why did it happen?	• Enterprise data warehouse • Data discovery • Data mining and correlations • Drill-down/roll-up	• Accurate projections of the future conditions and states	• Identify past patterns to predict the future
Descriptive (Hindsight)	• What happened? • What is happening?	• Data modeling • Business reporting • Visualization • Dashboard • Regression	• Well defined business problems or opportunities	• Uncovering patterns that offer insight

business activity, and bring businesses benefits including enhanced customer service, optimized production levels, superior capacity planning, reduced repair and maintenance costs, and improved working capital utilization (Bughin, 2016). According to a 2016 Forester study, the top three tangible analytics benefits were identified as: increased margin, profitability, and increased gross sales (Evelson and Bennett, 2015). Several research studies have documented the advantages and widespread applications of analytics tools in corporations around the world (Evelson and Bennett, 2015; Gaitho, 2017; Lebied, 2016; Eckerson, 2016; Henke, at al., 2016; Minelli, et al., 2013).

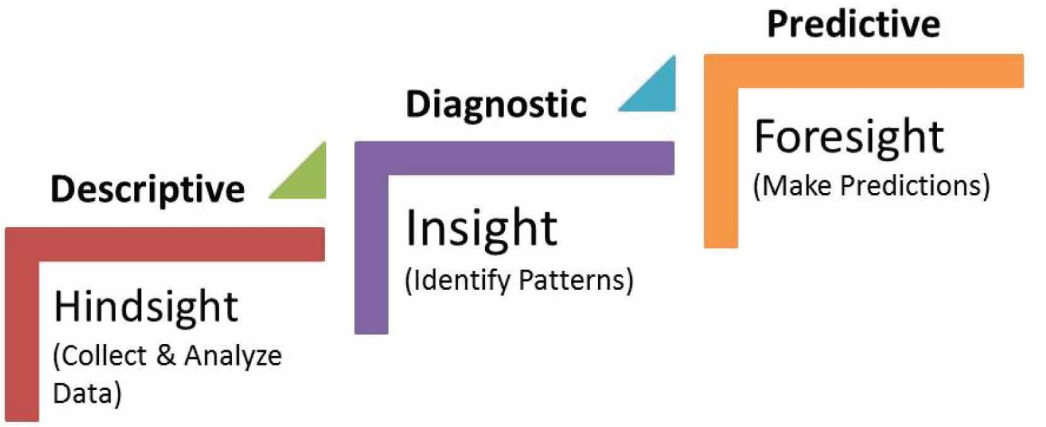
2.3. Traditional Vs Modern Analytics

In the past five years, technology has set off waves of changes in the BI landscape. Advances in data collection, computational power, machine learning, and deep learning have expanded the field of BI well beyond previous forecasts. More sophisticated algorithms are being devised by scientists (Henke et al, 2016). Moreover, the growth of cloud-based platforms has given companies elastic scalability, up-to-date security, and the tools and storage capacity to conduct advanced analytics (Attaran, 2017).

In today's business environment, analytics is increasingly strategic and is now central to most business roles. A recent study by Gartner, published in 2015, identified shift of focus from IT-led reporting to business-led self-service analytics (Gartner Report, 2015). Traditional reporting-based BI platforms are not designed to handle the exponential growth in terms of the sources, volume, and complexity of data. The traditional platforms enforce strict data and report governance, only allowing access by specialized reporting groups. In contrast, the modern approach views data governance as an important step in creating self-service analytics. Traditional BI platforms are being augmented with more agile solutions. Where traditional systems could take months to implement, the modern approach takes as little as a few hours. Latency is no longer tolerated. The advances in the Internet have resulted in greater expectations and less patience.

Modern BI platforms support organizational needs for greater accessibility, agility, and analytical insight from a diverse range of data sources. Every business process is an analytics process, and every business user is an analytics user. To meet the time-to-insight demands of today's competitive business

Figure 2. Moving up the Analytics Value Chain



environment, many organizations changed the traditional BI model and end-user requirements. The modern BI platform aims to democratize analytics with self-service capabilities. It is characterized by agility, flexibility, and ease of use (Gartner Report, 2015).

2.4. Categories of Analytics

Analytics is constantly evolving and has changed dramatically over the years and is advancing rapidly today. There are four categories of analytics: descriptive, diagnostics, predictive, and prescriptive (Table 1). These categories build on each other and enable enterprises to make faster and smarter decisions. As organizations evolve, they move from focusing on historical "what" and "why" questions to a more forward-looking predictive, and prescriptive predictions. The advanced analytics maturity path is shown on Figure 2 (Intel, 2017). Descriptive analytics is the simplest class of analytics. It allows you to condense big data into smaller, more useful nuggets of information. The purpose of descriptive analytics is to summarize what happened in the past and uncover patterns that offer insights. It uses data modeling, reporting, visualization, and regression to collect and store data in an efficient way, to create reports and presentation information, and to find trends in the data. Since data is scattered in large numbers of disparate data sources, analyzing all relevant data can be a challenge for most organizations. Most descriptive analytics are exact (number of likes, number of clicks, etc.) because they are defined by a single, deterministic model which does not allow contradicting results. It is estimated that more than 80% of business analytics, most notably social analytics are descriptive.

Diagnostic analytics is the next step up in data reduction and it is used for discovery. It examines data or content to answer the question "Why did it happen." Diagnostic analytics takes a deeper look at data to attempt to understand the root causes of events and behaviors in an organization. To optimize diagnostic analytics, it needs to be extended to operational employees of the organization. The result of the diagnostic analytics is often an analytic dashboard that is used for discovery or to determine why something happened.

Predictive analytics analyze current and historical data to provide insights into what will happen and why will it happen in the future with an acceptable level of reliability. It attempts to accurately project the future conditions and states. It does not predict one possible future, but rather multiple futures based on the decision-maker's actions. It utilizes a variety of statistical, modeling, data mining, text, media mining, forecasting, and predictive modeling to identify probabilities of potential outcomes and/or likely results of specific operations. Predictive analytics can only forecast what might happen in the future, because all predictive analytics are probabilistic in nature. Predictive analytics can help businesses with a wide range of problems. Businesses are using Predictive Analytics to analyze

historical data and facts in order to better understand clients' needs, market potentials, products, suppliers, and partners and to identify potential risks and opportunities for a company (Lebied, 2016). Other businesses use this type of analytics for predicting which customers are most valuable, scheduling preventive maintenance, and detecting fraud. Airlines use these analytics to decide how many tickets to sell at what discounted price for a flight. Similarly, hotels use it to predict the number of guests they can expect to book on any given night to maximize revenue.

The emerging technology of prescriptive analytics goes beyond descriptive and predictive models and shows the likely outcome of each decision. It goes a step further in the future and attempts to answers what should be done and why. It employs data techniques such as decision modeling, graph analysis, simulation, neural networks, heuristics, and machine learning to suggest actions that the organization could take to achieve the desired outcome. Prescriptive analysis tries to evaluate the effect of future decisions in order to adjust the decisions before they are actually made. Future outcomes are taken into consideration in the prediction. Prescriptive analytics are commonly used in organizations to optimize scheduling, production, inventory and supply chain design, and other organizational activities to deliver what the customers want, and meet and exceed customers' expectations. Prescriptive analytics is the most valuable kind of analytics and usually results in rules and recommendations for next steps. However, it is largely not used. A 2012 survey by Gartner shows most large retailers still focus on measurement of the past, with only 13 percent of them making extensive use of predictive analytics. Less than 3 percent of large retailers are using prescriptive analytics tools such as decision/mathematical modeling, simulation and optimization (Hetu, 2015). Another study shows that by 2020, 40 percent of new investment in analytics tools will be in predictive and prescriptive analytics (Intel, 2017).

3. THE EVOLUTION OF PREDICTIVE ANALYTICS

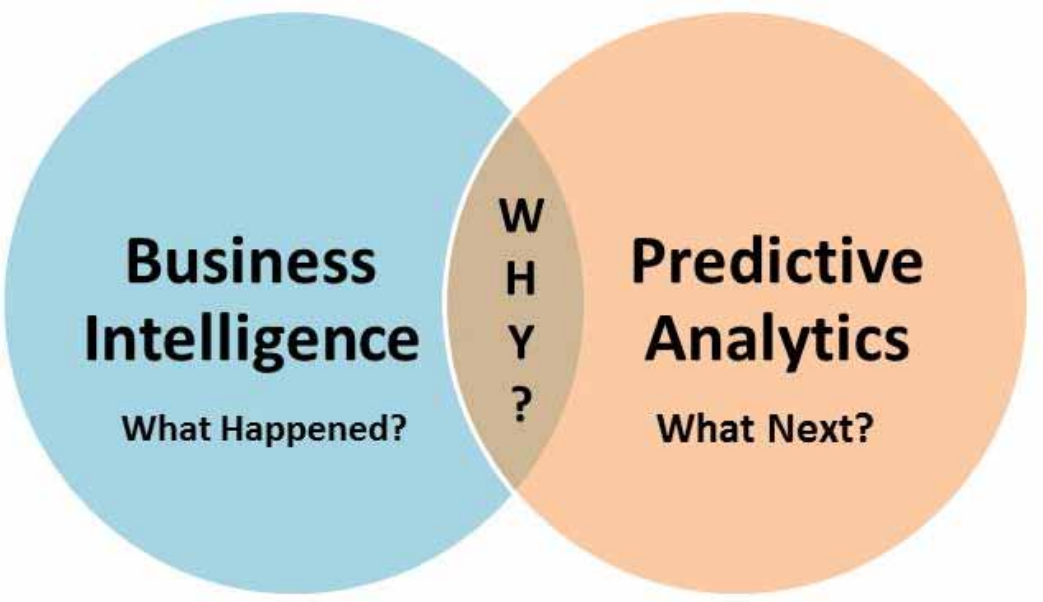
Predictive Analytics is an extension of Data Mining technology. Both are based on a huge amount of mathematical theory dating back to several decades. Data mining technology helps to examine large amounts of data. One can sift through all the chaotic and repetitive noise in data to discover patterns and use that information to assess likely outcomes, and then make informed decisions. Data Mining refers only to past data and uncovers relationships between measurable variables. Despite being around for such a long time, Data Mining has not yet reached the business mainstream.

3.1. Business Intelligence Vs Predictive Analytics

Traditional BI is a set of technologies, applications, infrastructure, and best practices that aggregate data from multiple sources, prepare that data for analysis, and then provide reporting and analysis on that data to optimize decisions and performance. These systems are specifically developed to operate by organizations' analyst and optimized for supporting managerial decisions that require aggregated views of information from across a department, unit, or entire organization.

Predictive analytics is the natural evolution of BI processes, tools and technologies to forecast future activities, behavior and trends. While BI focuses on historical analysis, analytics builds upon this set of technologies and techniques to re-focus on the future. Traditional BI platforms focus on data preparation and integration and provide analysis via scripting, reports, interactive visualizations, and static dashboards. An important shortcoming of traditional BI is its latency in receiving reports. By the time the decision maker received the reports, it typically was too late to undertake any action. Embedded analytics facilitate in dealing and addressing that latency by shifting from reactive analytics to proactive analytics. Embedded analytics inserts intelligence or a set of tightly integrated capabilities inside the everyday systems or applications such as (CRM, ERP, marketing or financial systems) that employees or customers use to improve the analytics experience. This makes users more productive by combining insight and action in the same application. There is no need for users to switch between multiple applications to derive insights and take action. Figure 3 shows the relationship between traditional BI and predictive analytics.

Figure 3. Traditional BI Vs Predictive Analytics



3.2. Predictive Analytics Process

Predictive Analytics allows organizations to become forward looking, anticipating and deciding based upon the data not on assumptions. The following processes summarize steps taken to implement Predictive Analytics (Figure 4.):

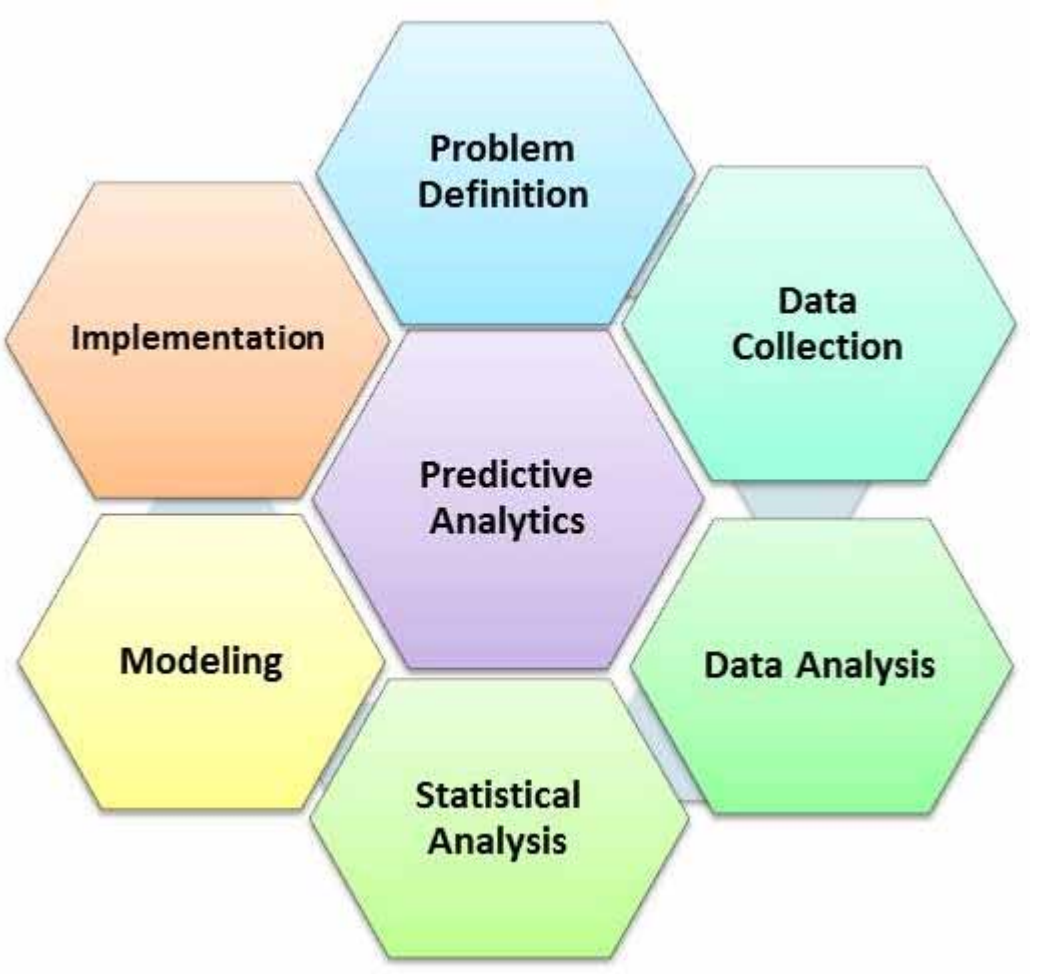
1. **Problem Definition:** Define the project outcomes and business objectives. Identify the data sets which are going to be used;
2. **Data Collection:** Collect data (structured or unstructured data) from multiple sources for analysis;
3. **Data Analysis:** Analyze data using different processes including inspecting, cleaning, modeling, and transforming data. The objective is to discover useful information;
4. **Statistical Analysis:** Use standard statistical models to validate and test the hypotheses and the assumptions;
5. **Modeling:** Use predictive modeling to create accurate predictive models or the best solutions about future;
6. **Implement Actions:** Deploy the analytical results in every day decision making process. Monitor and review the model performance to ensure the it provides the expected results.

3.3. Predictive Modeling Process

Predictive Analytics uses a number of modeling methods including statistics, artificial intelligence, and machine learning. The model is chosen on the basis of testing, validation, and evaluation of an outcome. Each model has its strength and weakness and is best suited for specific types of problems. Predictive modeling is the process of running one or more algorithms on the historical data where prediction is going to be carried out. The process involves training the model and using multiple models on the same data set and arriving on the best fit model.

Predictive Analytics utilizes three categories of modeling (Figure 5):

Figure 4. Predictive Analytics Process



- **Predictive Models:** The models in this category analyze the past performance to predict the future;
- **Descriptive Models:** The models in this category quantify the relationships in data. These models are used to classify data sets into groups;
- **Decision Models:** The models in this category describe the relationship between all the variables of a decision in order to predict the results.

Algorithms perform statistical analysis and data mining and determine trends and patterns in historical structured and unstructured data. Most of the predictive analytics solutions have built-in algorithms such as time series, decision trees, regression, neural networks, and clustering. Table 2 summarizes these algorithms.

3.4. The Rise of Predictive Analytics

The concept of building predictive analytics algorithms to boost business's bottom line is not new. It has been around as long as there has been BI software. Figure 6 shows analytical platform evolution where we have been, where we are and where we need to go in terms of our analytics capability. The transition in major companies is evident. From Business Reporting using KPI Metrics to Business

Figure 5. Predictive Analytics Modeling

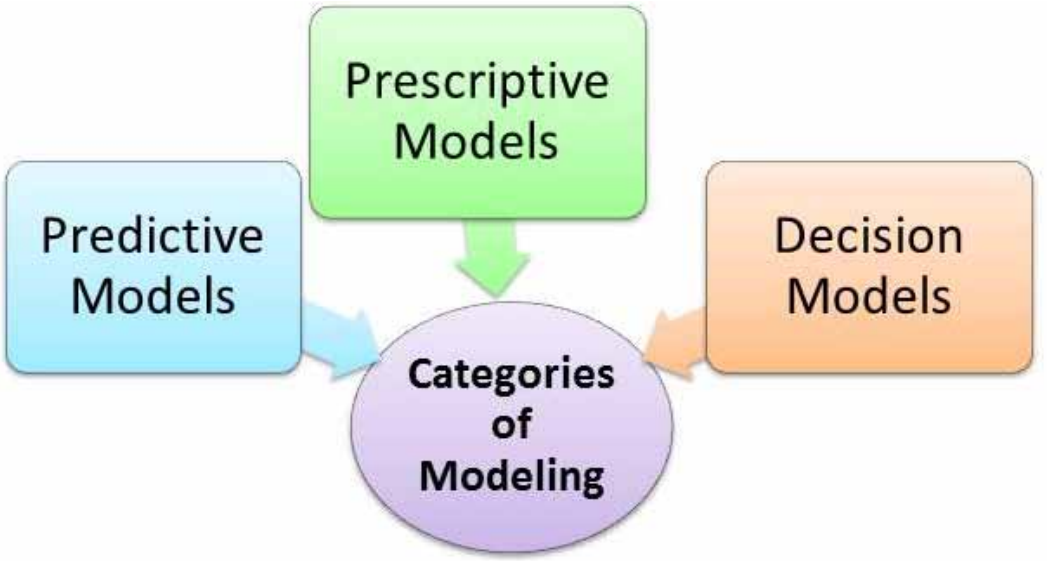


Table 2. Predictive Modeling Algorithms

PA Core Techniques	Methodologies Used
Predictive Modeling	• Statistical techniques for analysis and pattern detection • linear and logistic regression • Linear and nonlinear mathematical programming algorithms • Constrained optimization • Neural Networks • Bayesian and Monte Carlo Statistics • Matrix operations • Constrained optimization
Decision Analysis and Optimization	• Decision trees • Time-series analysis • Proprietary mathematical modeling & optimization technology • Data analysis • Cluster analysis • Association rules
Transaction Profiling	• Neural network models • Computational linguistics • Matrix and graph algorithms • Unsupervised clustering • Data mining
Predictive Search (supervised learning)	• Machine learning • Language processing • Text analytics • Primary components analysis • Scripting and development tools • Market basket analysis

Intelligence and Data Visualization and Dashboards to Descriptive Analytics and finally to Predictive Analytics. As we move, from Reporting to Predictive Analytics, the quality and value of analytics improves. Static reporting of 1980s was extremely inefficient and impractical at helping determine and guide decision-making Static reports of 1980s have evolved to the simplest class of analytics "descriptive analytics" of 1990s. Descriptive analytics provided clarity as to where an organization stands related to defined business measures. This leap forward came as a result of an explosion in the quantity of data and advances in the computer technology. At the next stage, there was a growing trend among businesses to use predictive analytics algorithms to boost their bottom line. Extracting information from data in order to classify data and predict data patterns based on statistical modeling became popular. Moreover, what has changed by the 2000s is the report tool that software vendors included into their commercial software packages. Static reports of 1980s have evolved to interactive reports and dashboards in the 2000s and self-service and blended analytics today. Furthermore, relational databases were predominant data source of 1990s. In the 2000s, BI tools could access a much broader range of data than traditional data sources. Today, many BI tools support Big Data sources; Cloud applications and Cloud file systems, server logs, event streams, and search indexes. Today, the best analytics are characterized by being repeatable, shareable, scalable, and transferrable. Figure 6 summarizes the evolution of analytics over the decades (Eckerson, 2016).

Technology companies, software companies, financial services, manufacturing, and retails are among the highest users of the embedded analytics. The adoption of embedded analytics continues to grow and exceed that of standard data recovery. A 2017 survey of 500 executives and managers found that 93 percent of respondents are currently embedding analytics in their applications. Companies now go beyond simply adding open-source charts or static visualizations. They are willing to spend the time and resources to embed sophisticated analytics to impress end users. Investment in embedded analytics continues to grow. Ninety percent of respondents plan to invest in embedded analytics going forward. Additionally, 60 percent of end users leverage embedded analytics on a regular basis, and 98 percent said embedded analytics contributed to revenue growth. Respondents also reported that embedded analytics plays a critical role in improving customer satisfaction and user experience. Executives and managers are paying more attention as their competitors use embedded analytics to win and retain customers (Butler, 2017).

3.5. Forces Driving Predictive Analytics Adoption

Today, enterprise around the world store large volumes of diverse data from many sources. The insights hidden within this Big Data hold tremendous business value. The highest value is achieved through predictive analytics which apply advanced analytical techniques to predict future events and drive decisions or actions. A recent IBM-sponsored study by Ventana Research has revealed that Predictive Analytics has emerged as the highest priority from the response of all participants regarding the top capabilities of Big Data Analytics (Ventana Research, 2015).

Today, business leaders are looking for analytics solutions that are flexible, saleable, and easy-to-implement. Business analysts, power users, and customers alike should be able to apply the analytics tools for their specific analytics needs. There are a variety of market forces driving predictive analytics including the advent of Big Data, an increase in computing power, a better understanding of the value of the technology, and the rise of certain economic forces (Figure 7). The increasing volume and availability of data, advances in data collections, computational power and storage capacity, advances in analytical techniques and technologies are all leading to formation of new business models and reshaping industry competition. Companies are looking to use the technology to predict trends and understand behavior for better business performance. Predictive analytics utilizes data mining, business intelligence tools, and statistics and modeling techniques to make predictions. Additionally, the emergence of enormous amount of structured and unstructured data and ground-breaking technology deployments are the major drivers for the predictive analytics market. Furthermore, the heightened level of competition is forcing enterprises to adjust their operations to compete in a global market.

Figure 6. The Rise of Predictive Analytics

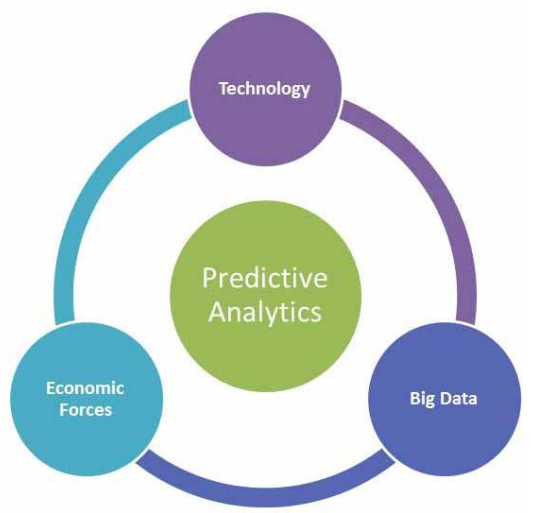
Customers are looking for visual analytics that requires no training nor technical expertise. These visual analytics must also be available from a variety of data sources. Internal employees desire a solution that allows them to push data in, and return easy-to-read analytics, allowing them to quickly produce results and solve problems.

3.6. Benefits of Predictive Analytics

Traditional analytics require significant development time and are accessible only within an analytics silo that must be accessed separately. Traditional BI tools quantify and compare historical data to uncover what has happened in the past. On the other hand, predictive analytics uses that same information to enable quick and accurate forecasting. Many of the benefits offered by predictive analytics are specific to business applications where analytics is seamlessly integrated. However, organizations of all sizes are using Predictive Analytics to support business core functions such as marketing, merchandising, sales, and risk management. According to several recent studies, organizations that incorporate predictive analytics tools into their business strategies can realize significant benefits including (Siegel, 2016; Stedman, 2017; Angelis, 2015; Kalakota, 2014):

- Optimize productivity and cost efficiency;
- More rapid identification of emerging opportunities;
- Higher levels of profitability;
- Greater customer loyalty and retention;
- Faster detection and corrections of problems;
- Reduce risk, eliminate waste, and accelerate time to improvement;
- Determine true process capacity;
- Reduce process cycle time;
- Optimize resources especially staffing levels and schedules;
- Improve equipment maintenance and reliability;
- Real-time insights of equipment health and performance;
- Improve availability, reliability and decision-making;

Figure 7. Forces Driving Predictive Analytics



- Better insight into both large and small communities of interest;
- Identify market gaps, turning them into revenue;
- Achieve better accuracy in sales forecasts;
- Increase asset utilization and the ability to identify underperforming assets;
- Proactively identify and target customers at risk of churning well before the loss;
- More targeted and effective promotions and campaigns, increase usage of value-added services;
- Create forecasts for assortment planning, shelf replenishment, pricing and promotion analysis, and sales and purchasing planning;
- Select specific promotional channels for your products and services;
- Dynamically price what you're selling (football tickets, low-cost airline seats, etc.);
- Detect false claims or applications.

Predictive analytics solutions transform raw data into easy-to-understand and actionable insights. It helps plant personnel take advantage of the massive amounts of data and use it to make real-time decisions that have a significantly positive impact on equipment maintenance and reliability. Early warning detection and diagnosis of equipment problems help employees work more effectively-plan necessary maintenance and avoid potential equipment failure. Predictive analytics solutions can identify problems days, weeks or months before they occur, creating time for personnel to be proactive. Organizations can leverage predictive asset analytics solutions to spend less time looking for potential issues and more time taking actions to get the most out of every asset. Several recent studies have documented the key benefits of incorporating predictive analytics into organization's business intelligence strategies. A recent empirical study of 205 Indian manufacturing organizations found that Predictive Analytics had significant impact on social performance and environmental performance (Dube et al, 2017). Another IBM-sponsored study by Ventana Research found that 68 percent of organizations that have implemented predictive analytics have gained a competitive advantage from it (Rajpurohit, 2014). The study identified other significant advantages including finding new revenue opportunities, increased profitability and customer service, and gained operational efficiencies (Figure 8).

Figure 8. Reported Benefits of Predictive Analytics

4. EFFECTIVE DEPLOYMENT AND USE OF PREDICTIVE ANALYTICS

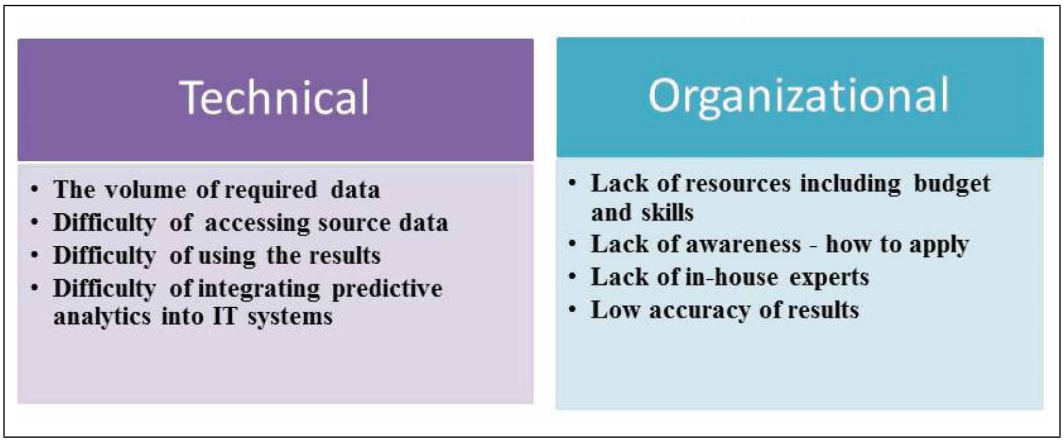
4.1. Challenges of Implementing PA

Predictive Analytics faces numerous implementation challenges. A Predictive Analytics Benchmark Research conducted by Ventana Research on behalf of IBM identified several challenges organizations have encountered in their use of predictive analytics. The study also identified the largest business barrier to the effective deployment and use of predictive analytics.

These challenges fall in two categories of technical and organizational challenges as highlighted in Table 3 and summarized below (Ventana Research, 2013):

1. Difficulty of integrating predictive analytics into organization's information architecture;
2. Difficulty of accessing source data;
3. Difficulty of using the results;
4. Lack of resources including budget and skills;
5. Lack of awareness - an understanding of how to apply predictive analytics to business problems;
6. Lack of in-house experts to implement the results;
7. Focusing on past pattern;
8. The data is too expensive to measure;
9. Low accuracy of results.

Table 3. Implementation challenges



4.2. Strategic Pitfalls

Organizations should not approach predictive analytics like they do other IT projects. When predictive analytics is implemented properly, the business benefits can be substantial. But there are some mainly strategic pitfalls to watch out for:

1. **Plan ahead:** Companies looking to take advantage of PA tools should think strategically about implementation upfront. Companies need to start with a comprehensive assessment of analytics needs, and internal resources and skills;
2. **Make data accessible for analysis:** As with other types of business intelligence and business analytics initiatives, predictive analytics applications must incorporate effective data management strategies in order to integrate, unify and standardize data coming from different source systems. Without an effective data management strategy, analytics efforts are wasted;
3. **Do not Use inexperienced workers:** Implementation of predictive analytics requires knowledge of statistics, regression, and other analytics tools and techniques that might not be found inside the organization. Hire a competent team composed of data analysts, business analysts, statisticians, and data engineers;
4. **Define the Role of Data Scientists:** Organizations often give data scientists too much responsibility and put too much emphasis on the role of data scientists. Most data scientists do not understand business practices. Business managers should be the ones in charge of identifying the kind of behaviors and trends the organization should predict;
5. **Focus on one business initiative at the time:** Limit the number of metrics you track and focus on one business initiative at a time. One needs to be tightly focused. Tracking too many indicators and tracing several business initiatives can become a distraction because the human brain simply can't make sense of continually increasing pieces of information at one time.

4.3. Predictive Analytics Deployments

Adoption of predictive analytics, when done correctly, leads to organizations being able to justify their analytics expenditures and create value tied directly to data visibility. Opportunities for deploying predictive analytics capabilities continue to evolve and grow with the broader adoption of technologies. Implementing a successful predictive analytics program takes time and effort. Many parts of the company will be affected, there are complex decisions to be made, and various stakeholders must be involved. It requires engagements and support from business users across the data analytics landscape.

Some companies have not been successful with deployment of predictive analytics process due to the failure of developing an analytics strategy rooted in the delivery of IT services linked to their business outcomes. Furthermore, many enterprises do not know how to initiate their analytics projects. A range of recently published research literature on the implementation of business intelligence and predictive analytics is reviewed to explore their current state, issues and challenges learned from their practice.

(McNeill, 2014; Asllani, 2015; Loshin, 2017; Loshin, 2017). It is argued that before deploying analytics process in a company, one must first determine where analytics will add business values. Then a scalable deployment approach must be planned. We have modified steps suggested by these researches and added more to create a practical implementation steps for successful deployment of predictive analytics process:

1. **Top management involvement:** Obtaining the support and backing of the top management is crucial in providing the necessary funding and ensuring that the organization supports the predictive analytics process. To manage Big Data and analytics in today's information economy, progressive organizations have created two new senior executive positions: the Chief Data Officers (CDO) and the Chief Analytics Officers (CAO). The CDO focuses on data strategies for the organization, whereas the CAO finds ways to optimize the use of analytics throughout the organization. These senior executives need to be provided with what they need, both in terms of technology and data;
2. **Proper planning and scoping:** It is necessary to understand the organization's key business objectives and concentrate on building analytics models that can have the maximum impact in meeting those objectives;
3. **Create a compelling business case:** A business case needs to be created and communicated clearly wherever appropriate across the organization. A business case presents the reasoning for initiating Predictive Analytics process. A compelling business case communicates the nature of the proposed project and the arguments, both quantified and unquantifiable, for its deployment;
4. **Identify business processes that can be improved:** Predictive Analytics tools will help organizations identify business processes that can be improved. It is necessary to get managers and workers on board with putting those findings into action;
5. **Define measurable business benefits:** Predictive Analytics not only influence changes in business processes, but also can have a measurable impact on business performance. One must create metrics that can be used to quantify the business value of employing the analytics models;
6. **Use experienced workers:** Hire a competent team composed of data analysts, business analysts, data scientists, and statisticians;
7. **Match application needs with analytics tools:** Look for predictive analytics tools that provide capabilities matching application needs. There are plenty of tools to choose from either from open source or from commercial markets. Among important factors to consider when choosing predictive analytics tools are: the ability to handle structured, semi-structured, and unstructured data, compatibility with a variety of Big Data platforms, and integration with data visualization tools;
8. **Maintain a solid data governance program:** We are living in a world of constantly changing data. Internal and external data sets are continuously being captured and integrated. Make sure to institute solid data governance practices to guarantee that the quality and consistency of the date sets in your analytics systems remain at an acceptable level;
9. **Give analysts access to relevant and trustworthy data:** Collect and store the inventory of relevant technical and business data sets and make sure predictive analytics applications have access to the right data;
10. **Move on to the next analytics model when fail:** If your analytics model did not deliver useful information to the business, move on to the next model.

4.4. Analytics Solutions Available to Organizations

Finding a right Predictive Analytics solution for your organization can be challenging. There is no one-size-fits-all option and no plug-and-play. There is a wealth of new tools that leverage analytics for specific purposes and independent standards are developing rapidly by vendors. Several companies are providing Predictive Analytics solutions including SAP AG, Tableau Software, SAS Institute Inc., International Business Machines Corporation (IBM), and TIBCO Software Inc., among others. Table 4 has the summary of these services.

5. ANALYTICS IN PRACTICE- BUSINESS APPLICATIONS OF ANALYTICS

Businesses are using predictive analytics to analyze historical data and facts in order to better understand clients' needs, market potentials, products, suppliers, and partners. Predictive analytics is also utilized to identify potential risks and opportunities for a company (Lebied, 2016).

Most often Data Analytics is associated with corporate decision-making. However, analytics has applications well beyond the for-profit world of business. From banking to manufacturing, from retail to healthcare, data analytics is used to make breakthrough discoveries, to deliver better services, and enrich the customer experience. Corporations around the world are using analytics to gain various business benefits, including new revenue opportunities, improved operational efficiency, better customer service, more effective marketing, and competitive advantages over rivals. According to a recent study by Business Application Research Center (BARC), organizations that used Data Analytics reported an 8 percent increase in revenues as well as a 10 percent reduction in costs. Other benefits reported are better strategic decisions, better understanding of customers, and improved control of operation processes (Lebied, 2017).

5.1. Business Applications of Predictive Analytics

The market for Big Data analytics directly parallels the growth of Big Data. According to research firm IDC, worldwide revenue for Big Data analytics was $130 billion in 2016. That number is expected to reach $150.8 billion in 2017 and grow to more than $210 billion by 2020 representing a 56 percent increase in just four years. The industries driving much of this growth in 2017 are banking, discrete manufacturing, process manufacturing, federal/central government, and professional services. Together, these five industries will spend $72.4 billion on Big Data and business analytics solutions this year. They will also remain the top five industries in 2020 when their total investment will be $101.5 billion (IDC, 2017).

Predictive analytics is becoming a mainstream application as organizations increasingly look to forecast customer behavior, market trends, effective medical treatments and more. The business value gained from predictive analytics efforts can add up to significant amounts. Knowledge of what a particular customer is likely to buy next, which piece of manufacturing equipment might break down, etc. can pay dividends now.

Predictive Analytics is used to predict: stock prices, risk, delinquencies, accidents, health problems, hospital admissions, malfunctions, oil flow, electricity outages, sales, donations, clicks, cancellations, fraud, tax evasion, crime, approvals for government benefits, thoughts, intention, answers, opinions, lies, grades, dropouts, friendship, romance, pregnancy, divorce, jobs, quitting, wins, votes, and more (Siegel, 2016).

Tables 5 and 6 highlights applications of analytics in different industries. The following summarizes the application of Predictive Analytics:

- **Healthcare:** The health care industry has used analytics to analyze large amounts of information quickly in order to provide lifesaving diagnoses or treatment options in a timely manner. Walgreens is using data analytics to make its pharmacy operations as customer-focused as possible and

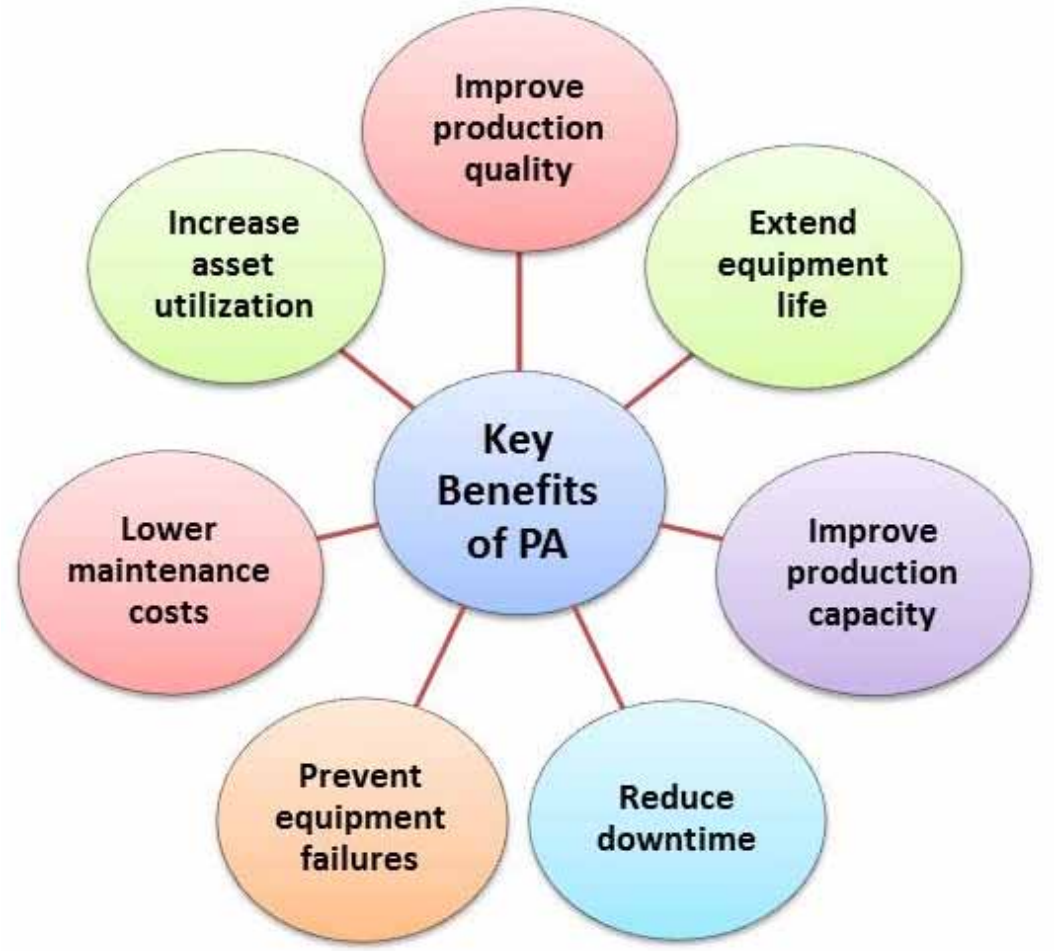
Table 4. Predictive Analytics Solutions Available to Organizations

Service Providers	Markets Served	Services Provided
Tableau Software	**Tableau** • Colleges and Universities • Manufacturing Analytics • Financial Services and Insurance	• Student performance management • Enrollment movement • Donor Relations and Federal Funding • Improve process efficiency, centralize production monitoring • Improve service, capture new opportunities, and stand out from the competition
Detica	• Insurance and healthcare solutions • Banking market	• Credit scoring • Fraud solutions • Collections and recovery solutions
Fair Issac Corporation (FICO)	**FICO® Score** • Banking and financial • Insurance and healthcare solutions	• Credit scoring • Fraud solutions • Collections and recovery solutions
ViPS	• Insurance and healthcare solutions	• Sarah Lawrence College
KXEN	**InfiniteInsight™** • Customer lifecycle	• Help companies to optimize every step in customer acquisition, cross-sell, up-sell, retention and next best activity
IBM	**IBM Business Analytics** • Fraud solutions • Healthcare market • Commercial, government and academic customers	• Delivers information that decision-makers trust to improve business performance • Provides clear, immediate and actionable insights into current performance and the ability to predict future outcomes.
SAS Institute Inc.	**Visual Analytics** • Fraud solutions • Insurance & healthcare solutions • property & casualty • workers' compensation	• Interactively visualize, explore and communicate data discoveries • Transform structured and unstructured data into fact-based insights for better decisions • Monitor results and facilitate continuous refinement of your analytic models
Microsoft Corporation	Visual Analytics	• Sinclair Community College • University of Oregon
TIBCO Software	College Scheduler	• University of Arizona • Arizona State University
SAP AG	• Customer lifecycle • Campaigns and promotions optimization • Sales and purchasing planning	• Customer acquisition, cross-sell, up-sell, retention and next best activity • More targeted and effective promotions and campaigns • Creating forecasts for pricing and promotion analysis, store clustering, store location selection, and sales and purchasing planning. • Identifying market gaps, turning them into revenue.

to personalize interactions with customers and anticipate their needs. The company is using predictive analytics as part of patient assessments at its in-store health clinics. The analytics process is aimed at improving patient care and identifying potential health risks before they become issues (Stedman, 2017);

- **Airline Industries:** The airline industries across the world are using analytics to predict flight delays, effectively drive customer loyalty programs, and decide how many tickets to sell at each price for a flight. Southwest and Alaska Airlines are among the top users of embraced analytics to bring changes in their way of working;

Figure 9. Key Benefits of Predictive Analytics in Manufacturing



- **Banking, Financial and Insurance:** The banking and financial industries are using analytics in order to analyze the probabilities of risk and default. Moreover, analytics helps them to push their banking products based on customer's purchasing power. The financial market uses analytics in high frequency trading sentiment measurement, and pre-trade-decision-support analytics. PayPal is using predictive data analysis to help protect its users from fraud and stop fraudulent transactions before they are processed (Burns, 2016). The Security Exchange Commission (SEC) is using data analytics to monitor financial market activities and to catch illegal market activities. Insurance companies use analytics to enhance fraud detection and to provide faster service in the area of claims management. Life insurance companies are using it to predict the likelihood an elderly insurance policy holder will die within a few years in order to trigger end-of-life counseling. Credit scoring is another well-known application for predictive analytics. Financial companies use a range of information to assess the likelihood of future credit payments being made;
- **Government:** The government is using pattern recognition in images and videos for enhanced security and threat detection (Analytics Vidhya, 2015; Siegel, 2016). Other applications of analytics in government sector include: traffic control, route planning, intelligent transport systems, and congestion management (Gaitho, 2017). The Social Security Administration (SSA)

is using analytics to study social disability claims for detection of suspicious or fraudulent claims. Moreover, analytics enables the SSA to process medical information rapidly and effectively for faster decision making;

- **Manufacturing:** Analytics tools have been used in solving manufacturing challenges including demand forecasting, integrated business planning, supply collaboration and risk analysis, and in inventory management. Supply chain professionals have used Predictive analytics to improve supply chain efficiencies. Predictive analytics can help manufacturers to satisfy the increasing demands of consumers who expect products delivered exactly when promised. Supply chain professionals need a complete view of their supply chain as it exists now, but also being able to know where their supply chain needs to be. By applying predictive analytics tools to identify patterns and predict future events, manufacturers gain the ability to make better decisions that anticipate what their customers are asking for now, and will be asking for in the future. Data analytics is also used in self-driving cars and robots (DeAngelis, 2015). Figure 9 shows key benefits of Predictive Analytics in manufacturing;
- **Retail:** Predictive analytics is also being used for contextual marketing and retailing. The retail industry takes advantage of data analytics for fraud reduction, timely analysis of inventory, and for optimizing staff using data from shopping patterns and local events, etc. Moreover, the industry is also using data analytics to determine customer responses or purchases and set up for up selling and cross selling opportunities. (Gaitho, 2017). For example, Target uses predictive analytics to predict which customers had the most probability of rapidly becoming pregnant from shopping behavior (Salleh, 2013). The information is then used to contact prospects with offers related to the needs of a newborn's parents. Tesco is a large grocery store operating in 13 countries with headquarters in UK. The company uses predictive analytics to increase redemption rates of 100 million personalized coupons issued annually at its grocery cash registers across 13 countries;
- **Logistics:** Logistic companies (UPS, DHL, and FedEx) have used analytics to reduce costs and improve their operational efficiency (Rosenbush and Stevens, 2015). Predictive analytics ensures ships stay on shipshape for cargo companies. For example, RightShip, a Melbourne-based cargo company, is using predictive analytics to more accurately assess if ships are ready to be sent out to the sea (DeAngelis, 2015);
- **Social Networks:** Active usage of social networks for meeting new people is staggering. Social sites like Match.com, e-Harmony, OkCupid, Tinder, and Badoo use some very sophisticated predictive analytics to model and predict human attraction. They offer an interactive way for singles to meet other singles with whom they might otherwise never cross paths (Kalakota, 2014). Facebook uses analytics to improve the precision of suggested people you may know and wish to link to (Siegel, 2016);
- **Sports:** Competitive sports is a heavy user of predictive analytics. The application of analytics to a wide variety of sports is now standard practice. When signing players, selection committee analyzes hundreds of detailed statistics from every player and every game, attempting to predict future performance and production. Some statistics are even obtained from game footage by using video recognition techniques;
- **Human Resources:** HR Analytics was the initial term used to describe the effectiveness of HR programs. However, recently the other terms came into use specially, people analytics, talent analytics, and workforce analytics. People analytics has largely become the dominant term. People analytics applies math, statistics and predictive modeling to HR related data to predict patterns and make better decisions about all aspects of HR strategy with the objectives of improving organization performance. People analytics is being used to help more companies in their recruiting, compensation, performance management, and retention efforts (Rouse, 2017). Similarly, people analytics have been used to determine which employees are most likely to leave, valuate employees' performance, and decide employee's bonus. For example, Hewlett-Packard has developed a predictive analytics application to forecast the probability of employees leaving

(Salleh, 2013). U.S. special forces uses predictive analytics to determine which candidates will be successful and worthy of investing years of training. LinkedIn is also using predictive analytics to label one's profile with skills it predicts ones have from ones written contents. Wikipedia predicts which of its nearly million volunteer editors will discontinue their work (Siegel, 2016);

- **Marketing, Advertising and the Websites:** Google is a heavy user of predictive analytics and is continuously changing the landscape of search with this technology. Using predictive analytics, Google Suggests, Google AutoComplete and Google Instant are generating search results instantly as users' type. Google further enhanced predictive search, serving as a personalized assistant that can predict your needs, wants, and deep desires. Netflix is also using predictive analytics to predict which movies a subscriber will like based on what he/she watched (Kalakota, 2014). British Broadcasting Company (BBC) receives millions of attempted posts on its websites. BBC predicts which comments will be approved for posting on its web site reducing total numbers of posts which needed to be screened by human moderators to only a quarter of a million. PayPal use customer written feedback on its web site to identify which customer intends to leave with 85 percent accuracy. Harbor Sweets applied analytics to target lapsed customers to win them back. The response rate was around 40 percent. Harrah's Casino in Las Vegas predicts how much a customer will spend over a long term. Elie Tahari, a fashion designer, predicts and forecasts demand for women's fashion line products. Finally, Pandora recommends related songs based on 400 musical attributes (Siegel, 2016);
- **Utilities:** Predictive analytics is used in fault detection for safety and efficiency. Con Edison predicts energy distribution cable failure, and updates risk levels in New York City three times an hour. BNSF uses Predictive Analytics to predict broken train tracks. Argonne National Laboratory does predictive modeling of nuclear reactor failures. Finally, Nokia Siemens Networks improve service availability by predicting customer outage on its 4G wireless network with a high accuracy (Siegel, 2016);
- **Education:** Officials at the University of Maryland, use predictive analytics to analyze student data including grades, demographics, financial aid, course schedules, and enrollment status to find at-risk students and improve retention rate. They believe predictive analytics enables officials to intervene with struggling students before it is too late. Analytics help officials identify bottle necks and problems such as a difficult class or other pressing issues that could lead students to drop out. Analytics is used to predict student success or failure. One of their findings is that students who enroll in a course very late tend not to perform well in that class. Therefore, the new school's policy is not to let any student to enroll in a class few days before the class start. The student can drop a class four days after the class starts without a penalty. The university is also using a data tool called Student Success Matrix that is developed by Predictive Analytics Reporting Framework. Using the analytics tool, system officials can determine whether a "C" grade in an introductory marketing course indicates a low chance of student to graduate in the major. Then, they use "Intrusive advising" to help student to improve grades or change majors. (Wells, 2017). University of Phoenix also predicts student success or failure in order to target intervention measures including advising and coaching. University of Melbourne uses a predictive model to identify which applications for research grants will be approved (Siegel, 2016).

6. CONCLUSION

Enterprises are continually employing new and old strategies to overcome industry challenges and remain relevant in the changing marketplace. Adapting to new environments, innovating new offerings and investing in cost-saving technologies are just a few avenues for transforming challenges into opportunities. Over the past five years, the sheer volume of data has grown exponentially and new analytics tools have been developed to turn this flood of unstructured, semi-structured, and structured

data into insights. The amount of data available is providing enterprises with the information needed to operate more efficiently, effectively, and safely, consequently allowing them to overcome some of the challenging and disruptive obstacles. Utilization and management of the Big Data are increasingly becoming areas of competitive advantage. Predictive analytics software is one of the crucial tools that companies can use to obtain actionable information from the viable data. Hence, enterprises are adopting predictive analytics as one of the core technologies to be able to compete in the market.

As discussed in this paper, technology trends such as greater computational power, increased data storage capacity, the growth of cloud-based platforms, and advances in algorithms have all contributed to a breakthrough in the field of BI and are helping rapid advances in Predictive Analytics software. Predictive Analytics solutions allow organizations to predict trends and act on opportunities before they manifest. Companies that incorporate predictive analytics into their business intelligence strategies can realize significant benefits through more rapid identification of emerging opportunities and faster detection and correction of problems and issues.

However, as discussed in this paper, there are technological and organizational drawbacks to predictive analytics. The important ones are the amount of up-to-date data it requires and lack of in-house experts to implement the results. While this would not be an issue for larger organizations, smaller firms may not see as useful technology as a result.

Organizations around the world are operating in an increasingly complex and competitive environment. This paper identified contemporary challenges facing organizations and explored the potential of predictive analytics in addressing these challenges. Additionally, this paper proposed a conceptual framework for successful implementation of analytics in different organizations. Moreover, this study highlighted the applications of Predictive analytics across different industries such as banking, financial services, and insurance, government, healthcare, utilities, retail, logistics, and energy, among others. The paper also argued that organizations should consider analytics a strategic investment because adding new analytic functions affects an organization's existing applications, devices, services, and web sites. Important decisions such as the best way to deliver analytic content and report to customers and employees, and ensuring that analytic content is engaging must be made. Business leaders must also evaluate how a predictive analytics initiative will affect users (external and internal), existing applications and interfaces, and multiple stakeholders such as executives, managers, marketing and sales personnel.

Table 5. Application of Predictive Analytics in Different Industries

Industry	Organizations	Applications
Banks, Financial Institutions & Insurance	• Chase, Citigroup • London Stock Exchange • Capital • Citizen Bank • Rebellion Research • Allstate • Infinity Insurance • PayPal	• Generate a credit score –assessing person's credit worthiness. • Analyze the probabilities of risk and default • Predict which checks are fraudulent • Application approval and denials • Compliance and regulatory reporting • Trade surveillance • Predicting bodily injury liability • Detect the misuse of credit and debit cards • Protect users from fraud
Airlines	• Southwest Airlines • Alaska Airlines • Continental Airlines	• Decide how many tickets to sell at each price for a flight and predict flight delay • Decide which class of airplanes to buy • Effectively drive customer loyalty programs
Retail	• Target • Tesco	• Determine customer responses or purchases and set up for upselling and cross selling opportunities. • Merchandising and market basket analysis • Predict trends, recommend new products – and boost profitability. • Events and behavior-based targeting • Market and consumer segmentations
Healthcare	• Stanford University • Sisters of Mercy Health Systems • University of Pittsburgh Medical Center • Pfizer • Blue Cross Blue Shield of Tennessee	• Disease pattern and clinical trials data analysis • Identify changes in patient and provider behavior due to newly introduced legislation or pharmaceuticals. • Patient care quality and program analysis • Provide a rapid and conclusive overview of competitors, pricing, and substitute products when negotiating procurement of pharmaceuticals for hospitals, integrated care networks, and health insurers. • Drug discovery and development analysis
Marketing, Advertising & the Web	• Harbor Sweets • Target • Harrah's Las Vegas • Cox Communications • Elie Tahari • Pandora • Netflix • Google • Sun Microsystems	• Target lapsed customers to win them back • Predict how much a customer will spend over a long term • Predict propensity to buy • Forecast demand for women's fashion line products • Recommend related songs based on 400 musical attributes • Predict which new ads will get many bounces • Improve the number of leads per phone contact

Table 6. Application of Predictive Analytics in Different Industries

Industry	Organizations	Applications
Government, Nonprofit, and Education	• Social Security Administration • Internal Revenue Service • U.S. Postal Service • U.S. Armed Force • U.S. Department of Defense • University of Maryland • University of Phoenix • University of Melbourne • Chicago Police Department	• Streamline operations while giving the agency a more holistic view of criminal activity. • Improve traffic management & overcrowding administration. • Predict suspected incidence of contract fraud • Predict which students risk failing a course • Predict Which applications for research grants will be approved • Predict terrorist attacks and armed opposition group activities • Predicted which workers' compensation claims and payments are unwarranted.
Utilities	• Con Edison • BNSF • Argonne National Laboratory • Nokia Siemens Networks	• Predict energy distribution cable failure, and update risk levels • Predict fault detection for safety and efficiency • Predict broken train tracks • Predict customer outage
Human Resources	• Hewlett-Packard • U.S. Special Forces • Wikipedia • Amazon.com	• Determine which employees are most likely to leave. • Evaluate employees' performance. • Decide employee's bonus. • Predict which candidates will be successful • Predict the appropriate security access code of employees
Social Networks	• Match.com • e-Harmony • OkCupid • Tinder • Badoo • Facebook	• Model and predict human attraction • Improve the precision of suggested people you may know and wish to link to
Logistics	• UPS • DHL • FedEx	• Determine the best routes to ship, the best suited time to deliver, the best mode of transport to choose • Supply chain management and analytics

REFERENCES

Asllani, A. (2015). *Business Analytics with Management Science, Models and Methods*. Upper Saddle River, NJ: Pearson Education Inc.

Bughin, J. (2016). Big Data, Big Bang? *Journal of Big Data*, *3*(2).

Bughin, J. (2016). Big Data: Getting a Better Read on Performance. McKinsey Quarterly, (February). Retrieved from https://www.mckinsey.com/industries/high-tech/our-insights/big-data-getting-a-better-read-on-performance

Burns, E. (2016, January 28). How PayPal Fights Fraud with Predictive Data Analysis. *Searchbusinessanalytics*. Retrieved from http://searchbusinessanalytics.techtarget.com/feature/How-PayPal-fights-fraud-with-predictive-data-analysis

Butler, C. (2017). 2017 State of Embedded Analytics Report. *Logi Analytics*. Retrieved from http://go.logianalytics.com/rs/793-ECD-841/images/2017%20State%20of%20Embedded%20Analytics_Logi_final.pdf

Carlos, A., Gomez-Uribe, and Hunt, N. (2016). The Netflix recommender system: Algorithms, business value, and innovation. *ACM Transactions on Management Information Systems*, *6*(4).

DeAngelis, S. F. (2015, April 30). Predictive Analytics becoming a Mainstream Business Tool. Enterra Solutions. Retrieved from https://www.enterrasolutions.com/blog/predictive-analytics-becoming-a-mainstream-business-tool/

Decker, J. (2017). *Embedded Analytics for Dummies*. John Wiley & Sons, Inc.

Diebold, F. X. (2012). "On the Origin(s) and Development of the Term "Big Data (PIER Working Paper 12-037). Penn Institute for Economic Research, Department of Economics, University of Pennsylvania. Retrieved from https://economics.sas.upenn.edu/sites/economics.sas.upenn.edu/files/12-037.pdf

Dubey, R., Gunasekaran, A., Childe, S. J., & Roubaud, D. (2017, July). Can Big Data and Predictive Analytics Improve Social and Environmental Sustainability? *Technological Forecasting and Social Change*.

Eckerson, W. (2016, April). Embedded Analytics: The Future of Business Intelligence. *Eckerson Group*. Retrieved from https://www3.technologyevaluation.com/research/white-paper/embedded-analytics-the-future-of-business-intelligence.html

Evelson, B., & Bennett, M. (2015, January 8). Quantify Tangible Business Value of BI. *Forrester*. Retrieved from http://www.lavastorm.com/assets/2015-Forrester-Quantify-Tangible-Business-Value-of-BI.pdf

Feki, M., Boughzala, I., & Wamba, S. F. (2016, January). Big Data Analytics-enabled Supply Chain Transformation: A Literature Review. In *49th Hawaii International Conference on System Sciences*.

Gaitho, M. (201, August 87). How Applications of Big Data Drive Industries. *SimpliLearn*. Retrieved from https://www.simplilearn.com/big-data-applications-in-industries-article

Gartner. (2015, September 16). Gartner Survey Shows More Than 75 Percent of Companies Are Investing or Planning to Invest in Big Data in the Next Two Years [Press release]. Retrieved from http://www.gartner.com/newsroom/id/3130817

Gets, J., & Reinsel, D. (2013). *The Digital Universe in 2020*. IDC.

Henke, N., Bughin, J., Chui, M., Manyika, J., Saleh, T., Wiseman, B., and Sethupathy, G. (2016, December). The Age of Analytics: Competing in a Data-Driven World. *Mckinsey Global Institute*.

Hetu, R. (2015, October 22). "Retailers Increasing Predictive Analytics Capabilities. *Gartner*. Retrieved from https://blogs.gartner.com/robert-hetu/retailers-increasing-predictive-analytics-capabilities/

IDC. (2017). Worldwide Semiannual Big Data and Analytics Spending Guide. Retrieved from https://www.idc.com/getdoc.jsp?containerId=prUS42371417

Intel. (2017). Guide to Getting Started with Advanced Analytics. Retrieved from https://www.intel.com/content/www/us/en/analytics/getting-started-advanced-analytics-planning-guide.html

Kalakota, R. (2014, March 13). A Primer on Predictive Analytics. *inShare3*. Retrieved from https://practicalanalytics.co/predictive-analytics-101/

Lebied, M. (2016, December 15). Top 11 Business Intelligence and Analytics Trends for 2017. *Business Intelligence*. Retrieved from http://www.datapine.com/blog/business-intelligence-trends-2017/

Loshin, D. (2017, December 19). Five Steps to Build Better Predictive Analytics Applications. *Techtarget*. Retrieved from http://searchbusinessanalytics.techtarget.com/tip/Five-steps-to-build-better-predictive-analytics-applications

Loshin, D. (2017, August 17). Ten Steps to Start Using Predictive Analytics Algorithms Effectively. Retrieved from http://searchbusinessanalytics.techtarget.com/tip/Ten-steps-to-start-using-predictive-analytics-algorithms-effectively

Marr, B. (2015). Big Data: 20 mind-boggling facts everyone must read. *Forbes*. Retrieved from https://www.forbes.com/sites/bernardmarr/2015/09/30/big-data-20-mind-boggling-facts-everyone-must-read/#56a1b34e17b1

McAfee, A., & Brynjolfsson, E. (2012, October). Big Data: The Management Revolution. *Harvard Business Review*. Retrieved from https://hbr.org/2012/10/big-data-the-management-revolution

McNeill, D. (2014). *Analytics in Healthcare and the Life Sciences: Strategies, Implementation Methods and Best Practices*. Upper Sadler River, NJ: International Institute for Analytics.

Minelli, M., Chambers, M., & Dhiraj, A. (2013). *Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*. Hoboken, NJ: John Wiley & Sons. doi:10.1002/9781118562260

Perrin, A. (2015). *One-fifth of Americans report going online-almost constantly*. Pew Research Center.

Rajpurohit, A. (2014). Has Predictive Analytics Crossed The Chasm? *Ventana Research*. Retrieved from https://www.kdnuggets.com/2014/05/has-predictive-analytics-crossed-chasm.html

Rosenbush, S., & Stevens, L. (2015, February 16). At UPS the Algorithm is the Driver. *The Wall Street Journal*. Retrieved from https://www.wsj.com/articles/at-ups-the-algorithm-is-the-driver-1424136536

Rouse, M. (2017, November). People Analytics (HR Analaytics). *TechTarget*. Retrieved from http://searchhrsoftware.techtarget.com/definition/human-resources-analytics-talent-analytics?vgnextfmt=print

Salleh, S. (2013, June 26). Applying Predictive Analytics in Enterprise Decision Making. *Lumina*. Retrieved from http://www.lumina.com/blog/applying-predictive-analytics-in-enterprise-decision-making

Siegel, E. (2016). *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die*. Hoboken, NJ: John Wiley & Sons, Inc.

Stedman, C. (2017). Eyeing the future with predictive analytics can pay dividends now. *TechTarget*. Retrieved from http://searchbusinessanalytics.techtarget.com/ehandbook/Predictive-data-analytics-advances-businesses-ahead-of-the-game

Taylor, P. (2012). "Crunch Time for Big Data." The Financial Times, June 19.

Ventana Research. (2015). "Ventana Research Benchmark Research: Next-Generation Predictive Analytics." June. Retrieved from http://www.iconresources.com/Icon/eMailer/IBM/Ventana-Research/Ventana-Research-on-Next-generation-Analytics-june-2015.pdf

Vidhya, A. (2015, September 21). 13 Amazing Applications/Uses of data Science Today. Analyticsvidhya. Retrieved from https://www.analyticsvidhya.com/blog/2015/09/applications-data-science/

Weiss, S. M., & Indurkhya, N. (1998). *Predictive Data Mining: A Practical Guide*. Morgan Kaufmann Publishers, Inc.

Wells, C. (2017). "Maryland Universities to Use Data to Predict Student Success-or Failure." The Baltimore Sun. Retrieved from http://www.baltimoresun.com/news/maryland/education/bs-md-college-analytics-20160611-story.html

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