Chapter 8
A Model for Assessing the Widening of the Predictive Maintenance Strategy

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ABSTRACT

The essential aim of Industry 4.0 is to enable industries to be more productive, efficient, and flexible. A predictive maintenance strategy can make a positive contribution to all these things, as it uses industrial IoT technologies to monitor asset health, optimise maintenance schedules, provide real-time alerts about operational risks, and maximise uptime, and can provide digital services to customers based on data from its machines. It improves productivity, improves customer satisfaction, and therefore gives the company a competitive advantage. Nevertheless, decision making in relation to a predictive maintenance strategy is not systematised, and this may lead to some inappropriate decisions, which do not achieve the goal sought. This chapter describes a multicriteria model, designed with the analytic hierarchy process, to systematise decision making with respect to a predictive maintenance strategy.

INTRODUCTION

Predictive Maintenance (PM) is a maintenance strategy in which parameters correlated with the condition of physical assets are monitored periodically or continuously, to identify their state, and, if the state is not good, to provide a diagnosis of the fault and the remaining lifetime of the machine. PM is sometimes called Condition-Based Maintenance; however, PM also has a prognostic phase to its application (Shafiee, 2015)

PM is thus fundamental to Industry 4.0 as it predicts asset failure by analysing data on vibration, temperature, the state of the lubricant used, ultrasound, corrosion, etc., at times combined with produc-

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tion data, to identify patterns and predict failures before they happen or can affect production, quality and safety. Thus, PM can make industries more productive, efficient and flexible, which are the end goals of Industry 4.0. It should also be considered that the structure and behaviour of productive systems are both increasing in complexity, and so the volume of available data is also increasing, meaning that it is possible that all the available information cannot be accurately analysed by those making the diagnosis before the asset fails. It is thus useful to find alternatives to handle these quantities of data efficiently, and perform prognostic tasks automatically (Cao, Giustozzi, Zanni-Merk, de Bertrand and Reich, 2019). Smart Predictive Maintenance has recently emerged going beyond traditional PM in three ways (Durmus, 2019):

- A network of connected assets is controlled via the Internet of Things (IoT). The IoT connects PM information to the Internet. This allows all the assets to be monitored simultaneously. Also, by combining network data from operational technologies, patterns may be found between asset failures, and machine learning used to optimise the prediction algorithms over time.
- Some maintenance tasks can be automated. When a fault is detected, a maintenance work order can be emitted, a technician assigned to it, and a ticket programmed within a Computerized Maintenance Management System (CMMS). The spare parts inventory can then be checked for the necessary replacement for the defective component in an Enterprise Resource Planning (ERP) system, and the work order included within it. If there is no spare to replace the defective component, a purchase order can be generated automatically in the ERP.
- It can be integrated with other maintenance management systems. The PM platform could be introduced into other systems, such as ERP, CMMS, or Manufacturing Execution System (MES) to automate certain specific tasks. Integrating Smart PM with other management systems can automate all the maintenance processes over time.

Nevertheless, despite the significant improvements that a PM strategy can bring to the areas of safety, quality, productivity, availability, cost, company image, the environment (reducing energy consumption and greater use of assets) (Carnero, 2005) and therefore, in competitive businesses, contributions that analyse matters related to decision making in the introduction and management of a PM strategy are very limited (Carnero, 2006; Veldman et al. 2011); in fact, the costs and benefits of PM strategies are often not explicitly defined or assessed (Tiddens et al. 2017) and so in general, industries that apply it are still in the rear guard of the theoretically advertised benefits (Bianchini, Pellegrini, & Rossi, 2019). However, the technical aspects of applying a PM strategy are widely represented in the literature as new diagnostic techniques, case studies of fault diagnosis on different parts and devices, and prognosis studies (Carnero, 2016). Introduction will therefore be inefficient and will not achieve the goals sought, nor reach the full potential of the strategy. And so, this chapter describes a multicriteria model built on an Analytic Hierarchy Process (AHP), to systematise decision making in the widening of a PM strategy.

Among the contributions to different aspects of decision making in a PM strategy is Carnero (2004), which describes an indicator system to control the early detection of anomalies during the implementation stage of a PM strategy. It thus describes a predictive control of the PM strategy. The system comprises a series of indicators organised into four categories: economic evaluation, external and internal quality of the CBM, organizational structure and evolution over time. Carnero (2005) proposes a model combining AHP and factor analysis for choosing diagnostic techniques and instrumentation in PMs, integrating lubricant and vibration analyses. Carnero (2006) describes a model built by AHP and a series of decision