A Review Paper on the Applications of Green Manufacturing

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***ABSTRACT:** Manufacturing of "green" goods, particularly those used in renewable energy systems and clean technology equipment of all types are in high demand now a days. The "greening" of industry is achieved by limiting renewable resource use, recycling and reusing waste, and lowering emissions to reduce waste. This paper provides an overview on green manufacturing and why it is required now a day's globally as green manufacturing practices mitigates waste and emissions in a pragmatic manner. The current work reflects on ecological architecture for the environment, including energy efficiency and product creation with less pollution. Furthermore, the author stresses the use of agile products to provide a safer, reusable product with a shorter product life cycle. It was attempted to discuss both environmental accounting and green supply chain management (GSCM). Green manufacturing's main goal is to save the environment while reducing the product's cost.*

***KEYWORDS:** Emissions, Environment, Manufacturing, Technology, Pollution.*

1. INTRODUCTION

The population is increasing very rapidly all over the world and due to that various resources are in high demand in order to make people life easy but due to that global climate is affecting and creating several problems. The environment is vital, and any alteration in temperature causes the planet to become unbalanced. The International Organization for Standardization (ISO) has proposed a modern product quality control scheme as well as a system for environmental management. The key goal of this period is to reduce environmental harm caused by factories. Green manufacturing is a modern manufacturing method that is ideal for a sustainable development approach which is needed. Owing to demand and insufficient availability, the cost of energy and services is constantly rising. Furthermore, price patterns are difficult to predict, businesses strive to produce efficiently across broad price ranges for energy and services. Passing on price rises to consumers is one way to deal with price volatility. A price increase, on the other hand, could necessitate product changes. Improved output productivity, which can be achieved by reducing resource usage and improving the manufacturing sector's organization, can help to maintain prices low.

The key goal of this paper is to draw attention of producer who is producing product in mass production. Every day, a large amount of fuel is used, and there is a large amount of pollution; the waste is dangerous, and it could lead to human demise. Toxic threats are particularly dangerous to humans. This paper discusses all of the waste and green processing methodologies that can be used to minimize waste and maximize the use of renewable resources. Green production not only beneficial for the climate, but it is often good for industry. Other steps to lower energy production density in manufacturing processes are often similar; however, what is good for the environment is typically good for the income statement as well.

1.1 Green Manufacturing:

The revitalization of industrial processes as well as the implementation of environmentally friendly practices in industry was referred to as green development. It is basically in essence to the "greening" in industry, in which employees consume less renewable resources, produce less carbon and waste, recycle and reuse products, and moderate pollutants in operations. Green manufacturers conduct research, develop as well as adopt technology and practices to reduce the environmental effects due to the technological advancement. According to the Bureau of Labor Statistics staff at industrial firms must have specific production experience in green technology and procedures, such as:

1.1.1. Energy that is derived from natural resources:

Staff may use renewable energy sources to produce electricity, food, or fuel for their workplace. Airstream, sun, ocean, coal, geothermal, landfill gas, hydropower, and municipal solid waste are examples of these sources.

1.1.2. Efficient use of electricity:

Workers can make use of specific tools and procedures to boost energy efficiency in their workplace.

1.1.3. Pollution:

Pollution abatement and prevention, as well as greenhouse gas abatement and recycling. Green technology as well as various methodology can be used by staff to:

a. Reduce or eradicate pollutant output or release in their activities.
b. Mitigate or minimize the production of waste materials
c. Reduce greenhouse gas emissions.
d. Waste products should be collected, reused, recycled, or composted.

Workers can protect natural resources by using particular technology and activities, such as those relating to sustainable cultivation, land preservation, soil, water, and wildlife protection.

1.2 Green Manufacturing Benefits:

The green packaging not only help the world in several ways but also increasing number of companies around the country to discover emphasis on recycling and waste reduction to bottom line. Employees are experiencing a rise in motivation, morale, and public relations, while company leaders are seeing a boost in bottom line. In the United States, green packaging has now been a medium for long-term job growth. According to a new report in Quality Magazine, green manufacturing now hires 26% of all renewable energy staff. Clean economy employees benefit 13 percent more than other workers in the US economy due to their advanced skill set [1].

1.3 Green Technology:

The use of some or all of environmental research, green chemistry, pollution management, and mobile devices to map, model, and conserve the natural world is known as green technology and energy, as well as to mitigate the harmful effects of human activity, in today's world. Photovoltaics, bioreactors, wind turbines, bioremediation, bio-filtration and desalination are all examples of renewable electricity generation technologies. In today's advertisements, the term "normal" has become an over-used and misleading buzzword that has virtually lost its meaning.

1.4 Environmental Management Tools:

There are a variety of environmental protection resources available. Mass balance is the analysis of a process's inputs and outputs to assess its efficiency and waste. Materials, electricity, manpower, waste management, and other incidental expenses are all included in full cost accounting. A product's systemic engineering phase is split into three stages:

1. Preliminary, conceptual as well as element strategy.
2. Manufacture creation.
3. System support in addition to operative usage.

Imposing extended supplier liability on producers is one way to strike a critical balance between environmental and market advantages. Through engineering their goods for easy disassembly and reuse of components, manufacturers have the rare potential to enable inventory recovery and remanufacturing. The required products are chosen by product life-cycle value design, and such choices will minimize negative environmental impacts. Although there are many factors that affect the design and production expense of a component, it is fair to see it as a function that improves with product design life from the viewpoint of product development operation.

1.5 Sustainable Manufacturing:

A series of conferences and publications in the 1970s and 1980s gave birth to the concept of sustainability, which was largely motivated by environmental incidents and risks, as well as fears about chemical waste and resource depletion. The term "sustainable manufacturing" is often misused to describe actions aimed at characterizing and reducing manufacturing's environmental impacts. Sustainability, on the other hand, necessitates even more than simply assessing and improving the environmental performance of manufacturing systems and systems. Despite this caveat, it's likely that this agreement would stand. A system is called unsustainable if civilization consumes capital and generates contaminants at a rate which surpasses the ability

of nature to recycle industry and social waste into environmental nuts and riches. Sustainability can only be discussed, strictly speaking, as seen in Figure 1, in the form of a closed structure. The manufacturing subsystems are in harmony with human, green and natural subsystems. Thus, sustainable production is an inextricably tied term to wider environmental and social processes. Sustainable output fundamentals Engineers are well versed in assessing the economic significance of industrial innovation techniques, as this is a business activity. In terms of engineering and manufacturing it is harder to measure environmental and social productivity. Processes and innovations in the production of crude resources and resources use operations and procedures as marketable products with consequences for their sustainability. Inputs to manufacturing processes and mechanisms are needed for content and energy; waste and chemicals labelled as outputs are then used as input in other industry and natural environments with social, economic and political effects.

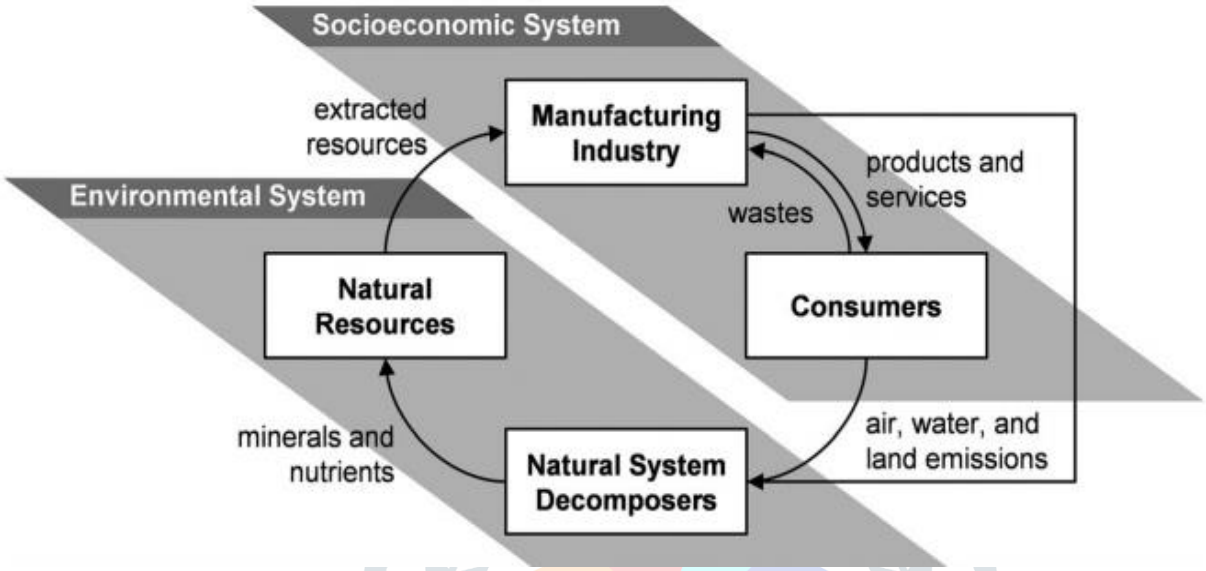

Figure 1: The manufacturing industry's position in a long-term structure. Sustainable manufacturing is a concept that is inextricably linked to larger environmental and social processes [2]**.**

1.6 Sustainable Green Operations:

As a creative environmental protection strategy, sustainable green operations ensures the effectiveness and ecological traditionalism of electronics constructor's inputs and outputs. To balance and boost financial efficiency as well as emissions control, green operations emphasizes quality and process-oriented sustainable activities. The product-oriented environmental activity of green operations, also known as product stewardship, is concerned with reducing environmental pressure by using less harmful and non-renewable products in product production, while still considering the impact of product development, packaging, and material on the environment It promotes the recycling and reuse of primary commodities, as well as the use of renewable cycle components and packaging, through eco-design. From the sourcing of raw materials to the manufacturing of end-to-end items, sustainability stewardship in the electronics industry acknowledges the environmental impact of goods and their packaging. The aim of this practice is to reduce the environmental effect of all product-related parts and materials.

1.7 Green Supply Chain Management:

Green supply chain management (GSCM) is characterized as the integration of environmental considerations into supply chain management. Furthermore, according to Zhu and Sarkis (2004), the GSCM supply chain covers the entire closed-loop supply chain, from vendors to distributors, consumers, and reverse logistics [3]. According to A. A. Hervani et al. (2005), there are a number of GSCM operations embedded in green design, green sourcing processes, overall quality environmental control, environmentally friendly packaging, shipping, and multiple commodity end-of-life practises, including reuse, remanufacturing, and recycling [4]. The global economy is transforming as a result of major automakers' aggressive expansion into Asia. International energy and environmental management surveys have debated the benefits of greening the car industry. The automotive industry's green supply chain has piqued the imagination of many other industries. When dealing with environmental problems all over the world, it is critical to evaluate and assess its success. However, few studies

have looked into the topic of GSCM success assessment. As a result, integrating green ideas into the car production process is crucial for mitigating environmental costs, increasing consumer competitiveness, and ensuring regulatory enforcement. The car production industry in developing countries, according to Q. Zhu et al., is a promising and interesting industry because it meets a wide range of needs, particularly since joining the World Trade Organization [5]. Automobile supply chains, on the other hand, are lagging. The Chinese automotive industry is still in its infancy, and the recycling of old vehicles is not given sufficient attention. Led with mounting environmental challenges, China's government has tightened environmental regulations. As a result, Chinese automakers have begun to research GSCM lessons learnt from foreign partners. GSCM pressures local car producers and governments to become concerned about their environmental obligations as the Malaysian automobile industry expands rapidly. As a result, GSCM is gaining momentum as a valuable tool for lowering environmental risks while also delivering economic benefits to producers.CO_2

1.8 Green Application:

Fuel is a big concern around the world; the fuel used in daily lives is non-renewable and will run out quickly, necessitating the procurement of new fuel. Renewable fuels, such as sun, wind, tidal, bio diesel, and other renewable goods, are the only salvation. As a result, sustainable energy will be used as a source of heat. Water purification is a different issue in human existence since water has been our most basic need, but it is unsafe to consume due to increasing population and chemical processes. In the purification of liquids, the solar distillation process is highly helpful.

The purifying of air since all plants absorb and turn the substance into oxygen can be grown indoors to keep the air cool. The simple and stable green plants can also be grown. This would reduce ozone pollution which lead to more oxygen and less CO every day for life on the planet. The disposal of sewage is in theory close to the purification of water. Waste treatment is critical because it cleanses water according to requirements of pollution. Water that is more concentrated is not used for anything, whereas water that is less polluted is delivered to areas where water is used extensively. It could contribute to a variety of other environmental conservation, biodiversity, and other principles. Energy saving refers to the use of technologies that use less energy in order to minimize the amount of power consumed. When somebody need less energy, they use less fossil fuels to generate the electricity [6].

1.9 Green Manufacturing - A Way to Reduce Waste and Improve Energy Efficiency:

Clean energy is gaining traction around the world. The US, Brazil, and China announced new commitments to combat climate change in June. President Obama announced a clean power plan in August to curb carbon pollution, with the aim of “reducing carbon dioxide emissions by 32% from 2005 levels by 2030.” In December, the United Nations will hold a climate change summit in Paris. Both of these policies have the potential to have an effect on the manufacturing industry, whether they are aimed at improving vehicle fuel quality requirements or merely raising customer awareness.

In terms of the climate and industry, green manufacturing is a smart idea. However, as environmental laws begin to emerge, it will become obligatory in certain situations. Leading businesses, on the other hand, are also heavily focused on eliminating pollution and improving energy quality, and this isn't just because of legislation. Green manufacturing isn't going to vanish, even though the Internet of Things (IoT) seems to have replaced it as the most popular movement. Indeed, the IoT will help a factory become more environmentally conscious. This is analogous to the rise of wearable’s, according to David Dornfeld, a professor at the University of California-Berkeley: “The Fit bit or Apple Watch offers evidence that one didn't have before”. It is believed that the industrial internet's accessibility makes it easier to track resource usage, just as a fitness tracker can allow person to track health statistics daily rather than once a year.Moreover, it helps businesses to consider how to operate a factory in the least impactful way". It is compared to building a racing car, considering that inefficiencies must be eliminated everywhere it exist. One may already be aware of the value of green manufacturing if you are already reducing energy and waste in your facility.

2. DISCUSSION

2.1 A Way to Get Greener:

It is not a case when it comes to improving the climate and the economy. "Air pollution has declined by almost 70% since 1970, as the economy has increased in size," according to the White House. Green manufacturing is an important aspect of running a sustainable business because it encourages to discover latent value while simultaneously helping the environment, customers, and the wider society, both now and in the future. Inside the industrial sector, there is a lot of passion for green manufacturing. A big change in theory, recognition, and focus is actually taking place. Companies must recognize the use of electricity, water, and resources, as well as the depletion of both from manufacturing operations.

2.2 Industry Examples:

However, there are many business experts to whom one may refer for advice. Bayerische Motoren Werke AG (BMW), for example, highlights its green manufacturing projects on its website, listing green measures that go beyond ISO 14001 certification, which it earned in 1998. Where practicable, the company uses water-based paints instead of high-solvent paints, waste water is pre-treated before being shipped to a nearby public water treatment facility, and manufacturers are encouraged to meet environmental standards.

Another industry leader is Toyota. While the company is known for hybrid cars (2.4 million Toyota and Lexus hybrids have been sold in North America), this is just part of the green equation. It's not only about the end result when it comes to green manufacturing; it's also about the operation. In addition, the procedure has become more environmentally friendly. According to the company's 2014 North American environmental survey, 95 percent of its own solid waste was eliminated, reused, or recycled. Toyota's Georgetown assembly plant will create green power from local landfill gas beginning this year, enough to produce 10,000 cars a year. Carbon, water, materials, ecology, and outreach are the five major areas covered in the survey. Whatever aspect of green manufacturing focused on, there's still room for growth. Companies, for example, are seeking to use fewer toxic chemicals.

2.3 Climate Challenges and Green Manufacturing Combat:

Recently it is observed that the climate crisis is much worse than we previously assumed. Green manufacturing, an evolving global development with a sustainable, long-term potential for sustainability, takes a holistic approach to environmental concerns. With such stark differences of opinion among governments around the world, seeking a shared voice to combat the climate crisis has become crucial. Manufacturing has become one of the most significant polluters of the climate. This is where green industrial patterns enter the picture. Green manufacturing is mainly concerned with modifying current industry and manufacturing processes, as well as consumer's mindsets, in order to minimize the industrial exposure to climate change and other environmental problems. Green, by the way, is not a meaningless term. There are practical ways to promote environmental practices within production plants, across the supply chain, and among customers.

Emerging Green Technologies (EGTs) are bringing in technological transition that affects the entire world, regardless of nation. Emerging green innovations are those that have achieved a certain degree of technical sophistication but have a poor consumer penetration, or those that are either in the early stages of technological maturity but are in theory relevant in everyday life. The Fourth Industrial Revolution (Industry 4.0) and the Industrial Internet of Things (IIOT) offer new possibilities for creativity in creating renewable, environmentally friendly products, decarbonizing energy, tapping digital ideas for achieving more with less, and expanding the life cycle of commodities under a "zero waste to landfill" system. Reduced usage of natural capital and electricity will result in a lower carbon footprint, as well as technological advances that improve performance, durability, and sustainability in the production sector, including the supply chain, and lay the groundwork for a global circular economy.

Energy savings are the most significant benefit of green production. It is assumed that decarbonizing electricity has a promising future. According to the most recent Energy Transitions Commission (ETC) report, "Mission Possible," achieving net-zero CO_2 emissions by the middle of the century is a very real goal. The advantages of integrating environmentally sustainable initiatives into production practices are becoming increasingly apparent; not only does this result in cost savings and increased performance, but it can also improve company's

image, placing the company as a good corporate level as more and more customers demand environmentally friendly goods and packaging.

Furthermore, supplies and raw materials are depleting, necessitating the use of affordable, green materials and methodologies in all sectors. Businesses are also looking for opportunities to enter the circular economy, which is a "take, produce, and dispose" solution to the conventional economy. Companies in the circular economy hold goods for as long as they can gain optimum profit from them, and recycle and reuse commodities as far as possible, reducing waste and focusing on green resources. Investing in green industrial activities would have the greatest impact on industry. Businesses who take a constructive approach to their production practices will save a large amount of money. Machines and facilities are getting even more energy efficient, which can have a long-term effect on a company's profitability. Many of the machinery on a typical factory floor is legacy equipment, which could be preventing a company from achieving its green production objectives.

There are other options for a producer to save resources aside from the actual production process. There are smart lights on the market that can detect the amount of natural light in a space and only illuminate the places that need it. And anything as basic as correctly sealing all air hoses and compressors will result in a significant reduction in a company's total energy usage. Getting a Reverse Logistics Strategy (RLS) in effect often assists in reducing the amount of raw materials needed to make new parts or goods. When a product hits the conclusion of its lifecycle, reverse logistics means that it is returned to the seller. Once the retailer has ownership of the used commodity, it can be broken down and the remaining raw materials secured. Making use of products that would otherwise be recycled will reduce the amount of money expended on new product creation.

Manufacturers benefit from reverse logistics techniques, but they may also reduce the amount of waste they produce. Rather than making goods wind up in landfills, producers should ensure that the items that can be reused are actually reused. This is particularly true in the manufacturing field. Steel is one of the most recyclable products on the planet, and these businesses operate on razor-thin profit margins. The rawer materials they can repurpose, the greater their chances of making a return. Businesses' carbon footprints can be reduced if they concentrate on renewable packaging and business activities. This may have substantial tax consequences and could also result in federal government benefits. Manufacturers can be eligible for extra benefits if they invest in clean energy projects such as wind turbines or solar panels on rooftops. A producer will not only be generating their own electricity, but they will also be paid for any energy they return to the grid.

Manufacturers aren't the only ones stressing the importance of going eco-friendly. The public has shown that they want to do business with a firm that considers the atmosphere during the production process. A business that spends a considerable amount of time, resources, and money to ensure that their goods are created with the world in mind will communicate with the public. The contribution of a manufacturer to being a green company will dramatically boost their marketing activities. Explaining what they're doing to minimize waste and energy use will make them even more appealing to potential consumers. While a fully viable large-scale production operation is still a few years away, factories will still reduce their environmental effects. The packaging industry is getting greener every day as factories invest in innovative technologies that can streamline operations, machines that can minimize energy consumption, and a continued emphasis on lean manufacturing. This focus on green practices supports not only the environment, but also the manufacturing sector.

3. CONCLUSION

This paper addressed green manufacturing and attempted to draw the researcher's attention to the usage of green manufacturing. The author conferred advantages of green production, as well as its applications and processes. Sustainable energy is a safer choice for everyday and commercial needs, and sustainable energy may be used in construction industry as well. This paper also discussed the green operations, which clarified the environmental protection principle as well as gears. The green supply cable is a most valuable tool since it reinforces the green brand as well as strategic edge while also enhancing industry efficiency. Future joint research projects will concentrate on integrating a wider range of quantifiable sustainability solutions within the facility, such as lighting, or pressurized air intake to find out how to factor fixed costs into the decision-making process. Although, several research is conducted in this field but there is enormous possibility of more research in this domain.

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