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Analyzing Environmental Performance of Green Manufacturing (GM) Initiative using Principal Component Analysis and Multiple Regression Method in Indian Context

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Abstract- Green manufacturing (GM) initiative to improve environmental performance is one of the important issues in Indian industries in recent decade. This research work emphasizes on statistical analysis of key factors playing significant role in the success of Green manufacturing initiatives in Indian industries. A questionnaire consists of independent and dependent variable was prepared as a data collection instrument and data is collected from Mumbai region (India) based industries. Principal component analysis of both independent and dependent variables is carried out separately by using SPSS 21 package as a statistical tool. Multiple Regression analysis is used to test empirical model and hypothetical relationship is verified. The results show that GM initiative has significant impact on environmental performance.

Index Terms- Green Manufacturing (GM), Green Design (GD), Factor analysis, Multiple Regression

1. INTRODUCTION

Green manufacturing (GM) is a term used to describe manufacturing practices that do not harm the environment during any part of the manufacturing process. It emphasis the manufacturing processes that do not pollute the environment or harm consumers, employees, or other members of community (Minhaj Ahemad A.Rehman et al.2013). Melnyk and Smith (1996) defined Green manufacturing as "a system that integrates product and process design issues with 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". Environmental performance is defined as "the result of an organization's management of its environmental aspect (ISO, 1999).It indicates the organization's influence on living and non-living natural systems, including ecosystems, land, air, and water" (Bulent Sezen et al.2013).

In recent decade, there has been increased pressure on manufacturers to think beyond the economic benefits of their manufacturing methods and products and consider the environmental and social affects. Toxic wastes and pollution created by industries are causing crisis for thousands of communities around the world. Even more threatening, global crises such as ozone depletion, greenhouse warming, deforestation and the loss of biodiversity are in one way or another rooted in corporate products and production methods. Such environmental problems are sounding a fear for the public. People are very much concerned about environmental degradation and about the continued functioning of the Earth's natural systems. The environmental liabilities that we are leaving behind for the new generation may be beyond their capacity of handling (Paul Shrivastava et al.1995).

Execution of Green manufacturing practices is one of the important issues in Indian enterprises due to public pressure, government regulations and need of market. This paper emphasizes on Statistical analysis of key factors playing significant role in the success of Green manufacturing initiative to improve environmental performance in Indian industries with Mumbai region industries as a case study. The data collected through questionnaire from 310 Mumbai region industries is analyzed by Principal component analysis and Multiple regression method.

2. REVIEW OF LITERATURE

This research work is aimed to investigate effectiveness of Green manufacturing (GM) practices being used in Indian enterprises intended for reducing environmental impact. So it very important to review what has been investigated and published on GM by accredited scholars and researchers. The review process is started with concepts and definitions of GM by different authors. It is followed by deriving performance measures and related success factors of GM by exhaustive literature review of variables and factors investigated and suggested by different authors.

Many researchers have defined GM by different ways. According to Devi s. Kalla et al. (2008), "GM is an emerging field in recent years and is also helpful in sustainable development for modern manufacturing industries. Sustainable green manufacturing emerges the thought of combining technical issues of design and manufacturing, energy preservation, prevention, health and safety of communities and customers". According to Arindam Bhattacharya et al. (2011), "Green manufacturing involves transformation of industrial operations in three ways: (1) designing and developing Green products, (2) using green manufacturing processes, and (3) using Green energy". According to Deif et al.(2011), " Green manufacturing is a sustainable approach to the design and engineering activities involved in product improvement and/or system operation to minimize environmental impact". As per Dornfeld (2013), "Green manufacturing is about implementing any kind of replacement in the manufacturing procedure which leads to a fall in energy consumption, resource utilization, waste by-products, and water utilization. Means the step that makes the manufacture of a product, component or part of a system additional sustainable can be termed as Green manufacturing". As per Cortellini (2001), "Green manufacturing is a method of manufacturing that reduces waste and pollution, slows the depletion of natural resources as well as reduces the extensive amounts of trash that enter the landfills". According to Atlas and Florida (1998), "Green manufacturing involves manufacturing processes with relatively less environmental impacts, capable, and generates no waste". As per Mihelcic J. R. et al.(2011), "Green manufacturing is the creation of manufactured products that utilize processes which reduces harmful environmental impacts, preserve energy and natural resources and are safe for staff, communities, and consumers and are economically beneficial".

Many researchers have attempted quantitative statistical analysis of performance measures of GM using different statistical methods for different products, sample size, geographical survey areas using appropriate questionnaire. Bulent Sezen et al. (2013) have investigated the pressure of green manufacturing and eco-innovation on corporate sustainability performance like economic, environmental, and social by collecting data through a questionnaire-based survey across 53companies from automotive, chemical and electronic sectors in Turkey. Regression analysis was used to test empirical model and to verify the hypothetical relationships of the study. The results of this testing indicate that the green manufacturing applications have a major positive impact on environmental performance and social performance. The research of Denis Boret Cordoba and Alireza Veshagh (2013) studied the principles of eco-design and sustainable manufacturing and also examined application of sustainable practices in manufacturing industry for eco design and sustainable manufacturing in the food and drink sector of UK. A questionnaire based survey was conducted with 258 manufacturers in the UK to inspect the business case for eco design and sustainable manufacturing in terms of the drives, barriers, advantages and risks. The results proved that the main barriers faced by the general manufacturing industry were most importantly high implementation costs, followed by weak justification for investment and lack of stakeholder and customer awareness. Sumit Gupta et al. (2015) have adopted Analytic Hierarchy Process (AHP) Model for evaluating Sustainable manufacturing processes in Indian industries with electrical panel industries as a case study. This research work presented an AHP model for different manufacturing processes viz. process design, eco-design, green supply chain, lean practices, recovery of product and cleaner production by which firms can attain sustainability in the realm of clean environment. The results of this study provide plans and directions for industries to get appropriate actions in improving sustainability in manufacturing. A study by Mukherjee and Kathuria (2006) measures the environmental performance of 14 major Indian States by ranking them under eight major environmental groups. The data analysis shows that environmental ranks of the states vary over time, which implies that environment has both spatial and temporal dimensions. Ranking of the states across different environmental criteria (groups) shows that those different states have different strengths and weaknesses in managing various aspects of environmental quality (EQ). They found out that Maharashtra (MH) shows low EQ with high industrial growth. It seems that they had neglected their environmental issues. Thus, individual States should adopt environmental management practices based on their local environmental conditions. Digalwar and Sangwan (2007) identified 16 performance measures of world class manufacturing (WCM) that are, top management commitment, knowledge management, employee training, innovation and technology, employee empowerment, environmental health and safety, supplier management, production planning and control, quality, flexibility, speed, cost, customer involvement, customer satisfaction, customer services and company growth of WCM in Indian context. Total 89 related variables are developed. According to them environmental health measures need to be focused by the industries due to rising pollution in India. The research of Abhishek Kumar Singh et al.(2014) deals to identify factors of GM practices adoption among the MSMEs in India and use of Analytic Hierarchy Process (AHP) to validate the developed multiple-item scale for identified factors and variables with matrices hierarchies which are generally used as the multicriteria judgment making. The data was collected from 195 Indian MSMEs through questionnaires comprising of 15 items revealed a six factor structure. This research has come to conclusion that GM relates to greening of product design, design of untreated materials, process, technology, packaging matter and packaging plan. Minhaj Ahemad Abdul Rehman and Rakesh L. Shrivastava (2013) have undertaken survey to find the extent of awareness and execution of GM practices within various medium and small industries (MSE) in the Vidharbha region of Maharashtra, India. In this study, an approach was made to develop an instrument to find the status of awareness and execution of GM in this section. It also aimed at developing and validating performance measures for GM in Indian context that could be utilized by manufacturers in improving their environmental performance. The data was collected from 65 medium and small industries from said region through an appropriate questionnaire consist of 27 questions. The author found that the execution of GM by industries is still at very early stage and a lot of efforts to be put to lift levels of awareness and to convince them the need and probable benefits of GM. The study of Kuldip Singh Sangwan (2011) was intended to identify the application as well as quantitative and qualitative benefits of GM for the managers who are considering GM introduction in the organization .Data is collected by survey of 198 Indian SMEs in India, using a questionnaire developed for this study. The collected data is analyzed by using SPSS statistical tool to validate the quantitative and qualitative benefits of GM. The results of reliability and validity analyses, give sure confirmation that the identified benefits are greatly reliable and applicable for the Indian SMEs. The research of R.P. Mohanty & Anand Prakash (2014) illustrates the application of Structural Equation Modeling (SEM) to recognize the green supply chain management (GSCM) practices relating to Micro, Small, and Medium Enterprises (MSME) in India by collecting data from 114 industries through a properly designed questionnaire. This study intends to learn whether the greening scores measure a common construct called GSCM and whether external and internal stress due to stakeholders have any control on GSCM practices when differences are controlled for different types of MSME and different environment of industries of MSME in Indian context. This study confirms and validates that the lower level of GSCM involvement of Indian MSME can be attributed to be short of the necessary external and internal stresses.

With the help of literature review in the context of GM implementation, research gaps are identified and viewed from the perspective of these gaps, it is decided to investigate effect of GM initiative on environmental performance with Mumbai region(India) as a case study. The major aspects of need of this research are considerable development of Indian industrial sectors, rising population and their demands, rising pollution, degradation of natural resources etc. The geographical survey area of industries in this research is metropolitan city, Mumbai and adjustment towns/sectors viz. Thane, Navi Mumbai, Dombivali, Kalyan, Ambernath, Taloja, Rasayani, and Bhivandi of Maharashtra state, India. This region pays special attention for this research due to more number of industries, highly densed population due to non availability of land, and rising pollution due to industries etc. Mumbai city is one of the metropolitan cities of India and considered as financial capital of India.

3. METHODOLOGY OF INVESTIGATION

After viewing different methodology of quantitative analysis, an appropriate quantitative approach was chosen as the tool of research to identify and validate a set of performance measure for Green Design (GD) and Green Manufacturing (GM) Practices being used in Mumbai region. A set of questionnaires, which is adapted based on past research, was used to measure the variables.

3.1 Design of data gathering tool

The questionnaires used in this research was gleaned and compiled from various validated instruments from the literature reviewed but some modifications were made to wording to suit the context of this research. A questionnaire consists of 24 variables was developed and distributed among the industries .The respondents were asked to rate the variables under a five point Likert scale (1-Not at all, 2- Limited extent, 3- To some extent, 4- Reasonable extent and 5-High extent).The following table 1 shows the different factors and related variables.

Table 1: Factors and related variables

No.	Factor	Related variables
1	Efforts of organization(EO)	EO1,EO2,EO3
2	Material selection criteria(MSC)	MSC1,MSC2,MSC3
3	Green design execution(GDE)	GDE1,GDE2,GDE3
4	Green manufacturing execution(GME)	GME1,GME2,GME3
5	Implementation of environmental acts (IEA)	IEA1,IEA2,IEA3
6	Environmental impact (EI)	EI1,EI2,EI3
7	Resources impact (RI)	RI1,RI2,RI3

8	Cost benefit impact (CBI)	CBI1,CBI2,CBI3

The details of related variables are as follows.

EO1- Organization has taken efforts to create awareness of need of GM among the employees, EO2- Organization has taken adequate efforts to bring green processes in organization,EO3- Organization has adopted Indian government norms of clean environment and also monitors the progress of GM, MSC1- Effects on human health involved in development and end use of product are considered while selecting materials, MSC2- End- of- life use and recyclability of material is considered, MSC3- Toxic and hazardous material uses are eliminated and environmentally friendly materials are used in product development, GDE1- Environmental regulations, safety standards are followed in product design, GDE2- Green design practises like Design for disassembly, remanufacturing and recycling are incorporated in design process, GDE3- Design approach is preventive and integrates environmental concerns in product life cycle, GME1- Environmental issues are considered in planning manufacturing processes and other related activities, GME2- Conventional Manufacturing processes are replaced by recent Green Manufacturing processes, GME3- Pollution control and emission control devices are modified, IEA1- Organization follows Resource Conservation and Recovery Act, IEA2- Organization follows Clean Air Act ,Waste Minimization& Management Act, IEA3- Organization follows Emission Norms, EI1- Pollution through air and water in the surrounding residential area is reduced, EI2- There is reduction in solid waste and other waste, EI3- There is control over industrial emissions, RI1- Consumption of energy is optimized, RI2- Healthy working conditions are created for human resources and human resources are optimized, RI3- Waste water and waste materials are reused, CBI1- Manufacturing cost is recovered through recycling, CBI2- Cost of energy consumption is reduced, CBI3- There is reduction in waste handling, waste disposal, and waste storage cost.

3.2 Sample size design

The target population in this research is all firms which implemented GM. Sampling size is determined keeping the aspects of generalization and desired power in mind. According to Hair, J.F.et al. (2007), minimum 5 respondents per variable are required. But Hair preferred more than 10 respondents per variable for better results i.e. (Number of respondents) >(10 x Number of variables). In this research379 industries based in Mumbai and nearby industrial areas commonly known as Mumbai region are selected and questionnaire is sent to the concern persons handling the practices of Green Manufacturing through proper sources. Total 310 industries have responded to the questionnaire properly and these responses are considered as data for research which suits the requirement of sample size (i.e. 310 > 10 x 24)

3.3 Respondent characteristics

The characteristics of total 310 responding industries is as shown in table 2

Table 2: Respondent characteristics

Sr. No	Type	Frequency	Percent
1	Small	70	22.6
2	Medium	114	36.8
3	Large	126	40.6
4	Total	310	100

4. Preliminary analysis of data

The data collected through questionnaire is entered in properly designed data sheet and it is analyzed by using SPSS 21(IBM) step by step as shown below.

4.1 Reliability test

According to Carmines and Zeller (1979), Reliability concerns the extent to which an experiment, test or any measuring procedure yields the same results on repeated trials. The internal consistency method works quite well in field studies because it requires only one administration. Also, it is the most general form of reliability estimation .Prior to further analysis, internal consistency of variable set was performed by SPSS21 software and reliability coefficient Cronbach's alpha is calculated for all sets of variables and the results are tabulated as shown in table 3.

Table 3: Cronbach's alpha

Sr.No	Factor	Cronbach's alpha	Overall Cronbach's alpha
1	EO	0.758	0.867
2	MSC	0.661	
3	GDE	0.692	
4	GME	0.797	

5	IEA	0.617	
6	EI	0.832	0.816
7	RI	0.759	
8	CBI	0.652	

According to Hair,J.F. et al.(2007) ,it is essential to perform reliability test to ensure Cronbach's alpha for all factor and it should be should be greater than 0.6.The Cronbach's value for all factors shown above are above 0.6, hence the reliability is ensured.

4.2 KMO test of sampling adequacy and Bartlett's test sphericity

Very first two important tests were carried out i.e. Kaiser-Meyer-Olkin sampling adequacy test and Bartlett's test of sphericity. According to Hair J.F.(2007),these both the tests evaluate the appropriateness of applying factor analysis. KMO measure checks inter-correlations among variables. Bartlett's test of sphericity provides statistical significance that correlations matrix has significant correlations among at least some of the variables.

Table 4: KMO and Bartlett's test for independent variables

KMO and Bartlett's test		
KMO measure of sampling adequacy		0.812
Bartlett's test of sphericity	Approx. Chi-Square	1842.816
	df	105
	Sig.	0.000

Table 5: KMO and Bartlett's test for dependent variables

KMO and Bartlett's test		
KMO measure of sampling adequacy		0.713
Bartlett's test of sphericity	Approx. Chi-Square	1148.819
	df	36
	Sig.	0.000

As per the guidelines by Hair J.F. et al. (2007), Malhotra and Dash (2011) minimum acceptable value of KMO is 0.5. Here as KMO value is more than 0.5 indicating the appropriateness of applying factor analysis. Bartlett's Test of Sphericity indicates that correlations matrix has significant correlations among at least some of the variables. Both the tests indicate that suitability of data for further analysis.

5. Factor analysis by Principal Component Method

Factor analysis is performed to reveal the factor structure. It is necessary to check whether items designed are loading on the designed factors. According to Hair J.F. et al. (2007), mixing dependent and independent variables in single factor analysis is highly inaccurate and if it is carried out it can result into inappropriate relationship. So for dependent and independent variables, separate factor analysis was carried out.

The method used here is Principal component analysis. As per Raj Kishore Sharma et al.(2015) ,the main difference between factor analysis and principal component analysis lies in the way the communalities are used. In principal component analysis, it is assumed that the communalities are initially 1. This is reflected in the fact that in factor analysis the communalities have to estimated, which makes factor analysis more complicated than principal component analysis, but also more conservative.

5.1: Descriptive statistics of variables-

Table 6 and Table 7 show descriptive statistics of independent and dependent variables obtained separately by SPSS 21 software.

Table 6: Descriptive statistics of independent variables

Variable	N	Mean	Std. Deviation
EOAVG	310	3.5957	0.63686
MSCAVG	310	3.6022	0.58766
GDEAVG	310	3.6774	0.54752
GMEAVG	310	3.7118	0.62037
IEAAVG	310	3.6581	0.55538

Table 7: Descriptive statistics of dependent variables

Variable	N	Mean	Std. Deviation
EIAVG	310	3.7667	0.57987
RIAVG	310	3.7269	0.55799
CBIAVG	310	3.6624	0.57390

5.2 Factor analysis

Method used here for factor analysis is Principal Component Analysis. Basic assumptions underlying Principal Component Analysis are that all variance is common. Hence all are one initially. Following Table 8 and Table 9 shows communalities.

Table 8: Communalities (Independent Variables)

Communalities		
Variable	Initial	Extraction
EO1	1.000	0.683
EO2	1.000	0.853
EO3	1.000	0.710
MSC1	1.000	0.501
MSC2	1.000	0.600
MSC3	1.000	0.524
GDE1	1.000	0.553
GDE2	1.000	0.482
GDE3	1.000	0.525
GME1	1.000	0.588
GME2	1.000	0.677
GME3	1.000	0.585
IEA1	1.000	0.756
IEA2	1.000	0.473
IEA3	1.000	0.642
Extraction Method: Principal Component Analysis.		

Table 9: Communalities (Dependent Variables)

Communalities		
Variable	Initial	Extraction
EI1	1.000	0.711
EI2	1.000	0.650
EI3	1.000	0.934
RI1	1.000	0.666
RI2	1.000	0.701
RI3	1.000	0.645
CBI1	1.000	0.689
CBI2	1.000	0.662
CBI3	1.000	0.533
Extraction Method: Principal Component Analysis.		

Extraction refers to common variance in data structure. Table 8 and 9 clearly indicates that for maximum variables minimum shared variance always exceeds 50% and in majority of cases it exceeds 60%.

Principal component analysis with Varimax rotation has resulted into rotated component matrix as shown in table 10 and 11.This rotation is carried out to redistribute variance to achieve simpler and meaningful pattern. All values less than 0.5 are suppressed for analysis purpose.

Table 10: Rotated Component Matrix for independent variables

Rotated Component Matrix					
	Component				
	1	2	3	4	5
EO1		0.816			

EO2		0.757			
EO3		0.698			
MSC1			0.545		
MSC2			0.701		
MSC3			0.656		
GDE1	0.669				
GDE2	0.672				
GDE3	0.626				
GME1	0.634				
GME2	0.703				
GME3	0.722				
IEA1				0.634	
IEA2				0.553	
IEA3				0.744	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 8 iterations

Table11: Rotated Component Matrix for dependent Variables

Rotated Component Matrix			
	Component		
	1	2	3
EI1	0.833		
EI2	0.716		
EI3	0.926		
RI1		0.757	
RI2		0.813	
RI3		0.772	
CBI1			0.806
CBI2			0.767
CBI3			0.635

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 5 iterations

Above rotated solution clearly gives idea about how items are loading on the factors. This clearly indicates unidimensionality of measures indicating that all items under one factor are strongly associated .This unidimensionality is highly essential for calculation of summated scale.

Number of factors extracted here is based on Scree plot which plots Eigen values against Component number. Latent root (Eigen value criteria) is adopted to determine whether factor selection is proper or not.

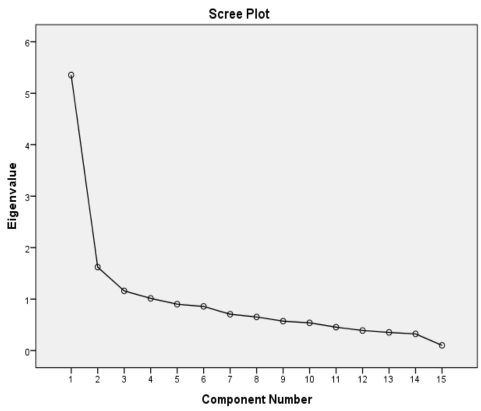

Figure 1: Eigen value plot for Scree test criteria for independent Variables

Above Eigen value plot for Scree test criteria for independent Variables clearly confirms presence of 4 components with Eigen value greater than one.

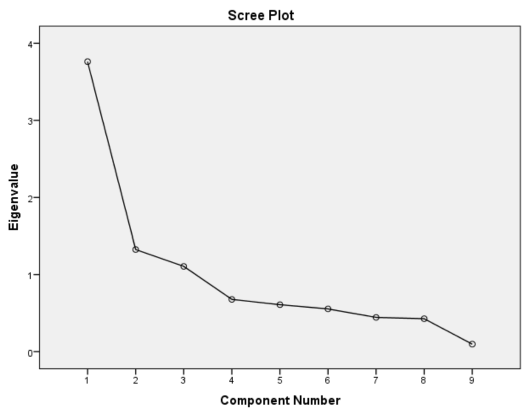

Figure 2: Eigen value plot for Scree test criteria for dependent Variables

Above Eigen value plot for Scree test criteria for dependent variables clearly confirms presence of 3 components with Eigen value greater than one.

All the above analysis clearly indicates the unidimensionality of measures indicating that all items under each factor are strongly associated ensuring construct validity.

6. Muliple Regression analysis

As per Hair J.F.(2007), Multiple Regression analysis is a statistical technique which is used to analyze the relationship between a single dependent variable and several independent variables. The objective of multiple regression analysis is to use the independent variables whose values are known to predict the single dependent value selected by researcher.

6.1 Design of hypothesis

The purpose of Multiple Regression analysis in this study is to find effect of independent variables EO,MSC,GDE,GME and IEA on dependent variable EI (Environmental impact). So various null and alternate hypothesis are designed as follows.

Table12: Various Null and Alternate hypothesis

Sr.No	Null hypothesis	Alternate hypothesis
1	$H1_0$: There is no positive effect of EO on EI	$H1_a$: There is positive effect of EO on EI
2	$H2_0$: There is no positive effect of MSC on EI	$H2_a$: There is positive effect of MSC on I
3	$H3_0$: There is no positive effect of GDE on EI	$H3_a$: There is positive effect of GDE on EI
4	$H4_0$: There is no positive effect of GME on EI	$H4_a$: There is positive effect of GME on EI
5	$H5_0$: There is no positive effect of IEA on EI	$H5_a$: There is positive effect of IEA on EI

6.2 Model Summery

The table 13 shows Model summary with EI as dependent variable and EO, MSC, GDE, GME as independent variables

Table 13: Model Summary (Linear Regression Analysis for EI)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.681[a]	0.464	0.455	0.42805

a. Predictors: EOAVG, MSCAVG GDEAVG, GMEAVG and IEAAVG
b. Dependent Variable: EIAVG

Adjusted R square value is 0.455; means 45.5% variation in the dependent variable is explained by independent variables. Here 0.455 is sufficiently high value of variance hence model is acceptable. (Hair J.F et al.; 2007)

6.3 ANOVA test for overall model fit

Table 14 provides ANOVA summary statistical positive test for overall model fit.

Table 14: ANOVA Statistical Test for overall model fit

ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	48.199	5	9.640	52.610	.000[b]
Residual	55.701	304	0.183		
Total	103.900	309			

a. Dependent variable: EIAVG
b. Predictors: EOAVG, MSCAVG GDEAVG, GMEAVG and IEAAVG

Here total sum of squares are 103.900.This much error would have occurred if only mean of dependent variable i.e. EI is used to predict dependent variable.
Reduction in error by use of this model= (48.199/103.900)x100= 46.38%
This reduction is found to be statistically significant with F-ratio of 52.610 and significance level of 0.000.

6.4 Linear Regression Coefficients Beta for EI

Table 15: Regression Coefficient[a]

Model (AVG)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	.670	.206		3.254	.001
EOAVG	.089	.045	0.098	1.992	.047
MSCAVG	.049	.051	0.049	.953	.342
GDEAVG	.124	.056	0.089	2.210	.028
GMEAVG	.084	.051	0.117	1.631	.104
IEAAVG	.501	.056	0.480	8.870	.000

a. Dependent Variable: EIAVG

Standardized Regression Coefficients are calculated from standardized data. Mathematically the model can be written as-

EIAVG=0.098[EOAVG]+0.049[MSCAVG] + 0.089[GDEAVG] + 0.117[GMEAVG] + 0.480[IEAAVG]

Here IEA is having maximum positive impact on EI. The impact of GME is also significant.

6.5 *Checking for the assumption normality of error terms (for Regression model for factors affecting EI)*

This assumption checks the normality of error term. This assumption can be checked by visual inspection of normal probability plot and histogram. Figures 3 and 4 shows histogram and normal probability plot respectively.

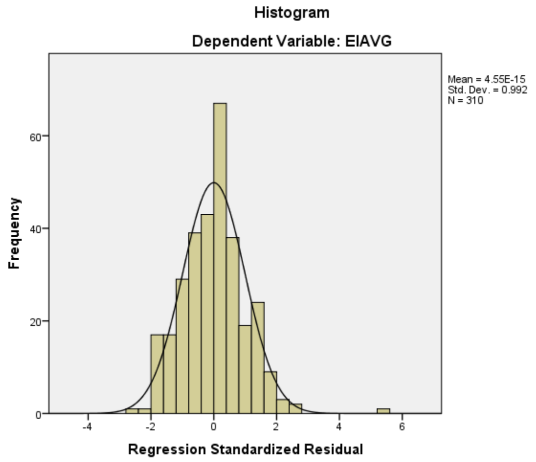

Figure 3: Histogram

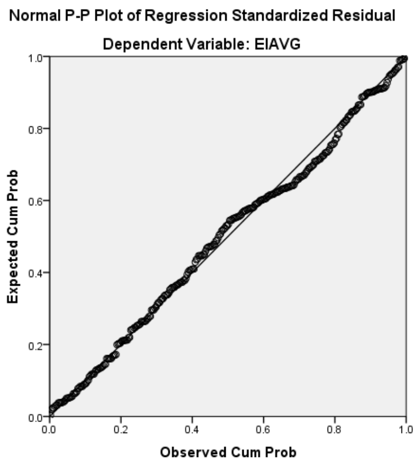

Figure 4: Normal P-P plot of regression standardized residual

6.6 RESULTS AND DISCUSSION

According to Hair J.F et al.(2007), Cronbach's alpha for all factor should be should be> 0.6.The Cronbach's value for all factors are above 0.6, hence the reliability of data is ensured. As per the guidelines by Hair J. F et al. (2007), Malhotra and Dash (2011) minimum acceptable value of KMO is 0.5. Here as KMO value is more than 0.5 for both types of variables indicating the appropriateness of applying factor analysis. As well as significant Bartlett's Test of Sphericity indicate that correlations matrix has significant correlations among at least some of the variables. Both the tests indicate that suitability of data for further analysis.

Principal component analysis with Varimax rotation has resulted into rotated component matrix as shown in table 10 and 11. This rotated solution clearly gives idea about how items are loading on the factors. This clearly indicates unidimensionality of measures indicating that all items under one factor are strongly associated

The effect of various independent variables EO, MSC, GDE, GME and IEA on dependent variable EI has been assessed by testing several hypotheses with the various multivariate techniques in previous section. The result of these analyses is tabulated in following table 16.

Table 16: Hypothesis testing results

Sr. No	Designed Hypothesis		Accepted Hypothesis
	Null Hypothesis	Alternate Hypothesis	
1	$H1_0$	$H1_a$	$H1_a$
2	$H2_0$	$H2_a$	$H2_a$
3	$H3_0$	$H3_a$	$H3_a$
4	$H4_0$	$H4_a$	$H4_a$
5	$H5_0$	$H5_a$	$H5_a$

7 CONCLUSIONS

The main objective of this study was to investigate the present status of Environmental impact of GM implementation and critical success factors affecting it in industries of Mumbai region industrial areas, India. The results of primary testing showed that the questions of questionnaire are appropriately designed with the aid of literature reviewed. It also indicates that the sample size is considerably adequate to do the analysis and data is internally consistent and adequate. The Principal factor analysis has resulted into proper factors loading which was suitable for further analysis. Multiple regressions were carried out with mean values of EO,MSC,GDE,GME and IEA as independent variables and EI as a dependent variable. The hypothesis testing reveals that, EO,MSC,GDE,GME and IEA have positive impact on EI of organizations. Multiple regressions were conducted with all checks on fundamental assumptions and validities clearly confirmed the positive influence of EO,MSC,GDE,GME and IEA on EI of organization. The standardized β (table15) values confirmed the highest effect of IEA on EI and secondly GME.

This comes to a conclusion that of Environmental acts framed by concerned regulatory authorities is the critical success factor to improve the Environmental performance of organization in Mumbai region. It also indicates that implementation of Green processes by the organizations has also considerable effect on Environmental performance. The other factors like Efforts of organization, Material selection criteria, and Green design execution also have positive effect on Environmental performance of Mumbai region based Industries. Finally it can be concluded that GM plays an important role in improving Environmental Performance of industries based in Mumbai region, India.

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