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IFAC PapersOnLine 55-10 (2022) 2318–2323

Maintenance-Free Factory: A Holistic Approach for Enabling Sustainable Production Management

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Abstract: For decades, different approaches have been designed and implemented for optimizing maintenance management systems in manufacturing. Especially advancing digitalization is leading to novel data-driven maintenance methods and strategies. However, the envisaged value-added implementation of novel solutions faces several challenges in the industrial context. Despite plausible advantages for manufacturing enterprises, maintenance is not yet considered as an enabler and driver of sustainable and resilient production management. Maintenance-Free Factory (M2F), thereby, is to investigate unexhausted potentials for transforming maintenance to an enabler rather than cost-driven system along manufacturing. Pursuing this line of research, this position paper reflects the perspective of the authors on maintenance management, based on experiences gained from research and practice over the past years. It aims to trigger thoughts on the vision of M2F considering i) profound change in maintenance organization and processes, ii) value-driven application of diagnostics, predictive and prescriptive methods, iii) significant change in the competence profile of maintenance engineers, and iv) a reorientation in strategic mind-set of managers and chief production planners. A key element is exemplary discussed in detail, i.e., the need for a flexible maintenance shift model, which may lead to a significant increase in performance of production systems and increase of overall equipment effectiveness.

Keywords: Digital transformation; maintenance; planning; production management; shift model; industrial data science.

1. INTRODUCTION

What ways can make a difference in the future of industrial maintenance? To answer this question, the term "maintenance-free factory" (M2F) has been addressed by the academic community, especially by the national academy of science and engineering in Germany (Acatech). M2F aims at planning and optimizing production processes with the highest resilience to external and internal disturbances, thus enabling sustainable production management (Henke et al., 2019). However, M2F has not been yet sufficiently explored in the body of knowledge in maintenance and operations management. It is in fact a quite vague and industry-oriented concept that requires scientific foundation. Yet, there is room to critically investigate how this concept can be defined and how it can contribute to the state of the art in maintenance and operations management. This position paper reflects the perspective of the authors on M2F towards laying the ground for future research. In this paper, the concept of M2F emphasizes that maintenance is an integral part of production systems throughout the entire product life cycle, including original equipment manufacturers (OEMs) and machine users.

Manufacturing enterprises, especially asset-intensive industries, aim at increasing the reliability, availability, maintainability and safety of industrial machines, while keeping maintenance costs under control (Bousdekis et. al., 2015 & Golpîra and Tirkolaee, 2019). An increase in product individualization and market volatility while shortening lead times results in increasing complexity in production and maintenance planning. For decades, production and maintenance planning have been mostly considered separately. This lack of a communication channel and integrative modeling and analysis is also evident in the literature of production, maintenance and operations management (Ansari et.al., 2019 & Liu et.al.,2018). For this purpose, it is necessary to consider the relation between maintenance and production planning in strategic, tactical and operative levels. In many cases, production units need to be shut down for maintenance activities, which may lead to a tension between the production and factory maintenance of a company and most importantly affects lead times. On the one hand, a sustainable and resilient production system needs maintenance. On the other it leads to shutting down the operations and therefore causes the loss of production margins, i.e. reduced overall equipment effectiveness (OEE). When planning maintenance, one needs to take production into account and vice versa. Maintenance is often seen as a subsidiary of production processes in the literature (Glawar et.al., 2021 & Budai et.al., 2008). Further, maintenance attempts to impose constraints on the production that it deems necessary to achieve complete equipment reliability. Consequently, the implementation of an optimal maintenance policy is constrained by the demands of production. Focusing on M2F, maintenance should become an enabler and driver of sustainable production management, i.e. integral part of the overall business strategy, and should be coordinated and scheduled within manufacturing activities. Thus, maintenance

Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2022.10.054