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Quantitative Analysis of Waste Management in Indian Industrial Context

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ABSTRACT: Solid waste is a product which is no longer useful after serving its primary purpose of work. There are different sectors which are responsible for the solid waste generation considering MSW, Medical, Construction waste, Industrial waste and many other forms of waste from supplementary sectors. As the population of the country increases, the country moves towards rapid industrialization along with economic growth, hence for environmental sustainability waste management is plays a very vital role. This research paper mainly focuses on waste management in Indian industrial context. In order to obtain effective solution against different phases like waste generation, waste reduction, waste handling, waste reuse then up to waste composition or demolition remediation it should be properly investigate and manage accordingly.In this research analysis impact of solid waste management using performance measures and factors affecting the performance measures are investigated qualitatively and quantitatively and for that study data samples were collected from small and medium scale manufacturing industries. Qualitative assessment done along with the status of having environmental legislation, literature surveys, certified ISO 14001 guidelines, important norms and rules related to solid waste management. More than 250 small and medium scale industries are used as a target approach for data samples collection. Data analysis done using SPSS 21 with performing data variable factors validation test using factor analysis through KMO and Bartlett's test (0.5 is the minimum threshold value for sample size adequacy). KMO and Bartlett's test performed separately for Independent and Dependent variables with getting two separate output for adequacy of sampling size. Then reliability of the collected data tested using Cronbach's alpha value test for Dependent and Independent variable factors (0.5 is the minimum alpha value required for factor validation). Regression analysis was performed using Modal Summary Test and ANOVA test. The significance value in ANOVA test should be less than 0.05 it reduces the regression model error to great extent and also helps to get data model validity. Linear regression coefficients assessment analysing standardized beta Coefficient values of all the variable factors with individual Dependent variable factor. Beta coefficient significance the null hypothesis accepted or rejected (as the Beta coefficient values of Significance should not be less than 0.005). The S-N curve, Histogram and graphical Scree plots add the impact in assessment of factors affecting performance measures which aim the Indian Industrial Enterprises to have environment friendly manufacturing scenario.

KEYWORDS:MSW Municipal Solid Waste, **LCA** Life Cycle Analysis, **EMS** Environmental Management System, **SWM** Solid Waste Management, **ISO** Indian Standard Organisation, **SPSS** Statistical Package for Social Sciences.

I. INTRODUCTION

Waste management is a major challenge in urban areas specially consider to Indian context. Where urbanization, industrialization and economic growth have resulted in rapid increased municipal solid waste (MSW) generation per person, rapid industrialization has resulted in the generation of huge quantity of solid wastes, both solid and liquid waste generated from various human, industrial and domestic activities can result in health hazards and have a negative impact on the environment. Understanding the waste generated, the availability of resources to carry the environmental conditions of a particular society are important to developing an appropriate waste-management programmed. Solid-waste management may be defined as the discipline method associated with controlling the generation, storage, collection, transfer and transport processing and disposal of solid waste in such a manner that is in condition with the best principles

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of health, economics, energy conservation, aesthetics, and other environmental considerations. It is also responsive to individual human and social public attitudes. In its scope of working for the solid-waste management it contains all administrative, financial, legal, planning, and engineering functional knowledge to obtain the solutions for all problems of solid waste. Every year, about 55 million tonnes of municipal solid waste (MSW) and 38 billion litres of manure are created in the urban areas of India. In addition, large amounts of solid and liquid wastes are generated by industries. Waste generation in India is estimated to increase quickly in the future. As more people transfer to urban areas and as their incomes increase, consumption levels are also to be expected to rise, these are rates of waste generation. It is expected that the quantity of waste generated in India will increase at a per capita rate of around 1-1.33% yearly. This has important effects on the amount of land that is and will be needed for disposal, economic costs of collecting and transporting waste, and the environmental consequences of increased MSW generation levels. Industries producing solid waste have to manage by themselves and are mandatory to seek approvals from particular State Pollution Control Boards (SPCBs) under applicable rules. With the help of complete cooperative efforts of SPCBs, local bodies and the industries, a mechanism could be evolved for better management.

II. METHADOLOGY

The aim of this research is to study origin of solid waste and further to manage this waste using various methods of analyzing the data and developing a system with amending the existing system to improve the present scenario of the solid waste management in India. Data analysis means the mass of systematic data turns into meaningful result. There are manydifferent data examination methods, depending on the type of research. Following is theHierarchicalrepresentation ofData preparation.

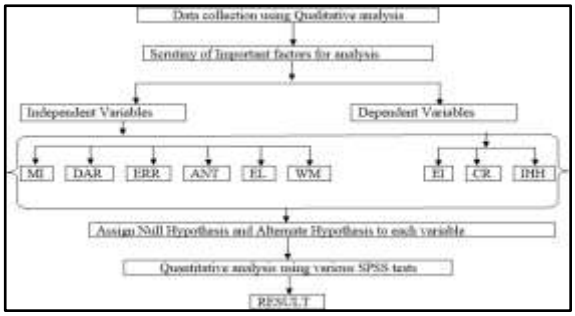

Fig 1: DatapreparationHierarchicalrepresentationbyAuthor.

III. DATA COLLECTION

Quantitative analysis work as a base for the questionnaire design verification done using expert advice and also include the feedback from people to make the questionnaire model appropriate for data collection. The variables which are worked as a primary source for the performance measures are termed as independent variables and the variables which are affecting due to primary performance measure are termed as dependent variables. For data sampling collection variable factors are used in following way.

TOTAL QUESTIONS	INDEPENDENT VARIABLE	DEPENDENT VARIABLE
34	25	9

Table 1: Variables Distribution table.

For data collection total 34 questions were designed considering various industrial solid waste management. Variables are designed in such a way that the independent variables give the structural frame work for the data and dependent variables are the outcome and affecting result for the data collection and analysis. This researched study consist 25 questions are independent variables and 9 as dependent variables.As the well-designed questionnaire is the powerful instrument for the investigation, as it has to succeed with following editing, coding, transcribing process. Similarly, data analysis required data cleaning process before it analysing the data. Valid and accurate data needed

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for the smooth analysis. Following categories are used for data scrutiny. Total 280 responses collected from small and medium industrial enterprises.

REPETITIVE DATA -The data response obtained for the single variable is entered twice or respondents are different but the enterprise is same or the data collection submitted twice or multiple time from same respondent such conditions are led to Repetitive data collection.

INCOMPLETE DATA -If the 10 % of the response is incomplete for particular variable or particular respondent submitted the incomplete data then it is problematic for data analysis.

VALUE ERROR DATA-If the variable value entered by the respondent is other than Likert value then that value is create error in data analysis. This value should discard or repaired after taking corrective measures to make the data valid for analysis.

ACCURATE DATA-After scrutiny test using these data cleaning methods the remain data consider as accurate data. It can be obtained after subtractingscrutiny test data responses from total responses collected.

REPETATIVE DATA	**34**
INCOMPLETE DATA	**27**
VALUE ERROR DATA	**11**
ACCURATE DATA	**208**
TOTAL RESPONSE	**280**

Table 2: Data Validity Table

IV. DATA ANALYSIS

1.DESCRIPTIVE STATISTICS

Descriptive statistics are used to represent quantitative description in research study.

Sr. No.	AVG List	N	Mean	Median	Std. Deviation
1	MI AVG	208	3.141	3.00	0.3585
2	DAR AVG	208	3.076	3.00	0.2680
3	ER AVG	208	3.205	3.00	0.3270
4	ANT AVG	208	3.155	3.00	0.3106
5	EL AVG	208	3.138	3.00	0.3361
6	WM AVG	208	3.186	3.20	0.3182
7	EI AVG	208	3.167	3.00	0.3357
8	CR AVG	208	3.295	3.33	0.3658
9	IHH AVG	208	3.242	3.00	0.3629

Table 3: Validation for Factors in Research using Descriptive Statistics.

2.RELIABILITY TEST

Reliability of the data ensured consuming Cronbach's alpha test on Dependent and Independent variables for factor validation. It is used to see the reliability validity of multiple variables used in each computed factor.

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Cronbach's alpha value Independent variable	Cronbach's alpha value Dependent variable
0.812	0.654

Table 4: Validation for Factors in Research using Descriptive Statistics.

Here all the variables having alpha values are greater than 0.6 which states that the content is valid. The above values indicate that the content is ensured the valid reliability which is used for further test of regression analysis.

3.FACTOR ANALYSIS

Sampling size adequacy tested using KMO and Bartlett's Test

Kaiser-Meyer-Olkin (KMO) measures gives the adequacy of sampling size (0.05 is the minimum threshold value for sampling size adequacy).
Bartlett's test of Sphericity significance value sufficient for correlation exist within the data with 95% confidence interval, so the data consider as suitable for further analysis.

KMO and Bartlett's Test for Independent variable		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.912
Bartlett's Test of Sphericity	Approx. Chi-Square	6432.5
	Df	300
	Sig.	.000

Table 6: KMO and Bartlett's Test for Dependent variable.

Factor analysis on independent and independent variable as value of KMO test is 0.823 is sufficiently higher than the minimum required threshold value that is 0.05. The sampling size adequacy is satisfied. Similarly, Bartlett's test of Sphericity significance value is 0.000 which is less than 0.005 hence correlation exist within the data with 95% confidence interval, so the data consider is suitable for further analysis.

4. SCREE PLOT

Scree plot indicated number of factors to be extracted from to be extracted from above factors. Here total number factors above value 1 extracted as their Eigen value is more than 1.

Scree Plot for Independent variable is as follows

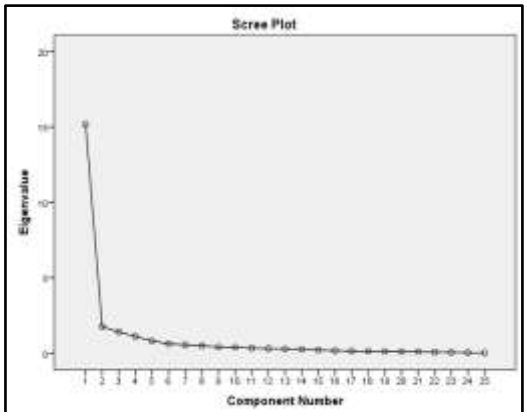

Fig 2: Scree Plot for Independent variable

Scree plot indicated number of factors to be extracted from to be extracted from above factors. Here total number factors above value 1 are 3 as their Eigen value is more than 1.

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5. REGRESSION ANALYSIS

The regression analysis is performed on individual Dependent variable against group of Independent variables using Model summary, ANOVA test, Regression Coefficients. Some graphical representation, curves and plots are justified the model validity. The 3 Dependent

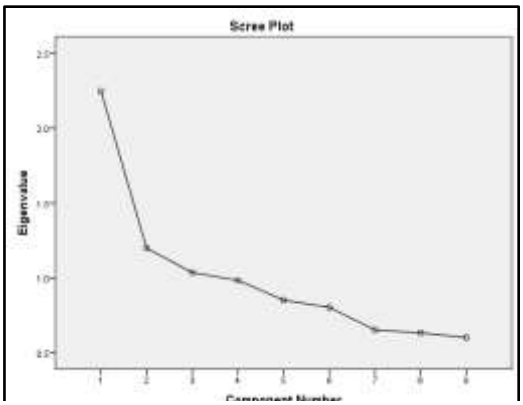

Fig 3: Scree Plot for Dependent variable

Scree plot indicated number of factors to be extracted from to be extracted from above factors. Here total number factors above value 1 are 3 as their Eigen value is more than 1.
variable factors give separate individual output for these regression analysis tests performed.

Modal Summary Test in which 'Adjusted R square' value decide the percentage variation in dependent variable by independent variables and it decide the model acceptability.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.879[a]	.773	.767	.1622	.773	114.395	6	201	.000	2.055

Table 7: Linear Regression Analysis forEnvironmental Impact (AVGEI)

a. Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL
b. Dependent Variables: EI

Since adjusted R square value is 0.767 means 76.7% variation in the dependent variable is explained by independent variable is sufficiently high value of variance hence model is acceptable.

LINEAR REGRESSION ANALYSIS FOR Cash Returns from SWM

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.623[a]	.388	.369	.2905	.388	21.205	6	201	.000	2.052

Table 8: Linear Regression Analysis for Cash Returns from SWM (AVGCR)

a. Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL
b. Dependent Variable: CR

Since adjusted R square value is 0.369 means 36.9% variation in the dependent variable is explained byindependent variable is sufficiently high value of variance hence model is acceptable.

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LINEAR REGRESSION ANALYSIS FOR Impact on Human Health

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.755[a]	.569	.556	.2417	.569	44.288	6	201	.000	2.019

Table 9: Linear Regression Analysis for Impact on human health (AVGIHH)

a. Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL

b. Dependent Variable: IHH

Since adjusted R square value is 0.556 means 55.6% variation in the dependent variable is explained by independent variable is sufficiently high value of variance hence model is acceptable.

Dependent Variable: EI

Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL

ANOVA value states that the validity of regression result due to error is reduced to great extent since the value of significance is less than 0.05. Hence the model is validated.

6. ANOVA TEST

Validity of regression analysis states using ANOVA test. The significance value in ANOVA test should be less than 0.05 it reduces the regression model error to great extent and also helps to get data model validity.

All three dependent variables are satisfying the required criteria hence the model is validated.

Linear Regression Analysis of ANOVA test for Environmental Impact

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.048	6	3.008	114.395	.000[b]
	Residual	5.285	201	0.026		
	Total	23.333	207			

Table 10: Linear Regression Analysis of ANOVA test for Environmental Impact

Linear Regression Analysis of ANOVA test for Cash Returns from SWM

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.734	6	1.789	21.205	.000
	Residual	16.958	201	0.084		
	Total	27.692	207			

Table 11: Linear Regression Analysis of ANOVA test for Cash Returns from SWM

Dependent Variable: CR

Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL

ANOVA value states that the validity of regression result due to error is reduced to great extent since the value of significance is less than 0.05. Hence the modelis Validate.

Linear Regression Analysis of ANOVA test for Impact onHuman Health

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.523	6	2.587	44.288	.000
	Residual	11.742	201	0.058		
	Total	27.264	207			

Table 12:Linear Regression Analysis using ANOVA test for Impact on Human Health

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Dependent Variable: IHH
Predictors: (Constant), WM, ANT, DAR, ERR, MI, EL

ANOVA value states that the validity of regression result due to error is reduced to great extent since the value of significance is less than 0.05. Hence the model is validated.

7. LINEAR REGRESSION COEFFICIENTS

Linear regression coefficients assessment analysing standardized beta Coefficient values of all the variable factors with individual Dependent variable factor. Beta coefficient significance the null hypothesis accepted or rejected (as the Beta coefficient values of Significance should not be less than0.005).

Linear Regression Coefficients for Environmental Impact of Waste Management System

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.297	.143		2.082	.039
MI	.596	.092	.637	6.505	.000
DAR	.095	.064	.076	1.475	.142
ERR	.056	.063	.055	.894	.372
ANT	.072	.050	.067	1.441	.151
EL	.191	.110	.191	1.740	.083
WM	-.095	.102	-.090	-.930	.354

Table 13: Linear Regression Coefficients for Environmental Impact

By analysing Standardized beta coefficients all the values of significance are not less than 0. 005.Hence one has less than 0.01 that relationship is supported and null hypothesis is rejected. Here null hypothesis says that Management Initiative average does not affect Average of Environmental Impact of Waste Management System

Standardized Beta Coefficient value of Management Initiative (0.637) is greater than the value of average of Environmental Legislation of (0.191) this indicates that **Management Initiative have more than double impact than Environmental Legislation on average of Environmental impact.**

Linear Regression Coefficients for Environmental Impact of Waste Management System

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.854	.255		3.346	.001
	MI	.420	.164	.412	2.557	.011
	DAR	.209	.115	.153	1.813	.071
	ERR	.058	.113	.052	.512	.609
	ANT	.137	.090	.117	1.525	.129
	EL	.042	.196	.039	.215	.830
	WM	-.085	.183	-.074	-.466	.641

Table 14:Linear Regression Coefficients for Cash Returns from SWM

a. Dependent Variable: CR

By analysing Standardized beta coefficients all the values of significance are not less than 0. 005.Hence one has less than 0.01 that relationship is supported and null hypothesis is rejected. Here null hypothesis says that Environment Friendly Procurement average does not affect Average of Environmental Impact of Waste Management System

Standardized Beta Coefficient value of Management Initiative average (0.412) is greater than the value of average of Application NEW Technology (0.117) this indicates that **Management Initiative have more than double impact than Application NEW Technology on average of Cash Returns from SWM**

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Linear Regression Coefficients for Environmental Impact on Human Health

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.436	.212		2.050	.042
	MI	.543	.137	.536	3.971	.000
	DAR	.126	.096	.093	1.317	.189
	ERR	.150	.094	.135	1.590	.114
	ANT	.099	.075	.085	1.321	.188
	EL	.024	.163	.022	.146	.884
	WM	-.048	.152	-.042	-.314	.754

Table 15: Linear Regression Coefficients for Impact on human health

a. Dependent Variable: IHH

By analysing Standardized beta coefficients all the values of significance are not less than 0.005. Hence one has less than 0.01 that relationship is supported and null hypothesis is rejected. Here null hypothesis says that Environment Friendly Procurement average does not affect Average of Environmental Impact of Waste Management System

Standardized Beta Coefficient value of Management Initiative average (0.536) is greater than the value of average of Environmental Rules and regulations (0.135) this indicates that this indicates that **Management Initiative have morethan double impact than Environmental Rules and regulations on average of Impact on human health.**

8. HISTOGRAM

HISTOGRAM ENVIRONMENTAL IMPACT (AVGEI)

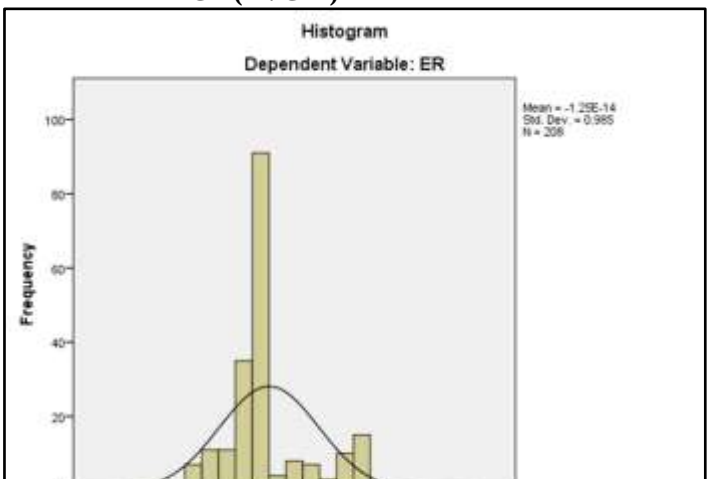

Fig 4: Histogram Environmental Impact

HISTOGRAM CASH RETURNS FROM SWM (AVGCR)

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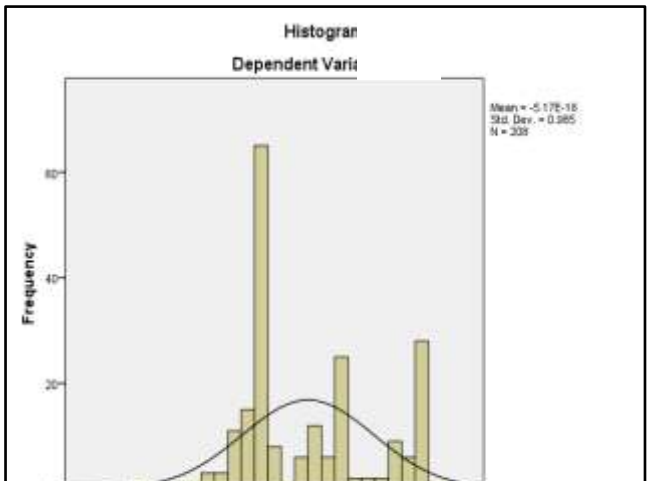

Fig 5: Histogram Cash Returns From SWM

HISTOGRAM IMPACT ON HUMAN HEALTH (AVGIHH)

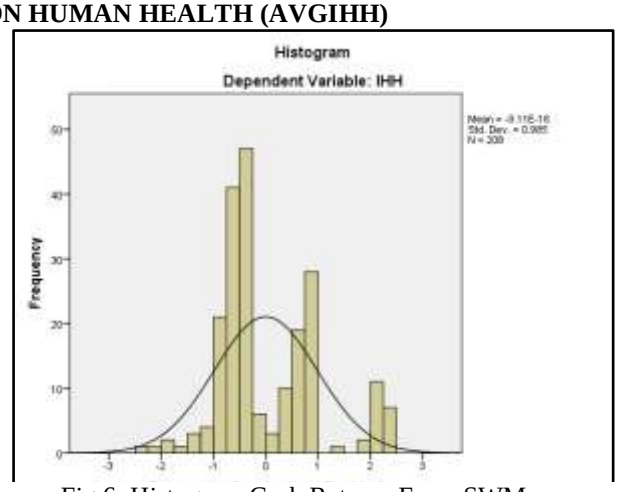

Fig 6: Histogram Cash Returns From SWM

9. NORMAL CURVES

NORMAL CURVES FOR ENVIRONMENTAL IMPACT (AVGEI)

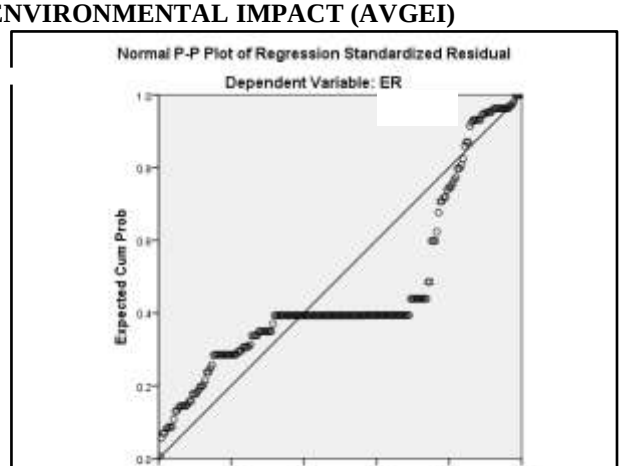

Fig 7: Normal Curves for Environmental Impact

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NORMAL CURVES FOR CASH RETURNS FROM SWM (AVGCR)

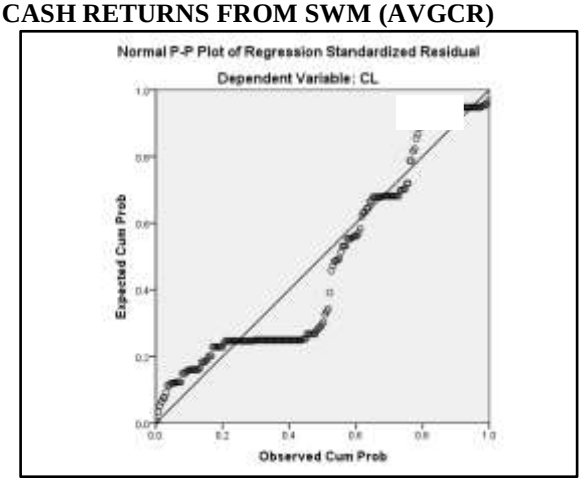

Fig 8: Normal Curves for Cash Returns from SWM

NORMAL CURVES FOR IMPACT ON HUMAN HEALTH (AVGIHH)

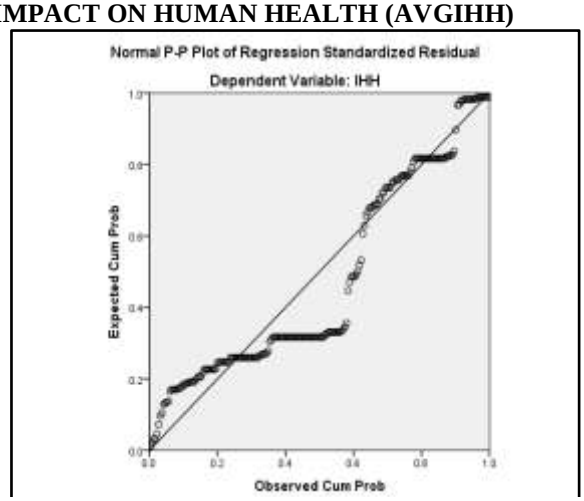

Fig 10: Normal Curves for Impact on Human Health

V. CONCLUSION

The researched value from SPSS give us the direction for taking corrective measures for solid waste management. Percentage of variation from model summary of regression analysis calculated the impact of independent variables on a particular dependent variable.

As 76.7% impact of independent variable factors created on Environment whereas cash return from give solid waste management is 36.9%. The designed independent variable factors affect 55.6% on human health due to solid waste management. Literature survey studied by the researcher and further methodology implemented. With the help of researched survey, it determines existing method and proposed the modifications needed in method. Modified method helps to stopped the unnecessary wastage of material during idle process hours, which results in huge waste recovery and material and cost consumption of the manufacturing process. In this survey study management initiative makes a huge impact in solid waste management. Beta coefficient from linear regression analysis gives the exact impact from the particular independent factor on selected Dependent variable factor.

Linear Regression analysis Independent variable factors With Dependent variable factor 'Environmental Impact of solid waste management' Beta Coefficient value of Management Initiative (0.637) is greater than the value of average of Environmental Legislation of (0.191) this indicates that Management Initiative have more than double impact than Environmental Legislation on average of Environmental impact.

Linear Regression analysis Independent variable factors With Dependent variable factor 'Cash Returns from solid waste management' Standardized Beta Coefficient value of Management Initiative average (0.412) is greater

than the value of average of Application NEW Technology (0.117) this indicates that Management Initiative have more than double impact than Application NEW Technology on average of Cash Returns from SWM.

Linear Regression analysis Independent variable factors With Dependent variable factor 'Impact on human health due to solid waste management' Standardized Beta Coefficient value of Management Initiative average (0.536) is greater than the value of average of Environmental Rules and regulations (0.135) this indicates that this indicates that Management Initiative have more than double impact than Environmental Rules and regulations on average of Impact on human health.

After doing detail study a correlate the data prepared, with facts that there are thousands of types of waste recovery methods are currently used in industries and thousand numbers of such conditions are generated from which tremendous amount of waste energy being recovered. Management initiative along with individual involvement for implementation of new technology, rules, day to day work practices boost the waste management initiative along with the help of suggested modification, we can explore policy measures and industrial actions to minimize the undesirable impact generated by solid waste on environment, human health and also beneficial at some extent to get cash return from solid waste management.

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