Review on Sustainable Industrial Maintenance

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ABSTRACT: ***Organizational success is no longer only measured in terms of financial factors. The use of social and environmental indicators is becoming more popular. The balance of these three aspects (the Triple Bottom Line - TBL) in day-to-day organizational operations to achieve better levels of performance is a complicated problem that involves the cooperation of many areas with their conflicting demands for resources and goals. The TBL dimensions are influenced by industrial maintenance. Semantic models, decision-making, and interoperability research have lately focused on improving maintenance performance. However, there is a need to talk more about how industrial maintenance affects organizational sustainability and vice versa. This study seeks to close this gap by describing industrial maintenance in a sustainable context via a systematic evaluation of papers published in peer-reviewed journals, with an emphasis on supporting themes like interoperability, ontology, and decision-making. What effect can updated maintenance, often known as "Smart Maintenance," have on the functioning of industrial plants? As a result of the shift to an industrial environment with ubiquitous digital technology, this issue has become a serious problem for practitioners and academics in industrial maintenance management.***

KEYWORDS: ***Decision-Making, Industrial Maintenance, Interoperability, Semantic Models, Sustainable Performance.***

1. INTRODUCTION

According to the Triple Bottom Line (TBL),[1] the framework of sustainable production and has had its conceptual structure reinforced by it. The three aspects of TBL are the economic, environmental, and social dimensions. Maintenance[2] is critical in the pursuit of long-term performance, especially in the context of achieving success in TBL's three dimensions in industrial production. In terms of finances, emphasize the significance of the maintenance function's operations in achieving the operational outcomes anticipated by the business in which it works. According to, this new productive idea is linked to long-term performance.
One of the current difficulties in this situation is to find ways to integrate maintenance and the producing sector via company information systems. According to the report, they are primarily represented on two levels: Enterprise Resource Planning (ERP)[3] and Manufacturing Execution Systems [4] (MES). According to, one of the challenges in integrating information systems is the heterogeneity of databases, which are based on various models. Interoperability plays a significant role in this context since it allows various systems to communicate with one another. Knowledge structure, on the other hand, allows for efficient integration of information systems. The representation of knowledge structure may be created using ontologies in order to achieve effectiveness in knowledge management [5]–[7].

A rise in scholarly papers on ontologies and sustainable performance has been documented from the beginning of the 2000s, as demonstrated in this article. They were chosen using the Systematic Review of Literature (SRL) concept after scanning scholarly publications. SRL and the conventional approach of literary research are both exploratory investigations, although they vary in terms of their guiding style. While literary research is based on the author's own viewpoint or objectives (or process), SRL is based on a clearly stated research objective, organized in a systematic way protocol. It is carried out using well-known methods and action-oriented principles. For example, proper structure reduces research subjectivity and enables for the synthesis and critical assessment of pertinent studies.
Due to the current variety of research sources, emphasize the necessity for an SRL mapping and demonstrate how it differs from conventional research methods. A Systematic Reviews Group is one of the suggested SRL guidelines.

The manufacturing sector is experiencing significant transformation as a result of fast advancements in digital technologies and lower technology-related expenses. As a result, extensive study is being conducted to determine the adoption trends and performance results of manufacturing facilities in the ‘Industry 4.0' era. Maintenance departments at industrial facilities are also working hard to adapt to this shift. For example, in order to increase productivity while lowering maintenance costs, they are attempting to implement new

technologies and invest in new skills. However, decision makers and practicing managers in industrial maintenance are having difficulty defining and/or agreeing on the goals of this change. Furthermore, even if the objectives are specified, the methods for achieving them are not well understood. At the same time, there is a scarcity of useful and actionable information.

2. DISCUSSION

In the first article, the general concept and execution of the large-scale qualitative research are detailed and openly described. As a result, in this second article, we outline the study's main methodological stages while urging interested readers to read the first paper for more information. We place a greater emphasis on openly revealing our underlying rationale for the method we used to identify conceptual variables and the general pattern of connections in this section.

The research provided here is categorized as an SLR and is based on [9]'s criteria. Before beginning an SLR, a time series of published papers was constructed with the goal of determining the optimum period for conducting a bibliographic search in scientific references databases relevant to the work's topic. Table 1 shows the papers that made up this series, which were published in 15 different journals.

Table 1: Scientific references databases used and their associated journals.

Database	Journals
Science Direct	Advanced Engineering Informatics Computers in Industry Decision Support Systems Engineering Applications of Artificial Intelligence Information sciences International Journal of Production Economics Journal of Cleaner Production Reliability Engineering & System Safety
Taylor & Francis	Enterprise Information Systems
IEEE Xplore Digital Library	International Journal of Computer Integrated Manufacturing
Springer	Production Planning & Control: The Management of Operations
Informs Pub on line	IEEE Transactions on Intelligent Transportation Systems IEEE Transactions on Reliability
	International Journal of Advanced Manufacturing Technology Manufacturing & Service Operations Management

These publications were chosen experimentally based on their significance and relevance to the paper's writers. From 1994 to 2014, some research was conducted using the publications listed in Table 1 on five important topics: interoperability, prognostics and health management (PHM)[8], ontology, decision support for maintenance, and sustainable performance. Using search keywords generated from these subjects, search strings were constructed to conduct searches in reference databases, and some articles were found.

Only articles written in English were regarded as a limitation. The title, abstract, and keywords of the papers were read, and their relevance to the specified subjects was determined. As a result of this action, the time period for completing this article was extended from January 2003 to March 2015.

Following this, a study protocol was developed, which included a problem space defined by two concepts: maintenance and long-term performance, as well as a solution space defined by two concepts: interoperability and ontology. Table 2 shows how search keywords relevant to the study proposal were linked to these four driving ideas.

The development of search strings was facilitated by the synthesis of search words, and both search terms and strings were refined via an iterative search and analysis process. Composition maintenance decision-

making, for example, will be linked to long-term performance, interoperability semantics, and an ontology-based approach.

As a consequence, the terms approach, methodology, technique, support, process, and design were used to search for the structure suggested by the guideline. The comparison step of the method was skipped. Furthermore, at this step of the study, the search phrase was composed using the Boolean operators AND / OR. This composition enables for the study to be expanded to include the connection (AND) and the total number of words (OR).

Following that, the criteria for finding and categorizing the works are given, as proposed by [9]. In Subsection 3.1, inclusion and exclusion criteria are addressed, and in Subsection 3.2, criteria for defining research types are given. Subsection 3.3 defines the phases of searching, and Subsection 3.4 describes the criteria used to classify the articles that were chosen.

Table 2: Search terms

Search terms related to concepts in the problem space	***Search terms related to concepts in the solution space***
Maintenance: decision-making, strategy, management, PHM **Sustainable**: performance, triple bottom line, indicators, methods	**Interoperability**: semantic, standards, assessment **Ontology**: based-approach, design, engineering, knowledge management

2.1 Characteristic of Sustainable Industrial Maintenance:

Industrial Ecology (IE),[9] which is primarily described as a science of sustainability, considers product maintenance in the context of the whole product life cycle. In a holistic or systems thinking approach, it is important to consider system complexity and a multidisciplinary perspective while managing assets as a whole. Green maintenance, which aims to make maintenance more environmentally friendly by removing all waste streams connected with it, entails integrating product design problems with maintenance planning and execution difficulties with the goal of reducing negative environmental impact. Maintenance design[10], maintenance strategy planning, maintenance task management (based on a chosen strategy), assessment of maintenance outcomes, improvement of maintenance and products, and dismantling planning and execution are all part of life-cycle maintenance.

In a more macroeconomic context, maintenance is seen as an enabling system for sustaining artefacts throughout their life cycle, then as a key tool for preserving the artefacts' regeneration potential, and finally as a target system that must be sustainable because a maintenance system is also a system that consumes and produces flows. Total Productive Maintenance (TPM) improves equipment performance, reduces failures, and encourages autonomous maintenance by operators via day-to-day operations engaging the whole workforce in a more short-term and local viewpoint. While this strategy is initially focused on improving economic impacts (overall equipment effectiveness - OEE), it also improves the most rarely considered social dimension: safety (improving workplace environment, eliminating hazardous situations), moral (increasing employee knowledge, involvement, and empowerment), and social relations (increasing employee knowledge, involvement, and empowerment) (managing synergic cooperation of production and maintenance). The principles of e-Maintenance are used to improve the management procedures and activities linked to the entire maintenance process, as well as the cost reliability, security, and lifespan of key systems.

Finally, many writers believe that the Opportunistic Maintenance approach is the best fit for the emerging problems of lean manufacturing systems (OM). A systematic technique of gathering, researching, preplanning, and publicizing a set of suggested maintenance tasks and acting on them when an unplanned breakdown or repair "opportunity" occurs is characterized as OM. In the context of driving maintenance

operations, seizing chances to take advantage of economies of scale or pool maintenance resources seems to be a method to contribute to the economic and environmental aspects of sustainable performance. However, regardless of the temporal or geographic scale on which we evaluate maintenance and its effect on long-term performance, this contribution is subject to certain constraints.

This new productive scenario necessitates favorable conditions for the maintenance function to be more closely integrated into production management systems in terms of informational and process perspectives, technological barriers being overcome, semantic understanding improving, and strategic alignment being promoted. Maintenance regulations have altered in this regard to align with a Product Life Cycle approach, in which activities should be synced with the manufacturing process as needed for an opportunistic maintenance plan. A major problem around a shared understanding of economic, environmental, and social performances between production and maintenance managers is the dispersion of interests and languages. Show that in the context of life on this subject

4. CONCLUSION

The paper provided an overview of maintenance management methods, namely Maintenance, and its application to decision-making on positional error calibration. This article focuses on predictive calibration as a proactive strategy to resolving machine tool inaccuracy and the decision-making process issue, emphasizing the significance of distinguishing between events and the need for on-machine inspection, preventative, and predictive calibration. This research aims to redefine the role of maintenance management techniques and create a framework to assist the process of adopting a predictive calibration program as a primary approach for supporting a shift in machine tool calibration decision-making philosophy. This article looks at some of the various TPM pillars for the issue of maintaining machine tool position accuracy.

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