

Trend study

Digital Industrial Revolution with Predictive Maintenance

Are European businesses ready to streamline their operations and reach higher levels of efficiency?

Dr Milos Milojevic
Industry Analyst

Franck Nassah
VP Digital Business Innovations

May 2018



Premium sponsor

SIEMENS
Ingenuity for life

Preface

SIEMENS

Ingenuity for life

Digitalization is affecting every industry, disrupting current leaders and creating new business opportunities. To survive disruption, manufacturers must rethink every aspect of their business and become a digital enterprise. This means leveraging cutting edge technology drivers across each phase of operations to reduce cycle times, increase yields, and create new business opportunities.

The PAC study found 93% of companies describe their maintenance processes as not very efficient, which means there is plenty of room for improvement. Major challenges that companies currently face are unplanned downtime and sudden failures, as well as aging infrastructure which brings innovation to a halt. The survey also found that 49% of companies have already invested in predictive maintenance initiatives and plan to further invest in the next two years. The results of the survey also reflect determination to address these issues as more than 90% of the companies plan to invest into technology solutions that enable predictive maintenance such as: data and predictive maintenance platforms, networking infrastructure, Internet of Things (IoT) and edge analytics.

IoT and advanced analytics provide the foundation for creating a digital twin of performance. Predictive maintenance enables companies to identify precursors for poor performance, such as sudden spikes within a normal operating range and specific test results, and correlate them with equipment maintenance records to predict which equipment may suddenly require unscheduled maintenance or downtime. Identifying patterns within normal operations that may otherwise go unnoticed enables companies to schedule preventive maintenance and avoid unscheduled equipment downtime.

Combining predictive technology with IoT, service, field and other customer data streams enables companies to create a deeper impact on the customer experience. Leveraging as-used data to identify patterns and sequences of events enables companies to engage with customers before problems arise and to resolve potential issues. Companies can proactively identify problems and push fixes (parts, software, hardware or firmware) to eliminate possible points of failure or degraded performance that end-users could experience – ultimately increasing customer satisfaction and improving net promoter scores. Siemens MindSphere, the cloud-based open IoT operating system, enables companies to transform data into productive business results which will drive up operational efficiencies and drive down costs.

TABLE OF CONTENTS

Introduction.....4

Key findings..... 5

Key trends 6

Transforming maintenance processes with predictive analytics..... 7

Appetite for predictive maintenance 13

Implementation of predictive mindset.....21

Conclusions 27

Methodology 28

About Siemens 29

About PAC 30

Disclaimer, usage rights, independence and data protection 31

TABLE OF FIGURES

Fig. 1: How would you describe your current maintenance processes for industrial equipment or vehicles within your internal operations?..... 8

Fig. 2: Which of the following are major, minor or not a challenge for your company when it comes to existing maintenance and servicing processes for your assets?..... 10

Fig. 3: Which of the following options best describes the current status of your predictive maintenance initiatives? 11

Fig. 4: Have you already invested in predictive maintenance solutions and/or do you plan to invest further within the next 2 years? 13

Fig. 5: Are the following departments of your organization involved in decision making about predictive maintenance solutions? (YES answers shown in figure) 14

Fig. 6: Will the following aspects be a major goal, minor goal, or not a goal of your predictive maintenance initiatives?..... 16

Fig. 7: What are the challenges in terms of your predictive maintenance initiatives and strategy? 18

Fig. 8: To what extent are the following third parties involved in developing your predictive maintenance strategy and initiatives? 22

Fig. 9: What type of external help would be of greatest benefit in supporting your predictive maintenance initiatives?..... 23

Fig. 10: Are you currently analyzing and using your assets' data for predictive maintenance? 24

Fig. 11: What type of data is gathered to perform predictive maintenance of your assets? 25

Digital industrial revolution with predictive maintenance

INTRODUCTION

As two of the most asset-heavy industries in Europe, manufacturing and transport are facing strong headwinds thanks to growing operational costs and competitive pressures coming from within the European continent and beyond. Additionally, dated legacy systems and operational technology add to the pressure as companies can struggle to integrate innovative digital solutions into these, thus slowing down innovation and limiting their growth. In such markets, improving operational efficiencies and cutting costs wherever possible becomes imperative for most businesses in these sectors.

Since major investments go into new industrial machinery and fleets of vehicles, maintenance is of critical importance in order to enable greater utilization and longer lifetime and thus maximizing the return on investment. However, existing maintenance processes are far from efficient which leaves plenty of room for improvement. As a result, companies are turning to digital technologies such as the internet of things (IoT) and predictive analytics to unlock the streams of data coming from the industrial machinery and vehicles and turn this data into value. This can be achieved by processing the data with predictive algorithms which can make the companies aware of when their assets might fail. On the back of these insights, maintenance processes can be optimized in order to reduce equipment downtime, but also of the products these companies make or services they provide. This provides an opportunity to boost utilization and productivity, while at the same time improving customer experience.

However, are manufacturers and transport operators aware of these opportunities, and do they have necessary capabilities in place? How far away are they from having all the maintenance processes based on predictive insights? This study sets out to explore how European manufacturers and transport operators are approaching predictive maintenance initiatives from an investment, infrastructure implementation, and strategy perspective. Based on interviews with more than 230 senior business and technology decision-makers, this report explores the impact that digital transformation has on maintenance processes and achieving cost savings. The study discusses specific predictive maintenance use cases from the industry that companies have recently undertaken and, as such, presents relevant and interesting reading for senior decision-makers at European manufacturing and transport companies who are looking to better understand the benefits of predictive maintenance solutions and peek into the progress their peers are making in this field.

More than 90% of the companies describe their existing maintenance processes as not very efficient, but are they ready to streamline them?

KEY FINDINGS



93% of companies describe their maintenance processes as not very efficient which means there is plenty of room for improvement.

Major challenges that companies currently face are unplanned downtime and sudden failures, as well as aging infrastructure which acts as a break for innovation.



55% of the companies are at least piloting predictive maintenance initiatives while 23% are generating a tangible business impact.

This shows a degree of maturity of adoption in the sectors and show that almost quarter of the companies are already bearing fruit and recognize its importance on the long-term.



49% of companies have already invested in predictive maintenance initiatives and plan to further invest in the next two years.

Furthermore, 34% haven't yet but plan to invest in the next two years, which means that in total 83% will invest over this timeframe.



Within majority of the companies, the departments that are most involved in predictive maintenance decision making sit within the lines of business.

These include after sales departments for 83% of the companies, operational technology departments for 71%, production departments for 67% and product development departments for 63% of the companies.



Unsurprisingly, data security and privacy concerns are at the top of the list of inhibitors of predictive maintenance developments for 89% of the companies, but there is a significant lack of internal capabilities as well.

The major challenges that directly affect the adoption of predictive maintenance and its success relate to an inability to handle growing volumes of available data, to process these, obtain valuable insight and then redesign maintenance processes based on this insight. Inappropriate available technology and infrastructure is another major inhibitor which is a prerequisite to make the predictive maintenance reality.



In order to address these challenges, companies turn to vendors for support along this road to improved operational efficiency.

This means that the major collaborations between the companies and vendors are currently happening in the infrastructure domain such as the deployment of new networks, the cloud, as well as provision of analytics services.

KEY TRENDS

Summary of key trends by industry

Automotive and discrete manufacturing	91% of companies see reduction of repair time and unplanned downtime as the major goal of their predictive maintenance initiatives. They are frontrunners in generating business impact with predictive maintenance at the moment as 27% of the companies are already doing so. In only 43% of the companies, IT departments are involved in predictive maintenance decision making, which is smaller than in other companies.
Process manufacturing	93% of companies see improvement of aging industrial infrastructure as the major goal of their predictive maintenance initiatives. More than half of the companies are only at the planning and evaluation stage of such initiatives. They also seem to have a bigger problem with the redesigning of maintenance processes based on predictive insights as 74% of the companies see it as the major challenge.
Transport	Transport operators are frontrunners when it comes to deploying predictive maintenance initiatives as 72% already have pilot projects underway, whereas 25% are also generating business impact. They are also leaders when it comes to current investments, as 63% have already invested and plan further investments.

Summary of key trends by geographies

France	In 93% of the companies, the predictive maintenance decision making involves after sales service departments. 52% are beyond the planning and evaluation phase of predictive maintenance adoption.
Germany	80% will invest in predictive maintenance in the next two years, while 54% have already invested. Only 30% need help with solution management which indicates strong internal capabilities.
Nordics	85% of the companies plan investments in predictive maintenance initiatives while 44% have already invested. 52% of the companies see purchase cost as a challenge in adopting predictive maintenance.
UK & Ireland	85% see redesigning of maintenance processes based on predictive insights as the major challenge for predictive maintenance adoption, while 28% generate business impact based on them.
Benelux	92% of the companies see their internal analytics capability as the major obstacle in adopting predictive maintenance solutions.
Italy	52% of the companies have current maintenance processes based on real-time monitoring using pre-established rules or critical levels, which is higher than in other countries.
Spain	60% have already invested and plan further investments in predictive maintenance, which puts them ahead of companies from other countries.



TRANSFORMING MAINTENANCE PROCESSES WITH PREDICTIVE ANALYTICS

Companies in asset heavy industries such as manufacturers and transport operators rely on numerous industrial assets such as machines and equipment, and/or vehicles such as trains, planes or road vehicles. Apart from major investments for buying them, significant costs also go into their maintenance which also directly reflects on their utilization rate and lifetime. Thus, companies need to make sure that all processes run smoothly to provide maximum availability of fleets, production lines and products. Current maintenance processes are usually based on a regular service schedule which includes check-ups and the replacement of some parts. Such an approach means that these activities might be done when it's not necessary and, for example, parts will be replaced that still have a solid lifetime ahead of them. On the other hand, things can go south, and parts can fail between these regular maintenance checks, causing sudden failures. As a result, companies can experience unexpected downtimes resulting in production or transport delays, as well as product outages which all negatively affect customer experience, and can possibly earn penalties from public authorities especially in the transport sector.

On top of these challenges, both industries are very competitive in Europe. Manufacturers are fighting with foreign rivals whereas transport operators bet on low cost tickets as passengers show very little loyalty. For transport operators, this brings wafer-thin margins, which is why customer experience is now a boardroom topic.

One of the first key questions to set the scene for the rest of this report was to find out how European organizations feel about their existing maintenance practices and processes.

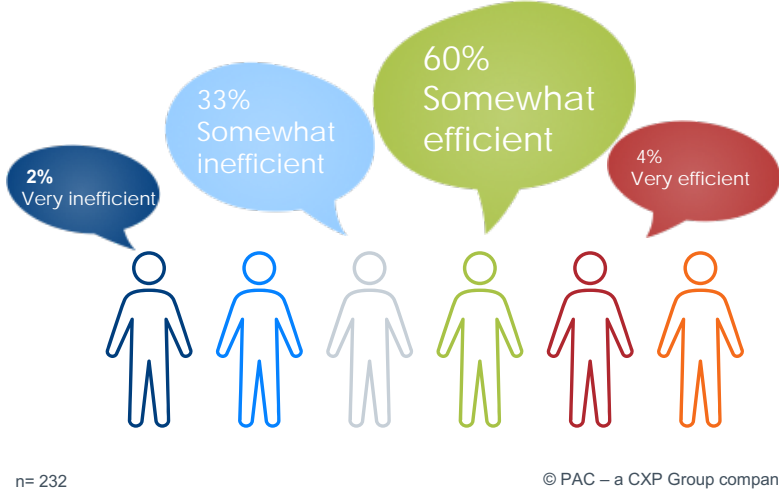


Fig. 1: How would you describe your current maintenance processes for industrial equipment or vehicles within your internal operations?

Answers to this question reflect that companies are not too confident about their existing maintenance set-up, as more than 90% of them do not see it as very efficient. This is a great indicator that room for improvement exists, especially as around a third of these companies see these processes as inefficient to a certain extent. This is a pan-European trend as there are no major differences in this perception of the companies in different countries, or even the sectors they operate in or the size of each company. PAC expects that companies will invest in digital technologies to streamline their processes and, in a few years' time, describe them as very efficient. Some of the companies, however, are already leading the way in this direction and showing a good example of how predictive maintenance can be done and what to expect.

The latest developments in the technology domain allow companies to reach higher levels of operational efficiency which not only benefits cost reduction but customer experience as well. Technology game changers for these challenges are definitely the internet of things (IoT) and a range of predictive analytics tools and techniques. When used together they can boost efficiencies by allowing companies to predict asset, vehicle, and product failures. IoT solutions are used to integrate the data coming from assets and products into IoT platforms. Once the data is available, processing it with predictive algorithms provides insight into the future and enables the companies to anticipate asset failures and leave plenty of preparation time to minimize the impact. This also puts companies in the position to completely redefine their current maintenance processes and practices and completely revolutionize operational efficiency. Thus, the servicing of assets in a pre-defined/prescriptive way might become a thing of the past, while

Predictive maintenance in action: Vestas
Danish wind turbine manufacturer wants to provide global availability of predictive insights into the operational data of its turbines to enable its customers to optimize their maintenance services.

servicing in the predictive way is becoming a thing of the future. Finally, improving the maintenance processes also enables product-oriented companies to improve the servicing of their products and develop new business models. This means that instead of selling, product companies can offer the service of using the product to customers as they have real time insight into the utilization which enables customers to pay only for what they use.

To cut a long story short, here is a quote from CEO of [EasyJet](#) Johan Lundgren who according to [Flightglobal.com](#) stated the following about [EasyJet's](#) newly deployed predictive maintenance platform: "It will transform the way that we maintain and operate our aircraft with the long-term aim of eliminating delays due to technical faults." As one of Europe's largest budget airlines, [EasyJet](#) went all-in on predictive maintenance and uses it for servicing its entire fleet of more than 300 planes after a successful pilot project. This is a great summary of the major direct benefit of the predictive maintenance approach, which also implies indirect benefits such as better customer experience.

These examples are a good indicator of innovative developments, but do they paint a realistic picture of wide-scale industry trends, and to what extent have companies moved on with their predictive maintenance initiatives?

This study delves deeper into European markets and evaluates the current maintenance practices in companies, explores their major pain points and motivation for revamping them with digital technologies.

The findings in this study are based on the survey of more than 230 senior business and IT decision-makers from large companies in the manufacturing and transport sectors. A more detailed breakdown of the sample is available at the end of this document.

The time for moving to predictive maintenance initiatives is definitely now, as there are plenty of ready-made solutions already available in the market. Even if companies need something more specific, the ecosystem of analytics platforms is increasingly growing allowing companies to be innovative in house. PAC sees that many of the companies are piloting their IoT solutions to obtain the data which they can use to predict outages, and a solid chunk of them have moved to large-scale deployment as well.

Current developments in European markets reveal that many of the companies are investing in IoT solutions to enable predictive maintenance and improve their operational efficiency. 94% of the companies plan to invest in the next two years, while 52% have already invested. For example, the largest Italian train operator Trenitalia is analyzing operational data provided by IoT solutions and aims to reduce the maintenance cost of its rolling stock by 8-10%. Another player betting on predictive maintenance is Danish wind turbine manufacturer Vestas. It is working with technology partners to enable predictive insights into the operational data of its turbines worldwide and enable its customers to optimize maintenance servicing work based on these predictive insights.

Transport for London (TfL) is one such company that is increasingly experimenting with data analytics to try to predict the maintenance

needs of its trains and ultimately provide Londoners with a reliable service. In its recent project, the transport operator analyzed train operational data to predict when the motors on the train would fail aiming to save approximately GBP 3 million a year. The company is also trying to use the same approach in order to predict the door failures on trains. Apart from the savings, this will also benefit customer experience as delays can be avoided.

Another good example of predictive maintenance in action, this time in the form of a large-scale deployment comes from the manufacturer **Nestlé**, which boosted its corporate coffee machine offering that serves more than 2,500 of its customers with IoT. This not only enables remote configuration of its machines, but predictive maintenance as well, and thus can boost the efficiency of its technicians. It is also important to mention that new machines are designed with these capabilities, while the old ones are retrofitted.

What are the major pain points in existing maintenance processes of European organizations?

Unplanned downtime and emergency maintenance together with aging IT infrastructure and technology is the major challenge for almost 90% of the companies

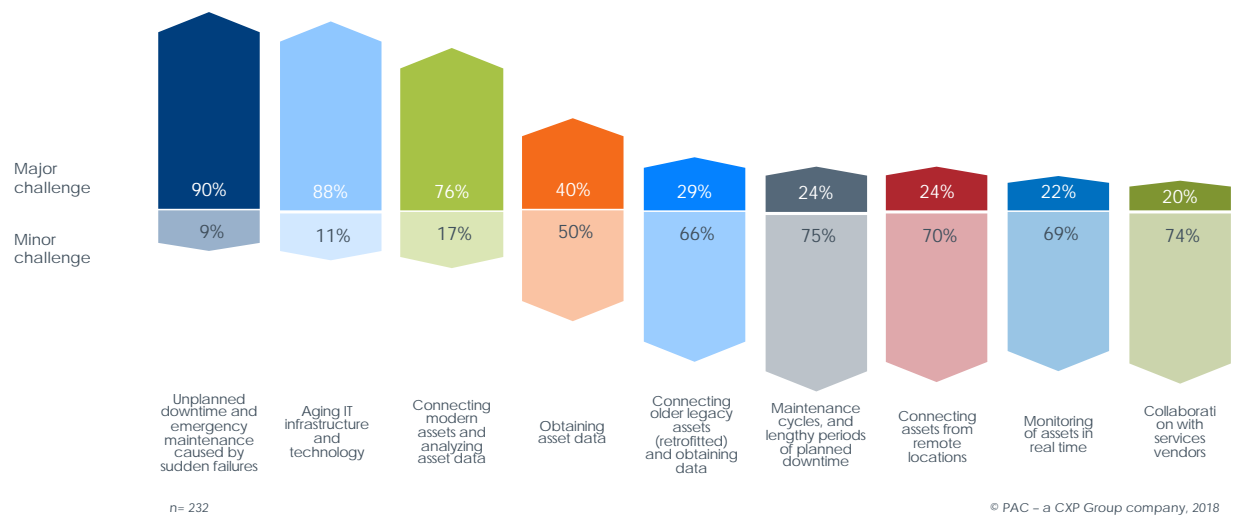


Fig. 2: Which of the following are a major, minor, or not a challenge for your company when it comes to existing maintenance and servicing processes for your assets?

When it comes to existing maintenance practices of European companies, they face many operational challenges but some of them particularly stand out, and actually provide fertile ground for improvements. The major obstacle on the road for most of them is unplanned downtime and emergency maintenance required when equipment suddenly fails. In manufacturing industries, these could put entire production lines on hold resulting in production and capacity delays, as well as product unavailability for customers. Moreover, sudden product failures also test customer loyalty. On the other hand, sudden failures in the transport industry cause delays and disruption in service, which can also come with a price tag for transport operators as they may even be penalized by public authorities or face customer refund claims.

As many of the companies in these sectors rely on dated, old core IT systems, it is not surprising that another major challenge is legacy IT

infrastructure which is aged and cannot support quick development, deployment, and scaling of new services, and the integration of new equipment.

When we delve deeper, several distinctive ways can be seen that European companies are using to approach existing maintenance processes:

1. Through periodic physical inspections and conclusions based solely on an inspector's expertise. This is performed by 59% of the companies which rely on human expertise for regular check-ups.
2. Through the same expertise of an inspector who will also use instrument readouts. This type of maintenance is practiced by the lion's share of the companies (73%).
3. Through the real time monitoring of assets while having real time alerts based on pre-established rules. This is performed by 37% of the companies.
4. Through the real time monitoring with alerts being given by using predictive analytics techniques such as regression analysis. This is performed by 25% of the companies.

Real time monitoring in points three and four is considerably less practiced which is not surprising considering the aforementioned challenges that companies face. Still, a representative number of companies use it today, and these are the likes of those who already have invested in IoT initiatives and deployed IoT platforms to process asset data. The most advanced in this aspect are transport operators, as 41% already have maintenance processes based on predictive insights. This is not surprising as PAC sees that many transport companies have already deployed IoT solutions on a large scale.

With obvious room for the improvement of maintenance processes, what is the current state deployment of predictive maintenance approaches among European organizations?

Predictive maintenance in action: Nestlé

Nestlé boosted its corporate coffee machine offering that serves more than 2,500 of its customers with IoT to enable their remote configuration and predictive and more efficient maintenance. Its older machines are retrofitted with IoT capabilities.

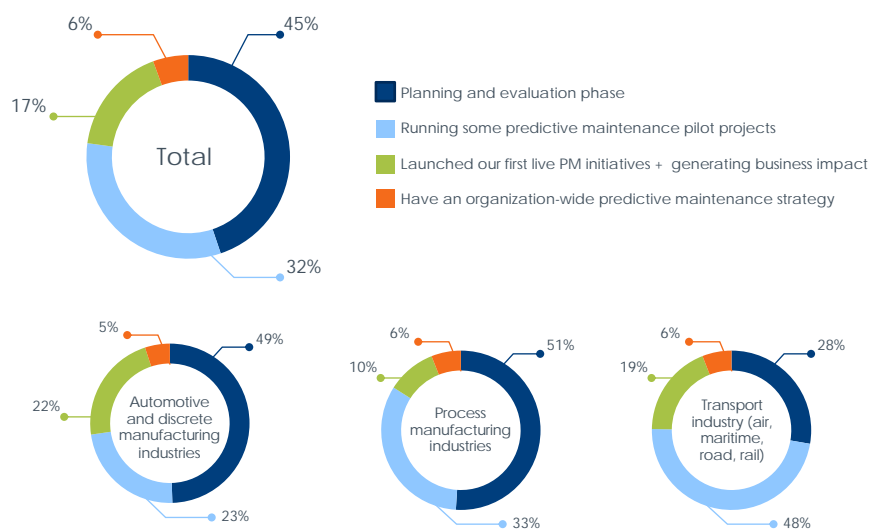


Fig. 3: Which of the following options best describes the current status of your predictive maintenance initiatives?

An overall look at the results paints a picture of a very active market as a total of 55% of the companies are at least running pilot projects with predictive maintenance, with transport being the frontrunner, as 62% of the companies in this sector are running these initiatives.

It is also worth mentioning that automotive and discrete manufacturers come on top by percentage of companies that generate business impact: 29%. This comes as a result of continuous investment in the automation of said industries and in the capability to deliver predictive maintenance-based processes where much of the production is already done by robots and many of which come with their own analytics platforms.

A per-country view shows that the UK is one of the most advanced with 28%, which can be a result of general high penetration of digital technologies in the UK market and its maturity. On the other hand, for example, companies in Germany are reluctant to playing with data thanks to its tight regulations and privacy concerns; hence only around 15% of the companies generate business impact with predictive maintenance initiatives.

Also, the company size affects the determination to explore the predictive nature of their asset operations. For example, companies within the smallest category (1,000-2,000 employees) are lagging behind their bigger peers as 50% of them are still at the planning and evaluation stage of predictive maintenance initiatives. There, resources are generally a bit more constrained, they have less imperative to change and are overall more agile and innovative.

The results show that the companies are most confident in the operational side of the business. For example, 57% say they are strongly versed in condition monitoring, 44% in the integration of solutions with the core IT technology such ERPs, and 44% in optimized scheduling. On the other hand, only 19% of the companies feel strongly versed in predictive maintenance. However, in PAC's opinion, being versed only with operational technology will soon not be enough to continue competing with digital native players. This is why companies need to invest in technology capabilities and embrace collaboration with technology vendors in order to enable the rollouts of maintenance processes based on predictive insights and achieve cost efficiencies.

55% of the companies are beyond the planning and evaluation stage of predictive maintenance initiatives.



APPETITE FOR PREDICTIVE MAINTENANCE

The results so far are encouraging for vendors as they show that there is a problem to be solved and interest in investing in predictive maintenance solutions. The current status of predictive maintenance initiatives is yet to reach its peak, but developments are definitely happening as more than half of the companies are running pilots and a solid number of them generate a tangible business impact.

Having all this in mind, the question remains, how big is the appetite of companies for predictive maintenance when it comes to placing their bets?

83% of the companies will invest in predictive maintenance, while 49% have already invested.

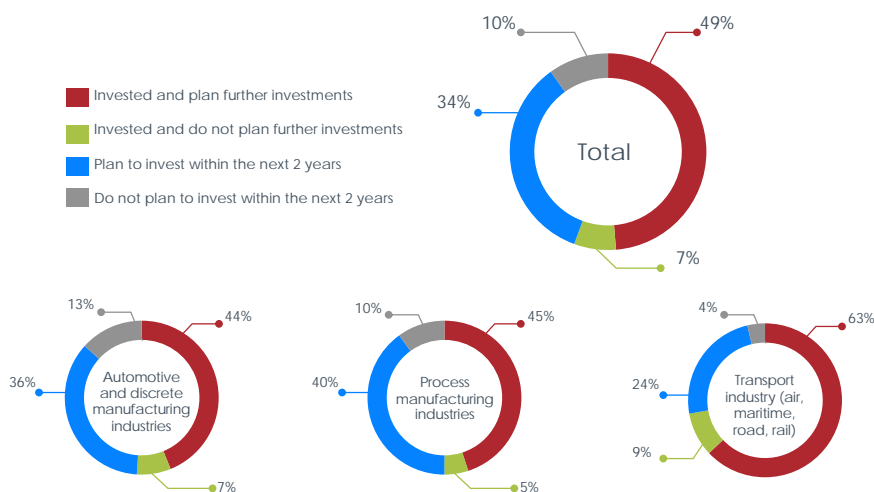


Fig. 4: Have you already invested in predictive maintenance solutions and applications and/or do you plan to invest further within the next 2 years?

The results paint a real picture of the need for investing in predictive maintenance solutions as 83% of the companies plan to invest in the next two years whereas almost 50% of them have already invested. This is in line with the major challenges that companies face, unplanned downtime being the major one.

Country-wise, Spain comes as a frontrunner in terms of the number of companies (60% of them) that already invested and that plan to increase investments over the next two years. This is because Spanish companies are facing somewhat stronger economic challenges than some other regions and the companies are on the right track to fight back. The per-industry view of the results reveals that transport operators are somewhat ahead the other industries as 63% of companies have already invested in predictive maintenance. This is because the industry is fiercely competitive, and companies need to think several steps ahead and aim for cost reduction wherever possible. Thus, they have been quite advanced so far when it comes to

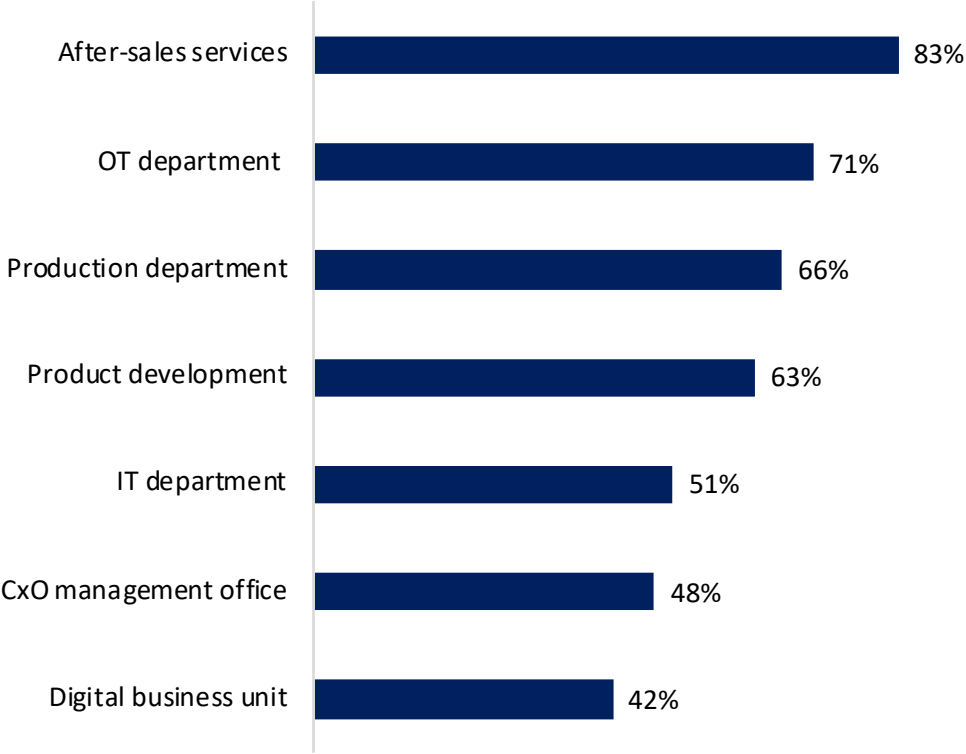


Fig. 5: Are the following departments of your organization involved in decision making about predictive maintenance initiatives? (YES answers shown)

Digital transformation within the manufacturing and transport sectors is increasingly being characterized by the swing of decision making and budget holding power from IT departments to lines of business. This is because these lines of business are starting to feel operational pressures and understand the specific technology needed to relieve it. Moreover, it is even more important to notice that after sales departments are mostly involved in decision making in all of the countries for several reasons. The major one is that predictive maintenance, apart from revolutionizing maintenance processes internally, can also enable more efficient maintenance processes for

the products manufacturers are selling. This can significantly improve customer experience. Take a look at the example of the lift and escalator manufacturer **KONE** and train manufacturer **Alstom**. The former uses predictive maintenance to improve the servicing of its lifts and escalators to the customers and enabled 24/7 connected services with IoT. It collects vast amounts of data about doors, temperature, and stopping accuracy and sends it wirelessly to the cloud platform for processing. It then uses the insights to develop a predictive maintenance schedule, which is then passed on to its maintenance teams with suggestions about which components to check or replace. **Alstom** launched its predictive maintenance initiative to improve its service offerings for trains. It provides its customers such as **Virgin Trains** the pit-stop style predictive maintenance service by analyzing the data coming from the train's parts such as wheels and brakes which triggers alerts and provides maintenance recommendations.

Also, it's worth flagging up that the second most involved departments in predictive maintenance related decision making are OT and production departments which seems obvious as they are responsible for the entire operation of shop floor machines and industrial systems like SCADA.

Geography-wise, there are interesting differences between the companies in different countries. For example, in the UK, the digital business unit is involved in decision making in 53% of the companies which is higher than in any other country. This is a reflection of the mature digital transformation market in the UK in which many of the companies already have structured digital business units. On the other hand, when it comes to the boardroom's influence on decision making Germany is highest ranked with 56% of the companies. This is because the topic of predictive maintenance is of strategic importance for German companies, especially manufacturers.

PAC believes that in order to successfully set out a strategy that will support the adoption of predictive insights, companies need to involve everyone from the IT department, to lines of business as well as management. IT departments need to make sure there is the right technology in place to enable such developments, while LoBs need to consider how maintenance processes on the shop floor could be redesigned. Product development departments could develop new servicing and maintenance strategies based on predictive insights to improve customer experience. Therefore, companies need to forge closer working relationships between all of these stakeholders. Additionally, the strategy should clearly define what data sources will be used in predictive maintenance algorithms. Companies should start with the data that is already available, but should also integrate more sources by connecting the assets to IoT. For example, **SNCF**, the French national railway company obtains data from sensors deployed on trains and rails and then processes it in the cloud to improve maintenance processes by detecting potential failures.

Predictive maintenance in action: KONE

KONE turned to IoT to improve the servicing of its lifts and escalators. It collects data about door operation, temperature, stopping accuracy, etc. to predict outages and provide warnings to maintenance teams.

What are the major goals of predictive maintenance initiatives?

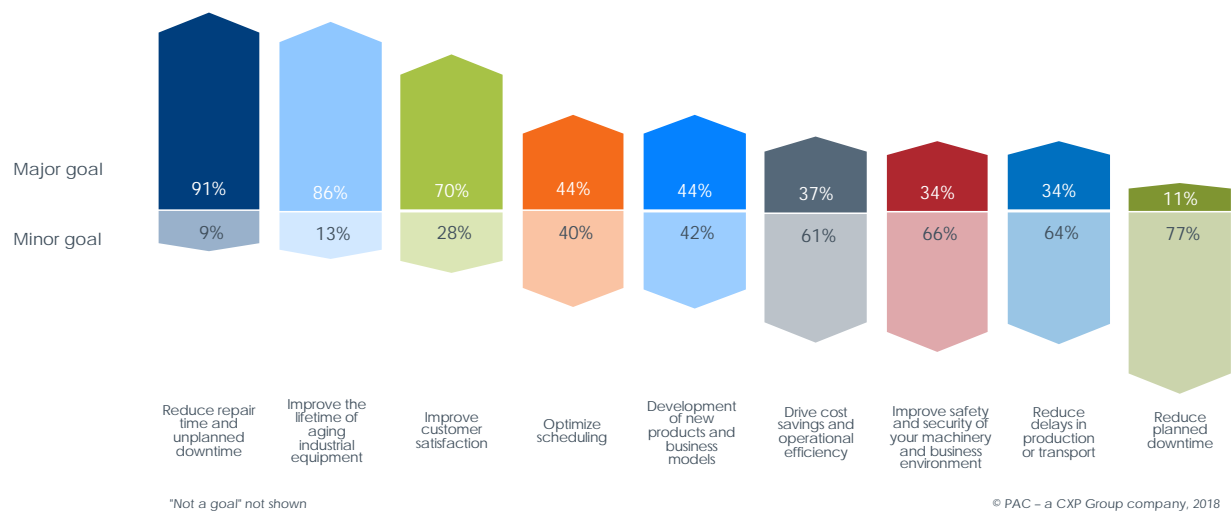


Fig. 6: Will the following aspects be a major goal, minor goal, or not a goal of your predictive maintenance initiative in the next 2 years?

Reduction of repair time and unplanned downtime tops the list of major goals. This is in line with the companies' perception of their existing maintenance processes which more than 90% of them do not deem as very efficient. This is not surprising as the consequences of unplanned downtime can be multifold and include negative customer experience, delays, and potential penalties, or even worse accidents and therefore liability as well. Another important driver is the improvement of the lifetime of aging equipment. This is also not surprising considering the cost pressures faced by these companies, and even more challenging economic environments in certain European regions. Thus, the companies want to improve asset utilization and maximize return on investment. The next most important thing is improving customer experience which will be the critical factor when consumers are choosing a product or transport operator, thanks to really fierce competition in both the manufacturing and transport markets. It is also interesting to notice that almost half of the companies want to use predictive maintenance in the development of new products and business models.

Industry-wise it is interesting to note that, for example, the improvement of customer satisfaction is more important to transport operators (80%) than to automotive and discrete manufacturers (70%), and companies in process manufacturing industries (64%). There are two reasons for this, first one definitely being the fact that most transport players are betting on low cost tickets to win the customer. Thus, winning them and keeping them loyal is imperative for transport players. The second reason is that these companies are generally interacting directly with customers unlike for example some types of manufacturers. Additionally it is more important, for transport players than for manufacturers to reduce delays and for 44% of them this is a major goal.

From a regional perspective, more than half of the companies surveyed in the Benelux region (60%), the UK (53%) and Germany (52%) see developments of new products and business models as their major

Reducing repair time, unplanned downtime, and improving lifetime of aging industrial equipment are major goals for the majority of the companies.

goal. This can be explained by the fact that these markets are digitally more mature than other markets, hence the companies are at the more advanced stages of digital transformation. Whereas in the very challenging markets such as Italy, all of the companies (100% of them) say that the reduction of repair time and unplanned downtime is a major goal. This is due to difficult economic environments and generally slower adoption of digital technologies.

To achieve these goals, many European manufacturers and transport operators have already started their digital journeys and implemented predictive maintenance concepts in some of their business processes.

French energy giant [EDF](#), which operates a nuclear power plant network of 58 reactors across 19 locations, implemented [Atos's](#) monitoring solutions into 70 of its power turbines. This allows [EDF](#) to have a real time insight into its operations, and critical data, which can detect faults within the internal reactor structure, pumps, valves, turbines, and generators.

Another good example of using the predictive maintenance concept comes from Spanish shipbuilder [Navantia](#), which started its IoT journey by deploying a digital ship management system powered by IoT. Initially, [Navantia](#) created its own platform but it also wanted to boost data management capabilities. The company then used [InterSystems](#) Data Platform as it wanted to replace traditional relational databases and SCADA systems which couldn't support development of more complex data models to allow integration of data from variety of sources. With this infrastructure in place, [Navantia](#) can deploy complex predictive models in order to detect failure of shipping systems.

Speaking of underlying infrastructure that needs to be in place before running predictive maintenance applications, one good example comes from collaboration between [Siemens](#) train manufacturing unit and [Equinix](#). As Siemens uses large data volumes from 300 sensors on each of its trains to perform predictive maintenance, data management and storage is quite challenging especially thanks to local data regulations which sometimes require the data being stored in its country of origin. [Siemens](#) took an interconnection-first approach to its cloud-based active disaster recovery solution by deploying the [Equinix platform](#) that ensures the availability of data in real time as well as for predictive maintenance and the scaling of the number of locations for capturing the data as needed.

Another good example comes from the mining sector, Russian steel player [Severstal](#) have managed to reduce unscheduled maintenance delays by 20% by deploying [GE Digital's](#) Predix Asset Performance Management solution. The solution is used to integrate [Severstal's](#) legacy data from its enterprise systems and data from critical assets, enable automation of reliability management and enable more efficient maintenance processes.

In the transport sector some of the train companies are quite advanced when it comes to deployment of predictive maintenance processes. Finnish railway player [VR Group](#) uses IoT and [SAS Analytics](#) to enable predictive maintenance of its fleet of 1,500 trains and assure better customer satisfaction and more reliable services. The main idea is to change current maintenance processes and perform it when it is

actually needed and not periodically in order to avoid replacing parts that still have a solid lifetime ahead of them. This is particularly important as some parts like wheels are maintained on scheduled services whereas many parts are maintained only when they fail. The company hopes that with such an approach, it will keep trains in service for longer.

Another example in the railway industry comes from German cargo company DB Cargo that is working with Siemens to install predictive maintenance systems across its fleet of more than 300 locomotives in a push to digitalize the fleet and optimize the locomotive value chain. The company is achieving this with analytics models from the Siemens Railigent platform which is also connected to Siemens IoT platform MindSphere.

In the industrial manufacturing space, British construction equipment manufacturer JCB has deployed an IoT telematics platform called JCB LiveLink developed by Wipro across 10,000 of its construction equipment machines in India. The platform provides the insight into the real time health data of the equipment and enables predictive analytics to be performed to ensure operational availability.

Despite plenty of benefits and a large number of companies deploying predictive maintenance, what are the big obstacles on the road that slow down the adoption of such solutions?

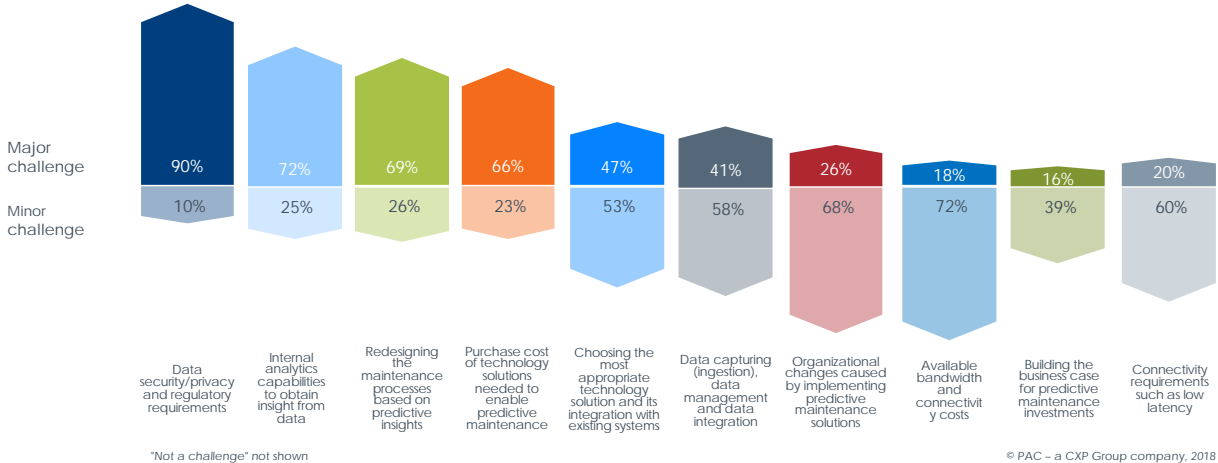


Fig. 7: What are the challenges in terms of your predictive maintenance initiatives and strategy?

When it comes to the pain points of moving forward with predictive maintenance initiatives there are several aspects to flag up. Naturally as Europe is a heavily regulated market when it comes to the privacy of the data and its security, most companies are very cautious and point out this as the major challenge. This is not surprising as there are a growing number of cyber-attacks happening, and that could even cause accidents in manufacturing facilities. Furthermore, thanks to the growing adoption of IoT, there are more and more connected devices and machines which could be potential endpoints of the breach in cyber-attacks. Therefore, special care needs to be taken when connecting the machines to the network. Moreover, products also

collate customer data thus companies need to take special care when embedding connectivity in them.

Another important challenge that might make companies think twice before investing in predictive maintenance solutions is a lack of confidence in internal analytics capabilities. This is very important as the deployment of IoT and predictive maintenance means companies will unlock new data streams that may become difficult to manage, and thus making it difficult to obtain an insight. As a result, companies need to make sure they have trained personnel to deal with growing amounts of data and who have the right set of skills to obtain valuable insights. On top of this challenge, even when companies manage to do this they still need to redesign their maintenance processes and practices based on these predictive insights and optimize the whole flow, which is a major challenge for almost **70%** of the companies. Finally, it is worth mentioning that on top of these challenges the purchase cost of the enabling technology solutions is a major challenge for two thirds of the companies, which again is in line with the cost pressure that companies in these sectors face.

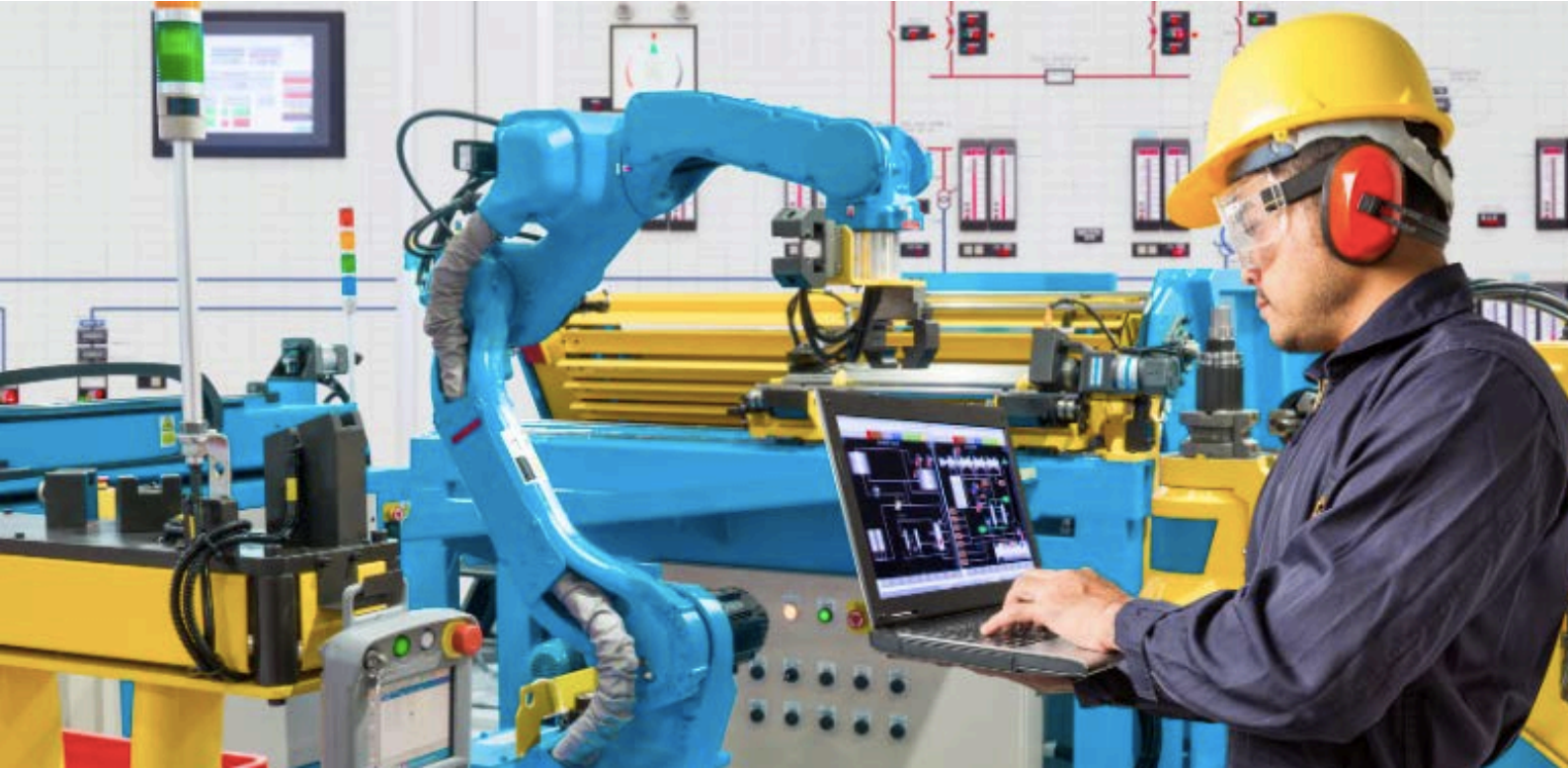
There are few major deviations in responses from various companies when observing size, country, and sector. For example, smaller companies with 1,000-2,000 employees are more agile and generally open to innovation and therefore redesigning maintenance processes is not the major challenge to the same extent as it is for larger companies with more than 2,000 employees. For **79%** of the biggest players with more than 5,000 employees, this is a major challenge which is understandable as they have long lasting and established processes and ecosystems of partners that provide maintenance. Industry-wise, transport operators are least concerned with the purchase cost with **57%** saying it is a major challenge while the number of manufacturers that feel similarly is greater. This is because transport players deal with more challenging markets and have a greater imperative to stay efficient hence they do not hesitate to spend more on predictive maintenance.

Country-wise, for example the challenge of capturing and managing data is the most obvious in France as **53%** of the companies see it as a major challenge, unlike for example in the UK and Germany where this figure is around **30%**. This could be due to the lack of talent as companies have weaker data management capabilities. Also, it is interesting to note that cost pressure is felt as a major challenge in Italy the most with **80%** of companies naming this as a significant obstacle. Finally, the UK and Spain are the countries with the largest number of companies with concerns about connectivity availability and prices which is the major challenge for around **30%** of the companies. Also, redesigning the maintenance processes based on the predictive insights is a major concern for **85%** of the companies in the UK. This is probably due to the fact that the manufacturing industry in the UK has a considerable amount of legacy IT infrastructure and dated old processes in place.

PAC advises a structured approach in moving forward with predictive maintenance related initiatives. Before major technology investments companies should leverage the existing data they have about the machines or products operations, services schedules and outcomes,

Apart from data security concerns companies see their internal capabilities as the major break to the quicker adoption of predictive maintenance.

maintenance history data, condition data and environmental data. Spotting patterns and trying to predict the outcomes here would be the first step. Then, the deployment of more advanced IoT solutions to connect more assets and bring new data streams and process it in the platforms could be the next step for providing better predictions. The most advanced step could be real time monitoring with edge-based analytics and predictions to obtain insights as soon as possible. Of course, moving from maintenance on frequent schedule to a real time insight-based schedule is the key, and therefore processes will need to be redesigned on the basis of these insights.



IMPLEMENTATION OF PREDICTIVE MINDSET

In order to revolutionize their maintenance processes, it is clear that the companies will need someone's guiding hand, since as already mentioned internal analytics capabilities are an obstacle on the road to obtaining insights from data and enabling predictive maintenance. Furthermore, as the redesigning of processes around maintenance to accommodate predictive insights is regarded as the third biggest challenge, it is expected that companies will need significant help from vendors in this area as well.

Still, there are plenty of fish in the sea of vendors, and various players are playing in this IoT related market from hardware and industrial companies, IT services and software companies, to network and infrastructure providers. Being able to choose the right set of partners for this journey will be the decisive factor for the success of predictive maintenance initiatives.

With which third-party players do manufacturers and transport operators collaborate in order to move forward with their predictive maintenance initiatives?

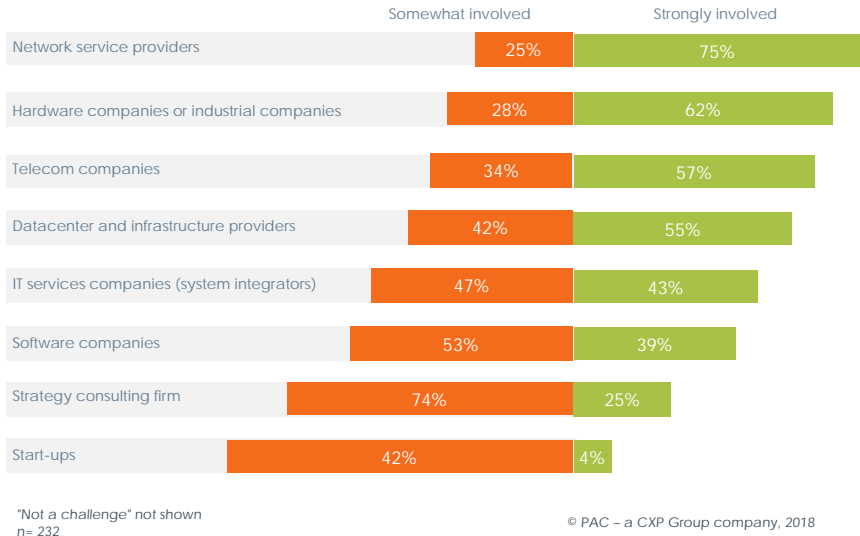


Fig. 8: To what extent are the following third parties involved in developing predictive maintenance strategy and initiatives?

The overall European results show that the lion's share of involvement goes to network services providers. This is because corporate infrastructure in these sectors currently cannot support connecting many of the respective assets and streaming large amounts of data thus the companies need to ramp up their networks and infrastructure first. Moreover, manufacturers also need to boost their products, and transport operators need to boost their vehicles with connectivity. This is also the reason why collaboration with telecom companies ranks highly too. Then the next most popular partners on the road to predictive maintenance are hardware and industrial companies. This is also understandable as many of these companies went through digital transformation themselves and started to offer technology solutions to enable digital industrial transformation to their clients. Overall, results show that infrastructure providers of networks, connectivity, data centers/cloud are the major collaborators. These are then followed by IT services providers and software companies which PAC expects will increasingly improve their footprint as companies will need platforms and analytics expertise to gain insight from the growing volumes of data. This will also depend on the internal capabilities as some companies do not want to commit too many in house resources to it and instead will choose to outsource. PAC sees that the importance of predictive maintenance is one of the most crucial in the IoT ecosystem and many vendors are starting to standardize their offerings. These include global system integrators, platform providers, and software companies as well as niche players like startups. On the other hand, not many companies are heavily involved with strategy consulting firms indicating strong confidence in internal expertise around some of the maintenance processes, whereas market maturity is still not at its peak

and a very limited number of companies is working on enterprise wide strategy. As discussed above, only 5% of companies currently have an enterprise-wide predictive maintenance strategy in place. Finally, startups are not strongly involved in providing support to manufacturers and transport operators, but developments in the market show significant interest. Plenty of European manufacturers and transport operators have established business incubators or competitions to source for the best startups to collaborate with and invest in. Good examples are **IAG Group**, the parent company of **Iberia** and **British Airways**, that started its accelerator called **Hangar 51**, which is dedicated to collaborating with IoT, blockchain and analytics startups. Similarly, **Virgin Trains** launched a GBP 25 million fund for its **Platform-X** accelerator, which encourages innovative companies to solve business challenges in the rail industry.

The collaboration trends with third parties are fairly uniform across all sub sectors, whereas there is some differentiation in the results at country level. For example, there is a stronger collaboration in the UK with network service providers and data center and infrastructure providers as 85% and 73% of companies, respectively, collaborate with them. This is thanks to a higher maturity in this market than some other markets when it comes to the implementation of cloud infrastructures as well as thanks to a generally poor connectivity infrastructure which needs a boost. Additionally, 54% of German and 58% of UK companies also collaborate with IT services companies, which is more than their peers in other countries indicating a relatively high level of maturity of the IT market.

PAC believes that the diversity of the vendor ecosystem is definitely a good thing which means there is a wide range of choices for companies looking to reap benefits with predictive maintenance. However, this could mean that finding the right ones might be challenging task thus companies need to keep an eye on the latest developments in technology focusing on their specific problems.

Companies mostly need a hand with the analytics of asset data, setting up an appropriate infrastructure as well as with solution implementation.

What type of assistance do manufacturing and transport companies look for in vendors when it comes to the implementation of predictive maintenance?

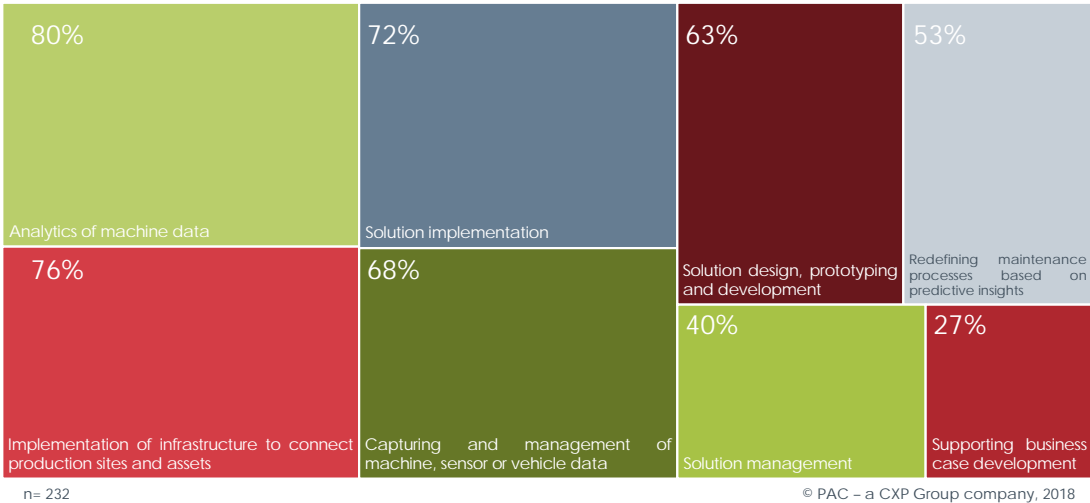


Fig. 9: What type of external help would be of greatest benefit in supporting predictive maintenance initiatives?

Results vary by country a little in this regard, with the exception of Spain and Italy. Apart from the help in implementation of infrastructure to enable predictive maintenance, 84% of companies in Italy need assistance in capturing and managing data. Assistance in solution design, prototyping and development need 72% of companies in Italy, while 64% need assistance with solution management.

When it comes to predictive maintenance, the real enabler and prerequisite is technology and a company’s readiness to support the analysis of the growing amount of data. It is also worth pointing out that the surveyed companies are planning to bet on this technology in the next two years:

- 98% plan to invest in software or predictive maintenance platforms
- 97% plan to invest in networking infrastructure
- 93% plan to invest in data analytics platforms.
- 94% plan to invest in the IoT solutions
- 94% plan to invest in edge analytics,
- 88% plan to invest in the cloud
- 67% plan to invest in artificial intelligence

The output from IoT solutions is data, and ultimately companies need to be able to monetize it. Whether or not they are successful in that depends on many factors, beginning with the aforementioned platforms, their internal analytics capabilities, the supporting infrastructure, and business acumen.

The major goal of technology related investments is to enable the collation of larger volumes of data, but to what extent are companies using it in the business decision making processes?

40% of the companies analyze asset data and use it in business decision-making.

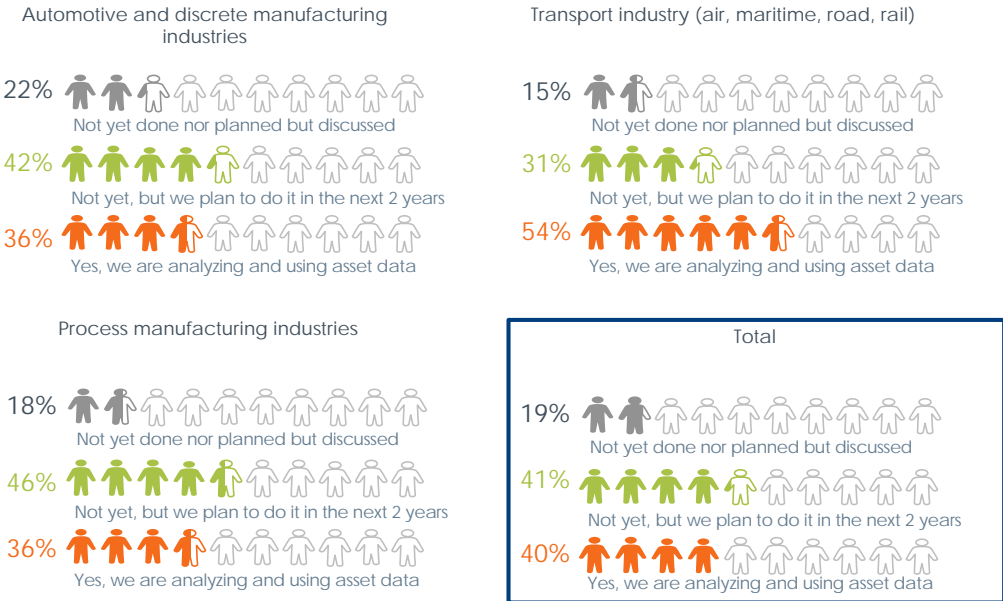


Fig. 10: Are you currently analyzing and using your assets’ data for predictive maintenance?

Industry-wise transport operators are a bit more advanced as 54% of them are using asset data for predictive maintenance. The use of asset data for predictive maintenance and business decision making, regardless of whether analytics is done in house or it is outsourced, can also be impacted by where and how the data is processed. Therefore, when laying out the predictive maintenance strategy it is important to choose the right combination of places where it can be done. Some of the options are on premise/data centers, in a hybrid infrastructure, or with the help of colocation providers and increasingly popular edge analytics. When choosing the right approach, companies need to take into account some of the important aspects such as the allowed latency in analytics, the price for connectivity to stream data as well as the price for infrastructure and supporting services. For example, companies that need lower latency and have connectivity constraints are likely to deploy edge-based analytics and only send important information or aggregates to the cloud. Current trends show that the most popular approach for analytics over asset data is within on-premise data centers for 61% of companies as well as hybrid infrastructure solutions for 57%. Other approaches to data analytics per popularity are with the help of colocation providers for 46% of companies, in the cloud for 34%, and on the edge for 27%.

Then apart from choosing the approach to analytics companies need to decide what type of data they will use and how they can obtain it. What are the current trends in this respect among European companies who already analyze asset data for predictive maintenance?

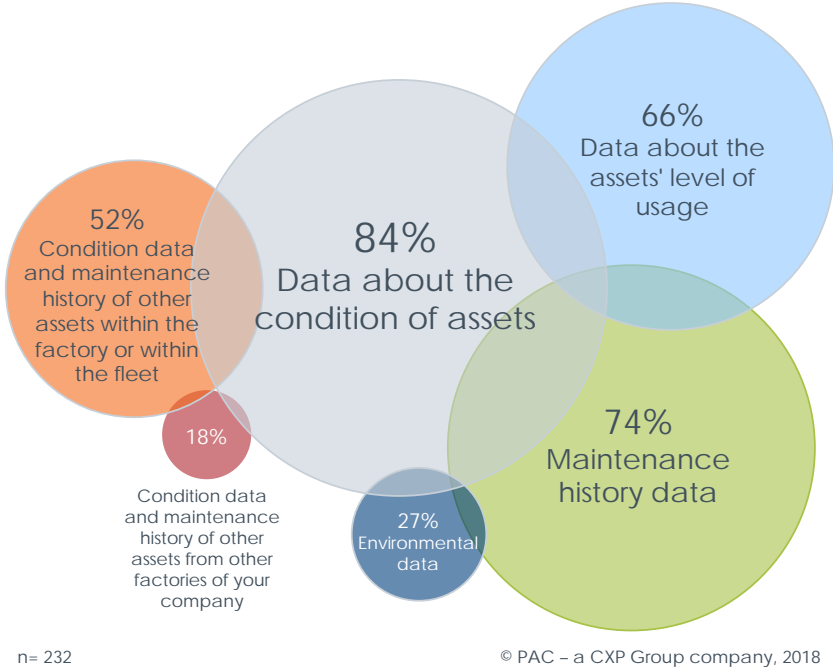


Fig. 11: What type of data is gathered to perform predictive maintenance of your assets?

Asset condition data tops the list as almost 90% of the companies use it to perform predictive maintenance. But using one type of data sometimes might not be sufficient and companies should use multiple data sources and try to correlate them to find any hidden patterns. Apart from condition related data, many companies use the data about maintenance history and about the usage levels of an asset. These two types of data are particularly important as they bring together maintenance and usage, which enables companies to find important correlations. Finally, companies can use condition and maintenance history data from their other sites or vehicles and try to correlate them mutually.

The results show that when it comes to the cloud, UK companies seem to be the most reluctant as only 22% perform predictive analytics in the cloud. In contrast, the Nordics with 50% and Germany with 47% are more cloud-friendly. Similarly, 41% of players with 2,000-5,000 employees and 33% with more than 5,000 employees are more open to using the cloud than smaller players with 1,000-2,000 employees, 28% of which is currently using cloud for predictive maintenance analytics. A probable cause might be the cloud's capacity to handle larger volumes of data and a better scalability, which is certainly a more frequent requirement for large companies. Geography wise it is interesting to note that 100% of the companies in the Nordics use maintenance history data in their predictive maintenance initiatives while Germany is second with 94%. These two markets are probably the most advanced when it comes to having well established processes, while in contrast this percentage is only 56% in France.

CONCLUSIONS



Major challenges with existing maintenance processes for European manufacturers and transport operators are unplanned downtime and aging IT infrastructure. The former impacts day to day operations and negatively affects customer experience while the latter diminishes ability to grow and adopt digital technologies.



The fact that the majority of the companies see the maintenance processes of their industrial equipment, vehicles, and products as not very efficient means there is plenty of room for improvement. The concept of predictive maintenance can be the key to unlocking higher levels of operational efficiency and optimizing the cost structure of maintenance processes.



Apart from streamlining operations and cutting internal costs, predictive maintenance can be a powerful tool for providing better customer experience and developing new business models. This can be the success factor for customer retention and future growth.



More than half of the companies surveyed are at least running pilots for predictive maintenance initiatives while almost a quarter already generate a tangible business impact. There are no significant differences between the levels of maturity of predictive maintenance adoption among the European countries and in total, more than 80% of the companies plan to invest over the next two years.



This study reveals that investments into predictive maintenance initiatives are mostly being driven by the lines of business such as production, after sales services, and product development departments. Still in order to bear fruit with these investments, companies will need to have a clearly defined strategy that embraces collaboration as well as underlying technology.



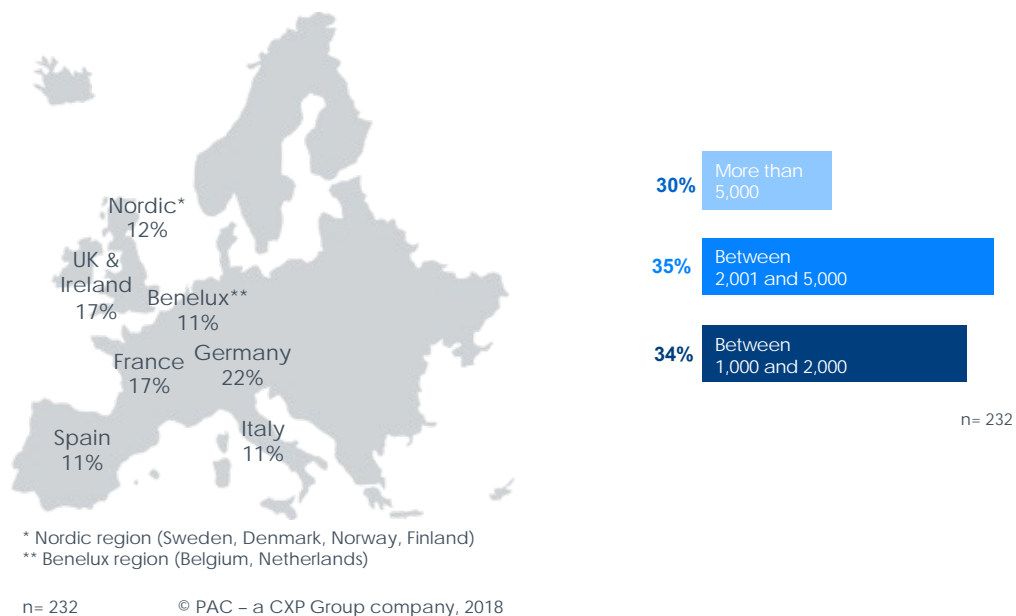
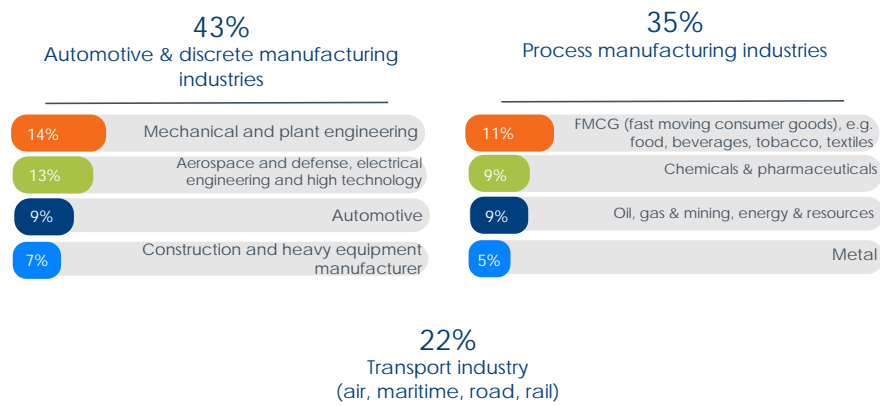
The major driver of adoption of predictive maintenance among European companies is the reduction of repair time and unplanned downtime which directly improves the utilization rate of assets. Another important driver is the improvement to the lifetime of aging industrial equipment as investment into new equipment requires major capital investment.



A major challenge slowing down the adoption apart from cyber related concerns is the lack of confidence in internal analytics capabilities as well as underlying infrastructure that should enable predictive maintenance. Thus, companies are turning to vendors for support, and the results show that these are mostly infrastructure providers as well as industrial companies providing industry specific technologies.

METHODOLOGY

This study is based on interviews with senior business and IT decision-makers with responsibility for predictive maintenance at 232 European manufacturing and transport companies with more than 1,000 employees from the UK and Ireland, France, Germany, Italy, Spain, the Nordics (Sweden, Denmark, Norway and Finland) and Benelux (Belgium and the Netherlands) regions. The study was completed during the first half of 2018. Here is a more detailed breakdown of the participants region, per industry and company size by number of employees:



ABOUT SIEMENS

For more information on MindSphere, please see:

www.siemens.com/mindsphere.

Siemens PLM Software, a business unit of the Siemens Digital Factory Division, is a leading global provider of software solutions to drive the digital transformation of industry, creating new opportunities for manufacturers to realize innovation. With headquarters in Plano, Texas, and over 140,000 customers worldwide, Siemens PLM Software works with companies of all sizes to transform the way ideas come to life, the way products are realized, and the way products and assets in operation are used and understood. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm

Follow us on Twitter at: www.twitter.com/siemens_press

Siemens AG (Berlin and Munich) is a global technology powerhouse that has stood for engineering excellence, innovation, quality, reliability and internationality for 170 years. The company is active around the globe, focusing on the areas of electrification, automation and digitalization. One of the world's largest producers of energy-efficient, resource-saving technologies, Siemens is a leading supplier of efficient power generation and power transmission solutions and a pioneer in infrastructure solutions as well as automation, drive and software solutions for industry. The company is also a leading provider of medical imaging equipment – such as computed tomography and magnetic resonance imaging systems – and a leader in laboratory diagnostics as well as clinical IT. In fiscal 2017, which ended on September 30, 2017, Siemens generated revenue of €83.0 billion and net income of €6.2 billion. At the end of September 2017, the company had around 372,000 employees worldwide. Further information is available on the Internet at www.siemens.com

PREMIUM SPONSOR

SIEMENS
Ingenuity for life

Contact:

Frank Kovacs
Market Programs and Operations
Cloud Applications Services
Mind Sphere
Phone: +1 513 607-4550
Email: frank.kovacs@siemens.com

ABOUT PAC

Founded in 1976, Pierre Audoin Consultants (PAC) is part of CXP Group, the leading independent European research and consulting firm for the software, IT services and digital transformation industry.

CXP Group offers its customers comprehensive support services for the evaluation, selection and optimization of their software solutions and for the evaluation and selection of IT services providers, and accompanies them in optimizing their sourcing and investment strategies. As such, CXP Group supports ICT decision-makers in their digital transformation journey.

Further, CXP Group assists software and IT services providers in optimizing their strategies and go-to-market approaches with quantitative and qualitative analyses as well as consulting services. Public organizations and institutions equally base the development of their IT policies on our reports.

Capitalizing on 40 years of experience, based in 8 countries (with 17 offices worldwide) and with 155 employees, CXP Group provides its expertise every year to more than 1,500 ICT decision-makers and the operational divisions of large enterprises as well as mid-market companies and their providers. CXP Group consists of three branches: Le CXP, BARC (Business Application Research Center) and Pierre Audoin Consultants (PAC).

For more information please visit: www.pac-online.com

PAC's latest news: www.pac-online.com/blog

Follow us on Twitter: @CXPgroup



A CXP GROUP COMPANY

PAC - CXP Group
15 Bowling Green Lane
EC1R 0BD London
United Kingdom

Phone: +44 207 251 2810
Fax: +44 207 490 7335

info-uk@pac-online.com
www.pac-online.com

DISCLAIMER, USAGE RIGHTS, INDEPENDENCE AND DATA PROTECTION

The creation and distribution of this study was supported among others by premium sponsor Siemens.

For more information, please visit www.pac-online.com.

Disclaimer

The contents of this study were compiled with the greatest possible care. However, no liability for their accuracy can be assumed. Analyses and evaluations reflect the state of our knowledge in November 2017 and may change at any time. This applies in particular, but not exclusively, to statements made about the future. Names and designations that appear in this study may be registered trademarks.

Usage rights

This study is protected by copyright. Any reproduction or dissemination to third parties, including in part, requires the prior explicit authorization of the sponsors. The publication or dissemination of tables, graphics etc. in other publications also requires prior authorization.

Independence and data protection

This study was produced by Pierre Audoin Consultants (PAC). The sponsors had no influence over the analysis of the data and the production of the study.

The participants in the study were assured that the information they provided would be treated confidentially. No statement enables conclusions to be drawn about individual companies, and no individual survey data was passed to the sponsors or other third parties. All participants in the study were selected at random. There is no connection between the production of the study and any commercial relationship between the respondents and the sponsors of this study.



BARC · Ie CXP · PAC