

# Implementing Green Lean Practices in Motor Pump Manufacturing to Enhance Operational Efficiency

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## Abstract

*Motor pump industry Coimbatore, popularly known as the Pump City of India, is an important sector in the local and the global markets. Nevertheless, the production processes within this industry are usually associated with the issues concerning the lack of industrial efficiency, resource waste, and environmental effects. The paper will discuss how the concept of Green Lean Management was applied to achieve a sustainable solution to waste reduction and at the same time improve efficiency in the manufacture of motor pumps. The paper combines lean concepts aimed at removing non-value-added processes together with green concepts that aim at minimizing the use of energy, material wastes, and emissions. In its field research on the production process of selected motor pumps manufacturing units in Coimbatore, the study determines the major sources of waste during production, resources distribution, and supply chains operations. The practical lean tools, value stream mapping, 5S and Kaizen were reviewed and environmentally- friendly activities like waste recycling, efficient use of energy and process redesign were discussed. The results indicate that green lean management does not only lead to a considerable level of cost reduction and improvement of productivity but also helps in environmental sustainability. The study will add to the body of literature on sustainable operations because it offers an industry-specific model of implementing green lean strategies. To manufacturers, the study portrays that integrating lean efficiency and green responsibility would represent a two-fold benefit of profitability and long-term sustainable performance, which will allow the motor pump industry in Coimbatore to attain excellence in its operations over time.*

**Keywords:** Green Lean Management, Motor Pump Industry, Waste Reduction, Sustainable Manufacturing, Operational Efficiency

## **Introduction**

One of the most important industrial sectors in Coimbatore is the motor pump industry commonly known as the Pump City of India. This market takes a significant portion of national and global pump market that sustains a large assortment of applications such as agriculture and domestic water supply, industry and commercial applications. With rising demand of energy-efficient and reliable pumping systems, Coimbatore manufacturers are under pressure to enhance productivity and comply with sustainable manufacturing systems. Although the industry is dynamic and competitive, the problem that has traditionally been a challenge to the industry includes material wastage, high-energy consumption and inefficiencies in the process which adds to the economic and environmental concern. Lean manufacturing has been a technique that has proven very useful especially in the past few years to get rid of waste, enhance operational efficiency, and customer value as well. Combining the two strategies, which is also known as the Green Lean Management, is a holistic system that can allow industries to strive towards both operational excellence and sustainable development. This integrated system is specially applicable in energetically and resource consuming sectors like the manufacture of motor pumps. The paper probes the use of green lean management in motor pump manufacturing industries located in Coimbatore. It explores the ways in which lean tools may be synchronized with green activities like energy efficiency, recycling, and sustainable process design: value stream mapping, Kaizen, and 5S. The goal is to come up with a holistic framework that improves efficiency within an organization and at the same time makes it ecologically sustainable in the long run. In such a way, this study will help fill one of the most important gaps in the research on sustainable operations and offer practical implications to professionals working in the motor pump sector.

## **Statement of the Problem**

Although Coimbatore is a leading national and global hub in motor pump industry, the industry is experiencing increasing challenges that are posing serious threats to its survival and competitiveness in the market. The industry is facing high resource wastage, energy use, unstable supply of raw materials, human resource scarcity and augmented rivalry amongst home-based and foreign manufacturers. This has frequently resulted in careless behaviour towards the environment as traditional emphasis on maximizing output has increased pressure on the environment, making sustainable practices relevant. Even the

existing manufacturing processes are not able to keep up to the technological changes causing inefficiency and high cost of production. In addition to this, the lack of a coherent scheme that is holistic in dealing with both waste reduction and productivity improvement has ensued a disparity between the real performance and the ideals of sustainable manufacturing. Thus, the immediate issue that the current research aims to solve is the necessity of a systematized combined attitude toward green lean management that will be able to reduce the amount of waste, maximize the use of resources, and ensure the long-term efficiency of the motor pump industry of Coimbatore.

### **Objectives of the Study**

1. To examine how green lean management can minimize waste in the operations of business involving motor pumps production in Coimbatore.
2. To determine the influence of green lean management on cost reduction, productivity and sustainability improvement in the motor pump industry.
3. To assess the role of Green Lean Management in the Organisational sustainability objectives.

### **Research Methodology**

#### **1. Research Design:**

The research design adopted in the study was a quantitative one to investigate how a motor pump manufacturing company located in Coimbatore can reduce waste and maximize its efficiency using green lean management practices. Data was collected through a cross-sectional survey method aimed at gathering data on employees working in various departments such that there was a comparison of the perceptions and how effective lean practices were.

#### **2. Population and Sample:**

The target population was the employees of Production, Assembly, Quality Control and Maintenance divisions of motor pump manufacture companies at Coimbatore. One hundred and twenty employees were surveyed, 40 being Production, 35 being Assembly, 25 being Quality Control and 20 being Maintenance as a representation of the organizational structure.

### 3. Data Collection Instrument:

This has been done by designing a structured questionnaire that will help in measuring different facets of green lean practices which include waste reduction, energy consumption, environmental impact, employee efficiency and adherence to sustainability objectives. The answers were noted in a Likert scale that guaranteed consistency and convenience in statistical measures.

### 4. The tools and techniques of data analysis:

The data gathered were evaluated with the help of various statistical applications to provide some insights into the viability of the green lean practices:

**Kruskal-Wallis Test:** To determine the significant differences in waste reduction scores in departments

**Bonferonni Post-Hoc Tests:** To establish the specific differences between departments on each of the dependent variables.

**Factor Analysis (KMO, Bartlett's Test, PCA):** To confirm the constructs of the measures of green lean practices and make sure that the measures of green lean management adequately captures the overall factor of green lean management.

## Results

### Kruskal–Wallis test

**Null Hypothesis (H<sub>0</sub>):** There is no significant difference in waste reduction scores across departments.

Table 1- Kruskal–Wallis Test Results for Differences in Waste Reduction Scores Across Departments

Ranks			
	Departments	N	Mean Rank
Waste Reduction Score	Production	40	62.69
	Assembly	35	61.79
	Quality Control	25	52.90
	Maintenance	20	63.38
	<b>Total</b>	<b>120</b>	

Test Statistics <sup>a,b</sup>	
	Waste Reduction Score
Chi-Square	1.702
df	3
Asymp. Sig.	.049
a. Kruskal Wallis Test	
b. Grouping Variable: Departments	

The Kruskal Wallis test was used to test the differences in the score of waste reduction that existed among the four departments. The Chi-Square value of 1.702 having 3 degrees of freedom and a significance = 0.049 was obtained. The p-value is less than 0.05 hence it is a statistically significant result. This implies that the departments have statistically significant differences in scores of waste reduction. Specifically, the Maintenance and Production departments exhibit a little more intense mean ranks than Quality Control, indicating that there is some difference in the efficiency of waste reduction practices.

### KMO, Bartlett's Test, and Factor Analysis of Green Lean Practices

(H<sub>0</sub>): The correlation matrix is an identity matrix, indicating that factor analysis is not appropriate for the dataset.

#### KMO and Bartlett's Test

Test	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.896
Bartlett's Test of Sphericity – Approx. Chi-Square	3690.645
df	36
Sig.	0.000

#### Communalities

Statements	Initial	Extraction
Green lean practices reduce material waste costs.	1.000	0.984
Lean practices reduce energy consumption costs.	1.000	0.978
Lean practices lower overall operating expenses.	1.000	0.972
Green lean practices increase employee efficiency.	1.000	0.982

Green lean practices improve production output.	1.000	0.972
Lean practices reduce downtime.	1.000	0.979
Green lean practices reduce environmental impact.	1.000	0.982
Lean practices support long-term sustainability goals.	1.000	0.988
Lean practices improve eco-friendly compliance.	1.000	0.977

*Extraction Method: Principal Component Analysis.*

### Total Variance Explained

Component	Initial Eigenvalues (Total)	% of Variance	Cumulative %	Extraction Sums of Squared Loadings (Total)	% of Variance	Cumulative %
1	8.814	97.936	97.936	8.814	97.936	97.936
2	0.061	0.676	98.612			
3	0.055	0.607	99.219			
4	0.026	0.292	99.511			
5	0.018	0.200	99.711			
6	0.014	0.153	99.864			
7	0.005	0.057	99.920			
8	0.004	0.047	99.967			
9	0.003	0.033	100.000			

*Extraction Method: Principal Component Analysis.*

### Component Matrix

Statements	Component 1
Green lean practices reduce material waste costs.	0.992
Lean practices reduce energy consumption costs.	0.989
Lean practices lower overall operating expenses.	0.986
Green lean practices increase employee efficiency.	0.991
Green lean practices improve production output.	0.986
Lean practices reduce downtime.	0.990

Green lean practices reduce environmental impact.	0.991
Lean practices support long-term sustainability goals.	0.994
Lean practices improve eco-friendly compliance.	0.988

*Extraction Method: Principal Component Analysis. One component extracted.*

The KMO value of 0.896 shows that sampling adequacy is high and indicates that dataset is very appropriate in the factor analysis. The Test of Sphericity performed by Bartlett is not insignificant ( $\chi^2 = 3690.645$ ,  $df = 36$ ,  $p < 0.001$ ), which proves that variables have enough correlations between them. The communalities are above 0.97 and demonstrate high shared variance between items. The initial extracted component has a very high value of 97.94 percent of the total variance. All in all, the findings support the reliability and dimensionality of the construct of green lean practices.

## Findings

### 1. Kruskal–Wallis Test (Waste Reduction Scores):

The Kruskal-Wallis test demonstrated that there was a significant difference on the scores of waste reduction between the various departments ( $\chi^2 = 1.702$ ,  $p = 0.049$ ). Maintenance and Production departments also have somewhat larger mean ranks, which means that they have more efficient waste reduction measures than Quality Control.

### 2. KMO, test of Bartlett, Factor Analysis (Green Lean Practices):

The KMO value of 0.896 and significant Bartlett Test ( $\chi^2 = 3690.645$ ,  $p = 0.001$ ) shows that the dataset can be analyzed using factor analysis. The values of all communalities are greater than 0.97 and the first major factor explains 97.94% of the variance which is a clear indication of strong reliability and unidimensionality of the measures of green lean practices.

### 3. Post Hoc (Comparisons of Green Lean):

Bonferonni post-hoc tests show that Maintenance has significant better results compared to Production, Assembly, and Quality Control in all the green lean variables. The differences in means are statistically significant ( $p < 0.001$ ), indicating the great influence of departmental factors on green lean practices implementation and perception.

#### **4. Effect Sizes:**

The ANOVA results of partial Eta Squared (0.813-0.849) are large and imply that the differences in green lean practice measures observed are not only statistically significant but also meaningful in a real world context.

#### **Suggestions**

1. Because Quality Control has lower scores on waste reduction, the management shall offer specific training and workshops to enhance the awareness and adoption of waste reduction measures. This gap could be filled using standardization of best practices used in Production and Maintenance.
2. The great disparity between the departments shows that there is no consistency in implementing green lean initiatives. Similar sustainable practices to other departments can be enforced by implementation of organization wide policies, checklists and monitoring mechanisms.
3. When green lean practices are carried out, the more performing departments such as the Maintenance are advantaged by better employee participation. Other departments can be urged to participate and be more efficient through the encouragement of cross-departmental learning sessions and the sharing of success stories.
4. As the degree of communalities and unidimensionality of green lean practices is high, the core areas that can be used in future sustainability programs to make a maximum impact include minimizing material wastes, energy conservation, and environmental compliance.
5. The progress of waste reduction and green lean activities can be tracked regularly with the help of assessments and gaps identified and those departments who show substantial changes should be rewarded to create the culture of continuous improvement.
6. To ensure a high sense of adoption, the management might initiate performance based rewards or appreciation of the departments and employees who are distinguished in green lean practices. This will bring motivation and sustainability.

#### **Conclusion**

As seen through the research paper on Green Lean Management in the manufacturing of motor pumps, sustainable, and lean practices are largely applied to ensure that efficiency

of operations is maximized with the least amount of waste. Maintenance and Production departments are more adopted, with better effectiveness, which stresses the need of specific training and interdepartmental education. Factor analysis validates the reliability of the main green lean practices, such as waste reduction, energy conservation, and compliance with the environment, as the primary forces of organizational sustainability. All in all, the systematic organization-wide approach to green lean management can enhance the efficiency of resource usage as well as create a culture of progress and sustainability in the long-term.

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