EVALUATION OF GREEN ACT IN SMALL SCALE FOUNDRY FRAGMENT

S. Janaki[1], R. Jayachitra[2]

[1]*Research Scholar, Department of Mechanical Engineering, PSG College of Technology, Coimbatore, India*
[2]*Assistant Professor, Department of Mechanical Engineering, PSG College of Technology, Coimbatore, India*

Abstract

More people are aware of the world's environmental problems such as global warming, toxic substance usage, and decreasing in non-replenish resources. The Government has released campaigns to promote this problem to people. Several organizations responded to this by applying green principles to their company, such as using environmental friendly raw material, reducing the usage of petroleum power, and using the recycle papers for packaging. Green supply chain management (GSCM) was emerging in the last few years. This idea covers every stage in manufacturing from the first to the last stage of lifecycle, i.e. from product design to recycle. The Green Supply Chain (GSC) is a key element of an enterprise-wide green management strategy. A GSC can help agencies comply with new federal guidelines while achieving a wide range of economic, social, national security, and environmental goals. This study aims to investigate the current green level of foundry industry in and around a specific city. The approach of the present research includes a literature review, in depth interviews and questionnaire surveys. The survey questionnaire was designed with 16 items using literature. This project evaluates the environmental assessment of small scale foundries to find the critical factors of green supply chain management and their relation to the organizational performance.

Keywords - *Green supply chain, recycle, and environmental assessment*

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1. INTRODUCTION

In India, various grades of castings weighing 9.99 million are produced annually in foundries. In majority of the cases, these castings are exported to the companies situated in different parts of the world which stipulate to adhere the International standards. The various types of castings which are produced are ferrous, non-ferrous, aluminium alloy, graded cast iron, ductile iron, steel etc. for application in Automobiles, Railways, Pumps, Compressors, Valves, Diesel, Engines, Cement / Electrical / Textile Machineries, Pipes and Fittings for Aero and Sanitary and Casting for special applications. However, Grey iron castings have the major share of 68% of total castings produced. There are approximately 4500 foundries, out of which 85% can be classified as Small Scale Units and 10% as Medium and 5% as Large Scale Units.

Approximately 800 foundries are having International Quality Accreditation. Several large foundries functioning in India are modernised and globally competitive and are working at nearly full capacity. Most foundries employ Cupolas using LAM Coke. There is growing awareness about environment and many foundries are switching over to induction furnaces and some Units in Agra are changing over to cokeless cupolas. Besides these, actions are taken by managements of foundries to conserve energy and natural resources like coke, oil and water. Proper selection of equipments, adaption of best practices during shop floor operations and maintenance of equipment are necessitated today to improve the competitiveness of the foundry industry. Also the encouragement is required for the sustainable growth of the foundry industry and downstream industries for the overall economic growth and employment opportunities in the country. One of the avenues of imparting sustainable growth in the foundry industry is the application of green practices in foundry sector (Torielli et al 2010).

Currently foundry industry faces specific challenges with respect to economic and environmental sustainability. Foundry processes require substantial energy, typically generated using fossil fuels. Melting the material consumes the majority of this energy. However, other energy intensive processes such as heat treatment are also included in many foundry operations. Also, a majority of foundries utilize sand as a moulding material. The binders utilized can often include organic compounds and are burned out in the casting process. During this process volatile organic compounds and hazardous air are released. Organic materials which are used during casting finishing process can also affect environment purity. Thus foundries situated in India are in need of much attention in the field of Green supply Chain Management (GSCM) According to Srivastra (2007) GSCM is an integrated environmental thinking into supply chain management including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers and end-of-life management of the product after its useful life. According to this definition, GSCM relates to a wide-range of production from product design to recycling or destroying the used products. In this background, the outcome of literature review on GSCM followed in industrial sector is presented in the next section.

2. LITERATURE REVIEW

On realizing the need of applying GSCM principles in foundries of India, the literature was searched to locate papers reporting such researches. This search resulted in the identification of six papers. The features of the researches reported in these papers are briefly described in this section. Ashiskumar Bhateja et al. (2011) discussed various activities of the Supply Chain processes of Indian Manufacturing companies. These authors have found out the percentage of the green factor involved in their supply chain activities from the procurement of the raw material to the transportation of the final product Pandya Amit and Mavani Pratik (2012) aimed to investigate the GSCM practices likely to be adopted by the pharmaceutical industry. They studied the relationship between GSCM practices and the environmental, operational and financial performances. Toke et al. (2012) developed appropriate strategy for implementing GSCM in Indian manufacturing industry. Ezutah Udoncy Olugu et al. (2010) proposed a holistic performance measurement approach to attain an effective and efficient closed loop Supply Chain (CLSC). In their study, a suitable approach has been proposed for CLSC performance measurement in the automotive industry. It is believed that this approach will result in increased effectiveness and efficiency in CLSC performance measurement. Ru-Jen Lin et al. (2011) discussed the criteria that influence the performance of the automobile manufacturing industry using fuzzy set theory and Decision Making Trial. This hybrid method evaluates its performance to find key criteria in improving the manufacturer's green performance. Their findings showed that the increase of cost for purchasing environmental friendly material is the most influential and significant criterion, while the pollution control initiatives is the most effective criterion. Managerial implications are also discussed and concluding remarks are made. Ru-Jen Lin et al. (2011) examined the moderating effects of Total Quality Environmental Management (TQEM) on the relationship between GSCM and Environmental Performance (EP). The research premised that the total organizational effort from top management and facilitation of employees in the implementation of GSCM will ultimately enhance green performance. The statistical results indicated the interactions of GSCM and TQEM in enhancing environmental performance. From the results of the literature survey reported above, it is observed that there is need for the study on environmental performance of Indian foundry industry.

3. OBJECTIVES AND METHODOLOGY

The following are the objectives of the research presented here which involved the statistical study of the green practices in foundry sector and their performances.

- To obtain the environmental assessment of small scale foundries in and around Coimbatore city of India.
- To obtain the performance of Green practices of the small scale foundries.

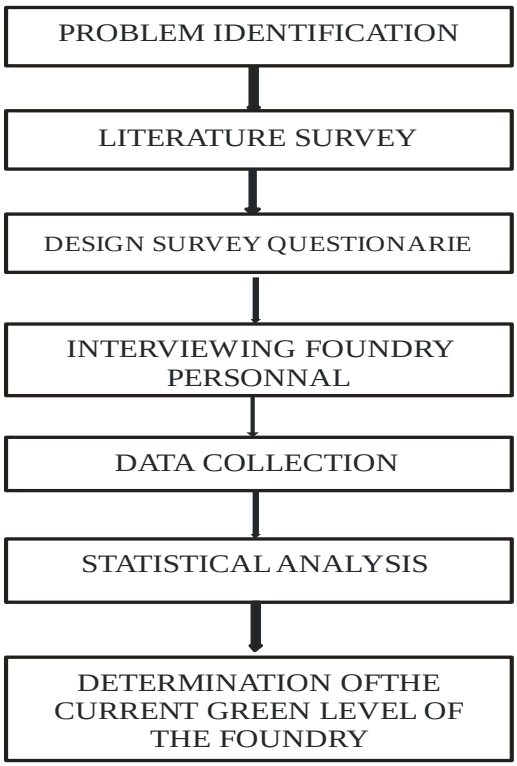

Fig. 1 Methodology

The flow chart shown in Fig. 1 represents the methodology of this study. The questionnaires were designed and circulated to the foundries to collect the data about environmental factors in and around Coimbatore city. Statistical analysis was used to test the collected data. Then the relationship between GSCM and environmental performances were obtained.

3.1 Variables

By review of the literature, three different variables were adapted. These variables are Environmental practices, Waste management and Air Quality management. Environmental practices reflects factors like Environmental policy, Environmental management plan, Emergency plan, Waste minimization policy, Environmental education or training, Environmental Regulations, Site available in the government allotted area and Firefighting equipment. Waste management reflects factors like licensed waste contractor, Separate wastes, Reducing waste, Reusing waste, Recycling waste and Records of waste removal. Air Quality management reflects factors like Controls for reducing fumes, odours and smoke and Controls for monitoring fumes, odours and smoke.

3.2 Hypothesis

To analyze the data gathered through the conduct of questionnaire supported survey, the null hypothesis (H0) and the alternative hypothesis (H1) were formed. These hypotheses are,

H0: There is no significant relationship between the foundries following GSCM and their level of environmental performance.

H1: There is a significant relationship between the foundries following GSCM and their level of environmental performance.

4. SURVEY ANALYSIS

The data were collected using questionnaire survey from the 25 foundries. The questions were grouped under the categories namely, General information about the company, Environmental practices, Waste management, Air Quality management and Environmental performance. The survey results were analysed using Minitab and Excel. Based on the work flow survey questions were prepared and are circulated among the foundry industries to know about how far the concept of green is adopted.

4.1 Hypothesis Testing

Hypothesis testing is a decision making process for evaluating claims about population. Economic performance is typically the most important driver for enterprises that wish to implement environmental management practices.

4.2 Equal Effectiveness Test

Cochran's Q test is an e to the McNemar test for related samples that provides a method for testing the differences between three or more matched sets of frequencies or proportions. The matching samples can be based on k characteristics of N individuals that are associated with the response. Alternatively, N individuals may be observed under k different treatments or conditions (for example different questions or one question at different times). The data must be supplied as dichotomous variables containing 0 to represent failure (or absence), and 1 to represent success (or presence). The variables can be stored in separate variants, or alternatively, all the data can be stored in a single variant, with a factor to indicate which variable is recorded in each unit of the variant. Note that, it is assumed that the individuals are recorded in the same order for each variable.

H_0: The treatments are equally effective.

H_1: There is a difference in effectiveness among treatments.

The Cochran's Q test statistic is

$$T = k\,(k-1)\,\frac{\sum_{j=1}^{k}\left(X_{\bullet j}-\frac{N}{k}\right)^2}{\sum_{i=1}^{b}X_{i\bullet}\,(k-X_{i\bullet})}$$

Where,

k is the number of treatments

X_j is the column total for the j^{th} treatment

b is the number of blocks

X_i is the row total for the i^{th} block

N is the grand total

The results of Cochran's Q test are presented in Table 1. On observing the data presented in this Table, it can be easily observed that, most of the foundry organizations believe that environmental regulation is the critical factor for the company.

Table 1: Foundry Environmental Assessment (Environmental Practices)

Foundry Environmental Assessment (Environmental Practices)			
Test statistics			
N	**Cochran's Q**	**Degrees of freedom**	**Significance level**
25	40.6	5	0.05
		Value (0)	**Value (1)**
S.No	**Variable**	**Factor not considered by respondent**	**Factor considered by the respondent**
1	Environmental policy	13	12
2	Environmental Management plan	15	10
3	Emergency plan	0	25
4	Waste minimization policy	9	16
5	Environmental education or training	21	4
6	Environmental Regulations	4	21
7	Site available in the government allotted area	0	25
8	Firefighting equipment	4	21

From the above analysis, it can be seen that, coefficient of effectiveness is 40.6. The Table value for the degrees of freedom 5 and the significance level 0.05 is 16. The value indicates that no factors have equal effectiveness on organizations thinking towards environmental practices. The data on foundry Environmental Assessment (Waste Management) are presented. From the Table 2, it can be easily observed that, most of the foundry organizations believe that separate wastes is the critical factor for the company. From the above analysis, it can be seen that coefficient of effectiveness is 42.3. The table value for the degrees of freedom 4 and the significance level 0.05 is 14.860. This value indicates that no factors have equal effectiveness on organizations thinking towards waste management.

Table 2: Foundry Environmental Assessment (Waste Management)

Foundry Environmental Assessment (Waste Management)			
Test statistics			
N	**Cochran's Q**	**Degrees of freedom**	**Significance level**
25	42.3	4	0.05
		Value (0)	**Value (1)**
S.No	**Variable**	**Factor not considered by respondent**	**Factor considered by the respondent**
9	Licensed waste contractor	21	3
10	Separate wastes	3	22
11	Reducing waste	0	25
12	Reusing waste	15	10
13	Recycling waste	6	19
14	Records of waste removal	16	9

In Table 3, the data on foundry Environmental Assessment (Air Quality Management) are presented from this Table 3, it can be seen that coefficient of effectiveness is 16. The table value for the degrees of freedom 1 and the significance level 0.05 is 7.879. This value indicates that, no factors have equal effectiveness on organizations thinking towards air quality management.

Table 3: Foundry Environmental Assessment (Air Quality Management)

Foundry Environmental Assessment (Air Quality Management)			
Test statistics			
N	**Cochran's Q**	**Degrees of freedom**	**Significance level**
25	16	1	0.05
		Value (0)	**Value (1)**
S.No	**Variable**	**Factor not considered by respondent**	**Factor considered by the respondent**
15	Controls for reducing fumes, odours and smoke	3	22
16	Controls for monitoring fumes, odours and smoke	19	6

4.3 Chi-Square Test

One of the equal effectiveness tests namely, Chi-square is a statistical test commonly used to compare observed data with data expected to obtain according to a specific hypothesis. The data obtained from the sample are referred to as the observed numbers of cases. These are the frequencies of occurrence for each category into which the data have been grouped. In the Chi-square tests, the null hypothesis makes a statement concerning how many cases are to be expected in each category if this hypothesis is correct. The chi square test is based on the difference between the observed and the expected values for each category.

Where,

O_i = Observed value

E_i =Expected value

Table 4 GSCM Affecting Environmental Performance of the Foundry

GSCM affecting environmental performance of the foundry					
S.No	**GSCM affecting environmental performance of the foundry**	**Level of influence**			**Total**
		Low	Medium	High	
1	Yes	5	6	11	22
2	No	0	3	0	3
Total		5	9	11	25

For the purpose of the study, the GSCM affecting environmental performance of the foundry has been studied under two categories namely, yes and no. With a view to find the degree of association between companies affected by GSCM and their level of environmental performance, a two way table was prepared and the same is depicted in Table 4. In order to find out the relationship between the foundries, GSCM and their environmental performance, a Chi-square test was employed and result of the test is given in the Table 5.

H0: There is no significant relationship between the foundries following GSCM and their level of environmental performance.

H1: There is a significant relationship between the foundries following GSCM and their level of environmental performance.

Table 5 Environmental Performance of the Foundry Based on $\chi 2$

GSCM affecting Environmental performance of the foundry				
Chi-Square Test				
Factor	**calculated χ^2 value**	**Table value**	**Degrees of freedom**	**Remarks**
GSCM affecting Environmental performance	6.06	5.99	2	Significant at 5% level

The Table 5 shows that the calculated value (6.06) is greater than the table value (5.99) and the result is significant at 5% level. Hence, the null hypothesis H0 is rejected and the alternate hypothesis H1is accepted. From the analysis, it is concluded that there is a close relationship between the GSCM and their level of environmental performance.

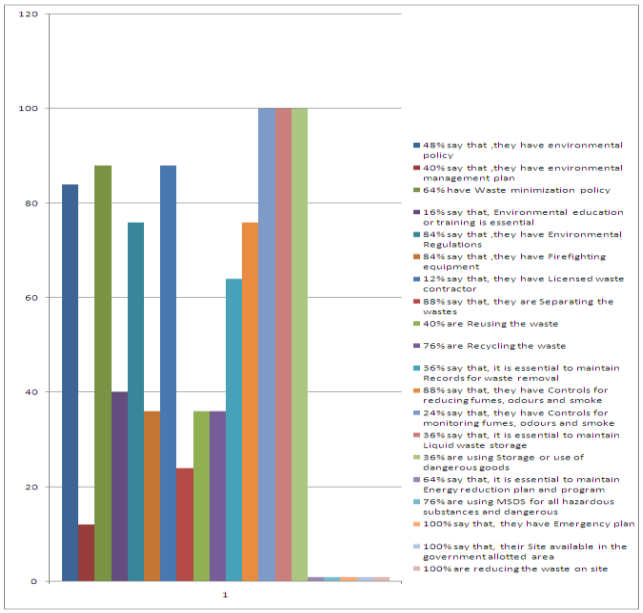

Fig. 2 Current Green Level of the Foundry Industries

Table 6 Summary of the Survey

Encouraging response towards GSCM	Obstructive response towards GSCM
48% of the foundry personnel say that ,they have environmental policy	52% not even considering environmental policy
40% of the foundry personnel say that ,they have environmental management plan	60% not even considering environmental management plan
64% of the foundry personnel say that, have Waste minimization policy	36% don't have Waste minimization policy
16% of the foundry personnel say that, Environmental education or training is essential	84% feels that it is not essential
84% of the foundry personnel say that ,they have Environmental Regulations	16% don't have Environmental Regulations
84% of the foundry personnel say that ,they have Firefighting equipment	16% don't have Firefighting equipment
12% of the foundry personnel say that, they have Licensed waste contractor	88% not even considering about Licensed waste contractor
88% say that, they are Separating the wastes	12% not even considering about Separating the wastes
40% of the foundry personnel say that, they are Reusing the waste	60% are not Reusing the waste
76% of the foundry personnel say that, they are Recycling the waste	24% are not Recycling the waste
36% of the foundry personnel say that, it is essential to maintain Records for waste removal	64% say that, it is not essential
88% of the foundry personnel say that, they have Controls for reducing fumes, odours and smoke	12% say that, they don't have Controls for reducing fumes, odours and smoke
24% of the foundry personnel say that, they have Controls for monitoring fumes, odours and smoke	76% say that, they don't have Controls for monitoring fumes, odours and smoke
64% of the foundry personnel say that, it is essential to maintain Energy reduction plan and program	36% say that, it is not essential
100% of the foundry personnel say that, they have Emergency plan	
100% of the foundry personnel say that, their Site available in the government allotted area	

Through from the survey results and hypothesis testing, it may be concluded that there is a greater understanding among the foundries about the positive impact to the environment in following green concept. There are many reasons because of which they are not following it. Table 6 shows the overall summary about the current status of apply of GSCM in foundries and Fig. 2 shows its graphical representation.

5. CONCLUSIONS

The environmental assessment of small scale foundries in and around Coimbatore was studied using questionnaire survey. The attempt was made to collect the data from the foundries to know about the current green level of the foundries situated in and around Coimbatore. From the data collected, statistical analysis was made from the survey results to know about the green current practices. From the analysis, it is concluded that there is a close relationship between the GSCM and their level of environmental performance. It is found that foundries in Coimbatore show little interest in green concepts. Though the awareness among the environmental effects is found to be positive, still there are many reasons prevailing in the industry which act as barriers. The government and the foundry industries should take some initiatives to change the prevalence of the current situation.

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