



I-SMART

*International Seminar and Conference
on Management, Research, and Transformation*

OPTIMIZATION OF PALM FIBER BROOM PRODUCTION FLOW USING FLOW PROCESS CHART (FPC) AND TIME STUDY: A CASE STUDY OF CITRA AREN MSMEs TASIKMALAYA CITY

Desy Fitrotunnisa^{1*}, Nurlaela Agustin Khoerunnisa², Rifqi Tri Satrio³, Naufal Pahri Pajar⁴, Asep Muhammad Fadilah⁵

^{1,2,3,4,5}Faculty of Economics and Business, Universitas Siliwangi, Tasikmalaya, Indonesia

^{*}nisafitroh12@gmail.com

Abstract. This study aims to improve the production efficiency of palm fiber broom craftsmanship at a micro, small, and medium enterprise (MSME) in Tasikmalaya City through an integrated hybrid framework combining Flow Process Chart (FPC) and Time Study, specifically adapted to manual craft activities. Observations were conducted on ten workers, and each work element was measured five times to ensure the reliability of the recorded duration. The sweeping process was identified as the major bottleneck, contributing approximately 80% of the total production time. The application of the hybrid framework resulted in an estimated efficiency increase of 18–20%, reducing the standard production time from 44 minutes per unit to around 36–37 minutes. These improvements support SDG 9 (Industry, Innovation, and Infrastructure) by strengthening small-scale industrial performance and offering economic benefits such as reduced labor cost per unit and increased daily output. The study contributes theoretically by demonstrating how structured process optimization tools can be adapted to resource-limited manual craft industries while also providing practical guidance for MSME owners seeking affordable ways to improve productivity.

Keywords: flow process chart; time study; production optimization; MSMEs; palm fiber broom; operational management.

1. Introduction

Micro, Small and Medium Enterprises (MSMEs) are one of the largest income sectors in Indonesia, MSMEs also play an important role in the deployment of labor and also contribute to regional income or Gross Domestic Product (GDP), one of which is in Tasikmalaya City. One of the MSMEs that is developing in Tasikmalaya City is the Juk Broom Industry. In addition to having the use value of palm oil broom, it also has cultural value that must be preserved, it also has promising economic value. One of the problems experienced by palm oil sweeping MSMEs is the manual and traditional production process which causes obstacles in the production process, such as long processing times, labor inefficiency, and the absence of working time standards. To overcome these problems, the researcher uses the *Flow Process Chart (FPC)* approach and the *Time Study* Method to determine, identify activities in the production process, and measure the duration of each activity so that an efficient time standard can be set in Sapu Ijuk Citra Aren MSMEs. These approaches and methods are carried out to find out which activities do not provide added value and can be reduced. Various previous studies have applied the FPC method and *Time Study* in various manufacturing sectors, such as the glass industry (Duran et al., 2015) automotive (Salleh et al., 2016), and garments (your Rehman et al., 2019). However, most of the research was done on large-scale companies with modern production systems and the use of automated machines.

Research that combines these two methods in the traditional MSME sector is still limited. Local research such as (Asmadi et al., 2023) and Rianti et al. (2024) only focus on measuring working time without analyzing the entire production process flow. Therefore, there is a research gap related to the application of the FPC method and *Time Study* simultaneously in the context of the traditional handicraft industry based on manual work.

The results of the previous research search there are several research gaps that underlie the importance of this research, the first is about improving efficiency in manufacturing companies generally using only one method, either FPC or Time study, and some are carried out in large companies with little research in MSMEs. Research from (Rahmawati et al., 2023) shows the application of analysis in process flow and time measurement in the health industry, has not integrated the two FPC and Time study methods at the scale of palm oil sweeping MSMEs. Research from (Kurnianingtias et al., 2024) conducting research in the garment industry by researching time measurement but has not researched value-added activities, therefore there is a gap related to the lack of research on the joint application of FPC and also Time study simultaneously on palm oil sweep MSMEs.

2. Literature Review

2.1 Flow Process Chart

Flow Process Chart (FPC) is one of the tools in the work process mapping technique that is used to systematically describe the steps of a production process or work activity. With FPC, each activity can be categorized into standard symbols such as operation, transportation, inspection, storage, and delay, so that the workflow can be understood visually and in detail (Quigley, 2019)

2.2 Time Study

Time study is the measurement of the amount of time it takes an employee to complete a job and the analysis of his physical movements in the execution of his work (Wirasasmito, 1999).

2.3 Combination of FPC & Time Study

To strengthen the novelty of this research, a hybrid FPC–Time Study framework specifically designed for manual craft industries is proposed. Unlike conventional applications of FPC or Time Study that are typically used separately in large-scale manufacturing, this hybrid framework integrates qualitative workflow mapping with quantitative work measurement and adapts them to the characteristics of labor-intensive craft production, where variability, multitasking, and non-standardized motions are common.

Hybrid FPC–Time Study Framework for Craft-Based MSMEs (Proposed Model):

1. Step 1 Process Decomposition
2. Step 2 FPC Mapping
3. Step 3 Time Measurement
4. Step 4 Bottleneck Identification
5. Step 5 Improvement Prioritization
6. Step 6 Standard Time Adjustment
7. Step 7 Productivity & Cost Impac

This framework provides a scalable and low-cost diagnostic tool tailored to artisan-based MSMEs, enabling owners to evaluate their workflow even with limited technical resources. The proposed hybrid framework supports SDG 9 (Industry, Innovation, and Infrastructure) by offering a practical method for small traditional industries to modernize their production flow without requiring machinery investment. By reducing bottlenecks and establishing measurable time standards, the framework enhances operational performance, fosters micro-level industrial innovation, and strengthens the economic resilience of rural craft-based enterprises.

3. Method

3.1 Design

The study uses a quantitative descriptive approach to describe and analyze actual activities and measure work efficiency numerically, the quantitative approach is a research method that produces data that can be represented and summarized into numbers, and although this approach lacks in depth comparable to the qualitative approach, it offers "more reach" because it generally covers a large number of cases. This shows that quantitative research is well suited to describe the conditions of production broadly in a population (Morden, 2024)

3.2 Data collection

3.2.1. Observation

Observation is a systematic process of recording patterns of behavior, objects, or events without having to communicate directly with the subject being observed. (Morden, 2024), data collection was carried out through direct observation involving five workers, who together handled all nine stages of the broom-making process. Due to the limited workforce, one of the workers was responsible for two consecutive process stages, which reflects the actual multitasking practice commonly found in small, labor-intensive MSMEs. Each worker was observed under normal operational conditions, and time measurement was conducted using a stopwatch. Every work element was recorded five times to ensure consistent and reliable measurement. The measurement steps included defining each work element, preparing the timing device, recording the duration for all five repetitions, calculating the average cycle time, converting it into normal time using a performance rating factor, and finally determining the standard time by adding a 15% allowance to account for fatigue and minor interruptions typical of manual craft operations.

- a. Production: 50 brooms in 7 hours (recorded as 5 cycles $\times$ 10 brooms).
- b. Time per cycle (minutes): Combing 34, Lakop 20, Cutting 10, Planing 6, PVC Seal 6, Nailing 8.
- c. Total per cycle = 84 minutes $\rightarrow$ per sweep = $84 / 10 = 8.4$ minutes = 504 seconds.

3.2.2. Time Study

Time measurement is also carried out using a stopwatch to find out how to record each duration of activity in the production process. This technique is used to determine the average value, normal time, and standard time at each stage of making palm oil broom. According to (Masniar et al., 2023) Measurement of work through *Time Study* is done by recording the time it takes for a trained worker to complete a job with Certain performance levels using a timer such as a stopwatch.

Table 1. Flow Process Chart of Palm Fiber Broom Production

Activity List	Symbol				
	○	□	⇒	D	▽
Pemesanan pembelian bahan baku kepada supplier					
Penerimaan bahan baku dari supplier					
Penjemuran bahan baku					
Penvisiran tahap 1					
Penvisiran tahap 2					
Penvortiran ijuk					
Penvisiran tahap 3					
Pemisahaan jenis-jenis ijuk					
Penjemuran ijuk					
Pemasangan lakop dengan ijuk					
Penvisiran dan pemotongan					
Penverutan gagang sapu					
Seal PVC					
Pemasangan gagang dan kepala sapu					
Packing					
Penvimpanan produk jadi					
Distribusi produk					

4. Technical Analysis

1. Normal Time

Formula:

$$\text{Normal time} = \text{Cycle time} \times \text{Rating factor}$$

For example, a Rating Factor of 1.03 (103%) is used (referring to the Westinghouse method which is often used in small industry research).

2. Standard Time

Formula:

$$\text{Raw Time} = \text{Normal Time} \times (1 + \text{Allowance})$$

Allowance is usually 10-15% for MSMEs (because there are breaks, fatigue, minor disturbances). Take 15%.

The combination of these two methods allows researchers to conduct measurable and structured analyses to identify *bottlenecks* and establish optimal working time standards.

5. Result and Discussion

5.1. Results

The palm oil broom production process at Citra Aren Tasikmalaya MSMEs consists of nine main stages, namely: drying, sweeping, sorting, installing lakop, cutting, squeezing handles, installing broom heads, sealing, and packing.

Based on the results of the analysis using *the Flow Process Chart (FPC)*, it is known that most of the stages are still carried out manually, causing delays and inefficiencies in the production process. From the mapping results, the sweeping process is the longest stage or bottleneck, because it takes about 80% of the total production time. This stage takes an average (34 minutes).

Through the *Time Study* method, time measurement is carried out five times on each work element using a stopwatch to obtain accurate data. The measurement results show:

Cycle time: 504 second

Normal time: $504 \text{ s} \times 1.03 = 519.12 \text{ second} (\approx 8.652 \text{ Minute})$.

Raw time: $519.12 + (519.12 \times 0.15)$
 $= 519.12 + 77.868$
 $= 596.988 \text{ Second}.$

Thus, the standard time required to produce one unit of palm broom is about 8 minute. Based on an effective working time of 7 hours per day, the theoretical production capacity can reach 48-50 units of broom per day. However, in real conditions in the field, this result tends to be lower because it is influenced by worker skill factors, fatigue, as well as technical and raw material constraints.

5.2. Discussion

The results of the study show that the palm broom production process in Citra Aren MSMEs still has great potential to improve efficiency. Through the analysis of *the Flow Process Chart (FPC)*, it can be identified that there are *non-value added* activities such as long waiting times at the drying stage, excessive storage of raw materials, and idle time due to delays in raw materials. These activities increase production time without providing added value to the final product.

Meanwhile, the application of *Time Study* provides quantitative data on the duration of each activity, so that a more realistic and efficient standard time can be set. The combination of FPC and Time Study helps researchers in determining the critical points that are the main cause of production delays. One of the main focuses of improvement is the sweeping process, which can be optimized by:

1. Dividing the sweeping workload to more than one employee.
2. Use simple tools to speed up the process.
3. Rearrange the layout of the work area to make the flow of movement more efficient.

By implementing these measures, time efficiency is estimated to increase by up to 20%, so that production capacity will also increase.

These findings are in line with the results of previous research, such as those conducted by Duran et al. (2015), Asmadi et al. (2023), and Marlina et al. (2024) which prove that the combination of process mapping and time measurement can increase productivity and reduce waste. Similar to research on the Neelam perfume industry by Asmadi et al. (2023), the calculation of standard time is an important basis in determining production capacity and efficient work schedules.

Overall, the results of this study prove that the application of the FPC and Time Study methods is very beneficial for small and traditional industries such as palm oil broom MSMEs. Through these two methods, business owners can:

- a. Understand the production workflow thoroughly.
- b. Determine an accurate standard time for each activity.
- c. Reduce waste of raw materials and working time.
- d. Design more scalable and efficient production planning.

The palm broom production process consists of nine stages, starting with drying, sweeping, sorting, installing lakop, cutting, squeezing handles, installing broom heads, *sealing*, and *packing*. Based on FPC analysis, the sweeping stage is the activity with the longest duration, reaching around 80% of the total production time.

Table 2. Frequency and Percentage Distribution of Activities in the Palm Fiber Broom Production Process

Activity Type	Sum	Percentage	Information
Operation (O)	15 times	50%	Main activities such as combing, tying and assembly of the handles.
Transportation (T)	6 times	20%	Movement of materials between workstations.
Inspection (I)	3 times	10%	Interim and final results check.
Delay (D)	4 times	13%	Waiting time for materials and drying.
Storage (S)	2 times	7%	Temporary storage of materials or production products.

Time Study

Before (Actual Condition)

Total cycle time per 10 units: 84 minutes

Cycle time per unit: 8.4 minutes

Normal time: 519.12 seconds

Standard time: 596.99 seconds (≈ 9.95 minutes)

Theoretical output per worker/day: ≈ 48 units

After (Estimated Moderate Scenario)

Total cycle time per 10 units: 68 minutes

Cycle time per unit: 6.8 minutes

Normal time: 420.24 seconds

Standard time: 483.28 seconds (≈ 8.05 minutes)

Theoretical output per worker/day: ≈ 60 units

Estimated Improvement

Cycle time reduction: 8.4 $\rightarrow$ 6.8 minutes

Standard time reduction: 9.95 $\rightarrow$ 8.05 minutes

Time efficiency improvement: ≈ 19 –20% faster

Output increase: 48 $\rightarrow$ 60 units/day

Estimated after condition was developed to illustrate the potential impact of the proposed improvements. Based on a moderate improvement scenario—such as reorganizing the work area, adding simple supporting tools during the combing stage, and redistributing minor tasks—the total cycle time is projected to decrease from 84 to 68 minutes per 10 units, or 6.8 minutes per broom. Using a rating factor of 1.03 and a 15% allowance, the estimated standard time becomes 8.05 minutes per unit, representing an improvement of approximately 19%, which aligns with the expectation that overall time efficiency can increase by up to 20%. This reduction also raises the theoretical daily output from 48 to about 60 units per worker. Although these figures are based on estimation rather than direct measurement, they provide a clear indication of potential productivity gains and form a logical foundation for the subsequent discussion on workflow optimization and efficiency improvement.

6. Conclusion

This study applied a combined FPC and Time Study approach to analyze and improve the production process of palm-fiber brooms in MSME Citra Aren. The results showed that the combing stage was the main bottleneck, causing most of the total production time. Under the actual condition, the process required 84 minutes per 10 units, with a standard time of 9.95 minutes per broom. Based on an estimated improvement scenario—focusing on workspace reorganization, simple supporting tools, and task redistribution—the total cycle time is projected to decrease to 68 minutes, reducing the standard time to 8.05 minutes per unit. This represents an estimated 19–20% increase in time efficiency and raises the theoretical output from 48 to about 60 units per worker per day.

Overall, the study demonstrates that integrating FPC and Time Study can effectively support productivity enhancement in manual craft-based MSMEs, while future research should validate these estimates through direct post-intervention measurement.

6.1. Theoretical Contributions

This research provides several theoretical contributions:

1. **Hybridization of FPC and Time Study**
The study introduces a combined analytical framework that integrates qualitative process mapping with quantitative work measurement. This hybrid model expands theoretical understanding of how dual-method diagnostics improve accuracy in identifying bottlenecks and inefficiencies in manual production systems.
2. **Extension of Work Measurement Theory to Manual Craft MSMEs**
The results validate the applicability of work measurement principles—typically developed for structured industrial settings—to highly variable, fully manual craft industries. This extends the external validity of time study theory to new operational contexts.
3. **Evidence of Bottleneck Dominance in Craft Production**
The finding that a single process (combing) accounts for nearly 80% of cycle time reinforces theoretical models of constrained flow systems in artisanal production, providing empirical support for bottleneck-centric analysis in low-technology environments.
4. **Clarification of VA–NVA Classification in Manual Craft Industries**
The quantification of value-added versus non-value-added activities contributes to lean theory by demonstrating that even informal craft MSMEs can be systematically analyzed through standard industrial engineering classifications.
5. **Linking Industrial Engineering Methods to Sustainable Development Goals**
The study contributes to SDG-oriented theoretical discourse by showing that process standardization and workflow mapping can serve as micro-level mechanisms for achieving SDG 8 (Decent Work) and SDG 9 (Industry Innovation) in developing economies.

Overall, this research enriches both the empirical and theoretical understanding of how low-cost, accessible industrial engineering techniques can enhance productivity, sustainability, and operational clarity in traditional MSMEs.

6.2. Recommendation

Based on the results of the research and analysis conducted, some of the recommendations that can be given are as follows:

1. Improvement of Work Layout, Rearrange the work area to make the flow of materials moving shorter and worker activities more efficient.
2. Production Aid Usage, added a simple tool at the sweeping stage to reduce process time and worker fatigue.
3. Training and Job Sharing, provide technical training for workers to improve skills as well as divide the sweeping workload to more than one worker.
4. Determination of Working Time Standards, Using the results of standard time measurement as a basis for planning production capacity and controlling work schedules.
5. Routine Evaluation of Production Processes, conduct periodic reviews of process flows to identify potential new inefficiencies and adjust time standards in the event of a change in the work system.

6.3. Limitation

This study has several limitations that should be considered when interpreting the findings. First, the dataset is limited to a specific organizational and industrial context, which restricts the generalizability of the results to other sectors or regions. The implementation of lean practices is also strongly influenced by sociotechnical factors such as worker experience, resistance to change, and limited lean expertise. These factors may introduce bias, as levels of readiness and understanding differ across organizations.

Another limitation arises from variability in raw material quality and operational conditions, which may affect the accuracy of efficiency measurements and waste identification. The availability of lean research within Indonesian SMEs is still limited, meaning that the findings may not represent the broader national industrial landscape. Additionally, many referenced studies rely on case-study approaches, making the results more contextual than universally applicable. Therefore, future research should expand its scope to include a wider range of organizations, apply more diverse analytical methods, and incorporate human, cultural, and operational factors to achieve more comprehensive and generalizable conclusions.

Reference

- Asmadi, D., Erwan, F., Rauzah, S., & Lufika, R. D. (2023). Analysis of Neelam Perfume Production Capacity with Time Study Method. *Performance: Industrial Engineering Scientific Media*, 22(1), 50. <https://doi.org/10.20961/performa.22.1.74462>
- Duran, C., Cetindere, A., & Aksu, Y. E. (2015). Productivity Improvement by Work and Time Study Technique for Earth Energy-glass Manufacturing Company. *Economics and Finance*, 26(15), 109–113. [https://doi.org/10.1016/s2212-5671\(15\)00887-4](https://doi.org/10.1016/s2212-5671(15)00887-4)
- Kurnianingtias, M., Wibowo, T. A., Khairunnisa, H., Astrini, G. Y., & Purwanningrum, D. (2024). Cycle Time Study in Improving Production Output in the Garment Industry Sewing Line. *Journal of Science and Scientific Applications of Industrial Engineering (SAKTI)*, 4(1), 47–54. <https://doi.org/10.33479/sakti.v4i1.91>

- Masniar, M., Marasabessy, U. R., Astrides, E., Asih Ahistasari, Nur Wahyudien, M. A., & Rachmadhani, M. M. (2023). Analysis of Work Measurement Using the Stopwatch Time Study Method at PTEA. *Journal of Industrial System Engineering and Management*, 2(1), 23–31. <https://doi.org/10.56882/jisem.v2i1.14>
- Morden, P. (2024). *Quantitative Research Methods for the Applied Human Sciences*.
- Rahmawati, S., Zuhri, S., & Arifin, R. (2023). Process Flow Analysis and Measurement of Working Time in Hospital Equipment Production Process: Case Study. *Tambusai Health Journal*, 4(1), 220–231.
- Salleh, N. A. M., Kasolang, S., Mustakim, M. A., & Kuzaiman, N. A. (2016). The Study on Optimization of Streamlined Process Flow Based on Delmia Quest Simulation in an Automotive Production System. *Procedia Computer Science*, 105(Iris 2016), 191–196. <https://doi.org/10.1016/j.procs.2017.01.206>
- ur Rehman, A., Ramzan, M. B., Shafiq, M., Rasheed, A., Naeem, M. S., & Savino, M. M. (2019). Productivity improvement through time study approach: A case study from an apparel manufacturing industry of Pakistan. *Manufacturing Procedure*, 39(2019), 1447–1454. <https://doi.org/10.1016/j.promfg.2020.01.30>