Productivity Improvement in a Small-Scale Industry Using Time Study

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Abstract - *Improvement of productivity is crucial for manufacturing industries to remain competitive and achieve breakthroughs. Work study serves as a powerful tool to identify and eliminate non-value-added (NVA) activities, thereby improving overall productivity. In this case study, the time study is conducted using process mapping to evaluate the work activities of manual operators in the casting industry. It aims to maintain the same output while minimizing input resources, particularly labor, to streamline operations effectively. The study aims to identify NVA activities, record cycle and idle time, assess workforce utilization, and provide recommendations for manpower planning. By analyzing and mapping the work processes, the research highlights areas of redundant activities and proposes changes to optimize labor efficiency, reduce workplace stress, and ensure better workload distribution. The results of this study are expected to contribute to both time and cost optimization within the company.*

Key Words: Productivity Improvement, Time Study, NVA, Workforce Allocation, Labor Optimization

1. INTRODUCTION

1.1 Productivity

Productivity is a critical measure of efficiency that reflects the relationship between outputs and inputs in a production process. It can be defined as the amount of output produced per unit of input used, which may include labor, materials, and capital.

In mathematical terms, productivity can be expressed as:

$$\text{Productivity} = \text{Output} / \text{Input}$$

This concept is fundamental in both economic theory and practical business applications, as it directly impacts profitability and competitiveness. High productivity indicates that an organization is effectively utilizing its resources to generate goods or services, while low productivity suggests inefficiencies that need to be addressed.

Productivity can be increased by:

I. Generating more outputs from the same level of inputs.

II. Producing the same level of outputs with a reduced level of inputs.

III. A combination of both.

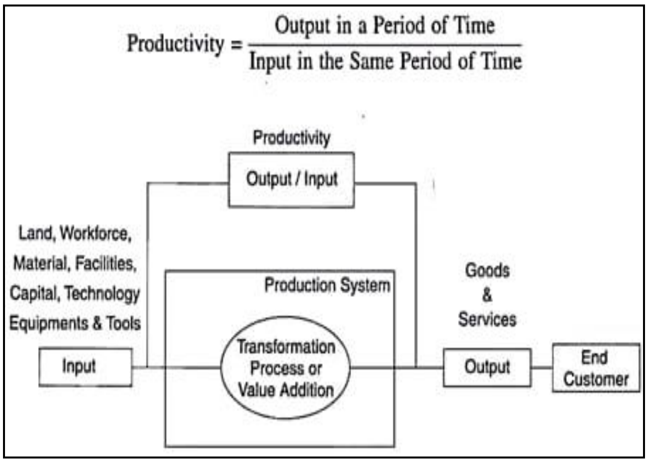


Fig -1: System Concept of Productivity

1.2 Work Study

Work study is a systematic approach aimed at improving productivity through the analysis of work processes. The objective of work study is to identify the most efficient ways of performing tasks while minimizing waste and optimizing resource use.

The International Labor Organization (ILO) defines work study as: "A term used to embrace the techniques of method study and work measurement which are employed to ensure the best possible use of human and material resources in carrying out a specified activity."

Work study comprises two areas of study: <u>Method study</u> (motion study) and <u>Time study</u> (work measurement).

Time study serves as a crucial tool to evaluate and improve work processes while maintaining quality standards. It helps in determining accurate labor requirements, optimizing resource utilization, and establishing realistic production schedules.

1.3 Industry Overview

This case study is based on a small-scale casting industry in the Maharashtra region. The casting industry is a cornerstone of manufacturing, enabling the production of intricate and durable metal components across diverse sectors such as automotive, aerospace, and construction. This industry relies on the process of pouring molten metal into molds to achieve precise shapes, making it essential for high-performance applications.

The industry process chart below illustrates the sequence of operations and key stages involved in the workflow

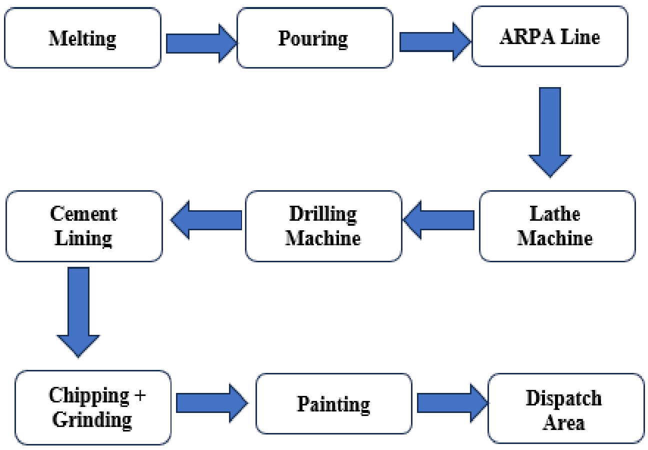


Fig -2: Process Chart

1.4 Problem Statement

Improvement of productivity to increase overall profitability by maintaining the same level of output while reducing the inputs required.

1.5 Objectives

a) Optimize resource utilization
b) Efficiency enhancement
c) Cost reduction

2. RESEARCH METHODOLOGY

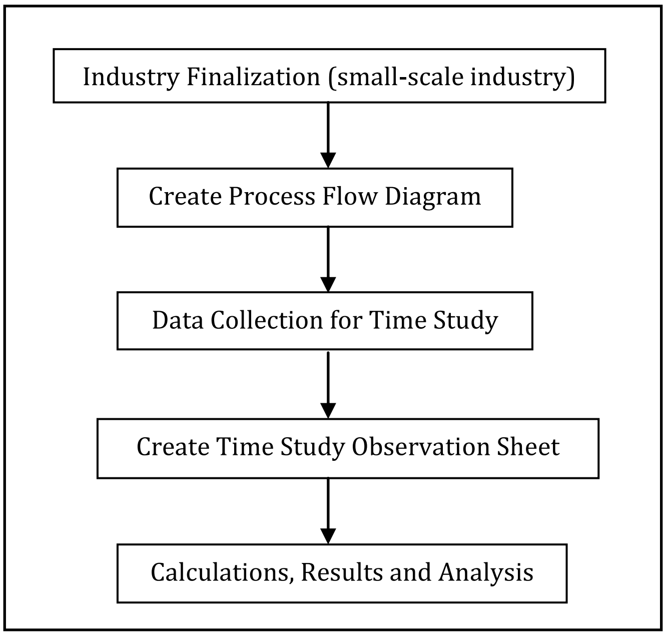


Fig -3: Research Methodology

3. DATA COLLECTION & ANALYSIS

Data was collected from the industry using videography to capture the melting and pouring processes. Four iterations of the process were observed, and detailed time study data sheets were created based on the recorded footage.

Table -1: Time Study Observation Sheet

MELTING + POURING (ITERATION 1)				
Sr. No.	Tasks/Activity	Touch Time (sec)	Idle Time (sec)	Total Time (sec)
1	Putting the raw material in the furnace	131	51	182
2	Melting in process	0	17	17
3	Placing the exhaust funnel above the furnace	12	0	12
4	Melting in process	0	37	37
5	Adding slag powder in the furnace	10	0	10
6	Melting in process	0	48	48
7	Mixing the material with the help of rod	17	0	17
8	Unloading the raw material in the furnace using crane	64	180	244
9	Melting in process	0	66	66
10	Again, mixing the material with the help of rod	64	0	64
11	Pouring the remaining molten metal of previous process in the furnace	39	0	39
12	Melting in process	0	48	48
13	Mixing the material with the help of rod	215	0	215
14	Melting in process	0	116	116
15	Mixing the material with the help of rod	53	0	53
16	Mixing the material with the help of rod + adding raw material	88	0	88
17	Melting in process	0	221	221
18	Mixing the material with the help of rod	37	0	37
19	Melting in process	0	139	139
20	Adding slag powder in the furnace	20	0	20
21	Melting in process	0	11	11
22	Healing the furnace	220	0	220
23	Melting in process	0	67	67
24	Removing the residue	31	0	31
25	Melting in process	0	249	249
26	Taking the sample of molten metal for testing	36	0	36
27	Melting in process	0	146	146
28	Adding slag powder in the furnace & removing the residue	92	0	92
29	Melting in process	0	44	44
30	Putting Mg in the Mg ladle and spreading across its boundaries	29	0	29
31	Melting in process	0	77	77
32	Tapping (pouring of molten metal from furnace into the Mg ladder)	140	0	140
33	Pouring the molten metal from Mg ladle to pouring ladle	69	0	69
34	Adding slag powder in the pouring ladle & removing the residue	49	0	49
35	Pouring the molten metal in the boxes within 420 sec	369	0	369
	Total Time (sec)	**1785**	**1517**	**3302**

Melting + Pouring:

The process begins with two crucibles, each having a capacity of 1.5 tons, used for melting raw materials. It takes approximately 60 minutes to melt the metals to their molten state at a controlled temperature.

T_{total} = Total time for the melting process = 3302 seconds

T_{touch} = Time when workers were not idle = 1785 seconds

T_{idle} = Time when workers were idle = 1517 seconds

Time without worker involvement = 1286 seconds (Only melting in process)

$N_{workers}$ = Total number of workers involved = 9

The ideal time for the pouring process is 7 minutes = 420 seconds

VA % = Touch Time / Total Time * 100

= 1785/ 3302* 100

= 54.06 %

NVA% = Idle Time / Total Time * 100

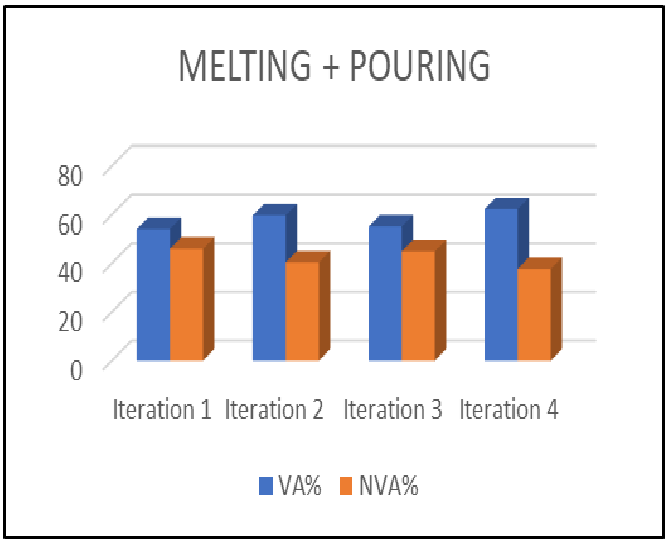
= 1517 / 3302 * 100

= 45.94 %

The above data corresponds to melting and pouring process of Iteration 1.

Similar data collection and calculations have been carried out for the other three subsequent iterations.

Chart -1: **VA and NVA Comparison**



The above graph reflects the scope of reducing NVA activities and enhancing overall productivity in the melting and pouring operation.

4. RESULTS AND RECOMMENDATIONS

Data was collected in a foundry, including touch time, idle time, and total time, to analyze the efficiency of activities. This data was used to calculate the Value-Added (VA) and Non-Value-Added (NVA) percentages of operations. Observations revealed significant NVA activities, during which several workers were unutilized. To address this, the workforce allocation was optimized by reducing the number of workers involved in NVA tasks. Based on this analysis, a revised workforce plan may ensure better utilization of labor and improved productivity.

Table -2: Workforce Comparison

PROCESS	MELTING + POURING
EXISTING WORKERS	9
RECOMMENDED WORKERS	4

Existing workforce:
Engineer -1
General Workers – 9
- Melting- 5
- Pouring- 4

Recommended workforce:
Engineer -1
General Workers – 4
- Melting- 2
- Pouring- 2

The data indicates that certain tasks can be reallocated or streamlined to optimize the existing workforce, eliminating inefficiencies and maximizing the utilization of current resources.

Insights from VA% and NVA% can guide us to eliminate bottlenecks, highlighting areas where reductions in non-value-added activities are necessary to improve efficiency.

5. CONCLUSION

This productivity improvement research highlights the critical importance of balancing Value-Added (VA) and Non-Value-Added (NVA) activities in a small-scale industry.
To improve productivity, the number of workers has been suggested to be reduced so that each one remains occupied with a task, with some buffer time available. This approach minimizes idle time and results in higher overall utilization. The labor that was previously reduced can be reassigned to other tasks during idle periods to optimize resource utilization.
By streamlining tasks and optimizing the existing workforce, the industry can enhance productivity without the need for additional labor. Implementing these changes leads to better utilization of resources and more efficient operations.

FUTURE SCOPE

The future scope of this project lies in further optimizing the productivity of small-scale industries by extending the findings to other processes and departments. By refining labor allocation through data-driven insights, industries can standardize operations and reduce dependency on excessive manpower, leading to cost savings. Advanced techniques such as automation and lean manufacturing could be explored for labor-intensive tasks. Additionally, this study can serve as a foundation for implementing ergonomic improvements and enhancing workplace safety. The methodology could also be applied to similar industries, helping them achieve higher efficiency. With continued analysis, the industry can adapt to changing demands while maintaining consistent output, ensuring long-term sustainability and competitiveness in the market.

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