

Abstract

The paradigm of sustainable manufacturing has attracted a great deal of attention over the last decade as an emerging manufacturing approach intending to empower the enterprises to cope with several challenges (such as depletion of physical resources, stricter laws and regulations, economic stagnation, and customer request for higher product quality) and guide them to stand out in today's competitive environment. Sustainable manufacturing is defined as creation of manufactured goods through the use of a series of processes that minimise the negative environmental impacts, conserve energy and natural resources, are safe for employees, communities and consumers, and are economically sound.

In such today's competitive industrial context, maintenance process is major lever of organisation efficiency. Indeed, maintenance provides company the ability to keep its production system in efficient state and able to provide product at the required quality. In that way, maintenance process has a large potential in pursuit of sustainable manufacturing thanks to its impact on other company's processes. In fact, maintenance affects production volume and costs, asset performance, equipment availability, quality of the final product, but also health and safety of people, the surrounding natural environment and the social welfare. Maintenance has many direct and indirect impacts on sustainability-related aspects and a proper and sustainable management of maintenance processes lead to reduce and control such impacts. A sustainable maintenance management strives for more efficient resource and energy management, for reduction of wastes associated to maintenance, elimination of negative environmental impact, and guarantee of employees and stakeholders' safety.

Despite of the increasing attention on the aforementioned area of investigation in very recent years, an exhaustive and detailed literature review related to 'maintenance and sustainability in industrial context' was not found. For this reason, the current state of the art was investigated in order to provide an overview of the literature in 'maintenance and sustainability'. The review was conducted through a scoping literature review methodology that, differently from conventional reviews based on the author knowledge perspective, follows a protocol minimizing the subjectivity. The main information was extracted and gaps were identified.

First, the literature review underlined the research challenge of better investigating and defining maintenance impacts on economic, environmental, and social sustainability. Therefore, the relationships between maintenance processes and sustainability indicators should be defined and formalised. A sustainable maintenance management should reduce maintenance impacts and their consequences, and new frameworks/methodologies/models should be defined in order to guide the stakeholders to reduce economic, environmental and social impacts associated with industrial maintenance activities.

A conceptual framework for measuring maintenance impacts on sustainability was then developed and provided in the thesis as scientific contribution to the research challenge identified and reported above. Therefore, maintenance impacts on sustainability and the relationships between sustainability indicators and maintenance processes were identified. The developed framework can guide and help several stakeholders to define maintenance direct and indirect impacts on sustainability aspects, to select the indicators of interest for measuring such impacts, and to be more aware about maintenance and sustainability relationship.

The framework was then validated through a pilot survey study conducted to reach such goal. In particular, an ad hoc defined interview was submitted to several stakeholders of different industrial contexts and the main results allowed validating the content of the framework. Contextually, the spread of measurement of maintenance impacts on sustainability in industrial field was unveiled.

The main contributions of this research can therefore be summarised as:

- the definition of the concept of 'sustainable maintenance';
- the development of a scoping literature review in the research area of 'maintenance and sustainability in industrial context';
- the identification of gaps and research challenges in the research area;

- the identification of maintenance impacts in the organisation up to the customer in the three pillars of sustainability through the definition and formalisation of sustainability indicators of different systems affected by maintenance processes;
- the development of a holistic conceptual framework for measuring maintenance impacts on sustainability, applicable to a wide range of industrial contexts;
- the development of a pilot survey study through the submission of an interview defined ad hoc for validating the content of the framework and for unveiling the current spread of measurement of maintenance impacts on sustainability in industries.