GREEN MANUFACTURING THROUGH DIGITAL TRANSFORMATION: TRENDS AND CHALLENGES

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1 INTRODUCTION

This paper examines the trends in in green manufacturing enabled by digital technologies and the challenges that firms have to face in implementing these innovations, through a comprehensive analysis of recent case studies and literature. Various studies done on the existing digital transformation technologies in marketing acknowledge the difficulties firms and industries are facing when implementing these technologies. The paper aims to provide insight into how digital transformation contributes to (re)shaping the green manufacturing practices [1].

Global trends such as the continued environmental degradation, climate change, and depletion of key natural resources have pushed the world to consider green manufacturing practices as a remedy to humanity [2]. Green manufacturing refers to manufacturing in a sustainable way that ensures that the organization leaves less carbon print. The manufacturing industry is the leading resource-intensive industry in any economy and is, therefore, responsible for a very large portion of carbon emissions and global energy consumption [3]. The green manufacturing strategy has gained prominence in the manufacturing industry as efforts are being employed to attain the sustainability strategy. In a study [4], the team discovered that the use of additive manufacturing models in redesigning the products with a single material, reduced the amount of material used by 60.45% and the CO_2 emissions by 85.59%. According to this study the production using this digital technology helped create a sustainable manufacturing without increasing the cost of production or materials.

The challenges to the implementation of green manufacturing supported by digital transformation solutions are not without challenges as noted by prior researchers such as [5], who noticed the implementation costs especially in SMEs as a constant barrier. Other possible obstacles such as data security regulations, integration with legal systems, shortage of skilled personnel in the labor market, and data security risks delay and sometimes derail the use of these manufacturing models [6, 7]. This paper fully explores these challenges and literature relating to the same. Moreover, the lack of standardized benchmarks for digital and green performance complicates cross-sectoral comparisons (ISO, 2022).

2 MATERIAL AND METHODS

This paper employes the use of qualitative research methodology adopting case study analysis and literature review. By using the materials of four case studies and an analyis of the trends on green manufacturing technologies, this paper maps the trends in sustatinable

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manufacturing within the globe. This paper identifies the organizational challenges using SWOT analyis, evaluating readiness of the organizations to face challenges as they appear during the process of implementation, and also the possible opportunities to develop lasting solutions and overcome the challenges and barriers.

3 RESULTS

Green manufacturing enhanced by digital transformation enhances energy efficiency via predictive maintenance and real-time monitoring systems. It also aims on minimizing waste through optimization of production methodologies and promotes the principles of circular economy through the digital management of product lifecycles [1]. The concept of digital transformation in green manufacturing advances the evolution of industrial production, aiming to harmonize economic growth with environmental sustainability. Digital technologies such as automation, additive manufacturing, big data analytics, and cloud computing have assisted with the optimization of the production processes, reducing waste of resources, discharging waste, and making data-driven decisions promptly [4].

4 CONCLUSIONS

Green manufacturing aided by digital transformation offers great potential for manufacturing industry to reduce its environmental impact while maintaining and improving operational efficiency. Digital Technologies like the Big Data, cloud computing, Additive manufacturing, Twin production, Just-in-time, AI and machine learning, and Blockchain are key drivers aiding better resource management, and energy efficiency while promoting sustainable production.

The implementation of the technologies is encountering various barriers such as Workforce gaps, high costs, critical security and confidential concerns, legal integration challenges, and resistance to change. Organizations have to overcome these by developing solutions that can counteract the challenges, which are not limited to cybersecurity, training, gradual technology adoption and process improvements.

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