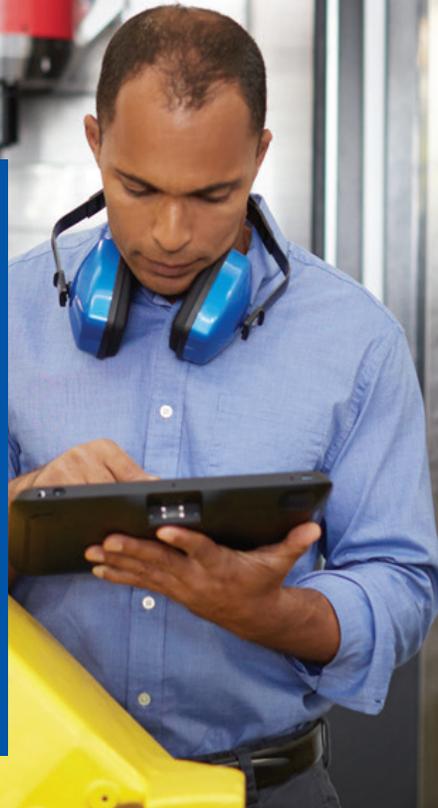


# Creating Business Value with Predictive Maintenance

How analyzing data from sensors can create game-changing ways to reduce downtime.



## Understanding your data can generate business transformation

The Internet of Things (IoT) and advanced analytics are practical technology trends that can redefine your business. By connecting devices, sensors and systems to collect data, and using advanced processes to analyze it, you can uncover game-changing insights. According to Gartner, "Advanced analytics can save lives, reduce customer churn and make equipment safer.<sup>1</sup>"

Whether you are connecting devices, drawing insights from data or combining the two to capture predictive or prescriptive intelligence, these trends are adaptable to your organization's unique business needs.

Across the globe every day, businesses are connecting assets to harness data and create new business value. Connecting devices is only the first step. The real value lies in collecting and analyzing the untapped data from those devices for compelling business insights.

By performing advanced analysis on new data streams either in the cloud or on the back-end, organizations can benefit from features such as machine learning algorithms and data visualization, ensuring that no data stream goes to waste. The insights gleaned can help optimize business processes, offer a basis for more informed decisions, identify new revenue opportunities, and clarify customer and partner behaviors in ways never before possible.

By working in tandem, IoT and advanced analytics can help companies automate business processes and predict and respond to changing market conditions.

At Microsoft, we believe that IoT and advanced analytics can make a difference to your business right now. It starts by building on infrastructure you already have in place, using devices and data in new

ways, and incorporating the right technology to help you use that data, so you can uncover insights and make more informed business decisions.

## The promise of predictive maintenance

Imagine if you could predict equipment failures before they happen, and systematically prevent them. That's what predictive maintenance offers. It involves using data to identify warning signs of potential problems, predict when equipment needs maintenance, and preemptively service that equipment before problems occur.

## Why IoT and advanced analytics are a game-changer

What used to be a manual, time-intensive procedure can now be dynamic, rapid, and automated. IoT-enabled predictive maintenance solutions take advantage of streaming data from sensors and devices, and use advanced analytics to quickly assess current conditions, recognize warning signs, deliver alerts and automatically trigger appropriate maintenance processes.

## Benefits of using Azure IoT Suite and Cortana Analytics Suite for predictive maintenance

With the Microsoft Azure IoT Suite and Cortana Analytics Suite, you can connect and monitor your devices and analyze their data in real time to create new intelligence that improves efficiencies and enables you to transform your business with new business models and revenue streams.

Get started quickly with the predictive maintenance preconfigured solution in the Azure IoT Suite to anticipate maintenance needs and avoid unscheduled downtime.

# A framework for getting started with your predictive maintenance projects

Each predictive maintenance project will be unique—tailored to the needs of your business and your equipment. But at its core, the principles and considerations for a predictive maintenance solution are very similar. Read more to learn the steps you should consider when getting started on a predictive maintenance project.



## 1 Identify the target outcome

Determine which business processes to improve and the desired outcomes you ultimately want to achieve

**What you predict must be something you can take action on—otherwise, that prediction has no value. For example, predicting that a heating and cooling unit is going to fail in the next day is not useful if there is nothing you can do to prevent it.**

Start by figuring out the outcome you are looking to achieve—this determines the predictive question you need to answer, and helps you measure the success of your effort.

Common predictive maintenance related questions include: :

- **Timing:** How much time does the equipment have left until it fails?
- **Probability:** What is the probability of failure in (x) number of days or weeks?
- **Cause:** What is the likely cause of a given failure?
- **Risk-level ranking:** What equipment has the highest risk of failure?
- **Maintenance recommendation:** Given a certain error code and other conditions, what maintenance activity is most likely to solve the problem?



## 2 Inventory data sources

Identify all potential sources and types of relevant data. The outcome you are seeking will influence what data is essential and what is optional.

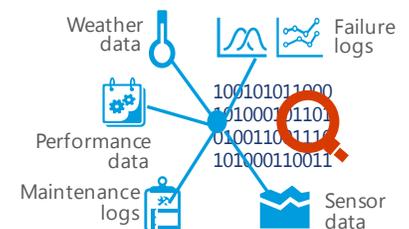
**Include data from a variety of sources—you may be surprised about the places where key information can come from.**

Start by understanding what data is available from where. This can be structured or unstructured data, and may come from internal systems or external sources.

Examples of relevant data include:

- **Operating conditions**—location, temperature, equipment operator, etc.
- **Failure details**—timing, weather, cause, etc.
- **Repair history**

Even with partial data, you can take advantage of intermediate solutions such as anomaly detection, which involves real-time monitoring to detect unusual trends and patterns. This way you can still detect anomalies while you collect specific data required to build a robust predictive model for your problem.



## 3

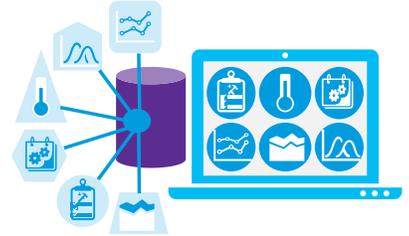
## Capture and combine data

Connect all your data to a single place and prepare it for analysis.

**Lay the groundwork for a robust predictive model by pulling in data that includes both expected behavior and failure logs.**

This involves:

- **Connecting data** from different sources into a single, consistent system. Since data may live in many different places, connecting it to a single, consistent system is a key step. In some cases data may need to be moved, but in many cases it's a matter of connecting a data source to an analysis system. Because you are likely dealing with large volumes of data, it is important to use an analysis tool like Cortana Analytics, which can handle data of any volume, variety or velocity.
- **Normalizing the data.** Though it can be time consuming, it is critically important that you normalize your data, especially if you are relying, even partially, on anecdotal information from your repair teams. Taking this step also helps improve the accuracy and validity of your analysis.



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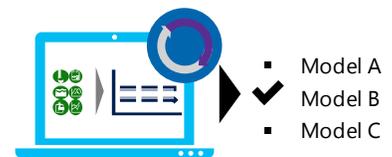
## Model, test, and iterate

Use an advanced analytics solution to develop predictive models, which will help identify unexpected patterns. Stack-rank the models to determine which is best at forecasting the timing of unit failures.

**Make your model actionable by understanding how much advance notice the maintenance team needs in order to respond to a prediction.**

- **Analyze data to identify meaningful patterns.** This starts with an advanced analytics solution, such as the Cortana Analytics Suite, to develop a set of predictive models, based on a subset of the data. Cortana Analytics Suite's machine learning capabilities streamline this process so you can devote more time to answering your questions. As you analyze and model the data, it can be helpful to have a hypothesis you are testing. This will guide your thinking about what signals to hone in on, and will give you a baseline against which to evaluate the analytical results.
- **Next, stack-rank the models,** using the remaining data to determine which model is best at answering your predictive question. Remember that a model must be actionable in order for it to be useful, so analysis efforts should be firmly grounded in business context. For example, if your repair team needs 48 hours' notice for maintenance request fulfillment, an actionable model is one that predicts failures more than 48 hours ahead of when they will occur.

Predictive modeling helps you identify conditions that indicate future equipment problems. With this information, you can adjust processes and systems to trigger preventive actions when those conditions occur. In other words, you can translate insights from the model into operational changes, which is where you see significant business value.



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## Validate model in a live operational setting

Apply your model to live, streaming data and observe how it works in real-world conditions.

**Use machine learning to improve your model and ready it for full implementation. Be willing to refine your approach based on the data you gather during the real-world pilot.**

### ■ Monitoring connected equipment

To run an IoT-enabled predictive maintenance pilot, your equipment needs to be connected and sending the latest operational data to the appropriate systems. That live data flow is what your model analyzes to detect problem signs and trigger alerts or preventive actions—like ordering a replacement part or scheduling a technician.

### ■ Pilot planning

Start by establishing the pilot scope, including equipment, systems, and locations involved, scenarios to test, conditions under which to trigger an alert or action (for example, automatic order of a replacement part), success measures and timing.

### ■ Apply your model and refine your results

Throughout the pilot, you will continuously gather new data that will help refine acceptable ranges and may also highlight new failure signals. Don't be afraid to adjust your approach based on what the latest operational data and analytics tell you.



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## Integrate into operations

Operationalize the model by adjusting maintenance processes, systems and resources to act on new insights. Make ongoing improvements by gaining insights from machine learning and advanced analytics.

**Strengthen your processes and procedures to take advantage of what you learn.**

Once you've met pilot objectives and refined the model, you're ready for broader implementation.

This will likely involve rolling out a number of operational changes, like a revised and/or dynamic repair schedule, or changing policies to prioritize immediate repairs when certain data exceeds a specified range. Because the operational change can be far-reaching, a phased approach is recommended so that incremental benefits can be realized.

The operational improvements that can be made when rolling out a predictive maintenance approach are extensive. For example, you can:

- Optimize what your repair crew is doing and when—adjust repair schedules and routes to reduce breakdowns and remove extra trips.
- Alter your purchasing approach for spare parts so you don't need to hold excess inventory—a parts order can be triggered just in time.
- Offer predictive maintenance as a service to capture annuity revenue and maintain ongoing relationships with your customers.

Companies are putting these solutions to work today and transforming their business in the process.

For instance:

**Rockwell Automation** created a solution that collects, integrates and organizes sensor data from remote equipment across global supply chains to support predictive maintenance, saving \$300,000 a day by eliminating asset downtime.

**ThyssenKrupp Elevators** connected its elevators to the cloud, gathering data from its sensors and systems and using that data to offer customers not just predictive maintenance, but preemptive maintenance.

These are just a few ways predictive maintenance enables companies to increase efficiency, reduce costs and evolve their business.



## Business Impact

Now that you know more about how to get started with a predictive maintenance solution, here are some ways it can impact your business' bottom line.

- Increase your ability to respond to maintenance needs in a proactive manner, rather than waiting until equipment fails to react to the problem. With advanced analytics, you may even be able to move towards prescriptive maintenance where you are using machine learning on large data sets to predict events and prescribe the appropriate solution with little to no intervention required.
- Decrease maintenance costs by being able to better anticipate maintenance needs, thus reducing unnecessary truck-rolls and maintenance staffing requirements
- Better utilize and optimize your existing assets and resources -- people, technology and equipment -- so that all your company's resources are put to the best use and contribute to the bottom line.

Now that you understand how predictive maintenance can impact your business results, be sure to engage with your internal team and get your technical lead to evaluate how to deploy a predictive maintenance solution that leverages the devices, assets and data you already have available.

## Learn More

Learn how you can put the Internet of Things and advanced analytics to work for your business today:

- [View a predictive maintenance demo](#)
- [Learn more about the Azure IoT Suite](#)
- [Learn more about Cortana Analytics](#)



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