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Test Quantitative Effect on Air, Water and Noise Pollution Before and After Implementation of Lean Green Practices in Marble Mining

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ABSTRACT

In increasingly inefficient forms, mining industries consume vast volumes of natural resources and emit massive amounts of greenhouse gases, contributing to numerous economic, environmental and social issues, from climate change to local waste disposal. The thesis is important for scholars working in the area of lean green practices and other related programs as the study would include an in-depth analysis of the literature and track the roots and evolution of green manufacturing, environmentally friendly manufacturing, sustainable manufacturing, sustainable manufacturing, Eco-friendly production, environmentally conscious production, sustainable packaging, and safer processing. The primary study also demonstrates the perceived advantages of integrating variables influencing the acceptance and application of lean green practices, the paper also analyzed the quantitative impact on air quality with the aid of a paired sample t-test before and after the implementation of lean green practices. The result indicates that the level of air emissions across the mine after introducing green industrial practices varies substantially in a positive way.

Key words: lean green, marble mining, t-test

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1. INTRODUCTION

The word marble is originated from the word 'Marmor' in latin, that itself has come from the Greek root ‘marmaros’ meaning both as a shining stone. In ancient and modern times also any dimensional stone that can be cut dimensionally and has a property to be polished is defined as marble irrespective of its colour, physical characteristics and chemical composition. India is endowed with vast and rich reserves of natural stones of different textures and colours, spread in many states in the north and south. The availability of a variety of stones, coupled with high talents & skills, attracted the attention of the world and now India holds a place of pride among the top stone producing countries. Historically the marble marvel of Taj Mahal, the priceless Mahabalipuram sculptures of the Pallava Dynasty in south, the wonders of Konark in the central India, inscription of Ashoka on stone pillars and thousand unmatched temples, reflects in volumes for rich heritage of Indian stones and Indian skills.

2. OBJECTIVE

To test the quantitative effect on Air, water and noise pollution before and after implementation of lean green practices using suitable statistical method.

3. RESEARCH STUDY

Agrawal V. & Vaish A.K. in “The Rajasthan Mineral Bulletin”, a quarterly publication of Department of Mines and Geology in Oct.-Dec.2004, wrote an article “An Overview of Rising Problems of Marble Slurry in Rajasthan and Need for its Eco-Friendly Management” Management of marble slurry is a major problem in many districts of Rajasthan. Substantial quantity of slurry waste generates every year from the processing units and unsystematic disposal of the waste can be converted into eco-friendly wealth by adopting the suitable technology.

- Status of Marble Mining and Processing Activities: Nature has generously endowed Rajasthan with a

variety of mineral deposits. Marble is a recrystallized (Metamorphosed) Limestone. In commercial term it is a crystalline rock, composed of calcite or dolomite or serpentine, having hardness from 3 to 4 and can be excavated as blocks. It can be sawed and take good polish.

- Marble Slurry: Marble is excavated in blocks of varying sizes. These blocks are then cut into slabs or tiles of variable sizes. During the process fine marble powder is generated as waste and this in combination with water makes slurry. This shares 20% powder and 80% water. The approximate water requirement in a gang-saw is about 43000 litters per hour.
- Physico-Chemical properties of Marble Slurry: Marble slurry is a snow-white mixture of marble powder waste (Approximately 200 mesh size) and water. Marble produced during processing of marble does not have fixed chemical composition as several varieties of marble blocks are processed in a single unit. However, broadly the
  chemical composition of marble slurry is classified in table 5.2 below (Agrawal, et.al., 1999; Garg, 2004; Singh and Vijaylakshmi, 2004)

Waste Utilization

Masood, I., Mehrotra, S.P., Tehri, S.P., Agrawal, S.K. & Ahmad, J.; from Central Building Research Institute, Roorkee described the utilisation of marble sludge from gangsaws and stone cuttings for building materials in their research paper "Utilisation of Marble Sludge from Gangsaws and Stone Cutting for Building Material." They experimented and found that:

- The marble powder when mixed with cement can be used as binder material for building materials.
- Cold bonded pressed bricks can be prepared by fine marble powder when mixed with cement and water with specific properties of water absorption and strengths. The so prepared bricks are at comparable costs.
- Masonry Cement: Masonry cement can be obtained by intergrading the Portland cement and some siliceous, argillaceous or calcareous powdery materials along with some other additives.
- Some other products are; Gypsum plaster-based boards and blocks, cellular concrete blocks, distempers etc.

Sharma, B. & Rajotia, S.; innovated mechanization in stone craft-initiated steps in positive direction of country's strategy to have viable, resilient and competitive technology. They quoted, "the 3-5 mm thin-shelled dining bowl is manufactured solely with our skill in developing fixtures, tools and manufacturing methods indigenously. They have shown that they developed beautiful value-added product from the waste of marble mine. They prepared bowls, balls, and interlocking tiles etc., which are giving very high return and are being exported.

Menaria K.L., N. Menaria & Prerna Mathuria explored on utilization of marble waste of Rajasthan in manufacturing of marketable chemicals and identified that useful consumable and industrial products based on marble quarrying and processing waste.

- As physical use in refractory manufacture, fillers, filter aids and aggregate for civil construction involving RCC works
- Limestone and Dolomite base chemicals for use in cement, dead burnt lime, flux, glass, whitening, putty, sugar industry, paper, poultry grit or paints.
- Use of quarried and processing waste powder for effluent treatment in place of lime, for providing calcium nutrient for a number of economic crops and soil stabilization of expensive soils.
- Coal mine dusting.
- Highway construction and anti-dust treatments.

Agrawal V. emphasized that industrial activities and surrounding environment are closely related and number of industries including mining are degrading the environment knowingly or unknowingly because of carelessness or lack of awareness. Marble mining creates pollution and environmental degradation in multiple directions viz. land degradation, noise pollution, dust pollution and change in land use. He also suggested measures for strengthening environmental management by proper disposal of overburden and waste rocks, use of machines and innovative mining methods so that generation of waste is as low as possible, systematic development of mining pits, introduction of personal protective equipments (PPES') for dust noise etc. and regular maintenance of machines to reduce the pollution.

Rathore S.S. discussed the Gainful Utilization of Marble waste for Environmental Protection and stressed on following points:

- The marble mining and processing contribute a very important economic activity in the state and a very large number of employment opportunities both in direct and indirect ways have been generated in this sector. Rajasthan produces more than 95% of the country's marble production.

He tabulated marble industry in Rajasthan, Marble production in Rajasthan, marble production and slurry generation in Rajasthan in data table forms.

4. HYPOTHESIS IMPLEMENTATION

Paired Sample t-test:

The paired sample t-test is a statistical method used for comparing two population means for two correlated samples. In 'before-after' tests, or where the samples are the corresponding sets, or when there is a case-control analysis, the paired sample t-test is used. For eg, if we offer a company employee training and we want to see if the training has any effect on the employee's performance or not, we might use the paired sample test. On a seven-scale ranking, before the training and after the training, we gather data from the worker. By using the paired sample t-test, we can statistically infer if the performance of the employ has increased or not by training, We may use a sample test combined with it. On a seven-scale ranking, before the training and after the training, we gather data from the worker. We can statistically infer, by using the paired sample t-test, whether preparation has increased the employee's performance or not. In medicine, we will work out whether or not a given medicine can heal the condition by using the combined sample t-test.

In this study paired sample t-test is used in case of data of air pollution only and analysis of the same is done through MS-Excel. Before implementing green manufacturing practices monitoring of air, water and noise was done and after implementation again the same monitoring method (use of machineries to measure pollution in and near mine for 12 hours continuously for a day) was adopted and results were taken and paired t-test was applied.

$$t = \frac{\Sigma d}{\sqrt{\frac{n\left(\Sigma d^2\right)-\left(\Sigma d\right)^2}{n-1}}}$$

(Eq-3.1) (where d is the mean difference between two samples, n is the sample size and t is a paired sample t-test with n-1 degrees of freedom)

Hypothesis for paired t-test

Null Hypothesis (H_0):

There is no significant difference between monitoring report of air pollution before and after implementation of green manufacturing practices.

Alternate Hypothesis (H_1):

There is significant difference between monitoring report of air pollution before and after implementation of green manufacturing practices.

As there is no inclination towards one side whether green manufacturing practice will benefit mine production and pollution or not, therefore two-tail test is being adopted.

5. QUANTITATIVE EFFECT ON AIR, WATER AND NOISE POLLUTION BEFORE AND AFTER IMPLEMENTATION OF GREEN MANUFACTURING PRACTICES

With respect to this objective as money was constraint, monitoring of all the three would be costly. Therefore, data of only Air monitoring is available to find whether green manufacturing practices have increased or reduced the effect of mining on surrounding air.

The data are shown in Appendix B. The previous year data was taken from the mine owner's and current year data has been collected and tested by via a NABL approved laboratory.

Hypothesis

H_0: There is no significant difference in the level of air pollution around mine after implementing green manufacturing practices.

H_1: There is significant difference in the level of air pollution around mine after implementing green manufacturing practices.

The hypothesis will remain same for all 4 components (PM 10.5, PM 2.5, SOx, NOx) of air that were tested. The level of significance (α) is taken as 0.05 (5%). Degree of freedom (d.f.) is n-1 = 19. Here, n = sample size = 20 in this case. The tabulated t-value of 19 d.f. at 5% level of significance is 2.09.

Paired t-test was used to interpret the collected monitoring data.

Objective: Paired Sample t-Test

S.No.	Mine Name	Air Pollution (Before lean Green practices Implementation)				Air Pollution (After Lean Green practices Implementation)			
		PM 10.5	PM 2.5	SOx	NOx	PM 10.5	PM 2.5	SOx	NOx
1.	M/s Rajlaxmi White Marble Pvt. Ltd.	62.2	25.4	9.6	18.6	62.2	25.4	9.6	18.6
2.	M/s Shree Balaji Marbles	64.2	26.8	11.4	21.2	64.2	26.8	11.4	21.2
3.	M/s Mangalam Shubham Marble Pvt. Ltd	64.4	26.8	10.6	20.4	64.4	26.8	10.6	20.4
4.	M/s Shree Om Marble	62.2	25.6	11	20.8	61.1	24.8	10.8	20.7
5.	Smt. Bindiya Sankhala	63.8	25.8	10.8	21.4	63.1	25.6	10.7	20.9
6.	M/s Vandana Marbles	62.4	25.8	10.6	22	61.9	24.9	10.4	21.8
7.	Shri Roshan Lal Sankhala	63.6	25.4	12.4	22.8	63.1	25	12.2	22.8
8.	M/s Mangalam Shubham Marble Pvt. Ltd	63.4	26	12.2	21.6	62.8	25.4	12	21.5
9.	M/s Excellence Marmo Minerals Pvt. Ltd	72.6	31.4	12	20.8	71.8	30.9	11.8	20.4
10.	M/s Shri Om Marble	72.4	32	12.4	20.6	71.6	31.5	12.2	20.5
11.	M/s Mangalam Shubham Marble Pvt. Ltd	73.4	31.6	10.4	22.2	72.4	31	10.4	22.1
12.	M/s Mangalam Shubham Marble Pvt. Ltd	75.2	32	10.6	21.8	74.8	31.2	10.5	21.9
13.	M/s Excellence Marmo Minerals Pvt. Ltd	76.8	33.2	11	23.2	76.1	32.7	11	23
14.	M/s Excellence Marmo Minerals Pvt. Ltd	75.6	30.2	10.6	22.8	74.9	29.6	10.4	22.7
15.	M/s Mangalam Shubham Marble Pvt. Ltd	74.6	32.4	10.4	22	74.1	31.8	10.1	21.6
16.	Mahaveer Singh Shaktawat	72.8	30.6	10.8	21.4	72	29.9	10.5	21.3
17.	M/s Shreenath Enterprises	74.8	32.8	10.2	21.4	73.9	32.2	10.1	21.5
18.	Roshan Lal Sharma	77.2	33.2	11.2	22.6	76.4	32.6	10.9	22.4
19.	Dinesh Chandra Sanadhya	74.8	31	15	25.2	73.7	30.1	14.9	25.2
20.	Chandra Shekhar Sanadhya	76.2	31.4	12.4	22.2	74.8	30.3	12.3	22

*Source: Before implementation Data was taken from Mines Owner after Implementation Data Collected with help of NABL lab

TEST	T-TEST result
10.5	1.77E-07
2.5	1.72E-07
Sox	9.29E-06
Nox	0.002655

6. RESULT AND INTERPRETATION

(a) PM 10.5

t (calculated value) = 3.17, which is greater than t (tabulated value) *i.e.* $t_{cal} > t_{tab}$

Hence, it can be said that null hypothesis stating that there is no significant difference in the level of air pollution around mine after implementing green manufacturing practices, is false and therefore, alternate hypothesis is true *i.e.* There is

significant difference in the level of air pollution around mine after implementing green manufacturing practices.
(b) PM 2.5
t (calculated value) = 3.04, which is greater than t (tabulated value) *i.e.* $t_{cal} > t_{tab}$
Hence, it can be said that null hypothesis stating that there is no significant difference in the level of air pollution around mine after implementing green manufacturing practices, is false and therefore, alternate hypothesis is true *i.e.* There is significant difference in the level of air pollution around mine after implementing green manufacturing practices.
(c) SOx
t (calculated value) = 2.6, which is greater than t (tabulated value) *i.e.* $t_{cal} > t_{tab}$
Hence, it can be said that null hypothesis stating that there is no significant difference in the level of air pollution around mine after implementing green manufacturing practices, is false and therefore, alternate hypothesis is true *i.e.* There is significant difference in the level of air pollution around mine after implementing green manufacturing practices.
(d) NOx
t (calculated value) = 2.45, which is greater than t (tabulated value) *i.e.* $t_{cal} > t_{tab}$
Hence, it can be said that null hypothesis stating that there is no significant difference in the level of air pollution around mine after implementing green manufacturing practices, is false and therefore, alternate hypothesis is true *i.e.* There is significant difference in the level of air pollution around mine after implementing green manufacturing practices.

7. CONCLUSION

Nowadays, almost every feature within organisations has been affected to become green by external and internal pressures. The company's corporate image has been affected/influenced by concerns such as eco consumerism, green goods, green processes, environmental footprints, etc. Many industries have come to recognize that green cultivation has economic benefits, in addition to environmental and social benefits. The paper also deals with the hypothesis whether there is significant difference between monitoring report of air pollution before and after implementation of green manufacturing practices or not.
The research also studied the quantitative effect on air pollution before and after implementation of green manufacturing practices with the help of a combined t-test sample. The result shows that there is a considerable gap between in positive sense in the level of air pollution around mine after implementing green manufacturing practices.

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