ANALYZING THE RELATIONSHIP BETWEEN SUSTAINABILITY AND MAINTENANCE IN THE FACILITIES SECTOR

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Abstract

The research is related to analyzing the relationship between sustainability and maintenance in the facility sector. A lot of attention has been given to sustainability in the past. In the facility sector, maintenance is the key strategy for achieving sustainability as it helps in maintaining the quality of the product and makes the production cost low (Benoitlung & Levrat, 2014). Maintenance helps in making the product efficient and also fulfills the demand of the environment. Using new technology to integrate sustainability goals into traditional maintenance management is a creative management approach to sustainability (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020). According to the research conducted in the past, maintenance impacts production volume, expense, machine performance, equipment availability, and final product quality (Sinaga, Suharyono, Musadieq, & Iqbal, 2022). The aim is to find out the impact of maintenance in the facility sector. This research has utilized a systematic review to fulfill the gap in the research and to formulate the results. According to the result, digital technology is the key strategy that is helping the utility and facility sector to achieve sustainability by maintaining it in a positive manner (Sabatin, M.Frangopo, & Dong, 2015). Therefore, it is recommended that facility companies may use digital technology to create a significant impact, unlock new efficiencies, reduce material consumption, and maintain quality for achieving a climate-positive future.

1. Introduction

In industrial settings, maintenance is performed on a variety of assets to keep them operating or to restore them to their original condition (Franciosi, Benoitlung, Miranda, & Riemma, 2018). This strategy is often applied to large machines and equipment to ensure their optimal functioning. Cleaning bearings, replacing filters, pumping tyres, and repairing conveyor belts, reactors, and pumps are just a few of the things that are accomplished using this method (Benoitlung & Levrat, 2014). Controlling airflow and air quality, replacing filters, maintaining tyres, and fixing conveyor belts, reactors, and pumps are just a few of the things that are included in this category. The strategy keeps many of these operations running efficiently and supports "the triple bottom line of sustainability: people, the planet, and profits" (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020).

A lot of attention has been given to sustainable manufacturing in facilities as a new technique in the last decade, thereby prompting facility companies to meet sustainability targets (Sabatin, M.Frangopo, & Dong, 2015).

Maintenance is very important for a facility industry as it allows the organization to make its production system efficient by maintaining quality in every aspect (Hojjati, Jefferson, & Metje, 2018). It has the potential to increase the volume and lower the cost, as well as maintenance, can perform asset performance and make the equipment available all the time. Maintenance in the facility also helps to maintain the workers' health and safety and also to make the national environment sustainable (Ahmad, et al., 2021).

The demand for higher product quality and economic instability have made life difficult for facility manufacturing companies, which must also deal with physical resource depletion, higher laws and regulations, and frequent economic downturns. Many firms have used sustainable manufacturing as an innovative manufacturing strategy to cope with these issues and gain an edge in today's competitive market (Sabatin, M.Frangopo, & Dong, 2015).

Customers' demands, government and regulation, the environment's concerns, the shortage of natural resources, and rising energy costs are the key factors driving sustainability, and manufacturing processes that are sustainable are those that reduce adverse environmental impacts, conserve energy, and save natural resources and are also safe for workers, communities, and consumers (Sabatin, M.Frangopo, & Dong, 2015). It is the process through which the organization produces goods by using a series of procedures that alternately minimize the negative impact on the environment and also contribute towards conserving energy. It preserves natural resources and also it is safe for the workers and society as a whole. Sustainable production requires indicators to evaluate an organization's journey toward it. There are three aspects of economic environmental and social impact that should be evaluated by such a measurement (Vlasov, Shakhnov, Sergey, & Krivoshein, 2019). In other words, maintenance functions to preserve the operation of a company's manufacturing system in good shape and deliver high-quality merchandise. Maintenance has the potential to significantly influence other firms' procedures, making it a good candidate for sustainable manufacturing (Benoitlung & Levrat, 2014).

From an innovative management perspective, integrating sustainability goals into traditional maintenance management, as well as using new technologies and methods, are just a few of the strategies that maintenance can use to promote sustainability (Byrne & Taminiau, 2015). More research and real-world experience have contributed to highlighting the importance of maintenance's role in sustainable operations (Sinaga, Suharyono, Musadieq, & Iqbal, 2022).

Maintenance impacts reproduction volume expenses and also the performance of the machine and equipment. And all this ultimately creates a positive impact on the final product category and quality. Maintenance has a variety of consequences, including people's health and safety, the environment around them, and social welfare. Maintenance has numerous ramifications on sustainability issues, including the production process and final product quality because of their competence or inefficiency (Sinaga, Suharyono, Musadieq, & Iqbal, 2022). A proper, sustainable maintenance management strategy can minimize and control these effects (Sabatin, M.Frangopo, & Dong, 2015).

The maintenance activities of an asset or equipment must ensure the production process, product quality, and environmental sustainability in addition to minimizing economic, societal, and environmental impacts. In contrast, a sustainable business function must be maintained in order to minimize the flows and impacts produced by maintenance activities (Nezami & Yildirim, 2013).

The modern world relies on electricity, an essential part of the infrastructure and an important part of daily life (Nezami & Yildirim, 2013). Electricity has played a critical role in productivity, wages, and employment around the world, as well as the lifeblood of what is being called the new global economy. Around the world, electricity-based innovation is helping to build increasingly sophisticated global, real-

time networks (Vlasov, Shakhnov, Sergey, & Krivoshein, 2019). Because of electricity, the business will be spurred in a variety of industries, from lasers to microprocessors that will make future industrial efficiency improvements (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020).

In the near future (two to three decades), wind, solar, and biogas are becoming more and more popular electricity alternatives (i.e., they will increase in popularity in the future), but coal, nuclear, large hydroelectric, and gas will continue to be the bulk electricity fuels of the future (i.e., for the next twenty to thirty years). Each of them has a distinct sustainability problem. To keep nuclear as a future energy source, spent fuel or high-radioactive waste must be stored for a long period of time. The development of clean coal technologies and carbon sequestration strategies might be crucial for the continued use of coal (Sabatin, M.Frangopo, & Dong, 2015). Flooding of ecosystems and the relocation of populations might be prevented by developing clean coal technologies and carbon sequestration strategies (Byrne & Taminiau, 2015). The development of clean coal would be critical to the continued utilization of coal. The availability and expense of gas, despite its being a cleaner fuel than coal, would have to be addressed in the future. None of these generation options is without long-term environmental implications (CISCO, 2022).

Sustainable development techniques pose significant obstacles for the electric facility industry, not only those associated with introducing these techniques into business, but also doing so at a time when the industry is experiencing radical changes in the business environment (Franciosi, Benoitlung, Miranda, & Riemma, 2018). Electric facilities are faced with a variety of uncertainties regarding government regulations, the market's reorganization, client demands, and technological change (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020).

Future approaches to environmental and social issues may also be altered. Growing demand for transparency and stakeholder participation, in addition to a globalized and interconnected world, requires a more inclusive approach to future dialogue (Ahmad, et al., 2021). These stakeholders, including customers, regulators, governments, electricity sector regulators, environmental NGOs, and academics and scientists, have a significant influence on decision-makers, and because governments are considering future energy directions and individual facilities are seeking changes to their operating licenses, these stakeholders will play a key role in discussions about future energy alternatives (Byrne & Taminiau, 2015).

The environmental and social pressures facing electric facilities are complicated, and companies must invest substantial dollars in response to them (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020). The most promising avenues for great strides towards sustainable energy futures lie in collaborating with other companies in research and development, sharing information on innovative practices, and partnering (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020).

Goals and objectives

The core objective of this paper is to analyze the studies that have been conducted in the past related to the impact of maintenance on the facility and utility sector and also identify the sustainable indicators. The research has been carried out using a systematic literature review to fulfill the gap in the research and to formulate a result. There are a number of studies conducted in the past but still, there is a lack of a comprehensive framework of maintenance impact on the sustainability of the facility industries. Maintenance is key to sustainability in a building factor which means that we must broaden our perspective by starting from the perspective of sustainability rather than focusing on maintenance (Hojjati, Jefferson, & Metje, 2018). To achieve this goal, the first step is to define sustainability and its impact on maintenance procedures. In addition, the research must identify indicators to gauge these impacts. We will therefore be able to obtain a comprehensive understanding of the impact of maintenance activities on sustainability

through this research. The purpose is to provide a valuable contribution to solve the research challenge and to meet the research objectives in a comprehensive manner that could help the facility sector to become more sustainable in the future.

The research objectives are summarized below

- "To examine the connection between maintenance and sustainability concerns."
- "To investigate the maintenance impacts on the sustainability of facility industries."
- "To find out the indicators used for measuring sustainability impacts."

2. Research methodology

In this study, we carried out a structured review following a clearly defined objective to minimize subjectivity and to obtain a detailed picture of maintenance impacts on industrial sustainability. It is not based on the author's knowledge perspective but rather on a clear objective. First of all, we searched for and reviewed papers that examined the impacts of maintenance on facility manufacturing industries' sustainability. Next, we measured the impacts of maintenance on sustainability by collecting sustainability-related indicators.

Thereafter, we evaluated research gaps and challenges. Academics and industrialists should better understand the no negligible implications of maintenance processes on industrial sustainability, as well as the need to monitor those impacts in order to safeguard the three pillars of industrial sustainability.

This study has been undertaken as a systematic literature review based on the research questions designed.

"RQ1. What is the relationship between maintenance and sustainability issues?"

"RQ2. What is the maintenance impact on the sustainability of the facility industry?"

"RQ3. What are the indicators that are used for assessing such impacts?"

The methodological steps involved in conducting the review are listed below.

2.1. Identification of research databases and keywords definition

This research was conducted using a systematic literature review and the research papers were acquired from Scopus and Web of Science, which are considered to be the biggest scientific and technological literature databases. Keywords were chosen to target the review, ensuring they were selected carefully in order to achieve the review's objectives and goals. The first set of keywords includes 'maintenance,' the second set includes 'sustainability,' and the final set includes 'sustainable,' 'facility,' 'industrial', and 'facilities'.'

2.2. Inclusion and exclusion criteria

A search was performed on all English-language scientific journals, conference proceedings or books that met the criteria to retrieve all papers published in the last year. Only papers that had been published in peer-reviewed journals, conference proceedings or books and contained the keywords were considered. All papers were imported into the software Mendeley after being identified through the search, eliminating any duplicates.

In the first step, we examined the abstract and the title of the articles to determine whether or not they met the scope. In the second step, we examined the conference proceedings to separate the articles that were not about maintenance and sustainability issues from those that were.

In order to provide a final assessment of the papers selected at the initial screening phase, the second step consists of reading the full text of all of them. During this step, irrelevant papers that don't specifically address the research questions are eliminated, while papers focusing on sustainability indicators or addressing sustainability issues on three core pillars are deemed to be included.

In the final step, the papers selected at step two are evaluated for citation relevance. Therefore, the citations were investigated to see if additional papers might be included.

2.2. Analysis process and information extraction strategy

In investigating the papers, we located the main information and used it to group them based on the type of publication whether be it a journal article conference paper or book chapter. The year of publication was carefully examined while extracting the research paper and also the objectives of the study reviewed. Those articles were extracted that were based on the research questions related to sustainability in the facility sector. Extraction criteria was carefully examined in order to carry out the analysis in a smooth manner and to have a holistic view of the investigation.

2.3. Review results

From the 3144 papers included in the databases searching for the keywords, 2489 yielded after removing the duplicates. After excluding the duplicates, 99 papers were identified for analysis. Of these, 99 papers were read in full, whereas the others were discarded during the first screening process in accordance to the two exclusion rules. After reviewing the 35 papers selected, 11 more papers were discovered through reference checking, for a total of 46 papers that were considered relevant.

2.4. Content analysis

The 29 articles included in this paper pertain to the research questions posed in the section. Therefore, the second subsection looks at the 17 studies that examine the links between maintenance and sustainability in the three dimensions of economic, environmental, and social sustainability.

3. Results

The facility industry is shifting to more sustainable practices, causing local, national, and global GHG emissions (Byrne & Taminiau, 2015). These forces will contribute to these targets:

The growing demand for green energy sources provided by facility companies could boost the demand for those energy sources, due to the expansion of wind turbines, solar arrays, and other renewable installations (Nezami & Yildirim, 2013). Consumers may elect to power their facilities using Eco investment power or traditional investment power, since more Eco-invested firms are purchasing green energy (CISCO, 2022). As more individuals purchase green power, it has a higher demand for renewable sources. The ongoing operating costs of renewable energy installations have fallen lower than traditional power plants

(Vlasov, Shakhnov, Sergey, & Krivoshein, 2019). The cost to operate a renewable energy installation is lower than with traditional hydrocarbon sources once the initial investment is paid off. The cost of raw materials such as sunlight, wind, and water is essentially free to produce power once the raw materials are used to produce the power (Byrne & Taminiau, 2015).

As renewable energy becomes cheaper to generate, facility companies will increasingly choose it as their source. It addresses all three of the driving forces listed above: it meets government regulations, consumer demand, and the cost of doing business (CISCO, 2022).

Process optimization and operational efficiency

Facility companies can monitor the use of sensors throughout the distribution network to determine real-time power consumption data (Sabatin, M.Frangopo, & Dong, 2015). By utilizing this data, companies can regulate power production, network configuration, and switching load, among other things. In case of outages, sensors on the grid may alert operators to damage, allowing them to turn off power to dangerous lines, and preventing electrocution, wildfires, and other accidents. Digitalization can help the power sector extend the lifetime of power plants and networks through condition-based constant preventive maintenance (Sabatin, M.Frangopo, & Dong, 2015).

Energy monitoring and efficiency

Facilities and customers can monitor their energy consumption and usage patterns via advanced data analytics and visualizations (Sabatin, M.Frangopo, & Dong, 2015). They can use this information to derive insights and create better energy efficiencies and optimize usage behaviors to reduce emissions and facility bills.

Smart meters and smart thermostats are two of the most popular applications of IoT in the energy sector besides being utilized for advanced analytics. By using IoT coupled with advanced analytics systems, power generators can forecast the generation capacity of renewable energy sources such as solar and wind as well as adjust their operations in the case of an emergency (Benoitlung & Levrat, 2014).

Audit/reporting and analytics

Block chain and smart contracts may allow you to trace the source of materials and energy through the supply chain. They can help reduce material and energy consumption and optimization by offering many new possibilities which can contribute to achieve sustainability. Users can now verify that the electricity they use is eco- or green-labeled, and they can ask for eco-/green-labelled energy (Franciosi, Benoitlung, Miranda, & Riemma, 2018). They're more aware of their own energy consumption and ecological footprint and make environmentally conscious decisions in their day-to-day lives. Facility managers can now track energy use, consumption patterns, and carbon footprint in real time through the use of energy audit, analytics, and reporting tools. They are able to select energy providers in a more efficient manner because of the available digital energy auditing, analytics, and reporting tools (Hojjati, Jefferson, & Metje, 2018).

4. Discussion

On the one hand, the effects of maintenance processes on sustainability in an organization as a whole have not been systematically investigated, and on the other hand, the link between maintenance processes and sustainability indicators has to be formalized and established (Nezami & Yildirim, 2013). Stakeholders should be encouraged to consider and monitor the impacts of maintenance processes in order to help reach sustainability targets (Nezami & Yildirim, 2013). However, the research examined in this paper demonstrates that, on the one hand, maintenance processes have not been systematically investigated and, on the other hand, the link between maintenance processes and sustainability indicators has to be formalized and established (Franciosi, Voisin, Miranda, Riemma, & Benoitlung, 2020).

It examines all three dimensions of sustainability as well as the consequences of maintenance on various parts of the organization, from the customer's viewpoint (Byrne & Taminiau, 2015).

The presented framework covers all sustainability indicators relevant to the maintenance system regardless of their nature (i.e. whether they are connected with the production system or the manufactured product), their specificity (i.e. whether they are very precise for a particular industrial case study or very general), or their nature (i.e. whether they are connected with maintenance activities or the production system).

This is due to the different viewpoint adopted compared with previous research. The majority of existing literature on this topic begins with a maintenance perspective rather than a sustainability approach and the whole business enterprise. We start with an original idea: the discovery of consolidated frameworks in the literature involving general sustainability indicators at business enterprise level.

In order to identify the indicators that can be used to evaluate the efficiency of maintenance processes and hence, the impact on organizational performance, the authors proposed a method. This method uses indicators from both the maintenance perspective and the organizational perspective, in order to find indicators that may be used to judge performance.

With regard to the first point, a general framework may be created by examining all aspects of maintenance impact from both a sustainability perspective and from a business perspective. In other words, maintenance may have both positive and negative impacts across a variety of areas and business sectors. In addition, performance indicators may be used to quantify the impacts to identify where gaps might exist and to direct effort and resources to the areas where they are most needed (Hojjati, Jefferson, & Metje, 2018).

In the United States, electricity generation is responsible for 25% of greenhouse gas emissions. It makes sense that coal and natural gas account for 60% of electrical supply, because these fuels are involved in a significant amount of electricity generation (CISCO, 2022). What may surprise you is that facilities are leading the way in sustainable practices. Facility companies are anticipated to commit in 2022, as environmental, social, and governance (ESG) aims, as well as value creation possibilities, are driving forces. The growing popularity of clean energy, evolving state clean energy mandates, and the chance of federal legislation are all factors driving the trend. (Vlasov, Shakhnov, Sergey, & Krivoshein, 2019)

The three key forces driving sustainability in the facilities industry are: 1) government regulations are expanding, 2) consumer and shareholder demands for eco-friendly corporate conduct are growing, and 3) the cost of renewable energy is falling as a result of expanding technology markets.

Recommendations

Global warming is getting worse, and countries and international organizations are drafting and announcing ambitious climate action plans in response. At the COP 26 summit, more than 100 world leaders promised to end deforestation by 2030, and more than 35 world leaders have promised to speed the deployment of clean technologies. Many of the promises evoked a mixed response from environmentalists and the public since there were no solid execution plans to back them in most cases. Greenwashing, in order to soothe people's concerns, may have been involved. Around 200 organizations have pledged net zero emissions by 2040, but very few have specified how they will reach that goal.

Countries and organizations must set lofty sustainability goals and put standard procedures and tools to monitor progress towards those goals in order to ensure the urgency of the matter is addressed. There is currently no visibility, data, or standardized monitoring tools that can assist organizations in tracking the progress of their climate action plans. Digital technologies like data analytics, blockchain, and machine learning can help organizations mine data and track the progress of their climate action plans.

Digital technologies are not just about providing a monitoring and reporting framework based on empirical data but also provide the foundation for exigent data that paves the way for improved efficiencies in many industries, helping them reduce their emissions and footprint through rampant digitalization. These technologies have the greatest scope in the industries traditionally considered hard to decarbonize and account for up to 80% of current global carbon emissions. These sectors are critically important in the economy and society and include power, transportation, industrial manufacturing, and construction.

According to a 2019 United States Environmental Protection Agency report, up to twenty-five percent of the global greenhouse gas emissions come from the power and electric facility sectors alone. In light of the current discussion, we plan to look at how digital technologies can help power companies reach and monitor the climate action targets without jeopardizing sustainable growth and the interests of all concerned parties, as specified by the abovementioned report. Facility companies may use digital technologies to create significant impact, unlock new efficiencies, and reduce material consumption and energy usage across the value chain for a climate-positive future.

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