International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 12 Issue 1 ǁ January 2024 ǁ PP. 150-157

Enhancing Productivity in Small Scale Manufacturing Industry through Work Study Approach- A Case Study

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Abstract:
The primary goal of this research is to enhance production capabilities within the small-scale manufacturing industry, with a specific focus on a company specializing in clamp block production. Employing work study techniques, the research aimed to optimize the company's work processes. The research objectives were geared towards identifying and addressing issues in the production workflow, achieving improvements in production time, process count, and production rate. The methodology involved systematic observation, flow process analysis, and stopwatch time study. Model testing and development were facilitated using SolidWorks model software. The enhancement of work processes was accomplished through the elimination and consolidation of certain steps, resulting in reduced production time, streamlined processes, and improved space utilization. This project underscores the significance of productivity enhancement through a comprehensive work study approach in the realm of small-scale manufacturing industries, showcasing tangible improvements in efficiency and productivity.

Keywords: *Production time, Productivity, Work study, Work measurement, Fixture Design, Profit*

Date of Submission: 05-01-2024 Date of acceptance: 17-01-2024

I. Introduction:

Small-scale industries, characterized by limited employee numbers and annual turnover, face inherent challenges in competing with larger counterparts. This research targets a specific small-scale enterprise engaged in the production of clamp blocks on vertical machining centres. The constrained size of such enterprises often hinders their ability to compete effectively in the market. Consequently, this study takes a proactive approach, employing work study techniques to enhance the work process and enable these enterprises to compete on an international scale.

The primary classification of small-scale industries encompasses three criteria: primary agriculture, manufacturing, and services. Our specific focus lies within the manufacturing sector, where the company's production of clamp blocks serves as a representative case. The study recognizes the imperative for these enterprises to overcome their limitations, and thus, work study techniques emerge as a strategic initiative to address this challenge. Recognizing the significance of efficient time management, this research seeks to analyse and optimize the work process. By eliminating nonproductive processes, the study aims to reduce production and operation time, enhance space utilization, and ultimately equip small-scale enterprises with the tools necessary for competing on an international stage.

This research is conducted in alignment with industry development strategies and encouragement, emphasizing the need for proper resource utilization to sustain growth. The financial growth of any industry is intricately tied to minimizing excess work and improving productivity. Production, defined as the process of transforming raw materials into specified output in terms of quality and quantity, forms the cornerstone of this endeavour mentioned in figure 1.

In light of the outlined challenges and objectives, this research sets out to explore and enhance the productivity of small-scale manufacturing, focusing specifically on the production of clamp blocks. The subsequent sections will delve into the methodologies employed, the production system's intricacies, and the scope of the study to provide a comprehensive understanding of the strategies employed to foster growth and competitiveness within the small-scale manufacturing landscape in figure 2.

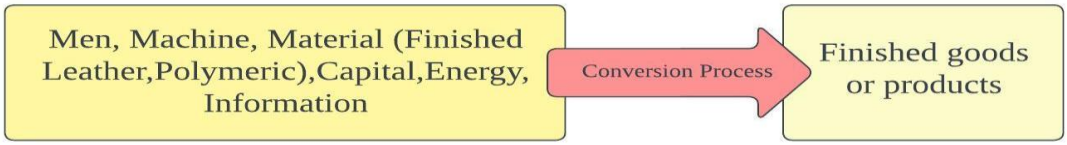

Figure 1: Production System (Jain and Agrawal (2014)[1])

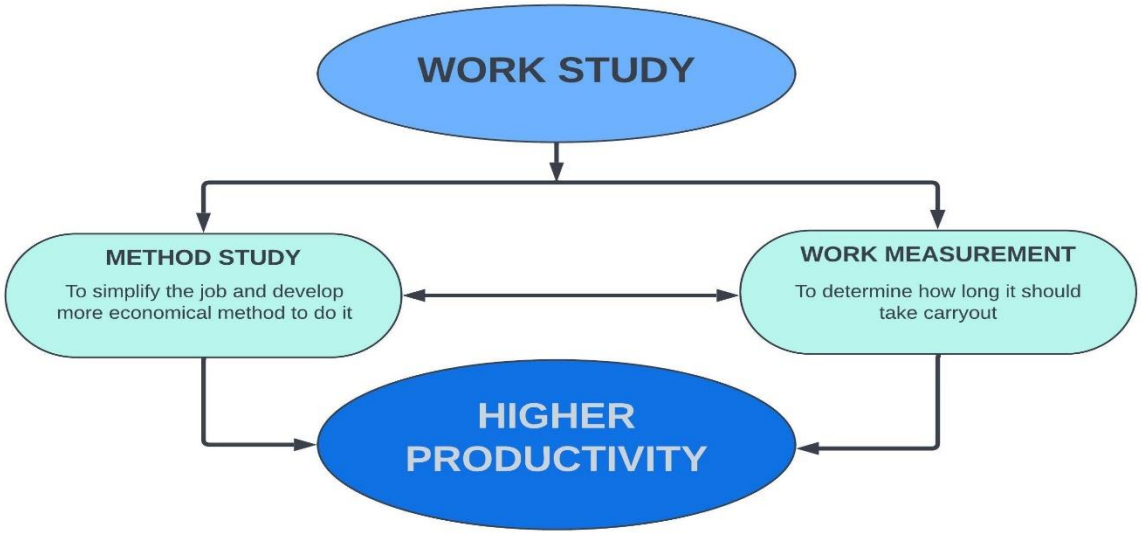

Figure 2: Diagram Shows to Increase the Productivity by Work Study Approach (Jain and Agrawal (2014)[1])

II. Literature Review:

Work study is the investigation process, by means of a consistent system of the work done in a industry, in order to attain the best possible use of the men, machines, materials, available in the building at present (Moktadir et al., 2017)[2]. Work study involves method study and work measurement, with a focus on examining and simplifying operational methods to eliminate wasteful practices. The close relationship between productivity and work study is emphasized, as it systematically enhances human working conditions and reduces work content in assembly lines. Singh MD et al., (2012)[3], conducts research on to improve productivity by using work study and design a fixture in small scale industry. Furthermore, he uses the Pro-E model software for model testing and developing a new model. These modifications are made by eliminating the wasted time and reduction of the work contents. Patel and Thakkar (2015)[4] have worked on reducing manufacturing cycle time of milk tanks by work study technique in small scale fabrication industry. He has applied work study techniques, which are expensive to implement in small-scale industries. However, this method gives better results than any other technique. These techniques not only help reduce the cycle time, but also have proved useful in numerous other departments in industry such as inventory control, productivity, quality, labour work, and at various machines in a machine shop to develop process variation. Rishabh Mishra (2015)[5] explored productivity improvement in automobile industry by using method study. He established improvements on the basis of the method study, work procedure, and proper utilization of machine and material. His study advanced the prevailing process by reducing transportation and worker's fatigue. Singh MP (2016)[6] worked on improvement in process industries by using work study methods through a case study. His study was concerned with the battery manufacturing plant. He observed that the battery plant was not using optimum layout, which had potential for improvement. Various layout and method study tools were applied and flow process charts, flow diagrams and existing layouts were prepared. Novel technologies were applied to lessen production cost, process time, cost, and energy consumption. Kulkarni PP (2014)[7] researched on the topic of productivity improvement through lean deployment and work study methods. He concluded that critical lean tools when effectively combined with work study Methodology could form a unique leaner system, which will provide a universal solution for any type of industry having any sort of problem regarding productivity. Kamble and Kulkarni (2014)[8] investigated the productivity improvement at assembly station using work study techniques. The unwanted motion involved in the operation of assembly has been substantially reduced by designing assembly table, fasteners tray, and design of proper workplace layout.

III. Problem Statement and Objective:

3.1 Problem Statement:

The current production method employed by the company is characterized by prolonged time consumption. Recognizing the imperative need for efficiency enhancements, various methodologies, specifically centred around work study principles, have been applied. The objective is to streamline and simplify the existing production process by introducing a novel fixture design. The critical challenge lies in reducing the overall time span, from job setup to the final dispatch phase, and thereby, significantly enhancing the efficiency of the production line.

3.2 Objective of the Study:

1. Evaluate and identify the most effective methodology, with a primary focus on work study principles, that yields a substantial reduction in manufacturing lead time.
2. Utilize SolidWorks to design a fixture tailored for the vertical machining centre, ensuring precision and compatibility with the manufacturing setup.
3. Conduct a comparative analysis of time consumption between the existing production method and the newly proposed methodology. This analysis will provide insights into the potential efficiency gains.
4. Implement the new methodology with the designed fixture to actively contribute to the improvement of overall productivity in the production process.
5. Undertake an analysis of the net profit generated as a direct result of implementing the new methodology and fixture design. This analysis will serve as a key indicator of the success and financial viability of the proposed changes within the production process.

IV. Research Methodology:

To enhance productivity through the work study method and reduce the work content associated with specific products, a systematic step-by-step procedure was implemented. The key steps of this case study outline a well-defined approach to achieving these goals. A conceptual framework was developed to guide the systematic execution of our research work which are mentioned in figure 3.

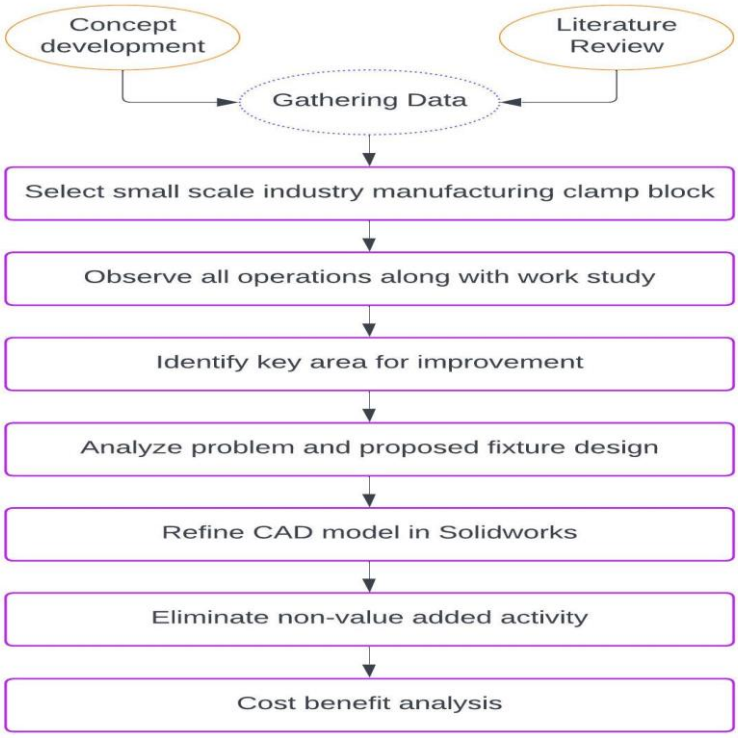

Figure 3: Conceptual Framework

The focus of our study was a small scale manufacturing industry, with a particular emphasis on specific products within a chosen production line. The systematic observation of all operations using a stopwatch allowed us to gain comprehensive insights into the workflow. Utilizing the critical questioning technique, we identified existing problems within the production process.

Once the problems were pinpointed, we employed innovative thinking to devise new methods or processes tailored for the specific products in question. The implementation of our proposed method on the machining process resulted in a notable improvement in productivity.

The research objectives we contributed to this study are as follows:

1. Conduct a detailed analysis of the production system using the work study technique to identify opportunities for productivity improvement.
2. Employ critical analysis to identify existing issues within a specific production line and develop a new system or methodology to address these challenges.

By following this methodical approach, we were able to not only identify and address existing issues but also contribute to the broader goal of enhancing productivity in the context of work study techniques.

V. A Case Study:

5.1 Data Collection:

For practical implementation of our research framework, we select Maruti Engineering company, which is a small-scale industry established at GIDC Makarpura, Vadodara. They are exporters focused customer driven company specializing in contract manufacturing and job shop activities for CNC turning, machining, and wire cutting & grinding.

For making clamp block (One of the company's products), company has used Vertical Machining Centre. Detailed workpiece design has been mentioned in figure 4.

For making clamp block two of tools are used :

1) End mill cutter (Radius cutter R12.5)
2) Face mill cutter (Radius cutter R10)

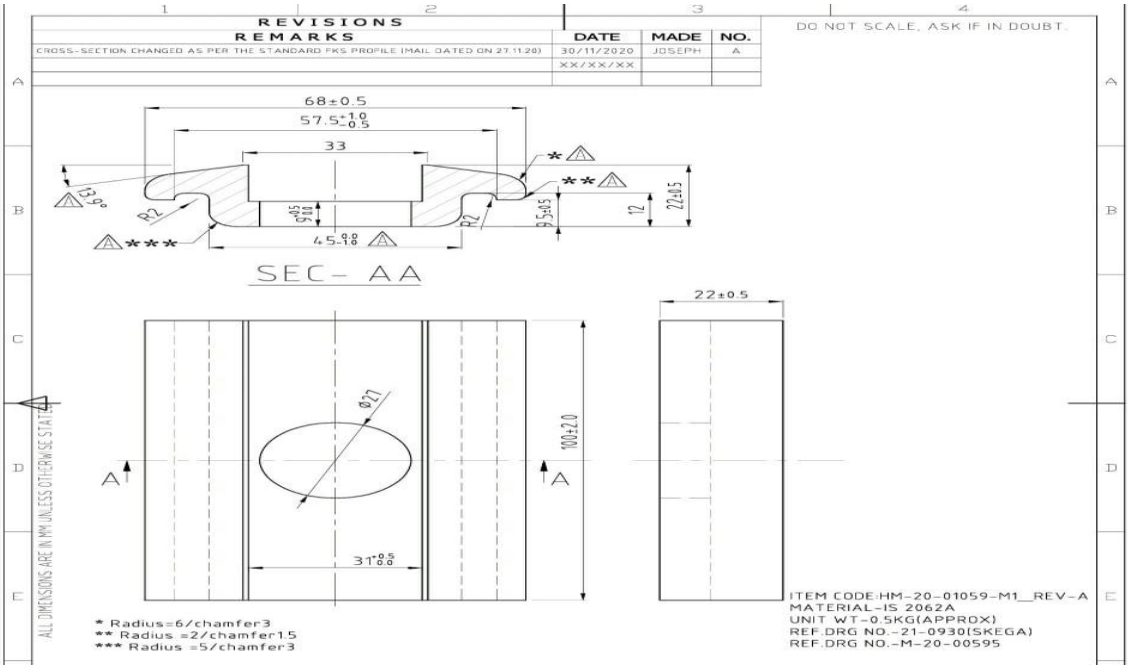

Figure 4: Workpiece Design

Here flow process of raw material to clamp block has been shown in figure 5.

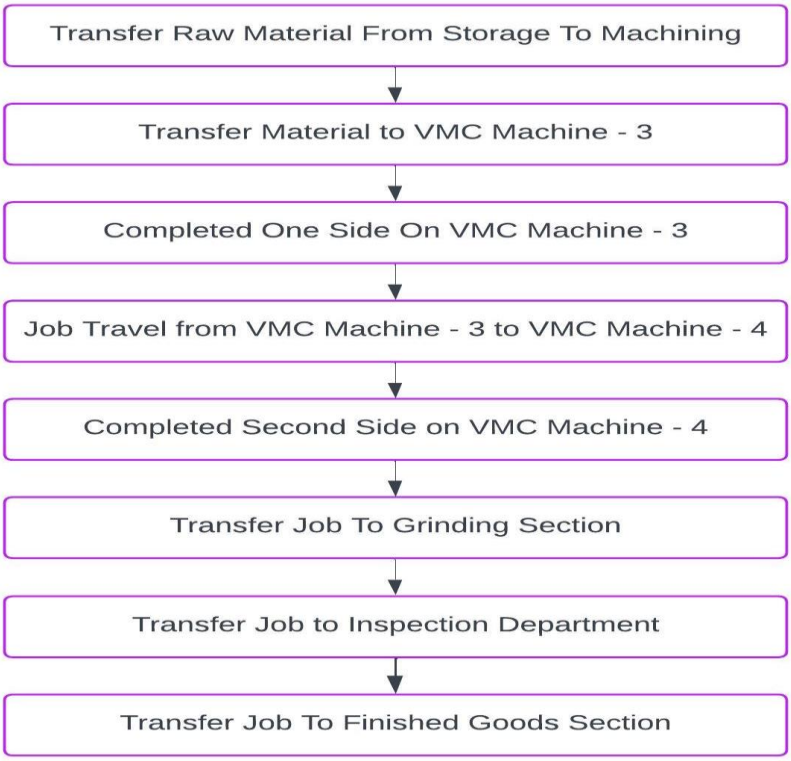

Figure 5: Flow Process of Raw Material to Finished Clamp Block

5.1.1 Actual job setup used before implementation:

Here figure 6 shows the actual job setup used before implementation in production line.

Figure 6: Actual Job Set Up (Top View and Side View)

5.2 Data Analysis:
Here new designed machining setup has been shown in figure 7.

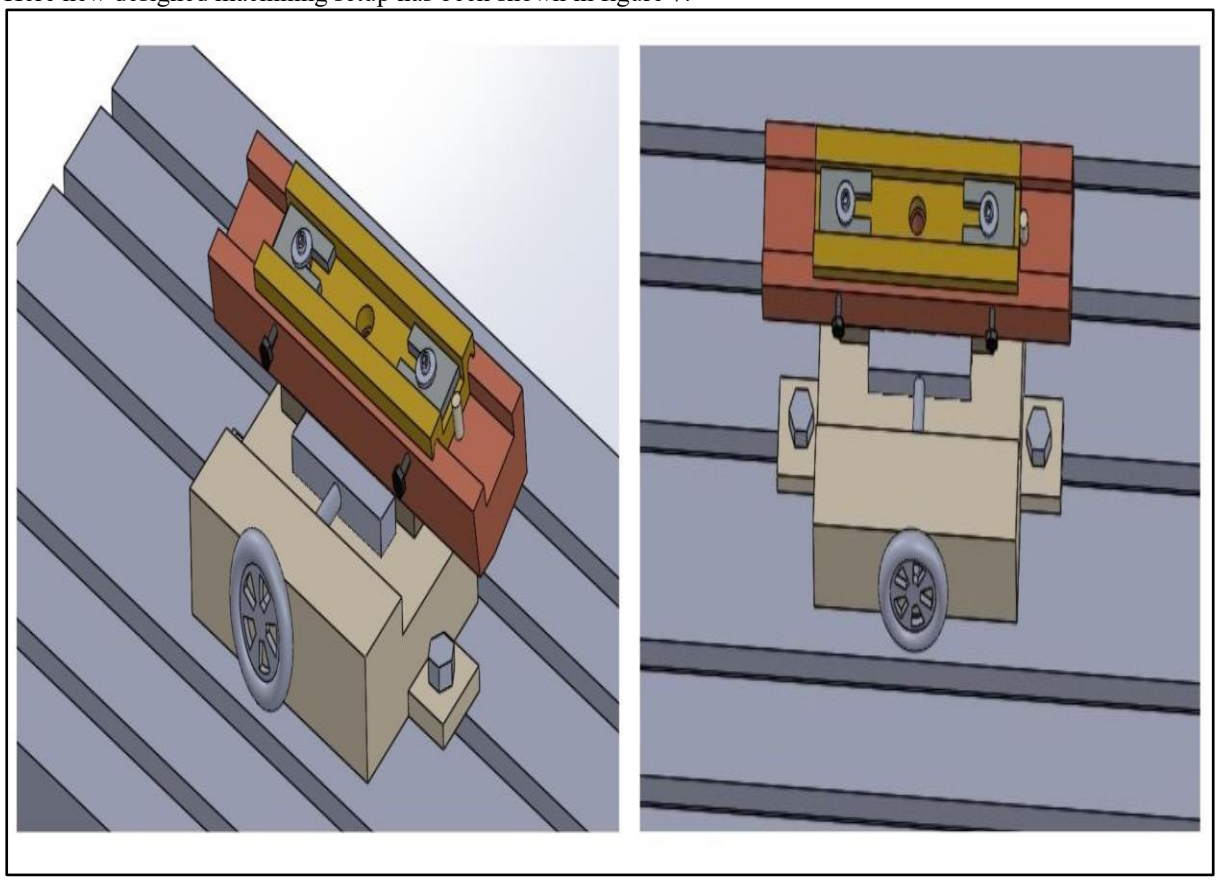

Figure 7: New Fixture Design Setup

5.2.1 Time study comparison:
This table shows the comparisons of total times to make 1 clamp block through existing and proposed setup has been mentioned in Table 1.

Table 1: Time Study Comparison (Before & After)

Sr. No	Activity	Time Study Comparison (hr: min: sec)	
		Before	**After**
1	Job setup time	00:02:00	00:02:00
2	Giving position of job to machine	00:01:00	00:00:00
3	Machining time	00:15:19	00:07:00
4	**Total time**	**00:18:19**	**00:09:00**
5	**Total reduced time**	**00:09:19**	

This table shows the comparisons of total times to make 2000 clamp block through existing and proposed setup has been mentioned in Table 2.

Table 2: Total Time Study Comparison (Before & After)

Sr. No	Activity	Time Study Comparison (hr: min: sec)	
		Before	**After**
1	Total time to complete one clamp block	00:18:19	00:09:00
2	Total time to complete 2000 clamp block	605 hrs. (18:19*2000=605hr)	300 hrs. (09:00*2000=300 hr)
4	**Total time**	**605 hrs.**	**300 hrs.**
5	**Total reduced time**	**305 hrs.**	

5.2.2 Profit analysis:

This table shows the profit analysis through existing and proposed setup has been mentioned in Table 3.

Table 3: Profit Analysis (Before & After)

Sr. No	Detail	Before implementation	After implementation
1	No of Clamp Block	2000	2000
2	Total time	605 hrs.	300 hrs.
3	Charge of Machine per hours: 550 Rs.		
4	Time difference after implementation: (605-300) hrs. = 305 hrs.		
5	Total profit after implementation: 305*550 = **1,67,750 Rs.**		

Net profit analysis after deducting cost of fixture has been shown in table 4:

Table 4: Net Profit per Clamp Block

Sr no	Details	Net Profit (Rs.)
1	Profit	1,67,750/-
2	Cost of Fixture	27750/-
3	Net Profit per Clamp block	1,40,000/2000 = 70/-

VI. Results and Discussion:

The implementation of the new setup for producing clamp blocks using a Vertical Machining Centre has yielded significant improvements in various aspects:

1. Time Efficiency: The total time required for producing one clamp block has been substantially reduced from 18 minutes and 19 seconds to just 9 minutes, resulting in a total reduced time of 9 minutes and 19 seconds per unit.
2. Production Scale Improvement: Scaling up the improvements, the total time required for making 2000 clamp blocks has decreased from 605 hours to 300 hours. This represents a considerable reduction of 305 hours in the production time.
3. Financial Impact:

- The implementation of the new setup has translated into a total profit of Rs. 1,67,750.
- After deducting the cost of the fixture, the net profit stands at Rs. 1,40,000.
- On a per unit basis, the net profit per clamp block is Rs. 70.

4. Tool Utilization: Two tools, namely the End Mill Cutter (Radius Cutter R12.5) and the Face Mill Cutter (Radius Cutter R10), were originally employed. Notably, after the implementation of the new setup, there is no longer a requirement to use the Face Mill Cutter, indicating a streamlined and more efficient process.

These outcomes underscore the substantial positive impact of the new setup in terms of both time efficiency and financial gains. The elimination of the need for the Face Mill Cutter further simplifies the production process, indicating a holistic improvement in the manufacturing of clamp blocks.

VII. Conclusions and Recommendation:

Productivity improvement is an important issue in small scale manufacturing industry. The profit earning of small scale industry largely depends on productivity improvement. This study shows the way of finding gap of production process and operations. By implementing work study and established new set up for operation, we must be able to increase productivity. In conclusion, the strategic implementation of work study methodologies in small scale industry has proven instrumental in boosting productivity, reducing production time, and contributing positively to the financial and operational success of the manufacturing process for clamp blocks.

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