



Review Paper

Requirements of sustainable manufacturing in industries: a review

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Abstract

As we know that manufacturing industries are the back bone of every nation. This paper shows the effort done in the field of manufacturing industries in Asia, towards the favor of global aspects and requirements. There is always a requirement to minimize unwanted cost, maximize production, improvement in working policy, economy and environmental balance. Every industry is now planning and implementing to have this key element in their engineering design processes of sustainable manufacturing. This papers also reviews on environmental issues, working policies and decision methodologies so that nation can go towards sustainability in manufacturing.

Keywords: Sustainable manufacturing (SM), Supply Chain, Reverse Supply Chain Management (RSCM), Multi Criteria Decision Making (MCDM).

Introduction

The term sustainable manufacturing means the criteria of producing product by considering several factors viz., minimization of pollution, using renewable resources and providing safe environmental policies for working people^{1,2}. Asia is now comes under the most populated continent in the world. And now the tough competition in the field of production makes them to utilize their resources very efficiently so as to produce the product which can fulfil market requirements. Present industries are more focusing on maximizing production at lowest cost and this causes heavy uncertainty in work and poor health of the people. The related statistics also suggests us that due to this heavy run to chase market demand, nation rapidly losing their natural resources, which will be worst for the future of that nation as well as for the world.

Literature survey in sustainable manufacturing

Every nation is facing the problem of losing their natural resources very rapidly and that's why they wants to conserve their natural resources and tries to utilize maximum renewable resources such as biomass, light energy, wind energy in their production planning and implementation³. But both things are not possible to be have together i.e. first to maximize production in lowest cost and second to minimize pollution. Because to make in use the tools use for reducing harmful end effects its requires heavy cost and investment, which results in increasing in production cost⁴. To solve such problems considering, engineering planning and designing taking help of optimization tool like multi criteria decision making (MCDM) and multi attribute decision making (MADM) in their policy making criteria. These techniques will help to make maximum

utilization of their useful resources and manpower with respects to all constraints which now they are facing^{5,6}. This methodology of using the various nontraditional things in their manufacturing practice called as sustainable manufacturing process and it is now the demand of world. In Asia China has proved that they are have been using natural resources, because of the emerging and fast competition in the market and dense population⁷.

This paper will explain the concept of SM, significant role of supply chain management in SM and also helps to understand the design and decision making models.

Sustainable manufacturing elements

Definition of Sustainable Manufacturing: The Figure-2 shows that to make in balance of the nation to be balances and sustainable three things to be take care: i. Social: The working policies must be in favor of employees in aspects of health and safety. ii. Environmental: The exit gases and waste should not disturb natural environment. iii. Economics: The maximize production by minimizing cost and connected terms.

For the true and sustainable economic development of the nation, there is requirement of identify the needs and capabilities of the various elements comes in the chain of production since from the design and planning^{8,9}. The ecological sustainability for the workers is also important where they will get good facilities for their working activities and implement those bio-physical laws which will not make the negative impact on them. Literatures show that China is one of the good example for world which is now more focusing on the ecological balancing by doing recycling of waste and other obsolete products from electronics, manufacturing industries.

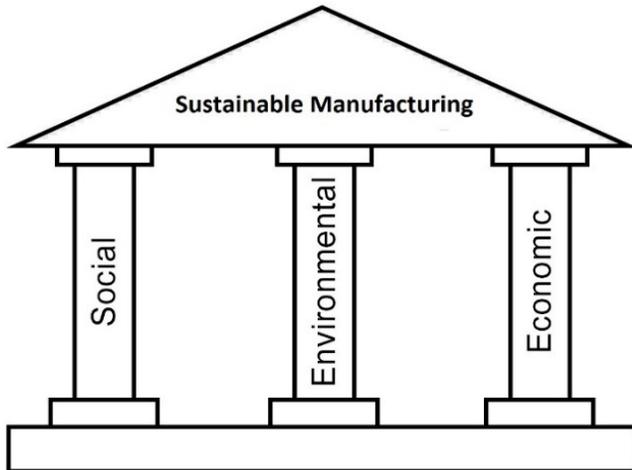


Figure-1: The concept of sustainable manufacturing.

They are emphasizing on extracting the valuable and usable materials from the waste materials so that they can use it in future⁷.

Supply Chain Management impacts in Sustainable Manufacturing: Now the researchers are working in the field of the chain management to fulfil the requirement of sustainability. One researcher has investigated that how to circulate the country economy by just recycle the waste and obsolete product using Markov chain law in reverse supply

chain management (RSCM). Another researchers has also concluded that for doing recycling and treating the waste there is not so easy due to some restrictions of country's legislation. In manufacturing industries the major energy can be able to save by about 60-70% by adopting the RSCM, so that the produced product could come in competition range and also balanced the ecology of the world⁹.

Industries are now more interested to process on returned product because of its advantages by doing several work on it like: i. Reuse, ii. Recanalization, iii. Recycle, iv. Remanufacturing.

To fulfill the above said requirements the companies are introducing various offers for the end users like buyback policies, and it has proved that it works for their economic development of industries¹¹. It has proven through various theories and research work has done in the reverse logistic models that it is good for nation like it has done in China¹². Now the requirement of eco-product is its usefulness throughout the life cycle and appropriate design. Mainly raw materials and processed elements should be environmental benign. As per the quality concerned in the sustainability the process must contains and design by considering the following things¹³: i. Process and steps which support recycling. ii. Energy conservation & environmental benign.

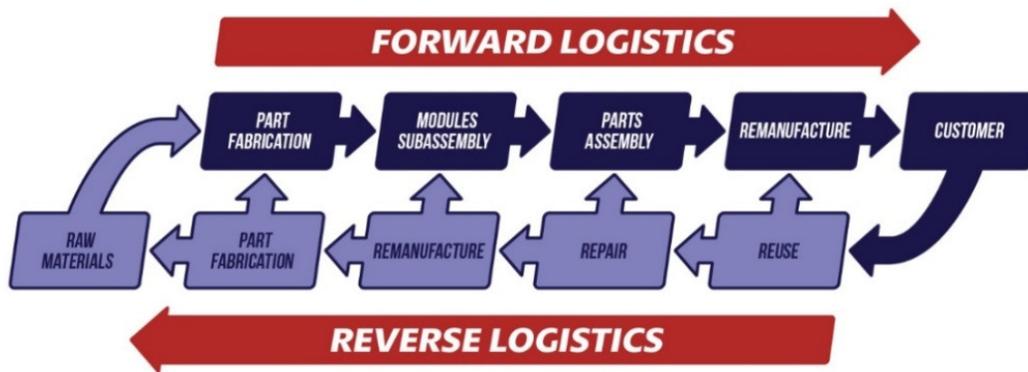


Figure-2: Schematic diagram to represent Reverse Supply Chain Management¹⁰

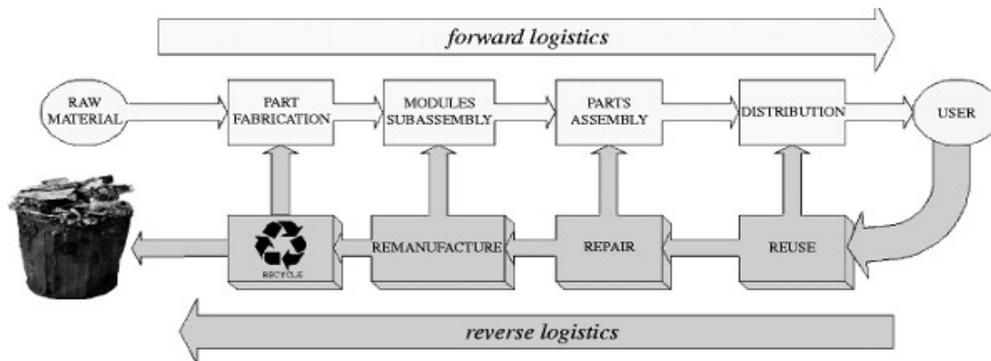


Figure-3: Fundamentals diagram of RSCM¹³

Significance of Decision Model in Sustainable Manufacturing:

The sustainability in manufacturing requires optimization techniques in process, product and system levels across the PLC¹⁰. Many researches has given their models to predict the manufacturing process so as to achieve with all the objective of the SM. This is complex to recreate production with the objective of several aspects such as environmental policies, employee's aspects. It is required to take significant decision for the SM during the design stage of the product because 70%-80% cost analysis has done during this level¹¹. Basically to maximize production and to get minimize cost the trend is to alter and upgrade the manufacturing process and practice. To promote the SM, designer should focus of weigh factors such as time of production, PLC, profits and returns durations¹².

To achieve the SM elements such as ecology, social and economics and also to resolve the conflicts between them it's required to apply the MCDM and MADM methods¹³. A framework was developed by Grabie for the various issues such as new products, new developed manufacturing process and systems for using weighted sum approach, to develop a design for sustainable manufacturing (DFSM)¹⁴. The MCDM can be helpful to predict the new horizon in SM over the topographical limitations concerned with traditional manufacturing practices⁵. Another research has done who tried to solve the problem in the area where providing power from main grid is challenging. So to solve this problem an algorithm study has done, to find an optimal location to develop and to utilize such resources²⁶.

Conclusion

The industries are now required to made advancement not only in the manufacturing process and system but also they have to consider the society, health of workers and also economics. To achieve this, industry has to use various strategies and implementations for the improvement of process and practice in manufacturing system. The various optimization techniques and model has to use to get optimized product and policies to fulfill the demand and supply in the market with respects to the proposed objectives of the sustainability in manufacturing.

References

1. Al-Hamamre Zayed, Saidan Motasem, Hararah Muhanned, Rawajfeh Khaled, Alkhasawneh E Hussam and Al-Shannag Mohammad (2017). Wastes and biomass materials as sustainable-renewable energy resources for Jordan. *Renewable and Sustainable Energy Reviews*. 67, 295-314.
2. Asiedu Y. and Gu P. (1998). Product life cycle cost analysis: state of the art review. *International journal of production research*, 36(4), 883-908.
3. Badurdeen Fazleena, Iyengar Deepak, Goldsby J Thomas, Metta Haritha, Gupta Sonal and Jawahir IS (2009). Extending total life-cycle thinking to sustainable supply chain design. *International Journal of Product Lifecycle Management*, 4(1-3), 49-67.
4. Banos Raul, Manzano-Agugliaro Francisco, Montoya FG, Gil Consolacion, Alcayde Alfredo and Gómez Julio (2011). Optimization methods applied to renewable and sustainable energy: A review. *Renewable and Sustainable Energy Reviews*, 15(4), 1753-1766.
5. Barbier E.B. (1987). The concept of sustainable economic development. *Environmental conservation*, 14(02), 101-110. <https://doi.org/10.1017/S0376892900011449>
6. Bhamra T.A., Evans S., McAloone Timothy Charles, Simon M., Poole S. and Sweatman A. (1999). Integrating environmental decisions into the product development process. I. The early stages. *Environmentally Conscious Design and Inverse Manufacturing*, 1999. Proceedings. EcoDesign '99 : First International Symposium. s.l., s.n., 329-333.
7. Blewitt J. (2014). Understanding sustainable development. Earthscan, London, 51-173, ISBN:978-184407-455-6.
8. Choi J.K. and Ramani K. (2009). A Quest for Sustainable Product Design: A Systematic Methodology for Integrated Assessment of Environmentally Benign and Economically Feasible Product Design. s.l.:VDM Publishing.
9. Chu S. and Majumdar A. (2012). Opportunities and challenges for a sustainable energy future. *nature*, 488(7411), 294-303. <https://doi:10.1038/nature11475>
10. Cuñat Alejandro and Melitz J Marc (2010). A Many-Country, Many-Good Model Of Labor Market Rigidities As A Source Of Comparative Advantage. *Journal of the European Economic Association*, 8(2-3), 434-441.
11. Fang Fan, Cheng Kai, Ding Hui, Chen Shijin and Zhao Liang (2016). Sustainable Design and Analysis of CNC Machine Tools: Sustainable Design Index Based Approach and its Application Perspectives. ASME 2016 11th International Manufacturing Science and Engineering Conferen, 3, Joint MSEC-NAMRC Symposia pp. V003T08A022--V003T08A022. <https://doi:10.1115/MSEC2016-8730>
12. Garbie I.H. (2011). Framework of manufacturing enterprises sustainability incorporating globalization issues. Proceedings of the 41st International Conference on Computers and Industrial Engineering, University of Southern California, 23-26.
13. Hung Lau K. and Wang Y. (2009). Reverse logistics in the electronic industry of China: a case study. *Supply Chain Management: An International Journal*, 14(6), 447-465.
14. Jayal A., Badurdeen F., Jr. O.D. and Jawahir I. (2010). Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels. *Journal of Manufacturing Science and Technology*, 2(3), 144-152.

15. Klein S.J. and Coffey S. (2016). Building a sustainable energy future, one community at a time. *Renewable and Sustainable Energy Reviews*. 60, 867-880.
16. Kumar Abhishek, Sah Bikash, Singh R Arvind, Deng Yan, He Xiangning, Kumar Praveen and Bansal RC (2017). A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews*. 69, 596-609.
17. Lele Sharachchandra M. (1991). Sustainable development: A critical review. *World Development*, 19(6), 607-621.
18. Li C.B., Liu F., Wang Q.F. and Li C.Z. (2010). AHP based SWOT analysis for green manufacturing strategy selection. *Key Engineering Materials*, Trans Tech Publications. 431, 249-252.
19. Mälkki Helena and Alanne Kari (2017). An overview of life cycle assessment (LCA) and research-based teaching in renewable and sustainable energy education. *Renewable and Sustainable Energy Reviews*, 69, 218-231.
20. Malviya A., Shekhar D.S. and Malviya C. (2016). Applications of RSCM- A Review. *International Journal for Scientific Research & Development*, 4(2), 1603-1605.
21. Panwar N., Kaushik S. and Kothari S. (2011). Role of renewable energy sources in environmental protection: a review. *Renewable and Sustainable Energy Reviews*, 15(3), 1513-1524.
22. Shekhar D.S. and Malviya A. (2016). Mathematical Modelling for Reverse Supply Chain in Manufacturing System. *Research Journal of Engineering Sciences*, 5(3), 6-13.
23. Ullman D.G. (1992). The mechanical design process. McGraw-Hill New York. 143-170. ISBN 978-0-07-297574-1
24. Veleva V. and Ellenbecker M. (2001). Indicators of sustainable production: framework and methodology. *Journal of cleaner production*, 9(6), 519-549.
25. Woldeyohannes A.D., Woldemichael D.E. and Baheta A.T. (2016). Sustainable renewable energy resources utilization in rural areas. *Renewable and Sustainable Energy Reviews*, 66, 1-9.