



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8

Issue: IV

Month of publication: April 2020

DOI:

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

Green Manufacturing Minimize the Wastage, Reduces Pollution & Environment Impact, as well as Encourages Sustainable Manufacturing

Aniruddh Mishra¹, Gaushiya Bano²

^{1,2}M. Tech. Student, Department of Mechanical engineering, ABSS Institute of technology, Meerut, AKTU university, INDIA

Abstract: We know that today, almost all the manufacturing company has the race to each other in this competitive world. Manufacturing Company wants to only earn in the form of money in spite of that, they harm to the environment. In other words, we can say that damaging or destroying to the nature or natural things. From these manufacturing companies a lot of wastage is coming out that polluting the natural resources that is air, water, and soil. This type of pollute environment is becoming crucial day by day for human being, animals and so on. Air pollution is one of the most important risk factors that can create diseases such as asthma, lung cancer, heart diseases and so on. Another one of the risk factors that is created by water is Jaundice, Malaria, Cholera and Typhoid and so on. Therefore, the wastages which are coming out of manufacturing company play a crucial role for poisonous to the environment. Such that Green Manufacturing is a very good concept because this encourages companies to reduce the pollution, reusing and recycling waste, fewer use of natural resources which are limited on the earth and reduces the emission. The research paper studies that if the manufacturing company should start the implementing of Green manufacturing process, they can save the environment from pollution and also can contribute to reduce the greenhouse gas effect in nearer future. The paper focuses how the manufacturing company reduces the uses of non-sustainable resources and encourages the use of sustainable resource. Research also gets the conclusion that increasing use of sustainable energy can give the benefits to an environment that reduces wastage & pollution, reduces the change of global warming, reducing the temperature changes and also most importantly saves the ecosystem.

Keywords: Green Manufacturing (GT), Sustainable Manufacturing (SM), Minimize Wastage, Reduces Pollution & Environment Impact, Benefits

I. INTRODUCTION

Green manufacturing is one of the most important renewal of production processes and also within the manufacturing field operations, which established that is environment-friendly. Because the word “greening” of manufacturing in which reduces pollution and waste, use of fewer natural resources, reuse and recycle of materials and also during the processes moderate emission from the manufacturing company. The government of around the world already started preserving land for wildlife and parks by the 1800s. It was popularized by John Muir and Teddy Roosevelt in 1903. After the world war 2nd, it around 1970s, there was a policy act made whose name was Earth day, the National Environment policy act was founded. During these periods a huge amount of toxic waste, Pollution was also linked to manufacturing. Around two decades, it was started massive. Meanwhile, 1990s. There was a huge amount of protests come for saving trees. The title was tree hunger. The main aim was building and selling in the industry would be greener and cleaner for survival. The manufacturing plants use fewer resources, manage waste, CO₂ to liquefy to protect from greenhouse gas. There is a term also come Sustainable Manufacturing has come. Sustainable Manufacturing was developed by U.S department of commerce, Manufacturing and services & International trade Administration. Sustainable manufacturing focuses on product attribution as well as how the product is made. It includes things that use less energy & materials, using fewer products as well as hazardous materials & produce less waste and also recycling of material. It is a simple investment to large investment.

The Green Manufacturing is one of the most important Paradigm, which is more eco-friendly and also various green strategies in it. This product and system, both consume less energy and materials. It converts output to input from the recycling process. The input product is non-toxic or toxic, renewable or non-renewable and reducing unwanted wastage. Therefore, this new paradigm Green Manufacturing result of technology drives and market. Green Manufacturing produces Green design product which is more eco-friendly. Now the Green Manufacturing and sustainability will give better results in the future. Therefore, more work is required for working with Green Manufacturing at different levels, process level, operational level and system level [1].

As we know there are two important challenges of manufacturing in the 21st century is that decreases of resources and energy and environment changes. We can see the CO₂ emitted from the Keeling curve that in 2013 400 ppm as compared to 315 ppm in 1958. Therefore, it can create greenhouse gases. If this greenhouse gases increase that major cities like Shanghai, Miami & New York will be affected more due to melting of ice caps. Due to increase of population reduction of the resource and energy. Another most

important energy consumption increases day by day like that heating/cooling of building that 28-29% and transportation which is 33%. The journal IJPEM-GT for comes forward along with collaboration with researcher and sharing knowledge faster about the Green Manufacturer. In the resource saving direction, the journal had selected. Some topics that are manufactured on the base of renewable energy devices, Manufacturing and design of Green products, waste reduction and energy saving in Manufacturing processes [3]. For the world environment globally, population and resources are the main problems. At any point due the changes of climate the environments become crucial that leads to the earth imbalance. For the products the ISO has proposed new environmental management system and quality management system. The main aim from industries minimize damage to the environment. A new manufacturing process is needed, which is suitable for sustainable development strategies that is green manufacturing. As we know that according to the demand, supply is limited that's why cost of resource and energy increasing day by day. Price is the main forecasting of the companies, therefore, within the large price of resources and energy companies aim is to produce good. There should be strategies for the customer that can face the fluctuation of the price due to the improvement of the product. Alternatively, therefore, stable price due to manufacturing system improvement in the organization and production efficiency increases. The companies should start the practicing of green manufacturing and also learn about their implementation [10]. Green manufacturing is one of the best innovations to protect environment and resources. It is a new trend for the development of manufacturing industry in the future. Because, as we know that the traditional way of manufacturing in the industry uses the high input, high emission and high consumption of energy and resources. But Green Manufacturing is efficient, low carbon, clean road of ecological civilization and recycling. It is helpful for solving the problem in the manufacturing industry. Upgrading of the technology the traditional manufacturing has declined, ecological problem arises such that no longer competitive advantages. But the structure is not clear that's why the innovation is weak. Green Manufacturing is the mainstream of country development of policy and strategy so it is necessary to convert the process uses in the manufacturing industry into Green Manufacturing [11]. Manufacturing is the backbone of the industry of any country. In the industry specialized, staff should be available for handling, tool, material, and equipment. Engineers & technicians have the knowledge of the modern concept of manufacturing. Forward facing the competitive manufacturing, research and modern development on the basis of CIM (Computer Integrated Manufacturing) and automation of the time. The government should make the rule and regulation for industry to follow the regulatory norms in the industry for changes of traditional manufacturing into Green Manufacturing and make the environment eco-friendly [12]. Most of the manufacturers getting recognition to Green Manufacturing Therefore, it is needed for manufacturing individuals and community to manage natural resources which is available. As we can see that most of the government of world making environment related policies and providing a favorable market for their work [13]. Now we come across that GM encourage to the SM. Because both GM or SM both reduce the environmental impact and minimizes waste. Therefore, in the near future if the green manufacturing started, then boosting to green. If changes will take place then it gives benefit to the planet, recommended consumers and make the environment eco-friendly.

II. LITERATURE REVIEW.

The researcher has focus Green Manufacturing is the innovation in a sustainable manufacturing process which is the most appropriate techniques to solve the problem of the environment. Green Manufacturing conceptual design of product life cycle, no harm to environment, reduction of waste, optimum use of resource and reduction of pollution. The main concept of the Green Manufacturing is 4RS (Reduce, Recycle, Reuse, Re manufacturing). This 4RS is being slowly accepted & adopted which will create models for stability and growth. The researcher at last give the conclusion that they should be a universal Framework made for GM work [2]. The paper researcher explores about the Journal which was inaugurated of research and knowledge sharing in the field of "Green Manufacturing". The paper explained the GM is very important for human being live today & future. The research had taken two measurable parameters according the development in the stage of technology vs technical Journal that is web of science-the number of paper and H-index. This journal IJPEM-GT deals on the manufacturing using Green technology. Therefore, it is necessary that continuously verified and monitored in the future [3]. This paper explained about the sustainable manufacturing due to increasing environmental and social issue. It has been concluded that sustainable manufacturing reduces the cost and give benefit to the company. But this sustainable manufacturing. I limited to only one or more company for getting the better result the researcher should have to work in the future [4]. The researcher studies about the factors which responsible for implementation of GM that is explaining green consideration technology analyses, according to technology, making design changes, specification and tolerance, establishment manufacturing process and quality control selecting, then organizing, monitory, evaluating, justifying the level of manufacturing process. Therefore, the purpose of this paper of a resource to find out factor and subfactors. Sub factors are Green design, Green purchasing, Green manufacturing, Green distribution, Customers awareness

program, Employee involvement and training. The relationship also shows between factors and subfactors prepared to then face competitive advantage. Lastly concluded that big industry invests more on greener than smaller one. Such that save to appropriate methodology should be made & every industry should start adopting GM. Therefore, emission of CO₂ and waste from industry will be responsible for warming and acid rain [5]. The purpose researcher of this paper to pay attention Green Manufacturing that is for the environment development for this Green technology should be used. The focus on the green manufacturing reduces both pollution and waste. The researcher also focuses that the use of GM to reuse of the product and to form the sustainable product which is made by sustainable manufacturing. We want to reduce wastage then should start Green Manufacturing system, development of product, energy conservation. The main aim is that reduction of cost and the safe environment. The sustainable green operation, which is important if management approach Green Manufacturing innovation. Green operation focusses on the process and product orientation, which improve and balance financial performance and also reduction of pollution. Therefore, green operation in the Green Manufacturing is the best tool [6]. The research mainly focuses on the GM design without harming the environment. It helps the manufacturer to pay attention on GM. The waste which is produced which can be minimized by GM. Therefore, the continuous improvement in GM improves firm performance and competitive capacity. If the GM will be improved then it can give support to the SM [7]. This paper studies about the manufacturing companies which is integrated about the GM at the organization level and operational level sustainable development. Because if the works done in the sustainable way, then, it increases resource productivity [8]. This paper researcher explained in this paper that day by day new technologies, new development, creates new challenges for the environment. So, it's necessary to pay attention to GM process, the purpose of this paper is that more and more use of sustainable energy in our daily life. Green operation included which explained the environment management tools, which is green image and also improve the performance in industry without change of the cost [9].

This research paper explores that Green manufacturing helps in conservation of natural resources and recycle of material that improves the production process. The paper deals that the relationship between manufacturing problem and working of foundry & sugar-cane factories. If economic growth increases, then decrease resource, pollution & waste generation. Therefore, for the technology should be used for promoting Green manufacturing and also quality improve. It is a very good concept of reducing industrial waste during manufacturing and emission. The main aim for GM is for sugarcane and foundry companies reduce waste, productivity increase, reduce risk of environment, increase quality and profit. We have to do work in the field GM or SM for their development [10]. This research paper exposed on the green manufacturing innovation can protect the environment resources. This paper explains the path of the innovation of the Green Manufacturing. Therefore, the path of the innovation is system of Green manufacturing, dimension of Green manufacturing, Dimension space of green manufacturing. The innovation system for environment protection promotes a combination of several elements that is interdependence and interaction which is key of Green Manufacturing. The dimension of the innovation system depends on the technology, internet, structural reform, which is formed by three-dimension space which gives advantage to researcher in the three dimensions [11]. This paper of the researcher focusses that a lot of research and theories that for implementation barriers and available. Therefore, it has been explained that there is a lot of technologies available for automation and replacing old technologies by the new technology methodology. There is needed that the stakeholder awareness of new technologies and also takes a step in the direction of betterment old society and society make them eco-friendly. Each & every industrial product standardized, therefore; they can take position in international markets. GM is a combination of conventional one to new one technology. It can give better results for environment protection [12].

This paper specific paper tells that GM has replaced the existing & current methodologies of the industry. The researcher finds out most important print that the government of every country comes in the front of the GM promote by cutting and laws on the tax for the manufacturing industries. The result was finding out the participate of 82% agree to replacing the methodology, mechanical experts of the 73% belief that existing production strategies can be replaced by GM [13].

III. PRINCIPLE OF GREEN MANUFACTURING AND SUSTAINABLE MANUFACTURING

The principle on which Green Manufacturing and Sustainable Manufacturing works which are explained in the figure. The major principle on which Green manufacturing works some of them are Encouraged use of renewable energy, pollution reduces, recycle and reuse of used material more of them has which has been discussed in the Fig 1. Secondly, Sustainable manufacturing basic principle on which sustainable works are environmental protection, material and product waste which is produces elimination, raw material waste produce elimination and so on. There are many principles of sustainable manufacturing has been discussed in the Fig 2. These principles are very important to understanding about both Green manufacturing and Sustainable manufacturing because of this principle both manufacturing works on their own.

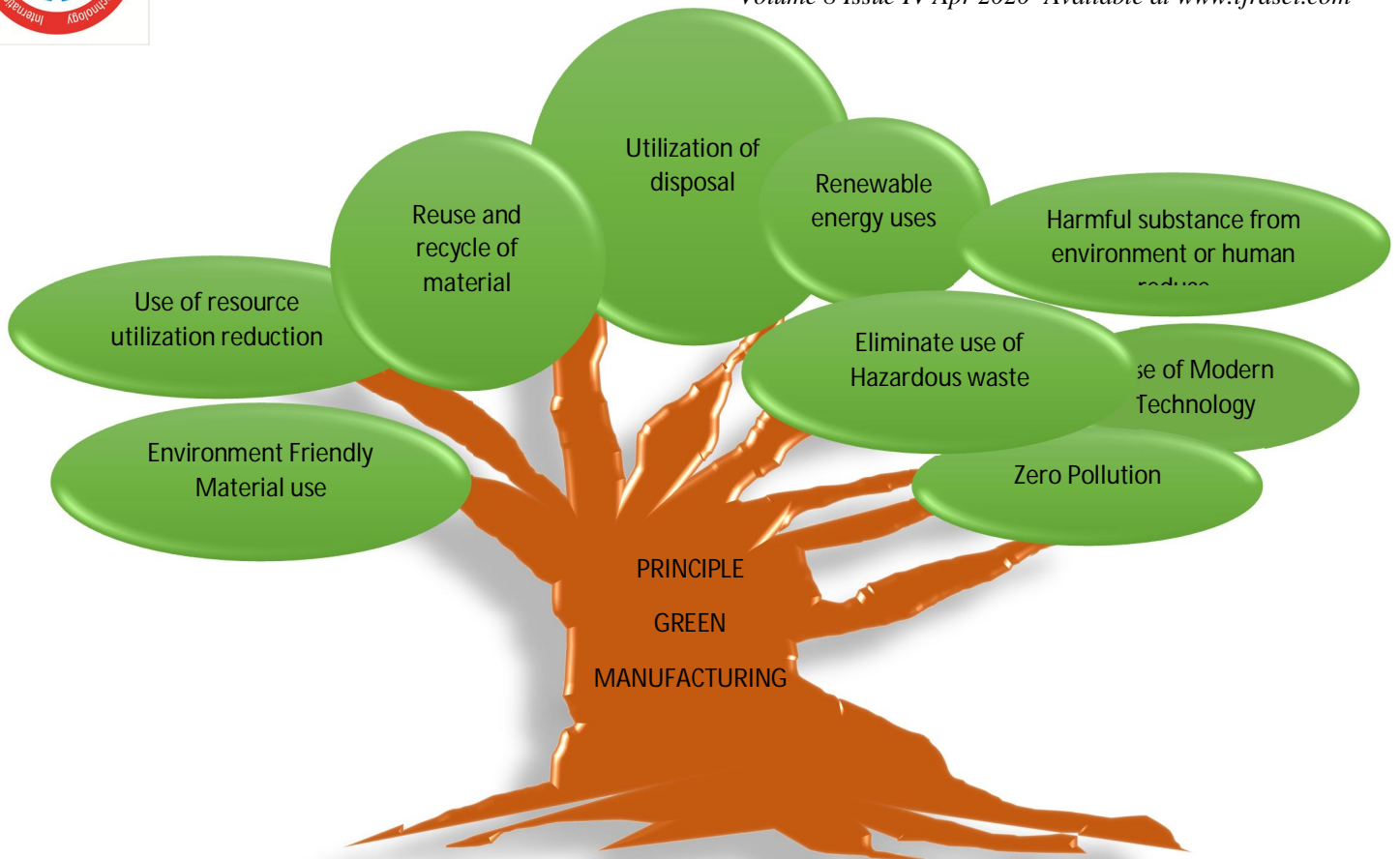


Fig.1 Principles of Green Manufacturing

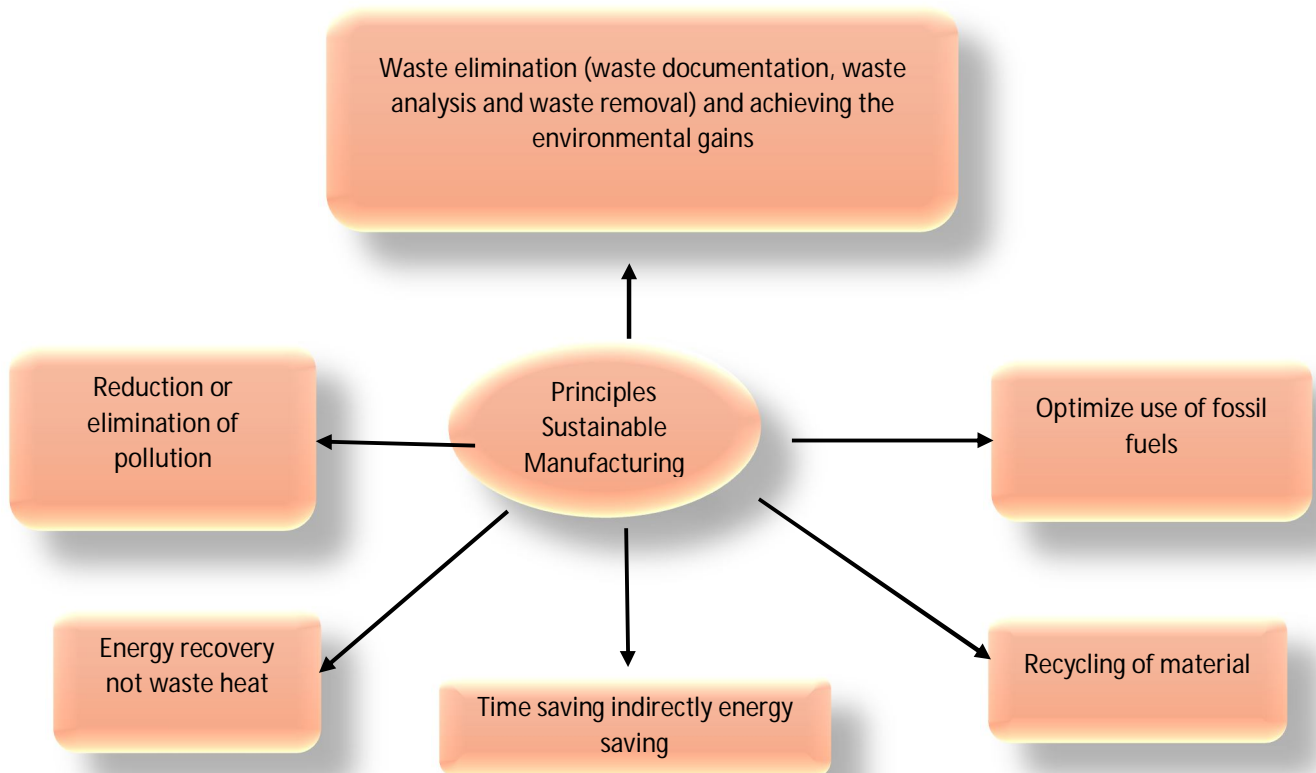


Fig 2. Principles of Sustainable Manufacturing

IV. ELEMENTS OF GREEN MANUFACTURING AND SUSTAINABLE MANUFACTURING

The elements are the key factors which is responsible for governing the process. Therefore, in this research paper element which are taken in explaining the process from that both the manufacturing is done, that is, the basic element which is responsible for Green Manufacturing and Sustainable Manufacturing process explained from the figure.

Firstly, we can see an element which deals about GM in which word “Green” play important. Green manufacturing is eco-friendlier and safer for the environment. Most important elements are explained in Fig 3.

Secondly, this study has discussed about elements of Sustainable manufacturing process, there are five basic element requirements for implementation of sustainable manufacturing that is manufacturing cost, energy, health and safety of the personal. These are the basic elements which are requirements for sustainable manufacturing in other word, we can say that for sustainable development for environment which has been explained in Fig.4 elements of Sustainable Manufacturing.

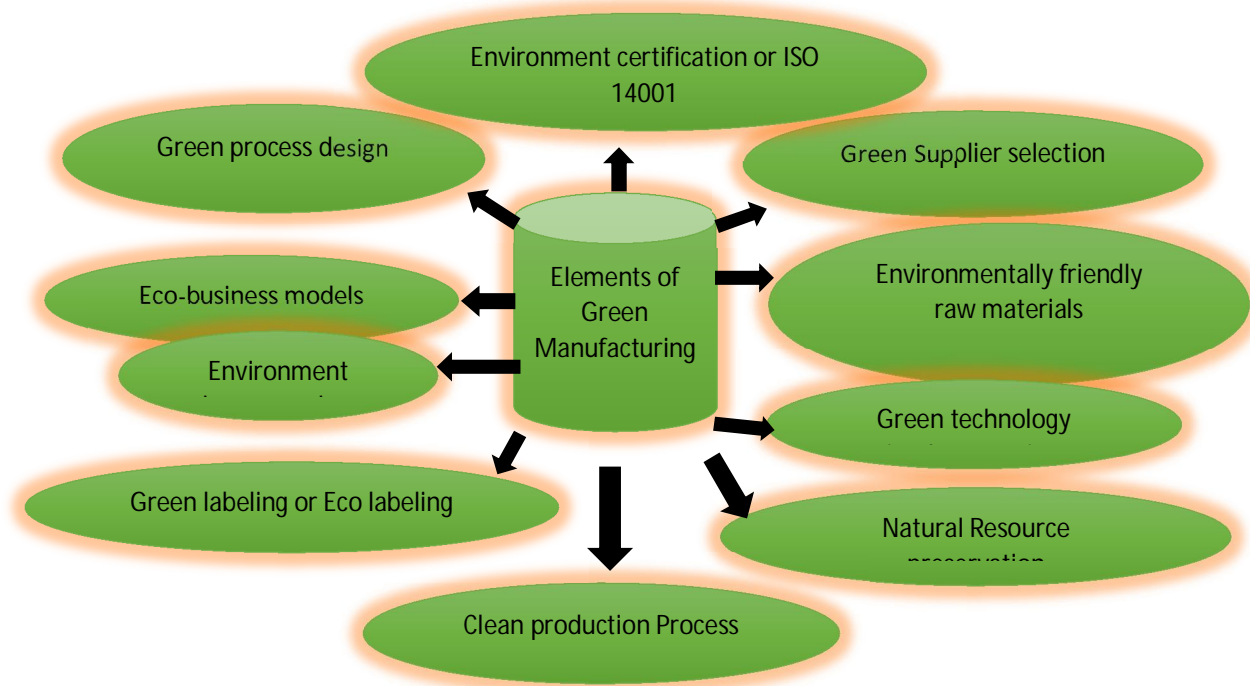


Fig.3 Elements of Green Manufacturing

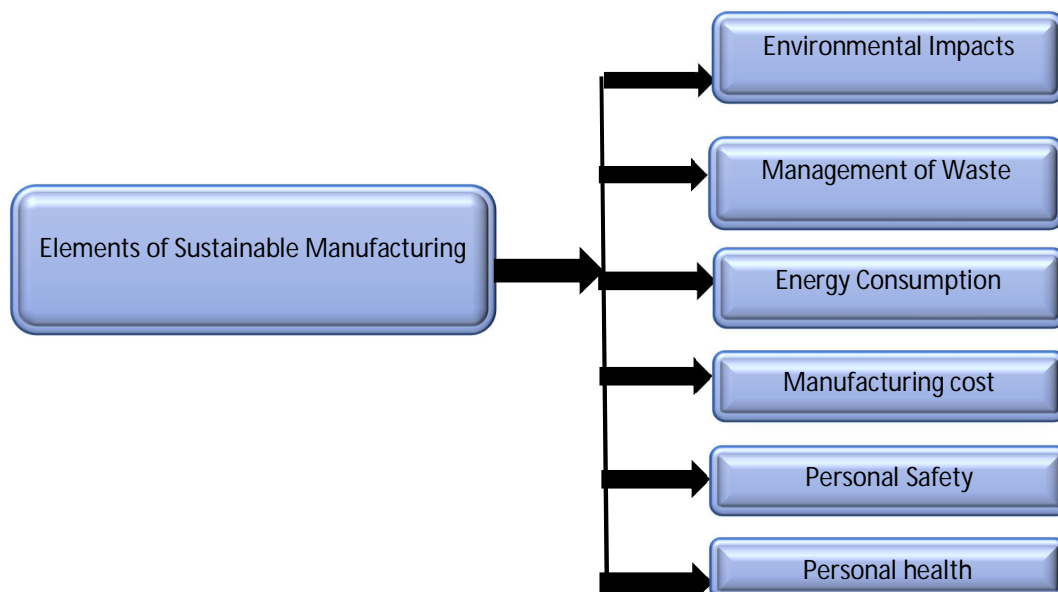


Fig.4 Elements of Sustainable Manufacturing

V. COMPARISON OF GREEN MANUFACTURING AND SUSTAINABLE MANUFACTURING

This research paper study on comparison between Green Manufacturing and Sustainable Manufacturing. Because, this give very important result about the both the manufacturing process about their similarities and some aspects they are different to each other more and more study can overcome some dissimilarities between these two-manufacturing process. GM and SM both manufacturing processes are made for reduction of environmental impact and minimizes waste. There are many more aspects they are different which has been explained in table 1. The comparison between two GM and SM has explained on the basis of these topics which are as follows: -

- 1) Concepts,
- 2) Purpose,
- 3) Definition,
- 4) Objective,
- 5) Goal,
- 6) Characteristics,
- 7) Techniques,
- 8) Trends,
- 9) Areas of Application,
- 10) Applying in the company name.

Aspects	Green Manufacturing	Sustainable Manufacturing
Concepts	<ul style="list-style-type: none"> ❖ Firstly, concept focus on the improvements of products and processes do better on the environment. ❖ Secondly, the concept is reused and recycle, reduction of waste and also minimize risk to species and human. 	<ul style="list-style-type: none"> ❖ Firstly, concept focus on the conserving natural resource and energy and minimize negative environment impacts. ❖ Secondly, also enhances employee and safety.
Purpose	The purpose of this manufacturing because this minimizes the waste and reduces environmental impact.	The purpose of this manufacturing process is same as that of GM because this process also minimizes the waste and reduces environmental impact.
Definition	The definition focus on reducing the pollution which gives a negative impact to the environment, conserving natural resources and recycle of products.	The definition also focuses on minimizing the negative impact on the environment through the use of products conserve natural resource and energy, safety for communities, employees and consumers at the last save for economically also.
Objective	The objectives of GM focus are: - <ul style="list-style-type: none"> ❖ It reduces the cost product and save the environment and also achieve the sustainability ❖ It conserves the resources for future generation 	The objectives of SM are: - <ul style="list-style-type: none"> ❖ It is societal, economic and environmental for all industrial operations. ❖ It conserves the resources for use of present generation not for the future.
Goal	<ul style="list-style-type: none"> ❖ The primary goal of GM is that conserve resources and prevent pollution. ❖ The Secondary goal is, recycle, reuse, renew, refuse, responsibility and the last one is that responsibility. 	<ul style="list-style-type: none"> ❖ The Goal of SM is that optimizes life cycle of the products, services and manufacturing systems. ❖ Similar works just like GM do that is 6R.
Characteristics	The characteristics of GM focus on <ul style="list-style-type: none"> ❖ Natural resource consumption reduces. ❖ Less toxic and gas material released. ❖ Less waste come out. 	The characteristics of SM focus on <ul style="list-style-type: none"> ❖ Sustainable design. ❖ Green technologies. ❖ Reuse and recovery of composite material. ❖ Green Engineering. ❖ Reduce waste.
Techniques	The techniques focus on that reduce or remove the pollution, greenhouse gas reduction, reduce or eliminates wastes, recycle or reuse of waste materials.	The technique focus of SM is that to achieve the GM by zero emission of measured that no pollution. By reducing the wastes and reuse or recycle of products. There is most important to follow the implementation of environment standard that is ISO 14000 or ISO 14001.
Trends	The trend of GM focuses on development in manufacturing industry. It is a new engine and driving force for various countries for their economic growth. Company to improve their standard of products Reuse and recycle of products and use or renewable resources.	The main trend of SM is reducing the use of energy and material resources, improve the energy management approaches, recovery and reuse of production system, use of renewable resources.
Areas of Application	The area of application on which GM is applied are Lean manufacturing, Material reuse and recycle, Green plastics (biodegradable), Green chemistry, product design, automobile manufacture and design, semiconductor and electronics	Life cycle analysis that deals how effectively and efficiently use material in the manufacturing process in the production industries.
Applying in the company name	These are companies name come under green manufacturing 2019 data totally are McDonald's, Dell, Google, Bank of America, Tesla Motors, Wal-Mart, Honda, Continental airlines, Tesco, Brooks, S.C. Johnson, Coca cola, Starbucks, Toyota, Pratt & Whitney, HP, Target.	These are companies comes under Sustainable Manufacturing according to the data are, Patagonia, Unilever, Ikea, Interface, Honda, Apple, Cisco system, Nestle, Google, Walmart.

Table 1. Comparison of GM and SM

VI. BENEFITS OF GREEN MANUFACTURING AND ASPECTS ENCOURAGE TO SM

Manufacturers of today's are facing many pressures that forces to improve the quality of their products and also cuts their cost. The range of pressure, which coming to them from customer and government that why many of the manufacturer left because they do not have a choice due to many pressures. Because many of manufacturers do not know that there are a lot of benefits available after becoming green to their company These benefits can help to boost the company product sales and also reduce their operating cost for many the products. These benefits enhance their company environmentally-friendly can change their workplace. The Fig 5. has explained the benefits which company can get after adopting GM and their detail has also discussed. These are more important benefits companies can get from Green Manufacturing are also they can adopt the benefits of Sustainable Manufacturing. These are main benefits companies can get after applying in their company, such that benefits are as follows: -

A. Green Manufacturing main Benefits

- 1) Reduce energy consumption, saving money
- 2) Incentives and tax credits
- 3) Growth of business
- 4) A Green reputation built up
- 5) Impact on the environments

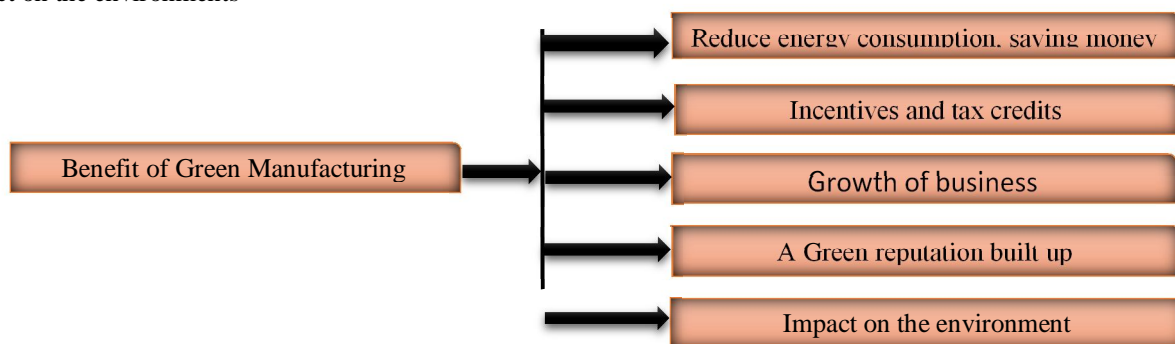


Fig 5. Benefits of Green manufacturing

B. Reducing Energy Consumption, Saving Money

There is a lot of changes in green in the workplace reduces the operating costs. The think that helps in reducing the money are energy efficient machinery and equipment as well as wind and solar energy minimizes the bills of electricity. In the other area cost is reduced that is supplied by using recycled and paperless.

C. Incentives and tax Credits

For switching the companies towards Green Manufacturing, the government has developed tax credit and incentives for implementing green policies. These credits are given at the federal and state level. Such that exact incentive varies from state to state.

D. Growth of Business

We know that there are competitions between manufacturers to win various government bids. One government contract is very beneficial and give benefits to the company. But these government contracts are limited and one those companies get benefits whom have met the green manufacturing standard.

E. A Green Reputation Built Up

About the environment, consumers concerned about the boost of the manufacturer's reputation. Manufacturing company rebrand their image and attract new customer for their products.

F. Impact on the Environment

Green manufacturing gives positive impacts on the environment. Therefore, it reduces the carbon and toxic release into the atmosphere.

G. *Sustainable Manufacturing Benefits*

- 1) Impacts on the environment.
- 2) Costs reduce.
- 3) Good brand image.

VII. FRAMEWORK OF GREEN MANUFACTURING AND SUSTAINABLE MANUFACTURING

The research of this paper focuses on the most important topic on the Framework of Green Manufacturing and Sustainable Manufacturing. As, we know that Framework of any work is very important, because it explained implementation process and also how to work followed by the process. Therefore, we have taken this topic to explain the structure of the Green manufacturing and sustainable manufacturing works. There are a lot of step requirement for the implementation Green Manufacturing and Sustainable Manufacturing for both. From past year, we have seen that no any complete information on green manufacturing and Sustainable of paper give exact most appropriate framework for implementing both of manufacturing in the industries. Such that from our research we tried to solve the problem. Gapping of the research may be the problem that research is not giving appropriate framework for GM and SM. Firstly, we have discussed in the Green Manufacturing framework. The Green Manufacturing framework follows the steps from their design to their remanufacturing process. From this green manufacturing framework, we try to explain that there are many ways by which company adopt the way to reduce waste, eliminate pollution and make eco-friendly environment to dedicate toward our future generation. Secondly, we have studied in Sustainable manufacturing framework. Because the main idea for this paper, it's that if we go for Green manufacturing then we are already gone for sustainability or Sustainable manufacturing. Green manufacturing means that to be sustainable and also provides measures of environmentally friendly techniques to less negative impact on the growth of industries. The framework of Sustainable Manufacturing is more complicated than GM because according to our research. We have got the result that there is some step we will achieve in the GM then we already move toward the Sustainable Manufacturing. The SM is also dealing that reduces the wastes recycle and reuse of material for conserving the natural resources which are available in the environment in the nature. Sustainable manufacturing is a combination of environment, economy and society. From the above study, we now understand that GM and SM these two methods of manufacturing framework are more important to know, because, if manufacturer go for both manufacturing that is GM and SM then it is very necessary that more and more research work should be done on framework of GM and SM. Such that we have explained the both manufacturing process step by step. Now, we have explained the step of our research topic that is GM framework first, then, we will explain the second SM framework.

A. *Green Manufacturing Framework*

These are mainly six steps involved in Green Manufacturing Framework, which has been explained in Fig 6. is as follows: -

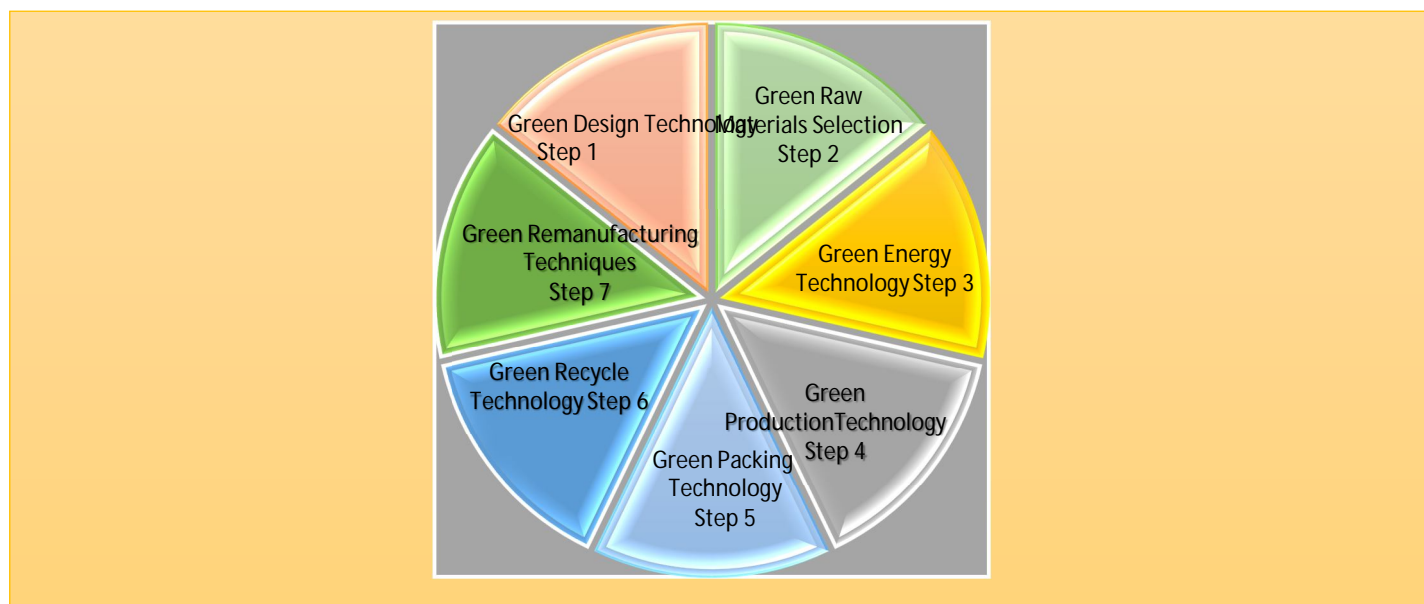


Fig 5. Framework of Green Manufacturing

- 1) *Green Design Technology*: Green initiatives must be factored into the Green design technology for the product. The product which should be made green means which is reliable for the environment, ecosystem and customer safety purpose also. The Green design product are recyclable, made for reuse that they do not harm to the environment which is eco-friendly in nature. The green design basically deals with in designing of products that is Designed for the environment, Design for efficiency and to achieve Sustainable product design. The examples of Green design for GM are Insulated thermal bags, wine paper bags, Recycled Fabric Clothes, Rechargeable Batteries, Reusable Water Bottles. Among all examples one of them is shown in Fig 6.
- 2) *Green Raw Materials Selection*: The Green raw material is generally inexhaustible in natural resources. They are restored in a short period of time. Green resources for raw materials are trees and plants as well as food waste which many components. The raw material which extract from the nature, they should be recyclable, reusable and less waste to the environment. For raw material's selection the company keeps in mind that the material has renewable, material and energy conservations, replanting program in the forest, all these are tools do not harm the environment. The raw material does not harm to our ecological system which can create global warming. The example of Green raw material for GM that is Critical raw materials which include rare earth elements, Cobalt and Niobium. Now they are used in electronic manufacturing industries because they are renewable energy technologies and also, they are used for electric motors.
- 3) *Green Energy Technology*: Green Energy technology are renewable energy technologies which enable us to generate electricity, fuel and heat from renewable sources. Renewable energy gets the energy from natural resources such that sunlight, tides, winds and geothermal heat that are naturally replenished. These are example of Green renewable energy technologies are Solar, hydro, wind, wave, heat-exchange, tidal, Bioenergy and wave technologies. The Green energy technologies, one of examples are shown in the Fig 6. All of them gets energy from the sun directly or indirectly. But there is an exception that Geothermal technologies are get powered by deep heat from the Earth's core. Therefore, it is necessary that Green energy technology should be used because as we can see that is clean in nature for the environment and it is a renewable source of energy. It can give benefits to near future.
- 4) *Green Production Technology*: It is an initiative of Green Production in the Green manufacturing. Green production technology is made for industries that focuses on manufacturer can achieve profitability through environmentally operating processes. Green production if the manufacturer applies industries it can give key advantages in the nearer future decade. Green production when the manufacturer applies in their manufacturing then it simply means that recycling programs or pollution controls. Therefore, it is necessary that the manufacturer should replace the traditional way production techniques and apply the new or latest technologies for the production of good to their industries. Because the new green production technology focuses upon three Fundamental goals are: -
 - a) Minimize the use of unused raw materials and non-renewable forms of energy.
 - b) Minimize effluents, emissions and accidents.
 - c) Minimize life cycle cost of services or products.
- 5) *Green Packing Technology*: Green packing is a new environmental packing phenomenon which has replaced the traditional packing materials that is paper, plastics and cardboard. The old technology utilized for making these materials. The huge amount of fossil fuels wastage then after results that millions of tons of methane and carbon dioxide released into the atmosphere while the waste packing material ends up into the water bodies or landfills. Therefore, 73% of manufacturer are satisfied from Green packing better than traditional packing. It is also giving benefits in the reduction of packing materials costs. From this research study, we can see if 73% manufacturer is conscious about Green packing, then 27% manufacturer should have to attention toward Green packing. Green packing technology can help in achieving eco-friendly environment. The example of Green packing technology as shown in Fig 6. The products which are made for packing from Green packing technology can give advantages are as follow: -
 - a) Reduces carbon footprint,
 - b) Biodegradable in nature,
 - c) Reuse, Repurposed and versatile for major industries,
 - d) Easy disposal that means compostable and recyclable,
 - e) Create good brand image to the customer
 - f) Reduces the cost of raw material uses for packing'
 - g) No harmful plastics,
 - h) Reduces the pollution.

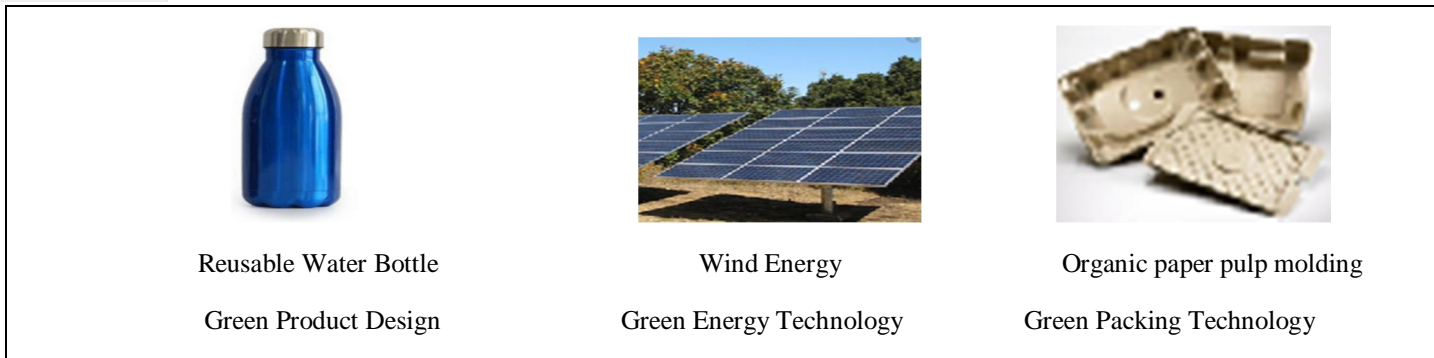


Fig 6. Framework of Green Manufacturing Based examples.

6) *Green Recycle Technology*: Green technology is an initiative in the direction of recycling. The Green recycles technology is used to recycle waste, including incineration as well as paper cardboard. Recycling material can be used for fertilizer, plastics and fuel. Green technology is applied in production, such as a way or processes to recycle waste or water in the manufacturing process. According to the data 2019 it has been said that new technology will have to polymer waste recycling from the year 2020-2030. It is very much important that recycle can be done in large extent. Because recycle reduces the waste. As we have studied that Recycling process is three types as shown in Fig. 7. These are the name of recycled process Primary Recycle, Secondary Recycle, Tertiary or chemical Recycle.

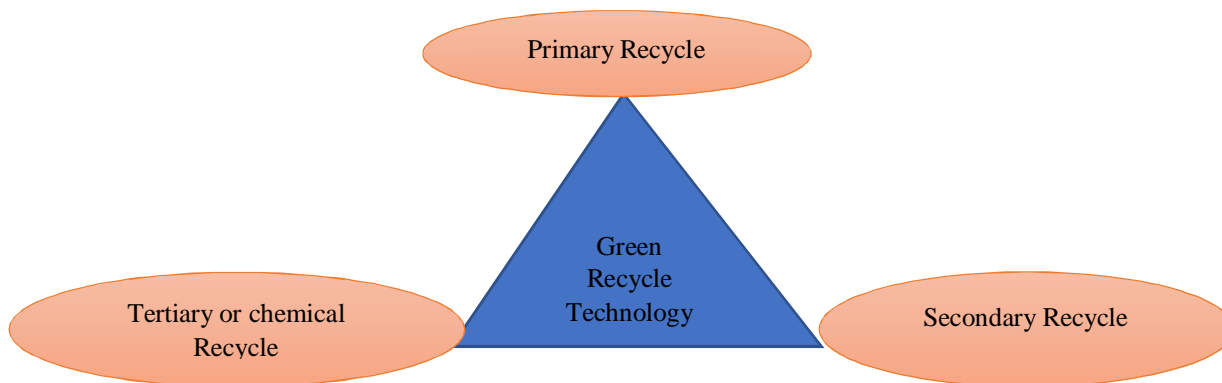


Fig 7. Green Recycle Technology

- a) *Primary Recycle*: It is also known as close loop recycling. It is the process of turning one to another or more in the same thing. Examples are papers, soda cans
- b) *Secondary Recycle*: It is a process in which moving into one to another only made up from the same materials.
- c) *Tertiary or Chemical Recycle*: In this process materials are broken by the chemical process.
- 7) *Green Re-manufacturing Techniques*: Green re manufacturing is techniques to scrap the product after cleaning, disassembly, renovation, inspection, repair and assembly again after the return. The new performance standard method for reusing resources. The Green re-manufacturing techniques is a process of bringing used products into “like new” one functional state. Because, as per study, it has seen that less harmful and profitable than conventional manufacturing. These are the steps involved for remanufacturing of Green remanufacturing, which is followed as: -
 - a) Design for remanufacturing for product
 - b) Operation management in remanufacturing
 - c) Additive manufacturing for remanufacturing
 - d) Business model for remanufacturing

Therefore, Green remanufacturing is an emerging green technology. It has been defined as a series of process which used for utilization of end of life products. The example of remanufacturing is aerospace, carpet tiles, compressors, defense equipment, gaming machines, power bearing.

B. Sustainable Manufacturing Framework

The framework of sustainable manufacturing is similar to GM because as per our study, we conclude that if we go for GM then we are encouraging to SM. These are the steps involved in developing or implementing of SM which has been discussed in fig 9. The steps are as follows: -

The detail of Sustainable manufacturing is as follows: -

- 1) *Conceptual idea of Manufacturing of Products:* It is initiated of SM because it gives an overview. In other word, we can say that it is preplanning of the product before start to talk about the product manufacturing. It is very much beneficial for the researcher and manufacturer. It gives the idea of manufacturing about SM. Because, if the manufacturer understands the importance of the product value then they can take steps for sustainability.
- 2) *Product Design:* The product design for sustainable manufacturing are the pillar for SM. For the SM process and product levels are designed for minimizing the environment, impacts, Design for social, economic and environmental, Design for manufacturing and re-manufacturing, Design for resource utilization and most important design for functionality.
- 3) *Process Planning & Control:* Process and planning play an important goal in SM because it is a manner as to quantify, identify, assess and manage the flow of environmental waste. The main aim or goal of the process planning and control is that reducing the pollution and the environmental impact as well as also improve the self-recovery capability of the earth. Then after another main aim is that improving the self -recovery of the earth, then also maximize the resource efficiency.
- 4) *Resource Management:* Sustainable resource, management means that the way of using the resources as best as we can use the available resources. From the resource management, we have studied that it is conservation of resources for the present and future generation both. Through recycling and reuse process, we can conserve our resources which have available to us. We can manage our resource the best way utilization, reuse and recycling of material. The sustainable resources, examples are water, wind, wave and sun energy. Reduces the use of not sustainable resources such as coal, oil, gas, and fossil fuel. Because, finite number of non-renewable resources available.
- 5) *Manufacturing:* Manufacturing is process of Sustainable manufacturing. It is based on the economics sound that conserving the natural resources and energy. It also minimizes the negative impact on the environment. These are some aspects on which Sustainable manufacturing process deal is as: -
 - a) Manufacturing cost.
 - b) Energy consumption.
 - c) Waste management.
 - d) No pollution.
 - e) Personal health.
 - f) Operational safety.
- 6) *End of life of the Product:* End of life of the products in Sustainable manufacturing is that when the product usages by the customer then it goes to disposal and includes many ways to end up the life of the products. But after the ends of the life of the products, the products can go for reuses. The reuses ways products can follow different ways: -
 - a) Re manufacturing,
 - b) Recycling,
 - c) Emission or leakage into the environment.
- 7) *Waste & Emission:* The rapid development of industries and lifestyles. It leads to increases the reduction of resources because of rapidly increases the consumption of natural resources. Therefore, the result come out that have disposed and product wastage. It is necessary to manage the human activity and industrial waste. Such that, it is necessary that solid waste that is plastic waste and non-ferrous material have to be recycled because of reducing waste and also eliminate waste from the environment. Solid waste management in Sustainable manufacturing concerns about the environmental pollution, public health, Land use, Resources management, social impacts and economic impact for proper disposal of waste. There is another topic that is emission of gases into the environment. Therefore, it is important, energy-saving and emission reduction strategy used for measuring and promoting the Sustainable manufacturing. Such that LESER is used to evaluate and identify for carbon consumption footprint and waste discharge also. The sustainability rate of the company as shown in fig 8, in the graph 1.

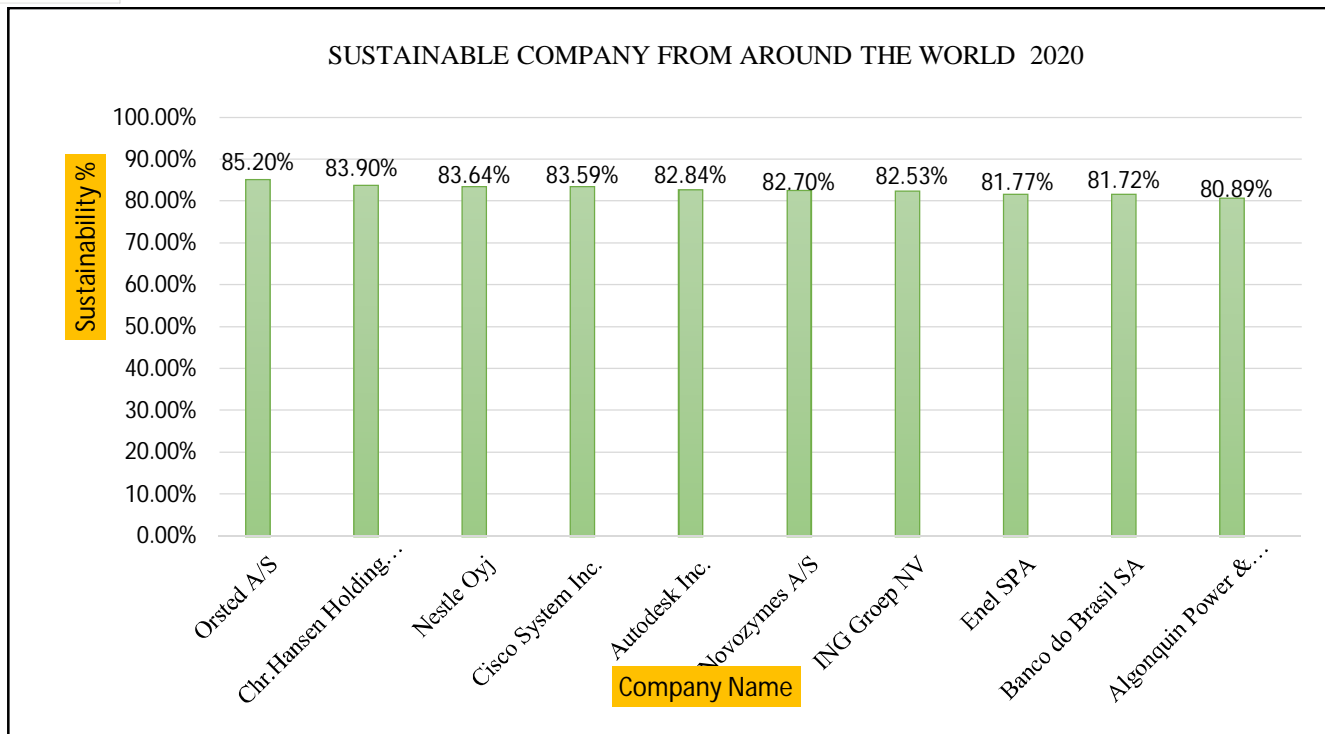


Fig 8. Graph for Sustainable company name in 2020.

8) *Recycle and Reuse*: The recycling in the Sustainable manufacturing is a method of turning waste and used materials into new products. This method required less resources and energy than new one making of products. Such that, it gives boost to our environment. In this process a lot of our house waste which can be reprocessed and broken down for making new things. Therefore, recycling process included three important steps for recycle are shown in the table 2: -

Recycling Type of SM	Collecting of waste materials	Processing the wastes	Purchasing recycled products
	<ul style="list-style-type: none"> • First step, recyclable materials are collected by drop-off centers, curbside, deposit/refund program and buyback centers. • After collection send to cleaned, sorted and baled. • Then after converted into marketable raw materials. • Then sold to the processing company 	<ul style="list-style-type: none"> • Second step, the raw materials is cleaned and sorted then they are retrieving to processed for recycling and manufacturing. • Now, the recyclable materials crushed, broken down, liquefied or melted into basic raw elements for remold of new products. 	<ul style="list-style-type: none"> • Third step, in this step purchasing of recyclable products from consumers. • If the products are made then it returns to the purchased by consumers or returned to the market.

Table 2. Sustainable Manufacturing recycling process

Now we understand that reuse of Sustainable manufacturing. It is the most effective way to improve the sustainability of our packaging is to reuse as much as possible. Reuse is a process in which we can use again and again for eliminating the waste. The most appropriate reuse example is that packing material and boxes, we get from manufacturing, inventory components which can we use for dispatch and shipping of finished goods.

9) *Remanufacturing*: Re manufacturing is the process in the SM in which we can use the products into new functional state. It is a more Sustainable mode of manufacturing and it can give more profit almost less harm to the environment.

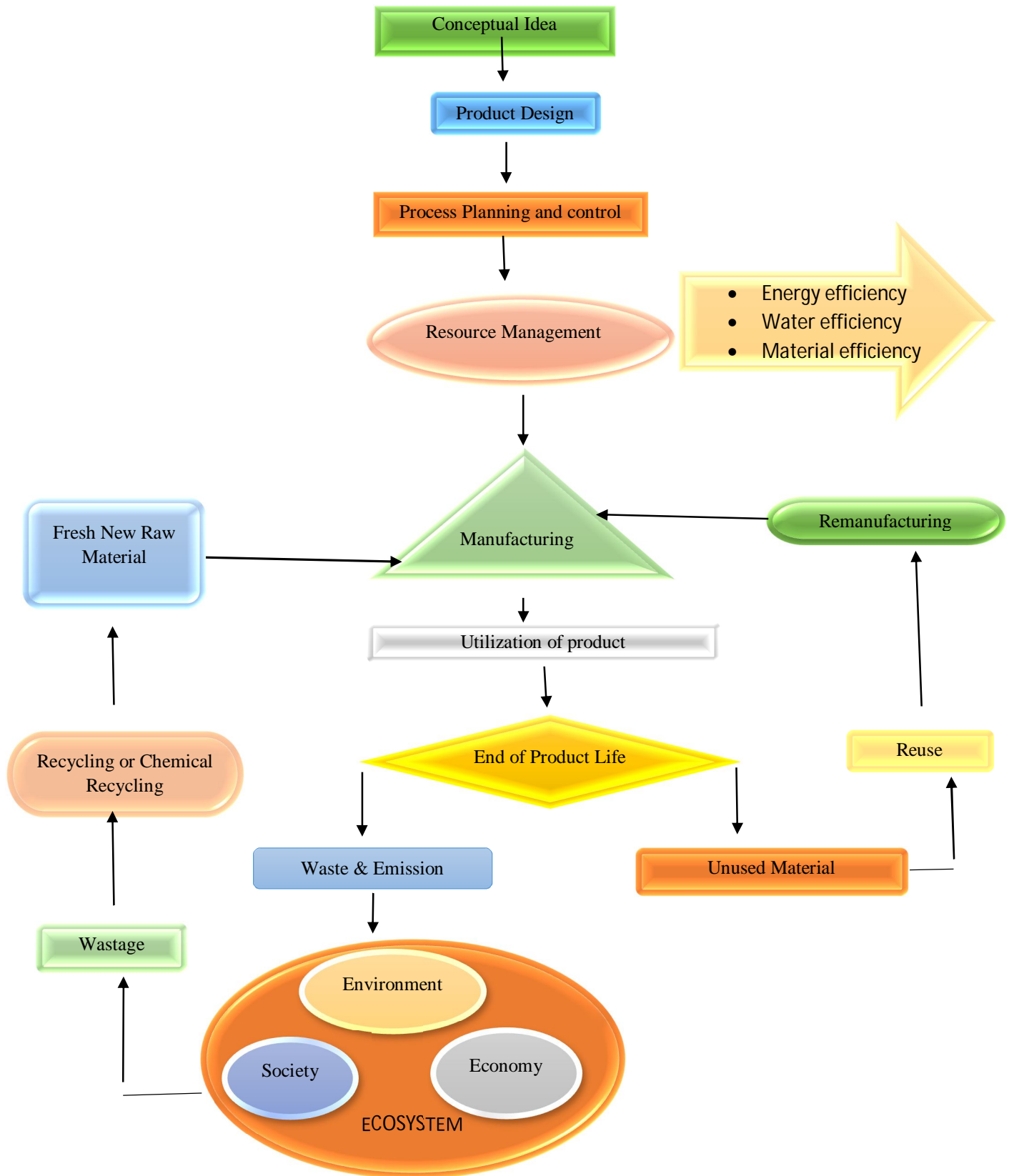


Fig 9. Framework Sustainable Manufacturing

VIII. METHODOLOGY

In this research paper, the research study on the Green manufacturing, but when we study, then Green manufacturing is Sustainable Manufacturing approach to the engineering activities and design involved in product development and operation system minimize. The methodology that we have adopted for our research paper which has been explained in the step table for a methodology that is table 3. In this research paper, we have read the article which has been published in different types of the journal and news journal. We have studied about 90 to 100 research papers of both about Green Manufacturing and Sustainable Manufacturing which gives the more relevant idea about our research. But most appropriate result and conclusion give us, we have chosen for our literature review for this research paper. We have studied about the principle of Green Manufacturing and Sustainable manufacturing. After study of the principle of both of them, we get the result that in most of the cases, they are coming to each other. Because, their main focus it reduces waste, zero pollution and minimum impact on the environment. The main objectives of the two-manufacturing process save the environment for the present and future generation. Now, we have explained methodology the steps involve for our research paper are as follows: -

- 1) Step 1- Concept understands
- 2) Step 2- Introduction
- 3) Step 3-Literature Review
- 4) Step 4-Principle
- 5) Step 5-Element
- 6) Step 6- Compare
- 7) Step 7- Benefits
- 8) Step 8- Framework
- 9) Step 9- Future work
- 10) Step 10-Conclusion

Step Involve for Methodology	Aspect of the Method	Brief Description of Aspect of method	
Step 1	Understand the concept	Study about the GM, meaning that that have to achieve Sustainable & think about the environment.	Study about the SM, meaning that Save the resources reduces environment impact.
Step 2	Introduction	From the article, research paper and website are concluded. A method for reducing waste and pollution and save the ecosystem.	Study research paper 20 and article 10 to 15 then get the result that the introduction of SM exact says that reduce use energy and material also reduce hazards.
Step 3	Literature Review	After study from 50 Research paper and questionnaires, we have chosen important conclusion given to us for our research paper.	After 30 research papers we get a more appropriate relation between GM and SM.
Step 4	Principle	The principle method for our methodology give relevant information about GM is that reduce waste, Zero Pollution and use Modern technology.	The method of SM principle study gives conclusion that reduce fossil fuel, reduce pollution and recycling.
Step 5	Elements	The element of GM is most appropriate ISO 14001, Green Production and natural resource preservation after study approx. 20 articles and research paper.	The element of SM focus on Manufacturing cost, personal health & safety, Waste management after study research paper.
Step 6	Compare	The similarities of GM with SM are that minimize waste and reduce environmental impact, both works on 6R, effectively use of resource for consumption in the future and present.	For the similarity's SM with GM, but there are some dissimilarities only we have gotten that SM mainly deal for present partially in the future.
Step 7	Benefit	We have taken from our research because our topical benefit of GM deals in some major point that is saving money, Business growth and saving energy.	Now this comes after GM approach to SM then we get some benefit common to the GM that is Cost reduce, Brand image reduces.
Step 8	Framework	We have included in our methodology because implementing of GM, some step to follow that is from design to re manufacturing. For this step, we have given examples for green design, green technology and green packing.	For SM, we have also included this step because it gives information for SM. In this, we have represented the graph for Sustainable Company also.
Step 9	Future work	In the future for GM, the researcher, government and stakeholder come from paying attention.	In future, the company should have to start recycle, reuse and remanufacturing and company should come for reduce carbon footprint.
Step 10	Conclusions	After study 100 research papers, article and magazine and our works concluded that positive aspect of nature	After the study conclusion comes that good aspect for natural resources conservation.

Table 3: - Steps. For the Methodology

The above table has explained our Methodology, we have adopted for our research work. From the step we also concluded the best valuable result of this research paper. These are five steps which are most important when we have worked for a topic, Green Manufacturing Minimize the Wastage, reduces pollution & Environment Impact as well as Encourages Sustainable Manufacturing. The steps are Introduction, Literature review, Principles, Benefits and Frameworks. Such that, these steps are very much important for our methodology and research work. Some example also explains our research which we have included in the Framework.

IX. FUTURE WORK

Impact on the future generation. We want to go Sustainable and going green, then we have to come to shake hand with each other. If the researcher reached in the direction of environmental impact on the product, then the company has to take necessary steps in the direction. Such that they can think that their product will not affect to the environment. The GM is a new approach to manufacturing as per study, we have found out. We have also gotten the result from study of Research paper that success toward GM also gets success toward SM. Therefore, GM uses the alternative sources of energy like wind, biomass, solar, ocean, hydropower, landfill gas and municipal solid waste. It uses the renewable source and sustain the Green environment. It is a modification of production processes and established eco-friendly environment. Therefore, if a business goes through this that is GM and SM then they will get more benefit in the future. The business gets excellent business because it will be defined path, measurable amount of achievement. The manufacturer and business will adopt the path, then, the journey will become satisfying in the future. The researcher tries to increase their research work in this direction for understanding the manufacturer benefits of GM and SM. If the manufacturing company understands, then they will things about the GM then after they take steps towards SM also. Because, GM also encourages go toward sustainability. In other words, we can say that moves towards SM. Because GM also focuses on minimize the use of non-renewable sources like coal, petroleum, fossil fuel, gas. These are available for a few years if they are constantly using on a large scale and also green the pollution by releasing of CO₂ in the nature as well as increases the greenhouse gas effect on the nature. Such that GM tells that stop or minimize the uses of non-renewable resources. Because, as we know that these conventional sources of energy are also responsible for carbon footprint in the nature also. Therefore, if non-renewable sources reduce them, carbon waste & emission reduces. As, a result that waste & emission reduces and also the carbon footprint reduces because non-renewable sources or conventional sources are almost fully responsible for carbon emission in the environment. Therefore, if reduces the waste and emission reduces as well as carbon emission minimize in the future, then, we automatically move towards SM. Because, as we know that SM also deals with reduces waste & emission, reuse & recycle and save the environment. But for achieving the best result the researcher should work with the renewable sources of energy utilization. The government and stakeholder should come in the future for large implementations of GM and SM in almost all the country. Because, as per our study, we have seen that all the continents are not giving an effort fully or some continents are giving partially an effort specially Asia continent in the world. Such that the research should work for the company of Asia continent for this they also try to go green and sustainable manufacturing. Lastly, more and more articles and magazine should be published in every year with the support of GM and SM and also show the benefit both of manufacturing. For this research should work for article and magazine. According to the achievement of both manufacturing researcher help for achieving the target.

X. CONCLUSION

As, per our study, we have got the concluded result about Green manufacturing helps to reduce the waste and pollution also approach to sustainability or success toward Sustainable Manufacturing. As we know that Green or Sustainable irrelevant in the modern market. Green manufacturing and Sustainable is a method which is developed for manufacturing industries for reduction of wastage and eliminate pollution from the environment as well as less impact on the environment that is main goal is to save our ecosystem because reduces or eliminate the change of global warming in the nearer future. As, we know that GM is the main focus on the attraction of consumers to the use of renewable sources of energy that is solar, wind, tidal, wave and geothermal energy because of reducing the pollution, waste and emission of gases like CO₂ in the environment. Secondly, the GM is focusing the reduces the use of non-renewable like fossil fuel, coal, petroleum and natural gases as well as focus on that Company should try for ISO certification. Now we have also concluded that Sustainable manufacturing focus reduces of gases like CO₂ and also utilized the available material after used for reuse and recycling for remanufacturing of the products. This also deals that Safety for personal and health both. Because, as we know that reduces and eliminates waste gases in the environment also reduces health problem in the human being like as asthma, lung cancer, heart diseases and so on, which is created by polluted air in the environment. So, we find the conclusion that both the manufacturing is beneficial for our ecosystem. Therefore, the manufacturer makes the project, which is

more environmentally friendly. Non-Sustainable technique should be removed, and try that ingredients should be used that is a green product. So, if the manufacturing company wants green for the environment a process or product Sustainable. Because, if the manufacturing company neglecting GM then they are also neglecting SM that will create negative impact on the environment. Due to this threat for the future, then environment friendly products should be researched and move to that side. Finally, we get the conclusion that Green manufacturing and Sustainable manufacturing beneficial for our ecosystem and also for reducing the greenhouse gas effect and also save the earth from it.

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