OPTIMIZATION PRODUCTION CAPACITY USING VALUE STREAM MAPPING AND FLEXSIM IN UMKM X

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ABSTRACT

Micro-scale bag manufacturing businesses often face challenges regarding the management of manual production systems, leading to workflow imbalances. This study focuses on a bag-making MSME in Sukoharjo that operates on a made-to-order basis with a single-operator setup. The primary issue is a critical bottleneck at the pattern-making stage, which consumes up to three hours—equivalent to 37.5% of the total daily production time for a single custom bag. This results in a buildup of Work-in-Process (WIP) inventory and reduced production flow efficiency. The study aims to identify the production process flow, pinpoint bottleneck locations, and design simulation-based improvement scenarios to optimize production capacity. The methodology integrates Value Stream Mapping (VSM)—to map material and information flows at a macro level—with FlexSim software to dynamically and stochastically simulate manual processing time variability. The proposed improvement strategy focuses on a low-cost, high-impact approach through managerial interventions in workload management (line balancing), avoiding the need for significant investment in physical assets. The digital simulation results from FlexSim are expected to provide a realistic visualization for minimizing work queues, increasing operator utilization, and maximizing daily production output in a manner that ensures the operational sustainability of the MSME.

KEYWORDS Bottleneck, Capacity Optimization, FlexSim, Bag MSME, Value Stream Mapping

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INTRODUCTION

The manufacturing industry in Indonesia, particularly micro, small, and medium enterprises (MSMEs), plays a vital role in supporting economic growth and job creation, with the creative bag craft subsector contributing 18.01% to the national creative economy GDP (Kementerian Pariwisata dan Ekonomi Kreatif, 2023). However, micro-scale businesses often face operational challenges due to manual production systems and simple management, which cause workflow imbalances and bottlenecks across sequential stages such as material preparation, pattern making, cutting, sewing, and packaging. In line with Goldratt & Cox (2024), losing one hour at a bottleneck station represents a lost hour for the total capacity of the entire system, leading to Work in Process (WIP) accumulation, extended waiting times, and reduced daily output.

This operational constraint is evident at UMKM X, a custom bag manufacturer in Ngruki, Cemani, operating on a make-to-order scheme with a single operator. The primary bottleneck occurs during the pattern-making process, which requires 3 hours—equivalent to 37.5% of the total 8-hour daily work shift per custom bag unit. Because physical trial-and-error changes on the shop floor risk disrupting daily operations, a research gap exists regarding the specific impact of extreme pattern-making bottlenecks on overall production capacity in bag craft MSMEs.Furthermore, maintaining delivery schedule consistency is critical to retaining customer trust in a competitive market.

To address processing time variability without operational risk, this study integrates Value Stream Mapping (VSM) with FlexSim 3D Discrete Event Simulation (DES). VSM maps material and information flows via Current State Maps to identify waste and process cycle efficiency, but its static nature is complemented by FlexSim to model dynamic, stochastic manual cycle times and test Future State scenarios (W. S. Utami, 2026; Kurniawan et al., 2026; M. H. Utami, 2024). Adopting a low-cost, high-impact approach focused on managerial workload engineering rather than heavy capital investment, this research titled "Optimasi Kapasitas Produksi Menggunakan Value Stream Mapping dan FlexSim Pada UMKM X" aims to minimize queues and optimize daily throughput.

RESEARCH METHOD

This descriptive quantitative study was conducted in April 2026 at a Bag Craft MSME located in Ngruki, Cemani, Sukoharjo, focusing on the custom bag manufacturing process from raw material gathering to product packaging. Primary data were gathered through structured time study observations and in-depth interviews with the owner acting as a single operator, while secondary data included monthly order histories and relevant manufacturing literature. Data processing began by mapping the current operational flow via Value Stream Mapping (VSM) and classifying activities into Value Added (VA), Non-Value Added (NVA), and Necessary but Non-Value Added (NNVA) to determine baseline parameters, including total Lead Time and Process Cycle Efficiency (PCE).

To handle dynamic cycle time variability, a 3D Discrete Event Simulation (DES) model was developed using FlexSim software by converting physical shop-floor elements into standard objects (Source, Queue, Processor, Task Executer, and Sink). Statistical distributions were applied to input cycle times across six sequential work stations over an 8-hour operational shift. Following model verification and statistical validation achieving a 0% Percentage Error against real daily output various low-cost, high-impact improvement scenarios were simulated to resolve the primary bottleneck at the pattern-making station and establish a Future State Map.

RESULT AND DISCUSSION

The actual measurement of work element times in the manufacturing cycle of a single unit of a custom tote bag product resulted in a total production time of 30,600 seconds. Activities were separated based on their value-adding contribution, as shown in Table 1.

Table 1. Classification of Actual Operational Activities

No.	Workstation / Activity Element	Category	Time (Seconds)
1	Designing Process (Translating orders into a basic pattern)	VA	3,600
2	Material Preparation (Retrieving canvas, lining, and webbing)	NNVA	1,800
3	Pattern Making (Measuring, drawing pockets & body on cardboard)	NNVA	10,800
4	Fabric Cutting (Spreading fabric, marking, manual cutting)	VA	3,600
5	Sewing Process (Sewing body structure, lining, and zippers)	VA	10,000
6	Finishing (Quality Control, thread trimming, neatening, packing)	NVA / NNVA	1,800
	Total production cycle time		**30,600**

Explanation table: Activity classification based on lean manufacturing concepts to map the baseline workload of the single operator. The aggregate accumulation of value-adding groupings includes a total Value-Added (VA) time of 16,200 seconds, Necessary but Non-Value Added (NNVA) time of 13,200 seconds, and pure Non-Value Added (NVA) time due to unergonomic work movements of 1,800 seconds. The total flow time calculation (Lead Time) was obtained by integrating the accumulated pre-production waiting time of 1,800 seconds retained in the existing manufacturing line, thereby generating a daily Lead Time value of 32,400 seconds (9 Hours). The initial work line efficiency analyzed mathematically through the Process Cycle Efficiency (PCE) formulation yielded an actual baseline value of 50.00%.

The baseline model was compiled in FlexSim software and executed for a runtime of 28,800 seconds (8 normal operational hours). The model validation test was evaluated based on the alignment of the daily real output via the Percentage Error (% Error) approach. Simulation replication results showed a stable output of 1.00 unit per daily work shift, generating an error variance of 0%. Since the error value is $\leq 10\%$, the simulation model was declared statistically valid to establish the baseline for testing line improvement scenarios.

The root cause of flow congestion (bottleneck) at the pattern-making station was interceded through the application of a permanent pattern tool standardization using a rigid acrylic mold (Master Pattern Jig). This intervention cuts repetitive marking activities from scratch, transforming them into direct tracing. In the proposed FlexSim model, the processing time parameter on the Pattern Making Processor object was optimized from 10,800 seconds to 3,600 seconds. The efficiency after improvement is summarized in Table 2.

Table 2. Comparison Analysis of Production Line Performance Before and After Improvement

No.	Performance Matrix Indicator	Actual Condition (Before)	Proposed Condition (After)	Efficiency / Impact
1.	Pattern Making Station Cycle Time	10,800 seconds	3,600 second	Reduced by 7,200 seconds (-66.67%)
2.	Total Production Flow Lead Time	32,400 seconds	25,200 seconds	Faster by 7,200 seconds (-22.20%)

No.	Performance Matrix Indicator	Actual Condition (Before)	Proposed Condition (After)	Efficiency / Impact
3.	Process Cycle Efficiency (PCE)	50.00%	64.29%	Increased by +14.29%
4.	Queue Accumulation (WIP Level)	High in Pre-Pattern Queue	Minimal (Smooth flow)	Balanced material flow
5.	Throughput Capacity (Per 8 Hours)	1 unit (pressured)	1 unit + 1 hour idle remaining	Increased daily capacity potential

Explanation table: Comparison results of simulation efficiency matrix for the integrated future state production system (Future State Map).

The integrated future state results prove that reducing the upstream station workload successfully smoothened the material flow displacement rate (smooth flow). The total processing time for the bag shrunk to 7 hours (25,200 seconds), leaving 1 hour of loose time from the total of 8 normal daily working hours that can be allocated by the owner to increase creative manufacturing output without adding massive capital expenditures for physical assets.

CONCLUSION

The integration of Value Stream Mapping and FlexSim simulation has successfully optimized the production system capacity at the Cemani Bag Craft MSME. The Pattern Making Station was identified as a critical bottleneck point with an initial processing duration reaching 10,800 seconds (3 hours) per custom bag unit. The implementation of a modular acrylic-based master pattern template significantly cut the processing time by 66.67% at that primary constraint station. This operational managerial engineering is proven to accelerate the total production flow Lead Time from 32,400 seconds to 25,200 seconds and boost the process cycle efficiency (PCE) percentage to 64.29%, leaving a residual 1 hour of effective daily loose time. The owner is recommended to apply physical standardization of this permanent pattern template for all product variants that have a high frequency of repeat orders.

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