

Maximize asset productivity and operational performance

Business analytics solutions for predictive maintenance



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Overview

With increased consumer empowerment, global supply chains, aging infrastructure, raw material price volatility, stricter compliance standards, and an aging workforce, organizations must reduce operational costs in order to remain competitive. All too often, however, organizations lack not only visibility into their assets' health and performance, but also predictability. Maximizing asset productivity and ensuring that the associated processes are as efficient as possible are key aspects for organizations striving to gain those strong financial returns.

Imagine the impact to downstream operational processes and customer satisfaction when a manufacturing line, an electrical grid, an offshore oil drill, a city water pipe or a mining excavator fails or does not function as it should in the plant or field. Dealing with these issues costs organizations hundreds of thousands to millions of dollars a year.

In a recent Aberdeen Group Analyst Insight report,¹ *Asset Management: Using Analytics to Drive Predictive Maintenance*, a survey of executives states that the number one risk to operations was failure of their critical physical assets—ensuring that they are available, reliable and performing as originally intended. Though, such a risk can become an opportunity. Top-performing companies rely on analytics related to maintenance, safety and replacement equipment to plan for capital expenditures, manage their assets on a daily basis and maximize asset performance. Today, forward-looking organizations rely on *predictive maintenance* to go beyond preventive and regularly scheduled maintenance to ensure asset performance and production quality. Overall operational costs are reduced by minimizing asset downtime and improving the efficiency of their operational processes.

In this white paper, you'll learn about predictive maintenance, the specific benefits it provides organizations, and how IBM Business Analytics software makes it possible.

What is predictive maintenance?

As defined in the Aberdeen report mentioned earlier, predictive maintenance “is an approach that allows maintenance, quality, and operational decision makers to predict when an asset needs maintenance.” IBM Business Analytics solutions for predictive maintenance use predictive analytics and business intelligence technologies to help your organization rise to the challenge with better business insight, planning and performance.

Predictive maintenance is based on the notion that increasing amounts of data are being generated about the performance of equipment and systems, but often this data is used for only short-term reactive needs. However, amalgamation of this historical data can provide a rich reserve for data mining purposes, to unearth trends and patterns for predictive models. Producing predictive models from this data is only of value if an organization acts upon the predictive insights gained to improve operational performance and processes.

Finding ways of acting on the predictive insights is typically one of the biggest challenges in achieving the benefits that predictive maintenance approaches can potentially yield. Obstacles to action include resistance to accepting recommendations derived from predictive analysis versus “gut feel” and established practices based on the knowledge and judgment of key individuals. However, as the population of knowledgeable maintenance engineers ages and nears retirement, it becomes increasingly important to capture maintenance insights in a more systematic way.

Predictive maintenance solutions from IBM access multiple data sources in real time to predict asset failure so your organization can avoid costly downtime and reduce maintenance costs. The information may be about the asset itself or even the conditional information about the asset’s surroundings. Based on such statistical and data mining techniques as Bayesian networks, Weibull distribution, neural networks, linear and logistic regression, time series analysis, C5, CHAID, QUEST, Kaplan-Meier and Kohonen grids, these solutions detect even minor anomalies and failure patterns to determine the assets and operational processes that are at the greatest risk of failure. This early identification of issues helps you deploy limited maintenance resources more cost-effectively, maximize equipment uptime and enhance quality and supply chain processes—ultimately improving customer satisfaction.

Studies show that organizations that apply analytics outperform their peers. Further, those with a broad-based, analytics-driven culture perform, on average, three times better.² Not only do they drive more top-line growth and control costs, they also take timely corrective action to reduce risks that derail their plans. Here are some specific benefits organizations have achieved by using analytics:

- \$1 million in savings for a large equipment manufacturer to spot failure before it occurred
- \$71 million (Canadian) in savings for a municipality by reducing a pothole backlog
- A 36 percent reduction in customer calls from improved asset planning for a water utility company
- An electrical company increased awareness of the time before an asset failure from 30 minutes to 30 hours

You can optimize performance and use actionable insights and trusted information to make informed decisions with business analytics. By bringing together all relevant information in an organization, executives can answer fundamental questions such as *What is happening? Why is it happening? What is likely to happen in the future?* and *How should we plan for that future?*

With IBM predictive maintenance solutions, organizations in asset-intensive industries can:

- Predict when and where asset failures are likely to occur.
- Avoid asset downtime and reduce maintenance costs.
- Perform root-cause analyses of asset and process failures.
- Minimize product quality issues.
- Optimize spare-parts inventory.
- Predict warranty claims for particular products and customer types.
- Ensure alignment with sales and operations planning.

The next two sections in this paper describe how your organization can use IBM Business Analytics solutions for predictive maintenance to maximize asset productivity and optimize asset-associated processes, such as quality, inventory, warranty and sales and operations.

Maximize asset productivity

An organization's assets may include:

- Manufacturing machinery
- Field-level assets (consumer appliances, vending machines, heavy equipment machinery, all types of networks, and connected transportation, such as planes, trucks, buses, tanks, fleets, lift trucks, etc.)
- Buildings (property, real estate, universities, stadiums corporate offices, headquarters and field offices)

While assets may be different in each industry, the underlying methodologies and principles of predictive maintenance tend to be very similar. The following examples illustrate how predictive maintenance solutions can increase the productivity of various assets in different industries.

Predictive maintenance on the production line

Production line stoppages are either due to regularly scheduled maintenance or unplanned equipment failure. Performing timely maintenance is critical to preventing failures that may result in costly production interruptions, but relying on a fixed schedule may result in higher than necessary costs for both parts and labor. Simply increasing maintenance efforts by conducting more scheduled maintenance or hiring more maintenance employees is cost prohibitive. IBM predictive maintenance solutions use the rich set of master and event data that manufacturers already have available, such as equipment type, number of days in operation, operating voltage, days from last service, days to next service, failure history, costs for planned and unplanned maintenance, parts analysis and other data (depending upon the machinery involved).

A fully automated process analyzes this data in real time. It quickly detects failure patterns and identifies the root cause of the problem. Subsequently, the current status of every asset can be evaluated and a maintenance schedule can be created where inspections and/or maintenance are performed just in time to prevent failures. As operating conditions change, the reliability of every piece of equipment is updated in real time. The advanced algorithms contained in the predictive maintenance software can determine the reliability of every asset at any point in the future, so that inspections and maintenance can be performed at the optimal and most cost-effective moment. This eliminates the need for shutting down a line simply to perform regularly scheduled maintenance that may not be really necessary.

Predictive maintenance in action: Avoid production equipment breakdowns and product defects

For manufacturers of steel, the difference between profit and loss often comes down to production efficiency: keeping lines running smoothly and on time and maintaining quality in an environment where product tolerances are measured in tenths of a millimeter. An iron and steel manufacturer in Japan required a more systematic and granular approach to monitoring equipment condition and performance.

The company used an IBM predictive maintenance solution to pore through volumes of near-real-time production management and operational data for signs of impending problems across a range of processes and equipment, so that operational staff can address them before issues shut the production line down. Moreover, by uncovering insights into how subtle variations in equipment operations and procedures can affect product quality, the system provides operations managers with clear guidance on how to optimize production efficiency and maximize product quality.

As a result, the company:

- Reduced costs by more than USD 2 million for every 0.1 percent improvement in production efficiency
 - Improved steel and iron production efficiency by reducing the incidence of production shutdowns related to equipment failure and product defects
 - Boosted skills transfer by embedding process knowledge into equipment and process optimization algorithms
-

Predictive maintenance in the field

In addition to breakdowns on production lines, many field-level assets also fail. When this occurs, the failures impact productivity, downstream operations and stringent customer service-level agreements.

Using predictive maintenance, organizations can determine what circumstances are likely to cause failure. It can support a root cause analysis, by determining the specific variables or characteristics of the machine, operator or policy that led to failure, and then analyze the financial implications of the failure to determine the optimal response for that scenario.

Predictive maintenance in action: Prevent field-level asset downtime

A major American beverage company's top operational priority was to ensure that its next-generation soda fountains functioned properly in the field. Given the logistical realities, traditional break-fix approaches fell short in terms of cost, efficiency and outcomes. The company looked instead for a way to stay ahead of the curve by focusing on preventing machine malfunctions through proactive maintenance practices.

With an IBM predictive maintenance solution, the company decoded the component failure patterns within reams of sensor data gathered from its new soda fountains and provided field technicians the insights they needed to help prevent failures before they occurred. In addition to sensor-based data, the solution extracted valuable information from the unstructured service logs entered by field technicians. Combining both data sources with predictive modeling and dashboard capabilities, the solution gave the company's planners and management the deep, comprehensive insights they need to keep the fountains running optimally.

Predictive maintenance for buildings

A third focus of predictive maintenance is buildings. Buildings are complex, multisystem entities with many individual control and maintenance systems. These systems include heating and cooling, lighting, communications, security and access control systems and are intended to keep occupants safe and comfortable.

Worldwide, buildings consume 42 percent of all electricity, more than any other asset. By 2025, buildings will be the largest emitters of greenhouse gases on our planet³. In the United States, buildings consume 70 percent of all electricity, up to 50 percent of which is wasted.⁴

IBM predictive maintenance solutions can help organizations address the usability and efficiency of buildings—while also reducing energy and operating costs. One way they do this is by providing visibility, control and automation to building systems so that facility managers can monitor and address particular issues. Predictive maintenance solutions can also communicate in real time to supporting infrastructure, such as smart grids and broadband.

Predictive maintenance in action: Improve facilities management

A Canadian university wanted to go beyond traditional energy analytics for buildings and gain a more comprehensive understanding of how energy usage could be reduced — and then put that understanding into action.

With an IBM predictive maintenance solution, the university:

- Optimized energy use and scheduling of energy consumption.
 - Gained the ability to conduct what-if scenarios for estimating the impact of energy-saving initiatives and behaviors.
 - Targeted opportunities for reducing the campus' and hospital's carbon footprint and greenhouse emissions.
-

Optimize asset-associated processes

While predictive maintenance focuses on assets, it is also linked with various other processes within an organization beyond just maintenance, such as quality, inventory, warranty, sales and operations, finance and budgeting and human resources.

Create high-quality products

Maximizing quality has always been a costly issue for manufacturing. If a production line asset fails, for example, a lean cell may need to be created, where employees manually assemble certain parts, rather than have the machine do it. Inherently, employees cannot guarantee the quality of every single product as a machine would, so quality takes a back seat in this scenario. Additionally, a malfunctioning asset may produce bad quality parts.

The key to reducing costs is to determine the problem and embed the quality control process early in the production cycle instead of having to inspect and scrap defective products on the back end. Companies use IBM predictive maintenance software to continually assess part quality throughout the manufacturing process. This allows any defects to be identified quickly and corrected before the part is released into full production, protecting both resources and the customer.

With predictive maintenance, you can determine operational equipment effectiveness and part quality against control limits within a discrete manufacturing production process. It can help with in-depth root cause analysis by not only providing metrics against key performance indicators, but also by determining key performance predictors—those variables that are most likely to cause issues in the future. In order to determine root cause, it is important to know that quality issues can stem from not only asset issues, but operator error, supplier issues, design issues or even environmental aspects. By holistically addressing these issues, your organization improves customer satisfaction and reduces warranty cost.

Predictive maintenance in action: Quality control

An automotive manufacturer had problems with its molding and casting process. A high number of engine blocks were coming out with minor cracks — and not meeting quality specifications. They had to be recycled or scrapped; this led to loss of time and effort, and also caused delays in assembly and vehicle shipment, affecting revenue.

With an IBM predictive maintenance solution, the manufacturer was able to accelerate root-cause analysis. The solution determined that almost all failures occurred during the afternoon and also when there was a spike in humidity. The team looked at the casting line and immediately noticed the problem: it was below a window and when the afternoon sunlight hit the asset and its surrounding environment, it caused humidity fluctuations. The humidity caused the chemical composition of the metal liquid to change, causing the engine block to crack at the end of the process. The manufacturer put a shade on the window, and reduced the reject rate by 80 percent in 12 weeks.

Reduce inventory costs and control spending

When an asset fails, production is negatively affected. For example, if an assembly machine on the manufacturing floor cannot function, finished goods cannot be produced. At the same time, suppliers must deliver fewer manufactured subcomponents or parts, otherwise there will be a glut of those parts waiting on the failed asset—adding waste and cost in the system. Also, the organization needs to have enough spare parts for the asset that failed in order for the maintenance team to fix the asset as soon as possible.

Inventory management can be a dangerous balancing act as businesses seek to avoid maintenance teams waiting for parts that are out of stock, and reduce the expense of overstocking the wrong asset components or over-ordering the wrong inventory. IBM predictive maintenance solutions can help by ensuring that you can get the right inventory to the right locations at the right time. With these solutions, organizations can predict which spare parts are needed for which asset, as well as optimize inventory levels throughout every phase of the supply chain, from sub-suppliers to middle warehouses to retailers.

Predictive maintenance in action: Improve inventory management

A crane manufacturer had problems with its cranes failing in the field, leading to huge losses based on time to repair, as well as a customer satisfaction issue. To cover potential losses, the company set aside \$2 million for spare parts in their warehouse. Since they didn't know exactly which parts would need to be replaced they kept the typical parts that usually failed, as well as others that had a two-week lead time for ordering. Every year, the company noticed that their budget was either too low or too high, with fluctuations over hundreds of thousands of dollars.

Using an IBM predictive maintenance solution, the company analyzed information on the cranes, such as boom angle, loading weight, hook height, wind speed and operator information. The company determined causes of failures and gained a better understanding of the interactions with the operator. This valuable insight resulted in improved spare parts inventory levels for all of their field-level assets.

Reducing warranty claims

When an asset fails, it may produce poor quality parts, which eventually find their way to the consumer. The consumer may then return the product. Predictive maintenance can help provide visibility into the return and help determine if it was due to an asset issue.

A company avoids many costly warranty claims by providing the resolution to its service channel even before most customers know a problem exists. Although warranty claims can be costly, if you use analytics, they also can have a positive side. They can give companies valuable insights to help them identify the root cause of a claim, and whether there's a delivery or production-related problem.

In situations like this, IBM predictive maintenance solutions can identify when equipment in the field is likely to fail or need maintenance, enabling companies to predict future warranty claims costs and maximize uptime/in-service time for equipment sold to customers or for equipment used to deliver service. This helps manufacturers avoid high services costs and product recalls due to late product issue identification. It also minimizes or eliminates bad publicity and the resulting lost sales from recalls or negative customer product reviews.

Predictive maintenance in action: Reduce repeat repairs and warranty claims

A European manufacturer of quality vehicles for worldwide markets needed to gain deeper insights into the causes and combinations of circumstances which led to warranty issues in each geography.

With IBM predictive maintenance solutions, the company mined existing data to discover patterns connected to a wide range of warranty issues. The product design process was modified to improve known issues, as were service patterns that contributed to warranty issues. The company experienced a 5 percent reduction in warranty cases, reduced repeat repairs by 50 percent and averaged annual savings of €30 million.

Improving financial processes

Finance departments are important stakeholders when assets are involved. Ideally, they should know when assets were purchased and how often maintenance is performed, as well as when the assets will need to be decommissioned—and which assets will be purchased as replacements. However, most finance departments don't have any insight into the health of their assets until the assets fail and Production or Field Operations requests funding for an immediate purchase. As a result, most organizations allocate a portion of their budget for asset repairs and replacement; however, they don't know how the end-of-year actual total will compare to what was allocated at the beginning of the year.

This is where predictive maintenance helps. With an IBM predictive maintenance solution, organizations feed the latest information regarding an asset directly to financial systems and processes—so Finance receives a real-time view of asset performance and can update the budget accordingly throughout the year or better plan for next year.

In addition, understanding when an asset is likely to fail also will improve an organization's sales and operations processes. Organizations routinely review customer demand and supply resources and reassess their current state against corporate metrics, monitoring the execution of the company's strategies. With IBM predictive maintenance solutions, organizations can ultimately better ensure that their production schedules can meet consumer demand.

Along with IBM predictive maintenance software, manufacturers may use IBM Cognos software and a sales and operations planning implementation accelerator to understand better the financial impact by:

- Integrating consumer demand, asset and component supply and financial plans for better executive decision-making
- Improving supply chain product performance for better competitiveness and responsiveness
- Providing actionable insight (event driven, exception-based or consolidated) to improve process efficiencies and reduce costs
- Providing real-time dashboards that give visibility into all aspects of supply chain performance
- Reconciling sales and demand forecasts with supply chain and production plans

Predictive maintenance in action: Streamlining sales and operations planning

A multinational company that develops a wide range of agricultural products and solutions wanted to implement a system for planning and financial consolidation, improve supply chain operations for inventory optimization, and synchronize global communication and collaboration both internally and externally with customers and suppliers.

The company used an IBM predictive maintenance solution to gain visibility into their manufacturing machines and incorporate that information into their processes. Now the organization has consistent information for improved collaboration, which led to more customer-focused product improvements, better customer service and shorter lead times. Finally, the sales team now reviews rolling 12-month forecasts due to the improvements in forecasting information.

Optimize employee productivity

One key aspect that tends to be overlooked, but is critical to ensure predictive maintenance sustainability, is human resources. Every asset is managed, maintained and run by an operator or employee. Predictive maintenance enables organizations to ensure that they have the right employee assigned to the right asset.

Many organizations already have enough information about employees either in their HR, ERP or manufacturing databases. They just haven't analyzed the information in coordination with their other data.

The value of using an IBM predictive maintenance solution is that it gives managers enough information to evaluate employees and help them improve their performance. No guesswork or favoritism is involved. More significantly, it can also measure how effective an employee is by analyzing machine readings, logs and sensors to report how physical assets performed while being operated by that employee.

Predictive maintenance in action: Enhance employee performance

A crane manufacturer had problems with its cranes failing in the field, leading to huge losses based on time to repair, as well as a customer satisfaction issue. The company did not know which factors were causing the failures.

Using an IBM predictive maintenance solution, the company analyzed not only crane and environmental information, but also operator data, such as work duration, previous asset experience, training courses taken and previous asset failures and corrective actions taken. The company determined what caused the failures and gained a better understanding of the interactions with the operator. This valuable insight resulted in increased operator training.

Using predictive maintenance in your organization

While each company is different, below is a typical approach to developing a predictive maintenance application:

1. Discover problem areas within the organization.
2. Determine how the problem affects profitability or corporate initiatives.
3. Uncover gaps in processes, people, or existing systems.
4. Ascertain your analytics maturity.
5. Create an overall strategy with a phased approach.
6. Determine what data you have and what data is needed.
7. Analyze data and predict outcomes.
8. Integrate insights into decision-making portals.
9. Optimize the analytical process in your organization.
10. Continuously monitor, measure, analyze, predict and improve.
11. Begin to create a culture of analytics.

Integration

A key aspect to a predictive maintenance solution is its ability to integrate with other pieces of software, hardware and operational processes. Our easy-to-install, pre-configured, packaged software, IBM® Predictive Maintenance and Quality, includes:

- *Real-time capabilities*—processing of machine data requires efficient data handling
- *Open architecture*—adapting to a variety of customer environments requires extensibility
- *Big data, predictive and advanced analytics*—handling data of all types with the full spectrum of analytic tools
- *Quick and accurate decision-making*—capturing institutional knowledge
- *Business intelligence*—understanding the current environment

IBM Predictive Maintenance and Quality provides data integration, analytics and decision management all in one solution. It accelerates your ROI and reduces the need for additional service engagements by including the necessary foundational content: an optimized data schema for real-time analytics, data connectors, predictive models, dashboards and reports.

In addition, the software can integrate with numerous other IBM best-in-class products, including:

- *IBM Maximo® Enterprise Asset Management systems*: Control all types of assets—production, infrastructure, facilities, transportation and communications—by managing them all on a common platform.
- *IBM Infosphere® Streams*: Enable continuous analysis of massive volumes of streaming data with sub-millisecond response times

- *IBM Infosphere BigInsights*: Leverage an enterprise-ready, Apache Hadoop-based data for managing and analyzing massive volumes of structured and unstructured data.
- *IBM Business Process Management*: Discover, document, automate and continuously improve business processes to increase efficiency and reduce costs.
- *IBM Intelligent Operations Center*: Deliver insight into all aspects of city agencies.
- *IBM PureData® systems*: Simplify and optimize performance of data services for analytic applications, enabling very complex algorithms to run in minutes instead of hours.
- *IBM ILOG® CPLEX® Optimization Studio*: Develop and deploy constraint-based optimization models quickly by using flexible interfaces and prebuilt deployment scenarios.

Further, your organization may benefit from IBM's rapid and efficient end-to-end implementation service for IBM Predictive Maintenance and Quality. Using IBM proven practices, qualified IBM specialists work closely with your team and aid them in multiple work streams, including a detailed walk-through of the solution components, product installation, configuration guidance, training and deployment. IBM not only provides the software but will also assist you during your deployment, and then follow up with post-implementation mentoring to ensure that you are getting the most out of the platform. After the implementation is complete and in production, IBM can provide post go-live support where an IBM specialist is available remotely to help resolve possible issues, answer questions and help ensure a smooth roll-out of the solution.

Conclusion

As companies face increasing pressures to control costs and improve productivity, predictive maintenance has emerged as an essential capability. Supported by business analytics, predictive maintenance increases asset and equipment uptime, prevents production interruptions, improves product quality, helps reduce warranty costs and increases customer satisfaction.

It empowers organizations to isolate and solve maintenance and operational issues before they become significant and expensive problems. Results from recent IBM studies⁵ have found that, on aggregate, companies that use predictive maintenance solutions attain ten times higher ROI, a 20-25 percent reduction in maintenance costs, a 70-75 percent elimination of breakdowns, a 35-45 percent elimination in downtime and a 20-25 percent increase in production than those that use traditional approaches.

To find out how IBM technologies can help your organization achieve the benefits of predictive maintenance, please visit:

ibm.com/software/analytics/solutions/operational-analytics/predictive-maintenance/

About IBM Business Analytics

IBM Business Analytics software delivers data-driven insights that help organizations work smarter and outperform their peers. This comprehensive portfolio includes solutions for business intelligence, predictive analytics and decision management, performance management, and risk management.

Business Analytics solutions enable companies to identify and visualize trends and patterns in areas, such as customer analytics, that can have a profound effect on business performance. They can compare scenarios, anticipate potential threats and opportunities, better plan, budget and forecast resources, balance risks against expected returns and work to meet regulatory requirements. By making analytics widely available, organizations can align tactical and strategic decision-making to achieve business goals. For further information please visit:

ibm.com/business-analytics

Request a call

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- 1 Asset Management: Using Analytics to Drive Predictive Maintenance. Aberdeen Group, March 19, 2013. (www.aberdeen.com/Aberdeen-Library/8380/AI-predictive-asset-analytics.aspx).
- 2 Analytics: The New Path to Value, IBM Institute for Business Value and MIT Sloan Management Review, 2010. (ibm.com/de/solutions/asc/pdfs/analytics-path-to-value.pdf).
- 3 Smarter Building website, Sustainability from the Earth up web page. (ibm.com/ibm/green/index4.shtml).
- 4 Conversations for a Smarter Planet™ (ibm.com/smarterplanet/global/files/us_en_us_overview_com03003usen.pdf).
- 5 These results are based on averaging the ROI of IBM customers that have utilized predictive maintenance solutions. They are also part of an infographic that was used by IBM Corporate Advertising during the 2012 US.

Open: www.huffingtonpost.com/2012/09/11/ibm-predictive-maintenance_n_1873701.html?1347826655http://www.huffingtonpost.com/2012/09/11/ibm-predictive-maintenance_n_1873701.html.



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