# Analysis of Performance by Overall Equipment Effectiveness of the Injection Moulding Section of an Automobile Industry

**Rajat Tomar[1], Pradeep Kumar Soni[2]**

[1] *M. Tech. Scholar, Department of Mechanical Engineering, Maulana Azad National Institute of Technology, (MANIT), Bhopal, Madhya Pradesh, India*

[2] *Assistant Professor, Department of Mechanical Engineering, Maulana Azad National Institute of Technology, (MANIT), Bhopal, Madhya Pradesh, India*

---

## ABSTRACT

*This paper measure the performance of one of the unit of this industry. To do this Overall Equipment Effectiveness(OEE) is selected; as a tool of Lean Manufacturing widely accepted to measure the efficiency of a manufacturing plant in terms of availability, performance and quality and also identify the major productivity losses. Data were collected from the production unit to calculate the OEE percentage. The amount of three losses i.e. downtime, speed loss and quality loss was measured and liable factors behind these losses were identified. It is found that the Overall Equipment Effectiveness of production unit is 59.88%.*

## 1. INTRODUCTION

India has been since 1942 building cars and after liberalization, multinational automakers such as Suzuki and Toyota of Japan and Hyundai of South Korea were allowed to invest in Indian market. Maruti Suzuki was the first and most successful of these new entries. This also provides a field for joint ventures between various companies and outsourcing of various parts and components to small or medium vendors or suppliers. India is exporting automobiles to various African and South Asian countries. Although India itself has a huge market for automobiles. Automobile industry is considered to be a thrust sector in the economy of India having share of 7.1% of GDP by volume. In the automobile industry, various manufacturing functions are outsourced. The production of seats and other interior parts is one of them. Market research shows that there is huge supply and demand gap in quality products in Indian market which provides a ground to foreign players to capture Indian automobile market. As automobile giants of Germany and Japan increasingly focus on setting up their assembly plant in India , it provides a great chance to attract them to cater their needs of quality parts. But elevating the production system to a global standard in terms of productivity and quality is prerequisite to grab the global market opportunity. In this research, analysis of the performance of the Plastic Injection Moulding Section of a firm is made by Overall Equipment Effectiveness to identify the major losses exist here and to specify the room for improvement.[10]

## 2. METHODOLOGY

This paper is a case study in which a logical and systematic way is followed to achieve the solution of research problem. After a few primary visits, an idea is generated and literature is studied accordingly. Then the data is collected and analysed according to the literature. Finally, the result is obtained. Following flowchart represent the methodology in a lucid manner.

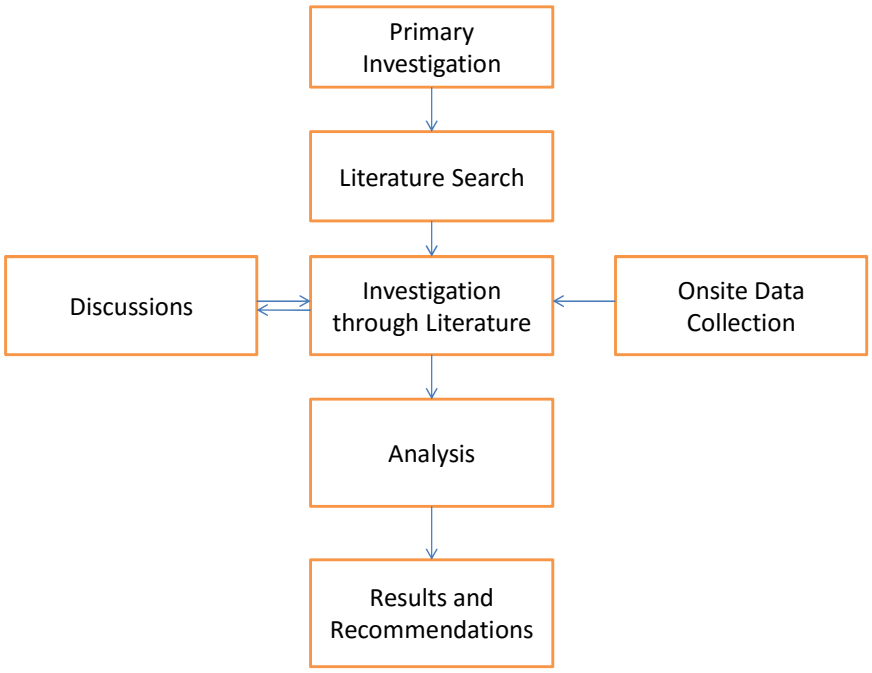



**Figure 1.** Action Plan of the study

## 3. OVERALL EQUIPMENT EFFECTIVENESS(OEE)

Overall equipment effectiveness (OEE) is a set of metrics to monitor and evaluate the utilization of the facility. Developed in mid 1960 by Seiichi Nakajima, OEE has become an accepted industrial tool measure and evaluate plant floor productivity. OEE consists of three measuring factors, i.e., Availabiltiy, Performance and Quality[4] These factors help to measure plant's efficiency and effectiveness. It also categorise key productivity losses that crept into the manufacturing process. OEE provide scope for manufacturing companies to improve their processes and in turn ensure consistency, quality and productivity. By definition, OEE is a product of Availability, Performance and Quality.

Mathematically,

OEE = Availability x Performance x Quality

**Table 1 : Six big losses addressed by OEE,[1],[2]**

| Six Major Loss Category | OEE Loss Category | Event Example |
|---|---|---|
| Breakdown | Availability | 1. Equipment failure<br>2. Major component failure<br>3. Unplanned maintenance |
| Setup and adjustments | Availability | 1. Raw material shortage<br>2. Equipment setup<br>3. Operator shortage |
| Minor stops | Performance or Availability | 1. Fallen product<br>2. obstruction blockages |
| Speed loss | Performance | 1.Running lower than rated speed<br>2.Not running at nominal speed due to untrained operator<br>3. Machine idling |
| Production rejects | Quality | 1.Scrap<br>2.Rework<br>3. In-situ damage |
| Rejects on start up | Quality | 1.Scrap<br>2.Rework<br>3. In-situ damage |

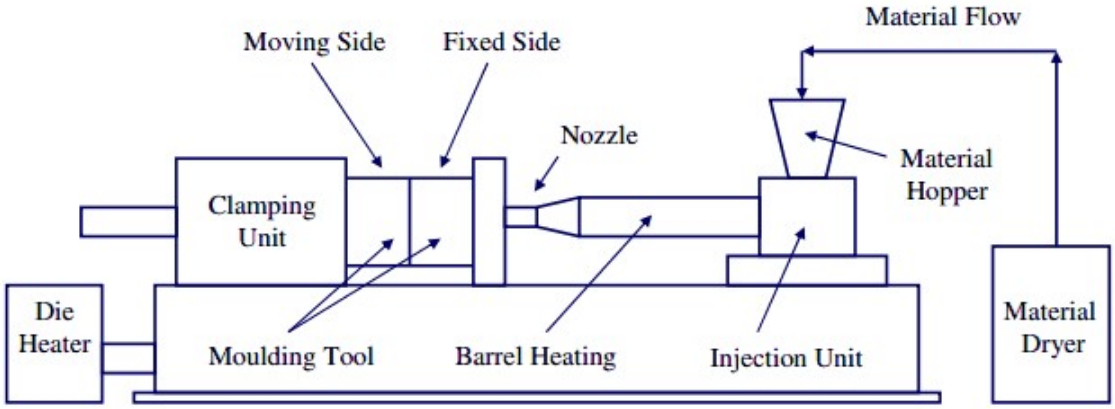
## 4. AN OVERVIEW OF THE PLASTIC MOULDING SECTION

In studied firm, Plastic moulding machines of various tonnage and moulds are used to produce different parts in a very orderly manner. The design are acquired from the client as per their need. Then according to the design moulds are procured. After that, the plastic pellets are injected in moulding machines for production.

In the firm, CLF-750, TS-550, CLF-120, HT-500, HT-250, TS-400, TS-200, STORK 660, DEMAGE 400, NGRB-150, 200 TON & 100 TON, injection moulding machines are used.

### 4.1 Injection Moulding

The Process of assembling by forming malleable crude material utilizing an inflexible edge is called Molding. Infusion embellishment is the most generally utilized polymeric manufacture process. It developed from metal bite the dust throwing, be that as it may, dissimilar to liquid metals, polymer liquefies have a high consistency and can't just be filled a mold. Infusion forming procedure is a dynamic procedure known for its pace and accuracy when contrasted with other embellishment forms. Infusion trim is a procedure of shaping an article by driving liquid plastic material under weight into a mold where it is cooled, set and in this manner discharged by opening the two parts of the mold. Infusion Molding is utilized for the arrangement of mind boggling plastic parts with fantastic dimensional precision. An extensive number of things connected with our every day life are delivered by the method for Injection Molding.




**Manufacturing Process**

- Pellets poured in hopper
- Pellets fall into barrel by means of throat
- Pellets are pressed to form solid bed. (air constrained out through hopper)
- Pellets are melted by mechanical shear between barrel and screw
- Melted plastic form shot in front of screw (screw moves back as plastic moves forward – reciprocating screw)
- Screw moves forward to infuse plastic into mould cavity
- Part cooled and cements (next shot is made)
- Mould opens
- Ejection pins push forward to eject part
- Mould retracts and Process begins once again

## 5. ANALYSIS AND RESULTS

Three OEE matrices have been collected i.e. availability, performance and quality field data. In this purpose interview of the moulding machine operators has been done and discussed with the appointed engineer of that section if required.

**a. Availability Matrices**

Availability data have been collected for 4 days directly from the floor of the section on all 13 machines. **Table 2 (a):** Availability Data

| S.No. | Production Data | Value |
|---|---|---|
| 01 | Plant Operating Time ( 4 days; 23.5 hrs per day) | 305.5 hrs * 4days = 73320 min. |
| 02 | Planned Shutdown | 390min * 4days = 1560 min. |
| 03 | Breakdown (total) | 5508+4770+6456+8310 = 25044 min. |

**Table 2 (b):** Availability Data

| | |
|---|---|
| **M/c Available Time** | 73320 min – 1560 min = 71760 min |
| **Operating Time** | Day 1 =12826.45 min |
| | Day 2 =13553.12 min |
| | Day 3 =11877.18 min |
| | Day 4 =10019.14 min |
| | ∑ Op. time = 48275.89 min |

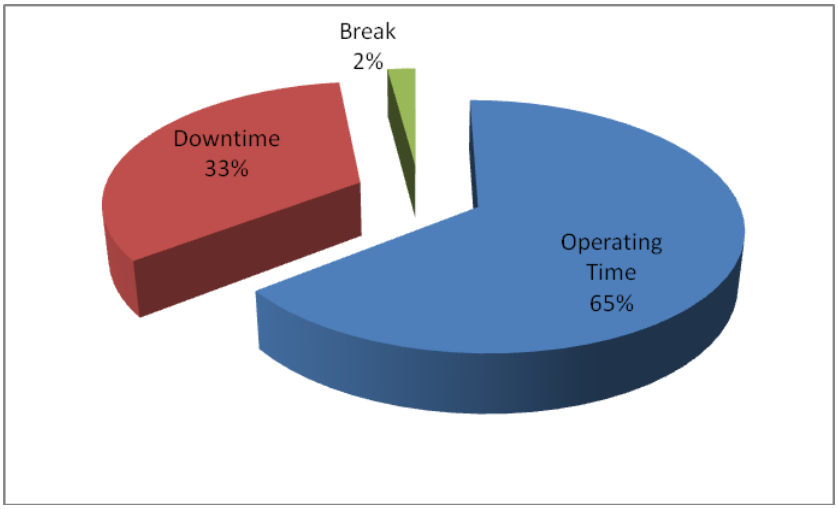



**Fig. 3 Pie Chart showing percentage division**

The pie chart and data above shows only 65 % of total time for useful production, rest 33% time went without any value addition.

**b. Performance Matrices**

The study make use of the total output to calculate performance percentage. The ideal moulding speed is found at Injection Moulding machines operating manual and actual speed from the field.

Performance = (Total Production Parts / Operating time) / Idle Run rate [11]
Idle Run Rate is cumulative average of all machines viz. 1.34 parts per min.

**c. Quality Matrices**

Total 57591 parts were found good after producing the 60147 parts. Rejection report of these parts is collected from the Quality Control (QC) department.

**Table 3 : Quality Data**

| Serial | Production Data | Value |
|---|---|---|
| **01** | Total Piece | 60147 |
| 02 | Rejection/Repair | 2856 |
| 03 | Good Piece | 57591 |

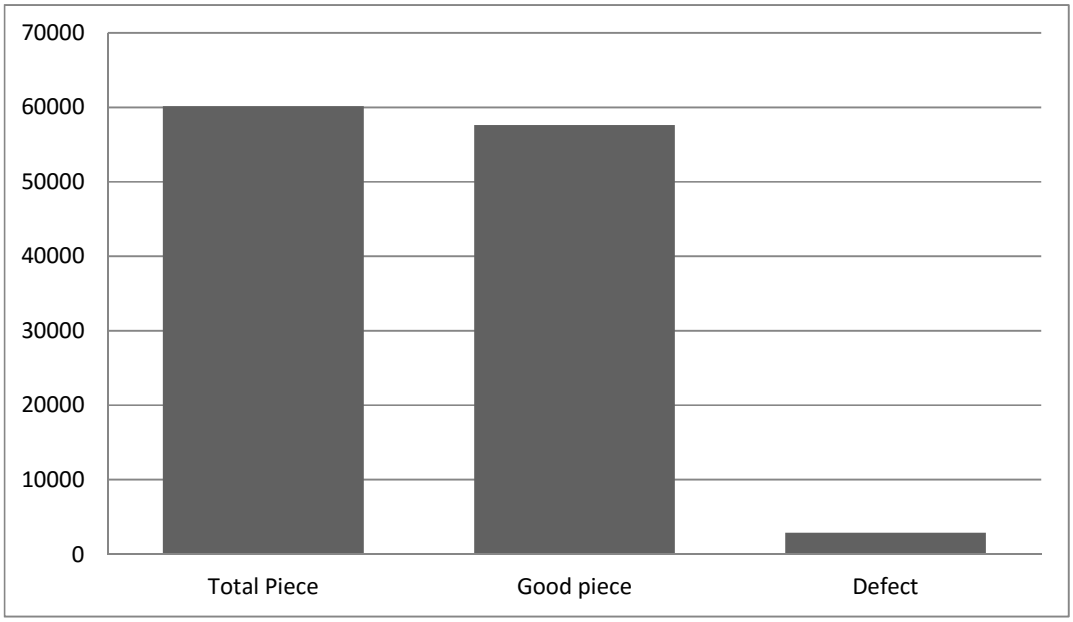



**Fig 4. Comparison of total piece, good piece and defective piece**

**d. OEE Matrices**

**Table 4 .** OEE Calculations [6]

| OEE Factor | Calculation | Calculated data | Percentage |
|---|---|---|---|
| **Availability** | Operating time / M/c available time | 48725.89 min. / 71760 min. | 0.6790 or **67.90%** |
| **Performance** | Total Produced Parts / Operating time x Idle Run Rate | 60147 / 48725.89 x 1.34 | 0.9211or **92.11%** |
| **Quality** | Good Piece / Total Piece | 57591 / 60147 | 0.9575 or **95.75%** |

The Overall Equipment Effectiveness = Availability x Performance x Quality

= 0.6656 x 0.9211 x 0.9554

= 0.5988 or 59.88 %

**e. Result :-**

It is found that, the OEE of the concern industry is **59.88 %** which is below of the global standard (85% for manufacturing industry).[3]

## 6. CONCLUSION AND DISCUSSION

Performance measurement is the basic principle of management. It is significant because it identifies the leakages and gaps between achieved and targeted performance and provides signs of progress towards closing the leakages and gaps.

This case study measured the existing performance of the moulding section of the selected industry in terms of Availability, Performance and Quality matrices by the tool, OEE. It is found that the average OEE percentage of moulding section is moderately low with respect to global standards. Among the three factors of OEE, i.e. Availability, Performance and Quality rate; Quality rate and Performance was found more satisfactory figure. But a lot of improvement are required in availability. Availability factor is very low due to large changeover time and no plan. So the factors lead to availability losses need to be identified and eliminated. Some factors were identified as responsible for productivity losses are mentioned below including specific suggestions to eliminate these flaws.

| Factors | Suggestions |
|---|---|
| 1.Delay due to raw material unavailability | Implementation of 5S program. This will organize the raw material and hence no time will be wasted to find out the required raw material. [7] |
| 2.Delay in providing new design while a project is just completed. | Computer Integrated Manufacturing (CIM) should be implemented. So immediately after completion of one project the supervisor can upload the next project data to the server and operator can download and use it at once from the shop. |
| 3.Setup time | SMED (Single minute exchange of dies) to be implemented to reduce setup time. [5] |
| 4.Delay due to no plan. | Whole shop should be integrated into Enterprise Resource Planning. |
| 5.Various mechanical problems and breakdowns in injection moulding machines . | Implementation of Total Productive Maintenance (TPM) program can solve these problems. TPM will grow sense of ownership to the machine operators, so they will take care of machinery on their own. Also, they will be provided with the necessary training for basic maintenance operations and practises. |
| 6.Human Errors | Implementation of Poka – Yoke or Full Proof technique to eliminate the errors crept due manpower. [8],[9] |

## REFERENCES

[1] Anonymous, Overall Equipment Effectiveness, Website: http://www.oee.com, Access date 24 February 2016

[2] Anonymous, The Complete Guide to Simple OEE, Website: http://www.exor-rd.com, Access date 24 February 2016

[3] De Groote, P. (1995). Maintenance performance analysis: a practical approach. *Journal of Quality in Maintenance Engineering*, *1*(2), 4-24..

[4] Nakajima, S. (1988). Introduction to TPM: Total Productive Maintenance.(Translation). *Productivity Press, Inc., 1988,*, 129.

[5] Palanisamy, V., Vino, J.A.,(2013). Implementing Overall Equipment Effectiveness in a

Process Industry, Indian Journal of Science and Technology

[6] Parihar, S., Jain, S., & Bajpai, L. (2012). Calculation of OEE for an Assembly Process. *International Journal of Research in Mechanical Engineering & Technology*.

[7] Sahu, S., Patidar, L., & Soni, P. K. (2015). 5S TRANSFUSION TO OVERALL EQUIPMENT EFFECTIVENESS (OEE) FOR ENHANCING MANUFACTURING PRODUCTIVITY.

[8] Shingo, S. (1986). *Zero quality control: Source inspection and the poka-yoke system*. Productivity Press.

[9] Shingo, S. *The Sayings of Shigeo Shingo: Key Strategies for Plant Improvement*. Productivity Press

[10] Tufail, M. S., & Mehovic, H. (2007). Investigation of the Ways to Improve the Performance of a Plant. *Växjö University School of Technology and Design*.

[11] Vijayakumar,S.R., Gajendran, S. , Improvement of Overall equipment effectiveness in Injection Moulding process industry, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)