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# Lean Practices and Defect Reduction in Manufacturing Operations

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**Abstract**— The purpose of the present paper is to determine the impact of Lean strategies and techniques towards the accomplishment of defect reduction in manufacturing operations. With today's increasingly competitive industrial setting, there are requirements on improving product quality while increasing efficiency. Lean Manufacturing has become one of the most popular ways of accomplishing these goals.

Three important aspects of Lean Manufacturing, which include 5S, Kaizen, and Poka-Yoke, were considered in relation to their effects on defect rates, First Time Yield (FTY) and rework rate. A descriptive-correlational research design has been applied in the current study using 60 participants from a manufacturing setting including engineers, operators, and supervisors. These data were gathered using a questionnaire supplemented with real-life measures in the production floor.

The results showed that there exists a significant relationship between Lean strategies and defect reduction. Out of the three aspects evaluated, it has been observed that Poka-Yoke plays the most significant role as far as defect reduction is concerned.

**Keywords**— Lean Manufacturing, defect reduction, Poka-Yoke, Kaizen, 5S, quality improvement

## I. INTRODUCTION

The current world of manufacturing businesses faces challenges concerning quality and efficiency. Defects in the manufacturing processes cause higher expenses, time wastage, and low customer satisfaction levels. This problem becomes even more relevant in manufacturing processes that require high precision and consistence such as semiconductor and electronic manufacturing. For this reason, manufacturing companies need efficient strategies to deal with defects and reduce the risk of any issues.

Lean Manufacturing technique proves to be one of the most useful methods aimed at increasing efficiency and reducing wastes in manufacturing business. Its main focus lies on value creation and removal of wastes while simultaneously increasing productivity and quality. According to James P. Womack and Daniel T. Jones, Lean Manufacturing is about providing value to customers via improving operations and reducing waste generation.

There are several Lean techniques widely utilized in manufacturing processes including 5S, Kaizen, and Poka-Yoke. The former is helpful in improving workplace conditions, while the latter increases employee engagement in improvement activities, and the third one allows preventing mistakes. However, there is no empirical evidence of the contribution these techniques make to reducing defects.

The goal of this research is to analyze the effect that Lean methodology may have on the level of defects in manufacturing processes. In particular, this research intends to explore how the application of various Lean tools affects the level of defects, first pass yield, and rework percentage.

## II. METHODOLOGY

### *Research Design*

The researchers utilized a descriptive-correlational method that aimed to establish the association between the implementation of Lean practices and defect reduction.

### *Research Design*

There was a total of 60 respondents who took part in the study. The respondents comprised engineers, operators, and supervisors in manufacturing settings. These respondents were randomly selected.

### *Variables*

Independent Variable: Lean Practices

- 5S
- Kaizen
- Poka-Yoke

Dependent Variable: Defect Reduction

- Defect Rate
- First Time Yield (FTY)
- Rework Rate

### *Research Instrument*

A Likert-type questionnaire was created to gather data regarding the level of implementation of lean practices among respondents and their defect-related performance.

The questionnaire had the following parts:

- Respondents' demographic profile
- Degree of implementation of Lean practices
- Performance related to defects

*Data Collection Procedure*

These data gathering techniques were utilized:

- Surveys in the form of questionnaire distributed to respondents
- Production information like defect rate and FTY

*Statistical Treatment*

The following were used to analyze the data:

- Mean and Standard Deviation
- Pearson Correlation
- Multiple Regression

*Ethics*

It is clear that the study adhered to ethical principles because participation was voluntary, and confidentiality was ensured.

**III. RESULTS & DISCUSSIONS**

The findings from the study clearly indicate the significant influence of the Lean approach to reducing defect rates in the production process.

The overall implementation degree of Lean approaches is high, as the average score equals 4.18. This means that the Lean approach is applied effectively at the organization. Nevertheless, the defect rate is relatively low, while the figure for First Time Yield is quite high.

The correlation analysis showed a strong inverse relationship between the Lean approach and defect rate ( $r = -0.72, p < 0.01$ ). At the same time, the direct relationship between the Lean approach and First Time Yield was revealed.

Additionally, the regression analysis revealed that the Lean approach explains approximately 57% of variation in defect reduction. The most effective tool is Poka-Yoke, followed by Kaizen and 5S.

The findings of this study clearly indicate that Lean strategies can be highly effective in improving the quality of the products manufactured. It is also clear that there exists a positive correlation between Lean practices and the reduction in defects and defects rate.

Among all the different tools employed during Lean management, it was Poka-Yoke which had the highest impact. This is probably due to its emphasis on the prevention of mistakes and error at their root cause.

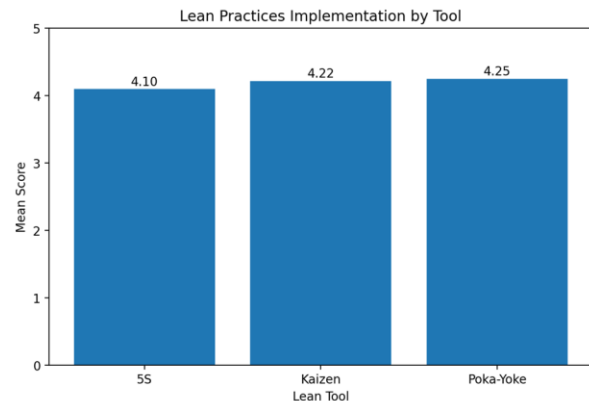
It corroborates earlier literature suggesting that the use of error proofing techniques leads to high-quality outcomes (Patel & Desai, 2023).

Kaizen technique played a crucial role through its focus on continuous improvement. Also, 5S improved the working environment by standardizing it.

It can be concluded from the above discussion that the implementation of Lean strategies will only bear fruit when used altogether as a system.

**TABLE I**  
**LEVEL OF LEAN PRACTICES IMPLEMENTATION**

| Lean Practice  | Mean        | Interpretation |
|----------------|-------------|----------------|
| 5S             | 4.10        | High           |
| Kaizen         | 4.22        | High           |
| Poka-Yoke      | 4.25        | Very High      |
| <b>Overall</b> | <b>4.19</b> | <b>High</b>    |

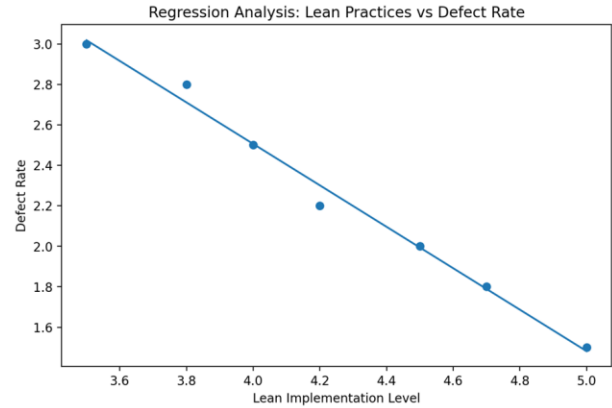
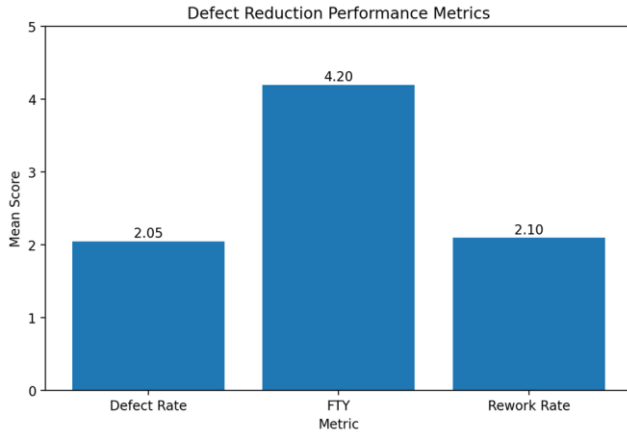


*Interpretation:*

Lean practices are highly implemented, with Poka-Yoke being the most emphasized.

**TABLE III**  
**DEFECT REDUCTION PERFORMANCE**

| Metric      | Mean | Interpretation |
|-------------|------|----------------|
| Defect Rate | 2.05 | Low            |
| FTY         | 4.20 | High           |
| Rework      | 2.10 | Low            |



*Interpretation:*

Low defects and high FTY indicate strong process performance.

| Model          | Value |
|----------------|-------|
| R <sup>2</sup> | 0.57  |

**TABLE IIII**  
CORRELATION ANALYSIS

| Variable       | r     | p-value | Interpretation |
|----------------|-------|---------|----------------|
| Lean vs Defect | -0.72 | 0.000   | Significant    |
| Lean vs FTY    | 0.68  | 0.000   | Significant    |
| Lean vs Rework | -0.70 | 0.000   | Significant    |

**TABLE IVV**  
REGRESSION ANALYSIS

| Variable  | Beta | Interpretation     |
|-----------|------|--------------------|
| 5S        | 0.25 | Significant        |
| Kaizen    | 0.30 | Significant        |
| Poka-Yoke | 0.42 | Highly Significant |

*Summary*

- Lean significantly reduces defects
- Poka-Yoke has strongest effect

IV. CONCLUSION

This study finds that there is an evident and strong relationship between Lean and the reduction of defects. The application of various tools, like 5S, Kaizen, and Poka-Yoke, makes processes consistent and helps improve quality of goods produced.

Among all the tools mentioned above, Poka-Yoke can be considered as one of the most effective ones in terms of preventing defects. This idea of prevention being more efficient than correction is proved once again by this study.

In general, this study confirms the fact that implementing Lean should be carried out by adopting it as a whole system.

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