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FACTORS AFFECTING THE IMPLEMENTATION OF GREEN MANUFACTURING- A CASE STUDY ANALYSIS IN AN AUTOMOTIVE INDUSTRY

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Abstract – *The development made in the manufacturing sector not only increases the production but also tends to environmental degradations. The industries now are implementing many of the green factors or practices in the industry. Green factors implementation not only increases the environmental protection but also increases the profitability, efficiency and customer satisfaction towards the company. Thus, the aim of the study is to investigate the main factors which affects the implementation of the green manufacturing in an automotive industry. A case study analysis is carried out to find which all factors have high importance and which all factors have less importance in the industry.*

***Key Words*: Green factors, green practices, environmental protection, case study analysis, profitability, efficiency.**

1. INTRODUCTION

The manufacturing plays a vital role in an organization, especially to build competitive advantage and to improve performance. Primarily the strategy adopted by the manufacturing in 1910s was mass production and subsequently it gives way for the flexible manufacturing, mass customization and recently it turns to green manufacturing. Green manufacturing have many definitions.

One of them is given below:
"It is a system that integrates product and process design issues with the issues of manufacturing, planning and control in such a manner as to identify, quantify, assess and manage the flow of environmental waste with the goal of reducing and ultimately minimizing environmental impact while also trying to maximize resource efficiency".

The goal of the green manufacturing is defined as:

To prevent pollution and save energy through the discovery and development of new knowledge that reduces and/or eliminates the use or generation of hazardous substances in the design, manufacture, and application of chemical products or processes.

It is a technology that:
-reduces ecological and human risks
-improves efficiency
-enhances cost effectiveness
-makes products and processes that are beneficial to the environment.

The firms are trying to implementing lots of green factors to increase the competitive advantage. Most of the green factors helps them to reduce waste, increase green innovation and technology advancement. Environmental management systems and ISO 14001 certifications are demanded by many of the suppliers in the automotive industry. According to many of the literature evidences we can observe that top management, employees, workers, suppliers and customers must perform in hand to hand for the attainment of the green manufacturing implementation in industries. So to improve green performance, companies must adopt several green factors in its operations, machineries, employees and finally in after sales operations. Thus it is important to explore the green manufacturing factors in order to improve the green performance of every industry.

2. LITERATURE REVIEW

A number of studies is being carried out in manufacturing industries to support the green manufacturing. The manufacturing firms faces environmental protection issues which forces them to turn towards a green SCM to achieve the competitive advantage. Developing technological and environmental standards for purchasing, production, design etc. will lead towards a GSCM[1]. Several performance measurement metrics are formulated in the level of strategic, tactical and operational areas. It is further divided into both financial and nonfinancial sections based on the study carried out by Gunasekaran[2]. [3] Discusses the empirical study on barriers and major criteria are identified using the weights and Fuzzy Technique for Order Performance by Similarity to Ideal Solution.

Green practices such as internal environment management, technology integration, logistic management, customer focus, supplier focus are analysed with the performance measures such as environmental, economic, operational and innovation performances [4]. This study provides reliable and valid instrument for green practices constructs.

Environmental management systems are important for the environmental performance improvement [5].Same factors which are defined in the [4] are again changed into a proposed model in the study carried out by Juriah[6] in 2012. An analytical approach cum review is carried out for the measurement of performance in the study of GSCM in Indian manufacturing industry. Ashish Kumar[7] states the GSCM is the sum total of green purchasing, manufacturing, distribution and reverse logistics. Charles[8] in his study deals with how the green trends influences the financial performance in the automotive industry. It illustrates several examples of implementation.

Control on pollution [14,18,22,28,30,31]and waste minimization [16,17,20,21,24,30,32,34] are important in the green manufacturing. A vast survey is carried out by Qinghua Zhu(2004) to find a number of green practices, pressures and performance in China. A decision framework for GSCM is modeled and solved as an analytical network process (ANP) by Joseph Sarkis(2003).Several GSCM survey items were analyzed by Sarkis[18] in 2004. Green operations in automotive industry [20] gives a strong basement for finding frequent factors for green manufacturing in an automotive industry.

Rane Madras Limited is one of the largest automotive industry in India which is involved in manufacture and distribution of steering and suspension systems. The company have a total of about 800+ employees in its Pondicherry plant and have ISO 14001,ISO 16949,OHSAS 18001 certifications.

3. METHODOLOGY

Nowadays manufacturing industries are also thinking about the environment in their operations. There are many works carried out in the area of green manufacturing. Here a comprehensive literature review is carried out to find the factors in the implementation of the green manufacturing.

Mostly frequent green factors are selected as the prime factors while considering the implementation of the green manufacturing**.** Further according to the methodology similar to that of Wong and Boon-itt (2008), a pure data interview was used to research according to the following notation:
i. μ_{kj} is the importance of green factor k in achieving a greener SC in case study j.

A cross-case score can be used to assess the importance of each green factors in achieving greener supply chain

$$GPp\_score_k = \sum \mu_{kj}$$

(where j=1,2…6)

3.1. DATA DESIGN

The important green factors which are selected based on the comprehensive literature review and high frequency are given below:

1. ISO 14001 certification: It is an internationally recognized standard which defines the criteria for an environmental management system, requiring commitment to regulations, legislation and continuous improvement.
2. Support from the employees for green manufacturing: Employees are the main element in every industries. The existence of strong environmental management employees will helps the organization for green manufacturing
3. Environmental projects: Every organization is now turning towards environmental friendly firms. So decrease in environmental degradation and projects related to the green are important for better environment. The company must encourage personnel to research about environment
4. Training for employees: Trained personnel will helps to boost the industry towards a greener face.
5. Environmental collaboration with the suppliers: It improves the ability to coordinate operations and workflow in different supply tiers to changes in the customer requirements. The concerted efforts of suppliers are needed for improvements in environmental quality.
6. Environmental friendly purchasing practices: purchasing implies cost, it can create value as reduced costs, resource conservation and public image of the organization. It directly reduces the minimization of wastes.
7. Simplification and standardizations: It decreases the level of wastes at the first stage of the production itself.
8. Measures for reduction of energy and material consumption: one of the goal of green manufacturing is to reduce the emissions. So reduction of material will in turn reduces the wastage.
9. Continuous checkup of process & machine at all stages of manufacturing process: checkup of the process and machines at all stages decrease the level of the formation of the wastes due to false machining
10. Eco design: The designing of the products with special consideration for the environmental impacts of the product during its whole life cycle. Lifecycle is usually divided into procurement,manufacture,use and disposal
11. Implementation of new waste control systems: waste control systems decreases the waste

generated during the lifecycle. So that it can minimize the waste and also the cost.

12. Reverse logistics: All the operations related to the reuse of products and materials is termed as reverse logistics. It comprises the 3 R (reuse, reduce and recycle) of the product.
13. Environmental collaboration with customers: an effective customer relationship allows cost reduction and maintains the reliability of operations, thereby increasing quality and customer satisfaction. It makes the customers as environmental partners
14. Control on pollution in production: other goal of green manufacturing is to decrease the environmental emissions and pollution (air, water and soil) produced during production.so it is to be decreased to improve the competitive and environmental advantage.
15. Control on pollution by wastes: wastes are the unwanted output of every industry. The measures adopted for control on pollution will improve the green image of the industry.

3.2. IMPORTANCE OF GREEN FACTORS

Considering each plant lines individually, it can be seen that each plant lines have almost same perspective on most of the green factors. Green factors such as "environmental friendly purchasing practices" and "environmental projects" are given less importance. While "reverse logistics" and "minimizing waste" are the factors which have a high importance in the cross case analysis. The highest score variable is reverse logistics with a GPp score of 30 and lowest is the purchasing factor which have a GPp score of 14. According to the analysis of 6 plant lines, we can infer that the company considers the adoption of green factors leads to implementation of green manufacturing.

Table -1: Cross case score for green factor importance

GREEN MANUFACTURING FACTORS	CROSS CASE GPp_SCORE
ISO 14001 CERTIFICATION	27
SUPPORT FROM EMPLOYEES FOR GM	26
ENVIRONMENTAL PROJECTS	15
TRAININGS FOR EMPLOYEES	21
ENVIRONMENTAL COLLABORATION WITH SUPPLIERS	21
ENVIRONMENTAL FRIENDLY PURCHASING PRACTICES	14
SIMPLIFICATION AND STANDARDISATIONS	19
MEASURES FOR REDUCTION OF ENERGY & MATERIAL CONSUMPTION	26
CONTINOUS CHECK UP OF PROCESS & MACHINE AT ALL STAGES OF MANUFACTURING PROCESS	25
ECO DESIGN	21
IMPLEMENTATION OF NEW WASTE CONTROL SYSTEMS	24
REVERSE LOGISTICS	30
ENVIRONMENTAL COLLABORATION WITH CUSTOMERS	20
CONTROL ON POLLUTION IN PRODUCTION	28
MINIMIZING WASTE	29

4. CONCLUSIONS

Several studies have been carried out in the field of green manufacturing in recent years. But there are no significant studies in Indian manufacturing industries especially in automotive industries. Green factors are the backbone of the green manufacturing. This paper explores the factors which helps the organization for boosting the implementation of green manufacturing. It proposes a set of green factors that can be deployed in an automotive industry. Further a case study analysis and GPp importance score proposed by Susane in 2011 is executed in the entire plant lines for finding the overall GP score. This score helps us to further identify which all factors have high and which all have low importance in the implementation of green manufacturing.

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