Predictive Maintenance: Five Techno-Economic Indicators you need to know

One of the main goals of our H2020 PROPHESY is to lower the barriers for the successful adoption of predictive maintenance solutions for manufacturing lines and related assets. To this end, PROPHESY is providing technical solutions (e.g., data collection, advanced machine learning and AI analytics, mobile dashboards, Augmented Reality) and deployment tools for predictive maintenance solutions. Likewise, it also designs and implements solutions and tools for calculating techno-economic parameters and estimating the costs and benefits of PdM, as a means of facilitating the calculation of the PdM's tangible benefits on industrial organizations bottom lines.

Predictive maintenance is nowadays considered as the killer application of Industry 4.0. There are two main reasons for this:

First there are already predictive maintenance deployments that have proven to provide positive Return on Investment (ROI) for industrial enterprises, which encourages the faster adoption and use of this novel maintenance paradigm. In particular, the proven benefits of predictive maintenance include better utilization of assets, reduction of unplanned downtime and safer field service processes.

Second predictive maintenance deployments are applicable in all industrial sectors such as manufacturing, energy, oil & gas, buildings and public infrastructure, as in all these sectors enterprises have to maintain, repair and service assets.

Despite the proclaimed benefits of predictive maintenance, industrial organizations are always concerned about the tangible and quantitative benefits of this maintenance paradigm. Quantification is key to justifying investments on predictive maintenance (e.g., such as investments in new sensors, machinery and software licenses), but also to convincing the business management to undertake these investments. Quantitative indicators are also very important when evaluating the positive effects of a deployment and comparing it again similar deployments, including the ones of the "best-in-class" in the industry. In particular, techno-economic indicators support industrial organizations in the following crucial processes:

Justification and Evaluation of PdM Investments: In most cases C-level executives (e.g., CFOs) need to become convinced about the positive effect of an investments in their corporate bottom lines prior to supporting it. Therefore, techno-economic and financial indicators about predictive maintenance investments can shed light on whether it's worth to plan and undertaken an investment.

Comparison of Alternative PdM Solutions: When preparing for predictive maintenance deployment, industrial enterprises have to evaluate and compare alternative solutions by different vendors and integrators. In most cases the comparison takes into account technical and economic criteria, which can be objectively reflected in various techno-economic indicators.

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Deciding on the Proper Mix of Preventive and Predictive Maintenance: There are numerous options for adopting a PdM solution. In most cases organizations employ preventive maintenance approaches that replace or service assets in advance, as means of safely avoiding unplanned maintenance and malfunctions of production lines. Preventive approaches are not optimal, yet they can be very effective for some assets (e.g., cheap assets that are replaced frequently). Therefore, we should not always take for granted that a transition from preventive to predictive maintenance is preferred for all assets. In this context, enterprises can use techno-economic indicators in order to decide the optimal mix of preventive and predictive maintenance i.e. deciding on the assets for which predictive maintenance should be applied.

Positioning against the "best-in-class": Following the successful deployment of a predictive maintenance system, organizations may want to access the benefits of the deployments against the state of the art. To this end, the values of various techno-economic indicators can be used as benchmarks for comparing the PdM-related performance of different organizations. Organizations

To support the above-listed techno-economic evaluation processes, industrial organizations calculate the above listed indicators:

Total Cost of Ownership (TCO): This refers to the calculation of the entire costs that comprise a PdM investment, including hardware costs (e.g., costs for sensors and servers), installation and deployment costs, software licensing costs, training and transition costs, cloud subscriptions costs (including costs for maintenance as a service subscriptions), costs for maintaining PdM software and more. TCO calculation shall take into account both capital expenses (CAPEX) and operational expenses (OPEX) as a means of calculating the total initial (upfront) PdM investment and the annual costs for operating the PdM deployment. The latter are key inputs for financial calculations such as the calculation of capital budgeting indicators like the ROI (Return on Investment) and the NPV (Net Present Value) associated with the Predictive Maintenance Deployment.

Total Benefits of Predictive Maintenance: PdM is theoretically associated with a wide range of benefits such as a reduction in inventory costs and unplanned downtime. Using international best practices and reference values provided by consulting firms. These benefits can be translated to estimates about cost savings and monetary gains. In particular, the monetary benefits of PdM can be approximated based on the sum of annual estimates about savings in spare parts, reduction of inventory costs, reduction of maintenance related expenditures, reductions in costs associated with unplanned downtime, as well as reduction of the overall operation costs that are associated with the assets for which PdM is applied. The calculation of the total benefits of a PdM solution is useful both for companies planning to adopt PdM (i.e. as a prospective indicator) and for companies that have already deployed PdM (i.e. as a monetary benchmark before and after the PdM deployment). The latter enterprises may also combine their total benefits with the TCO of their solution(s) in order to see where they stand with respect to the "best in class" enterprises.

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Average Cost of Downtime: PdM reduces the cost of downtime for specific machinery and asset. This reduction can be a significant component of the benefits of a PdM solution, which can be used to justify relevant investments. The cost of downtime can be approximated as the sum of lost revenue (i.e. due to the production of less products/items) and of the employees' idle time (i.e. as employees are paid but not working during downtime).

Replacement Asset Value (RAV): PdM reduces the RAV, when compared to the RAV of conventional reactive and preventive maintenance. A reduced RAV means that a manufacturer is making a more effective use of the asset and therefore getting more value on the original CAPEX of the asset. A RAV of approx. 10% is generally considered good, while 1% can be considered best in class. In practice, a RAV of 10% indicates that a manufacturer can buy new replacement capital assets every 10 years, when considering its annual expenditure on maintenance. As a result, RAV is extremely useful for taking decisions associated with the replacement and/or refurbishment of assets. Moreover, RAV can be combined with the TCO of a maintenance solution, in order to evaluate the impact of a specific PdM investment on the RAV of one more asset. Likewise, it can be used to gauge whether improvements in RAV of an asset, justifies the TCO of the PdM investment for the same asset.

Overall Equipment Efficiency (OEE): Most PdM adopters aim at achieving a substantial improvement of their OEE. Therefore, it's essential that they calculate their OEE in credible way. OEE for an asset is defined as the product of its Availability, Quality and Performance. Availability is calculated after dividing the actual run time with the planned production time of the equipment. Performance is calculated as the product of ideal cycle time with the total parts produced, divided by the run time. Quality is calculated by dividing the good parts produced by the total number of parts produced (including the defects). The above listed parameters can be either calculated by production monitoring systems (e.g., quality management systems) or even provided empirically by experts of the workforce (e.g., production managers). By calculating OEE before and after the deployment of a PdM solution, enterprises can benchmark their OEE improvement.

In H2020 PROPHESY we have developed tools for calculating the above listed indicators, with a view to supporting all of the listed use cases (e.g., comparison of alternative solutions, benchmarking against the best in class, planning of future deployments). We will soon make these tools available as part of the PROPHESY solutions ecosystem, which will become available at: www.pdm4industry.eu.

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