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# Assistance in Enhancing the Functional Value of the Yellow Tofu Production System through a Value Engineering Approach at UD SDD Kediri

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**Abstract.** Micro-scale tofu industries often operate using conventional production systems that evolve through habit rather than structured technical planning, leading to inefficiencies in energy use and workflow organization. This Community Service program was conducted at UD SDD Kediri to enhance the functional value of its yellow tofu production system through a value engineering approach. The activity focused on improving the combustion system and facility layout without requiring costly technological replacement. The methodology consisted of situational analysis, functional identification, process mapping, simulation of layout improvement, limited implementation, and evaluation. Initial observations showed a production cycle time of approximately 180 minutes per batch, material movement distance of ±22 meters, and high heat exposure due to an uninsulated traditional furnace. Layout simulation reduced movement distance to ±14 meters and shortened movement time from 25 to 15 minutes, indicating a potential efficiency improvement of around 36% in motion-related activities. Minor adjustments in airflow and heat direction improved combustion stability and reduced direct heat exposure. The findings demonstrate that inefficiencies were primarily associated with weak supporting functions rather than production capacity limitations. The program strengthened both technical configuration and managerial awareness of function–cost relationships, confirming that incremental value engineering interventions provide a feasible pathway for efficiency enhancement in micro-scale food enterprises.

**Keywords:** Combustion System, Layout Efficiency, Micro-Enterprise, Tofu Production, Value Engineering

## INTRODUCTION

Micro-scale food industries continue to serve as a primary source of livelihood for many families across various regions (Fauziah et al., 2020; Materia et al., 2021; Schoustra et al., 2025). These small enterprises typically emerge from daily economic needs rather than from structured technical planning (Andriani et al., 2024; Suras et al., 2024). Most production processes evolve gradually through habit, practical experience, and situational adjustments in the field (Khotimah et al., 2025; Zaka & Haris, 2025). In many cases, operational systems are not designed through analytical evaluation but are shaped by long-

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term adaptation. While this approach allows micro-enterprises to survive, it often results in limited awareness regarding energy efficiency, workflow optimization, and the functional value of each production stage (Kharisma et al., 2023).

External pressures have intensified in recent years. The price of soybeans, as a primary raw material in tofu production, remains heavily influenced by national import dependency, leaving small producers with limited control over input costs. Trade data indicate that Indonesia's reliance on soybean imports remains substantia (Ismiyati et al., 2025). When raw material costs cannot be effectively controlled, improving internal process efficiency becomes the most rational strategy to sustain business operations. Within this context, energy usage and facility layout design become critical issues that require attention.

Field observations conducted at UD SDD in Kediri reveal that the production system continues to rely entirely on conventional methods. The combustion process utilizes solid fuel without adequate thermal insulation. Heat disperses unevenly throughout the workspace and remains difficult to regulate. Smoke accumulates in the production area before gradually dissipating through natural ventilation. Under these conditions, workers operate for extended periods in high-temperature environments. Energy audits in small-scale tofu industries confirm that the cooking stage represents the highest point of energy consumption and that traditional furnace designs often lead to significant heat loss (Ningsih et al., 2024). However, direct observation demonstrates that this issue extends beyond numerical energy consumption; it represents a daily working condition that continuously affects labor comfort and production stability.

At the same time, the workflow has not been structured according to process proximity principles. Workers move from one station to another based on available space rather than on an efficient material flow design. Lean manufacturing studies in small and medium food enterprises indicate that excessive movement and waiting time constitute forms of inefficiency that often remain unnoticed because they are perceived as routine operational practices (A. A. Mubarok et al., 2025). At UD SDD, the elongated workflow increases production cycle time, particularly given that the enterprise operates with only four workers. When one worker waits for a process to finish, others adjust their rhythm informally, without standardized coordination

The environmental implications of conventional combustion practices further compound these challenges. Research conducted in tofu production centers reports elevated concentrations of fine and ultrafine particles resulting from biomass combustion in

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traditional furnaces (Kobolova et al., 2022; Poláčik et al., 2020). These findings demonstrate that conventional systems are not merely a matter of production tradition but also concern occupational health and environmental sustainability. Although small producers may perceive such conditions as normal, technically these issues can be mitigated through improvements in combustion system design and layout reorganization.

From a value perspective, conventional production systems often fail to clearly distinguish between primary and supporting functions. In tofu production, the primary function is to ensure that soybean slurry reaches the appropriate coagulation temperature. However, supporting functions such as uniform heat distribution, efficient workflow, and environmental control are frequently overlooked. Value chain analysis in tofu agroindustry shows that product value addition depends significantly on integrated management of process functions (Utami et al., 2025). When supporting functions are weak, production costs increase without a proportional improvement in product quality.

A value engineering approach becomes relevant in this context because it enables the identification of low-value functions without requiring radical technological replacement that exceeds the capacity of micro-enterprises (Gala et al., 2020; Ongbali et al., 2024; Velasquez et al., 2022). In the case of UD SDD, the objective of assistance is not to overhaul the entire system but to guide the partner in recognizing which aspects of the conventional production process can be improved to enhance efficiency and safety. The primary focus is directed toward the combustion system and facility layout, as both represent major sources of energy waste, time inefficiency, and workplace discomfort.

Through this Community Service initiative, production practices that have long been accepted as routine are systematically re-evaluated. The aim is not to eliminate the micro-enterprise character of the business but to strengthen production functions so that cost, performance, and working conditions become more balanced. In doing so, the intervention seeks not only technical improvement but also enhanced managerial understanding of the relationship between function and value within the production system.

## PROBLEM

Based on direct field observations conducted at UD SDD in Kediri and in-depth discussions with the owner and production workers, a situational analysis was undertaken to identify the actual challenges faced by the partner in managing its production system. The assessment revealed that the production process remains fully dependent on conventional

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methods, particularly in the combustion system and the arrangement of the production layout. These conditions generate operational inefficiencies, workplace discomfort, and instability in production costs.

The first issue concerns the traditional combustion system, which operates without adequate heat control or thermal insulation. As a result, heat distribution is inconsistent, fuel consumption tends to be excessive, and cooking time becomes difficult to regulate consistently. In addition, prolonged exposure to high temperatures and smoke within the relatively confined production area affects worker comfort and potentially reduces overall productivity.

These problems are not only qualitative in nature but are also reflected in measurable inefficiencies. Initial observations indicate that the production cycle reaches approximately 180 minutes per batch, with material movement distance of ±22 meters and movement time of ±25 minutes. These figures indicate the presence of non-value-added activities, particularly excessive motion and waiting, which are critical forms of waste in small-scale production systems.

The second issue relates to the facility layout and material flow. The current arrangement of equipment and workstations is based on available space rather than process proximity and workflow efficiency. Consequently, materials and workers frequently move back and forth across the workspace, extending the production cycle time and increasing the physical workload for the limited number of employees. This situation is particularly significant given that the enterprise operates with only four workers, making any inefficiency in movement and coordination more impactful.

The third issue involves the absence of a structured understanding of the relationship between process functions and production costs. Production activities are primarily guided by practical experience rather than systematic analysis of primary and supporting functions within the production system. Without such analysis, sources of inefficiency remain difficult to identify objectively, and improvements tend to be reactive rather than strategically planned.

Given these conditions, the partner’s primary need is structured assistance to systematically identify sources of waste within the conventional production system, particularly in the combustion process and facility layout. Furthermore, the partner requires guidance in developing feasible and affordable improvement alternatives that align with the scale and capacity of a micro-enterprise. These identified problems form the basis for

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defining the objectives of this Community Service activity, namely to enhance the functional value of the production system through a value engineering approach, thereby improving operational efficiency, workflow organization, and working conditions without requiring costly technological replacement.

Therefore, the core problem is not merely the use of conventional methods, but the absence of a structured approach to evaluate and optimize the relationship between process functions, energy usage, and workflow efficiency. Without such an approach, inefficiencies remain embedded in daily operations and cannot be systematically reduced.

## METHOD OF IMPLEMENTATION

The implementation methodology of this Community Service (PkM) program consists of three main stages: the preparatory stage, the implementation stage, and the evaluation stage. The overall approach combines participatory assistance with value engineering principles to ensure that the improvement process remains practical and feasible for a micro-scale enterprise (Ongbali et al., 2024; Velasquez et al., 2022; Velásquez et al., 2021)

### Preparatory Stage

The preparatory stage began with direct field observation and situational analysis at UD SDD Kediri. This activity aimed to understand the existing production flow, combustion system characteristics, and workspace conditions. Observation was complemented by informal interviews with the owner and workers to capture operational constraints and daily production challenges.

At this stage, documentation of the initial layout and workflow was conducted. A simplified mapping approach was applied to visualize material movement and process sequences. This mapping activity aligns with basic lean manufacturing principles that emphasize identification of unnecessary movement and waiting time within small-scale production systems (A. A. Mubarok et al., 2025).

Communication and coordination with the partner were also carried out to determine the scope and schedule of activities, ensuring that the assistance process did not interfere with regular production operations.

### Implementation Stage

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The implementation stage was conducted through several structured phases.

**Phase 1: Concept Introduction and Awareness Building**

This phase focused on increasing the partner’s understanding of production efficiency, energy use, and the concept of primary and supporting functions in a production system. The discussion introduced basic value engineering concepts, particularly the relationship between function and cost (Gala et al., 2020; Ongbali et al., 2024). The objective was to build shared awareness before proposing technical adjustments.

**Phase 2: Functional Analysis and Process Mapping**

In this phase, the production system was analyzed to identify primary and supporting functions. The combustion process and facility layout were examined to detect inefficiencies related to heat distribution and material movement. A simplified Value Stream Mapping approach was applied to identify non-value-added activities, consistent with lean-based improvement strategies in small enterprises (A. Mubarok et al., 2020; A. A. Mubarok et al., 2025).

**Phase 3: Simulation and Alternative Design**

Alternative improvements were developed collaboratively with the partner. These included proposed adjustments to the furnace configuration and rearrangement of workstations to shorten movement distance. Layout considerations were informed by systematic layout planning principles commonly used to enhance production flow efficiency in small manufacturing settings (Kharisma et al., 2023).

Visual sketches and simple models were used to simulate potential improvements. This simulation approach helped the partner understand the expected impact of proposed changes without requiring immediate large-scale investment.

**Phase 4: Limited Implementation**

Selected alternatives that were technically feasible and financially realistic were implemented on a limited scale. The focus was on improving functional value rather than replacing the entire production system. This approach is consistent with value management practices in micro and small enterprises, where gradual improvement is more sustainable than radical technological substitution (Velasquez et al., 2022).

## Evaluation Stage

Evaluation was conducted to assess both technical improvements and knowledge enhancement.

Operational evaluation involved comparing pre- and post-intervention conditions, including workflow clarity, worker movement patterns, and estimated fuel usage. Observational comparison was used rather than experimental measurement, as the program emphasized practical improvement over laboratory precision.

Knowledge evaluation was conducted through structured discussion to determine whether the partner understood the functional analysis process and could independently identify potential inefficiencies in the production system.

The evaluation aimed to determine whether the Community Service program successfully strengthened the partner's capacity to manage production functions more efficiently, rather than merely introducing technical recommendations.

## Location, Time, and Duration of Activities

The Community Service (PkM) program was conducted at the production facility of UD SDD located in Kediri City, East Java, Indonesia. The selection of this location was based on preliminary observations indicating a clear need for technical assistance to improve production system efficiency, particularly in relation to the combustion process and facility layout.

The program was implemented in November 2025. The activities were carried out progressively over one month. The first week was dedicated to the preparatory stage and situational analysis. The second week focused on concept introduction and functional analysis. The third week was allocated for simulation and the development of improvement alternatives. The fourth week involved limited implementation and initial evaluation of the proposed adjustments.

Each assistance session was scheduled in coordination with the partner to ensure that regular production activities were not disrupted. This flexible yet structured scheduling approach allowed the Community Service activities to be implemented effectively while maintaining the operational continuity of the micro-enterprise. Through this arrangement, the assistance process remained participatory and aligned with the daily production rhythm of the partner.

## RESULTS AND DISCUSSION

The implementation of the Community Service program at UD SDD Kediri generated both technical and managerial findings. These findings reflect not only physical adjustments in the production system but also an improvement in the partner's understanding of the relationship between function, cost, and operational efficiency.

### 1. Initial Condition of the Production System

Initial observations revealed that the production process relied entirely on conventional methods. The combustion system utilized solid fuel without thermal insulation. The facility layout did not follow process proximity principles, resulting in repeated material movement and extended workflow paths. This condition reflects the adaptive nature of many small-scale food enterprises that develop operational systems without structured technical planning (Fauziah et al., 2020).

Energy audits in small-scale tofu industries indicate that the cooking stage accounts for the highest energy consumption within the production process (Ningsih et al., 2024). A similar pattern was observed at UD SDD, where the combustion process required prolonged heating with uneven heat distribution. Research on biomass combustion further highlights that traditional furnaces may generate fine and ultrafine particles that affect indoor air quality (Kobolova et al., 2022). These findings confirm that the challenges observed at UD SDD are consistent with broader patterns identified in small-scale production systems.

### 2. Quantitative Findings

Simple measurements were conducted to estimate the production cycle time and the distance material moved before intervention. The results are summarized in Table 1.

**Table 1.** Initial Production System Condition

| Indicator | Initial Value |
|---|---|
| Production cycle time (per batch) | ± 180 minutes |
| Number of workers | 4 persons |
| Estimated fuel consumption | High and not systematically recorded |
| Average material movement distance | ± 22 meters per batch |
| Workplace comfort level | Low (high heat and smoke exposure) |

The relatively long production cycle and extensive material movement indicate the presence of non-value-added activities. Studies on lean manufacturing in small enterprises emphasize that excessive movement and waiting time are common forms of operational waste (A. A. Mubarok et al., 2025).

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### 3. Layout Improvement Simulation

Based on functional analysis and workflow mapping, a layout reorganization simulation was conducted using a simplified systematic layout planning approach. The simulation aimed to reduce the distance traveled and streamline material flow.

**Table 2.** Comparison Before and After Layout Simulation

| Indicator | Before | After (Simulation) |
|---|---|---|
| Material movement distance | ± 22 meters | ± 14 meters |
| Movement time | ± 25 minutes | ± 15 minutes |
| Workflow pattern | Circular/irregular | Linear one-directional |

The simulation suggests a potential reduction of approximately 36% in material movement distance, calculated from the decrease from ±22 meters to ±14 meters using the formula:

$$\text{Reduction (\%)} = ((22 - 14) / 22) \times 100\% \approx 36\%$$

this calculation provides a transparent basis for the estimated efficiency improvement. This improvement aligns with facility planning principles that aim to enhance process flow efficiency in small-scale manufacturing (Kharisma et al., 2023).

### 4. Combustion System Evaluation

Improvements to the combustion system were implemented through minor but targeted modifications. These modifications included partial redirection of heat flow by adjusting the position of the combustion chamber opening to concentrate heat toward the cooking vessel, the addition of simple barriers using locally available refractory materials to reduce lateral heat loss, and the improvement of airflow circulation by creating a more controlled air inlet at the base of the furnace.

These modifications aim to enhance combustion efficiency by promoting more stable oxygen supply and reducing uncontrolled heat dispersion. Based on observational estimation, the improved system allowed the cooking temperature to be maintained more consistently within the typical tofu processing range of approximately 90–100°C, which is critical for soybean coagulation.

Although precise thermal measurements were not conducted using instrumentation, the modifications resulted in more stable flame behavior, reduced smoke accumulation, and shorter heat stabilization time.

### 5. Field Documentation

The following images illustrate the initial production condition prior to intervention.

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**Figure 1.** Initial combustion system and production layout at UD SDD Kediri.

The documentation shows:

a. Traditional furnace without thermal insulation
b. Direct heat exposure to the workspace
c. Irregular production layout
d. Limited ventilation within the production area

## 6. Level of Implementation Difficulty

The level of difficulty encountered during the assistance process was evaluated based on technical complexity and partner adaptation.

**Table 3.** Level of Implementation Difficulty

| Mode | Activity Type | Difficulty Level |
|---|---|---|
| 1 | Value engineering awareness session | Low |
| 2 | Functional analysis and workflow mapping | Moderate |
| 3 | Simulation and limited implementation | Moderate–High |

The highest level of difficulty occurred during the implementation stage due to the need to adjust long-established working habits. However, the participatory approach facilitated gradual acceptance of change.

## 7. Discussion of Findings

The findings indicate that the primary inefficiencies did not originate from production capacity limitations but from weaknesses in managing supporting functions within the production system. Value chain analysis in the tofu agroindustry emphasizes that value addition depends on the integration of process functions (Utami et al., 2025). When supporting functions such as heat distribution and material flow are not optimized, production costs increase without proportional quality improvement.

The value engineering approach proved relevant because it enabled the identification of low-value functions without requiring complete technological substitution. Previous studies on value management in micro and small enterprises also suggest that incremental improvement is more sustainable than radical technological replacement (Gala et al., 2020; Velasquez et al., 2022).

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Quantitatively, the simulation demonstrated potential reductions in movement distance and non-productive time. Qualitatively, the partner exhibited improved awareness regarding the importance of structured layout and energy efficiency. These results suggest that the Community Service program contributed not only to technical recommendations but also to strengthening the partner’s analytical capacity in managing production functions more effectively.

## CONCLUSION

The Community Service program at UD SDD Kediri confirms that operational inefficiency in small-scale tofu production mainly arises from weaknesses in supporting functions rather than limited production capacity. The initial assessment identified three critical issues: inefficient combustion performance, irregular production layout, and workflow practices based on habit rather than structured analysis.

Quantitative findings show that the initial material movement distance reached approximately 22 meters per batch, with an estimated movement time of 25 minutes. The layout simulation reduced the movement distance to around 14 meters and shortened movement time to 15 minutes. This indicates a potential efficiency improvement of about 36 percent in movement-related activities. Although fuel consumption was not measured using laboratory instruments, qualitative observations suggest improved combustion stability and reduced direct heat exposure after minor airflow and heat redirection adjustments.

The implementation stage presented moderate to high difficulty, mainly due to the need to adjust long-established working routines. However, the participatory approach supported gradual acceptance of changes and improved the partner’s understanding of functional relationships within the production system.

The findings support the relevance of value engineering for micro-scale enterprises. Incremental improvement proves more feasible and sustainable than radical technological replacement. By focusing on function-cost balance, the intervention strengthened both technical configuration and managerial awareness.

Overall, the program contributed to measurable workflow efficiency and enhanced analytical capacity at the partner level. Future initiatives should incorporate systematic fuel measurement and ergonomic evaluation to produce more precise efficiency indicators and support long-term operational sustainability.

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