Chapter 16
Data-Driven Decision Making to Select Condition-Based Maintenance Technology

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ABSTRACT

Condition-based maintenance (CBM) may be considered an essential part of the Industry 4.0 environment because it can improve production processes through the use of the latest digital technologies. The literature includes a large number of contributions on new techniques for diagnosis, signal treatment, analysis of technical parameters, and prognosis. However, to obtain the expected benefits of a vibration analysis program, it is necessary to choose the instruments and introduction process best suited to the organization, and so guarantee the best results using data-driven decision making in accordance with the needs of Industry 4.0. Despite the importance of these decisions, no relevant models are found in the literature. This contribution describes a fuzzy multicriteria model for choosing the most suitable technology in vibration analysis. The goal is to create a model that is easy for organizations to use, and which reflects the judgements of a number of experts in maintenance and vibration analysis. The model has been applied to a Spanish state-run healthcare organization.

INTRODUCTION

As described in OECD (2017), Industry 4.0 has to do with the application in industrial production of the latest digital technologies, generally interconnected, to achieve new or more efficient processes.

These new technologies include big-data analytics, cloud computing and the Internet of Things (IoT), and will involve a huge digital transformation in companies, affecting the whole value chain. This transformation could lead to benefits in products, processes and business models. However, logistic and support processes for production, which include asset management, could also be a target for the application of Industry 4.0, as they have a very important role in improving the productivity of industrial processes, and even in creating new services with high value added for the customer. For example, by

DOI: 10.4018/978-1-5225-7152-0.ch016

setting up an automatic on-line predictive data acquisition system in an organization, sending the data instantaneously to the supplier of the critical device for remote analysis of the state of the equipment, allowing early detection of anomalies and faults which might diminish the quality of the product and affect productivity (Ferreiro, Konde, Fernández, & Prado, 2016).

Thus, condition-based maintenance can be seen to be an essential component of Industry 4.0 due to its ability to improve production processes by the use of the latest advances in digital technologies. For example, automatic learning can be achieved via the Industrial Internet of Things (IIoT).

The predictive maintenance software collects data which is transferred and analyses using predetermined rules and conditions. This automatic analysis provides a large quantity of data, which can be analysed by Big Data, allowing the company to be alerted to inefficiencies and future breakdowns in real time. The whole process requires automatic connection of all the data, both the process data and predictive data, and so an interconnection of the software used in the company is also needed, such as the Computerised Maintenance Management System (CMMS) or Enterprise Resource Planning (ERP).

This chapter describes a model for introducing advanced predictive technologies in industry, especially in the kinds of businesses, like health care organizations, which are very out-dated with respect to the energy, manufacturing, transport etc. industries with regard to the use of predictive techniques and the integration with on-line platforms for maintenance management. This favours:

- Adapting to demand for care services, providing the number of services requested, as assets are available at the time of need.
- Attending to patients with fewer delays, waits or cancellations of appointments due to unavailability of assets.
- More personalised attention to patients.
- More efficient use of resources.

Vibration analysis can be of great benefit to an organization. These benefits include improvements in availability of facilities and equipment, and in the quality of manufactured products and components, meeting delivery times, improvements in operational safety, reductions in maintenance costs (equipment and labour), reductions in inventory and energy consumption, as well as contributing to gaining and retaining ISO 9000, QS 9000, and other certifications, providing the ability to check the quality of maintenance activity, savings in machine replacements due to longer-lived machines, and improvements in business sustainability (reduction in material and human resources, avoidance of obsolescence of spares, decrease in pollutant spillage, protection of human resources from unexpected faults, etc.) (Bari, Deshpande, & Patil, 2015; Carnero, 2005; Carnero, Gónzalez-Palma, Almorza, Mayorga, & López-Escobar, 2010; Carnero, López-Escobar, González-Palma, Mayorga, & Almorza, 2015; Carvalho, Gomes, Schmidt, & Brandão, 2015; Charray, 2000; Jardine, Lin, & Banjevic, 2000; Mobley, 2001; Precup, Angelov, Costa, & Sayed-Mouchaweh, 2015). This all leads to an increase in profitability. Furthermore, manufacturers can now include diagnostic and prognostic services for the machinery they sell, which is seen as a competitive advantage.

Vibration analysis is the most commonly used predictive technique (Mahmood, 2011), as it is the most versatile, and can be applied to a wide variety of machines and diagnose a large number of faults and failures (Khwaja, Gupta, & Kumar, 2010). There is also the possibility of developing an automatic diagnostic system based on a pattern recognition technique or an amplitude modulation detector (Yang, 2015).