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Case Study on *Dodol* Production Process: Flow Process Chart (FPC) Analysis for Efficiency and Cultural Sustainability

Anak Agung Alit Triadi[1], Fikrihadi Kurnia[2*]
[1,2] Department of Industrial Engineering, Faculty of Engineering, Universitas Mataram
**CorrespondingAuthor*

Abstract:*The production of dodol, a traditional Indonesian confection, embodies both cultural heritage and economic potential but faces challenges in efficiency and sustainability due to its labor-intensive, artisanal processes. This study employs a Flow Process Chart (FPC) to systematically analyze the dodol production process, aiming to enhance efficiency while preserving its cultural essence. Through direct observation and quantitative data collection, including processing times, temperatures, and material proportions, the study maps 16 production steps, categorized into operations (64.29%), transportation (14.29%), inspection (7.14%), delays (7.14%), and storage (7.14%). Key findings reveal that prolonged cooking and stirring (8-12 hours traditionally) and extended cooling periods (6-12 hours) are critical bottlenecks. Recommendations include adopting automated mixers to reduce manual labor, implementing industrial cooling systems to shorten delays, optimizing workspace layout to minimize transportation, and standardizing quality checks with viscosity or density tools. Additionally, modern ingredients like agar-agar could shorten cooking times to 4-6 hours, enhancing scalability. These interventions improve productivity and reduce waste while maintaining dodol's traditional character. By integrating traditional knowledge with modern process management, the study supports the sustainable preservation of dodol as a cultural product and strengthens its competitiveness in local and global markets. This research contributes to the operational enhancement of traditional food industries and the safeguarding of intangible culinary heritage.*

Keywords:*Dodol production, Flow Process Chart, Efficiency optimization, Cultural preservation, Traditional food.*

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I. INTRODUCTION

The production of traditional foods, such as *dodol*, holds not only economic significance but also cultural value within many Indonesian communities[1]. *Dodol* production, often conducted through artisanal and semi-industrial processes, reflects the transmission of culinary heritage across generations. However, as demand increases and modern market dynamics evolve, traditional production methods face challenges related to efficiency, consistency, and sustainability. Therefore, it becomes essential to analyze and optimize these traditional processes without undermining their cultural essence.

One effective method to understand and improve production processes is the application of a Flow Process Chart (FPC)[2]. FPC enables a systematic visualization and analysis of each step in the production line, identifying activities such as operations, inspections, transportations, delays, and storages[3]. By applying FPC to the *dodol* production process, inefficiencies can be pinpointed and addressed, leading to better time management, reduced waste, and improved resource utilization. Moreover, this structured approach does not merely aim at industrializing traditional practices but seeks to enhance them in a culturally sensitive manner.

In traditional *dodol* production, challenges such as prolonged cooking times, manual handling inefficiencies, and energy-intensive processes are commonly observed. Without a structured analysis, these inefficiencies can lead to increased operational costs, decreased product quality, and worker fatigue[4, 5]. Furthermore, traditional production units often lack formal documentation of their workflows, making it difficult to transfer skills to future generations effectively. A well-conducted FPC analysis can thus bridge traditional knowledge with modern production management techniques[6].

In addition to operational efficiency, sustainability and cultural preservation must also be prioritized. The production of *dodol* relies heavily on natural ingredients and often involves communal labor, reflecting socio-cultural values. Any intervention aimed at efficiency must therefore also consider environmental impacts and maintain the traditional character of the product. This dual objective ensures that improvements align with both economic viability and cultural sustainability, preventing the erosion of traditional practices.

Thus, this study seeks to conduct a detailed analysis of the *dodol* production process through the application of the Flow Process Chart. The research aims not only to improve production efficiency but also to support the sustainable continuation of *dodol* as a cultural product. By identifying critical improvement points and proposing feasible interventions, the study aspires to contribute both to the operational enhancement of traditional industries and the safeguarding of intangible cultural heritage.

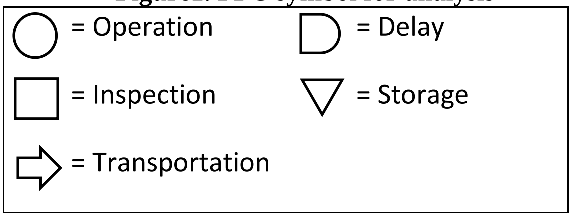
II. RESEARCH METHODS

This study employs a qualitative and quantitative approach to analyze the traditional Indonesian *dodol* production process through the *Flow Process Chart* (FPC). This approach was chosen to systematically map each production step, identify efficiencies, and evaluate optimization potential while preserving cultural values. The research was conducted using direct observation and document analysis methods, focusing on the *dodol* production process based on glutinous rice flour as a general representation of traditional practices.

1.1 Research Design

This research is descriptive-analytical, with the *Flow Process Chart* as the primary tool for documenting and categorizing *dodol* production activities. In this research, the FPC uses symbols, namely:

Figure1. FPC symbol for analysis



Data were collected through observation of the traditional *dodol* production process in a local artisan setting, focusing on quantitative parameters such as processing time, temperature, material proportions, and production output.

1.2 Research Procedure

The research procedure consists of three main stages conducted systematically to achieve the research objectives. The first stage is Data Collection, carried out through direct field observation and detailed recording of activities. The collected data include the sequence of activities, duration, and movements within the observed workflow. The second stage is the Development of the Flow Process Chart, which involves organizing the observed data into a flowchart that visually depicts the sequence, relationships, and types of activities occurring. The Flow Process Chart is designed to facilitate understanding of the workflow and identify potential waste or inefficiencies. The third stage is Data Analysis, where the constructed chart is analyzed to identify opportunities for improvement. The analysis focuses on identifying non-value-adding activities, redundancies, and possibilities for process simplification. The results of this stage form the basis for recommendations to improve the efficiency and effectiveness of the workflow.

III. RESULTS AND DISCUSSIONS

3.1. FPC Analysis

The *dodol* production process involves a series of meticulous steps, from ingredient preparation to the packaging of the final product. To analyze this process systematically, the *Flow Process Chart* (FPC) serves as an effective tool for mapping each activity, including operations, transportation, inspections, delays, and storage. The provided *Flow Process Chart* document offers a detailed overview of the 16 steps in *dodol* production, complete with quantitative parameters such as time, temperature, and material proportions, which serve as the foundation for understanding production efficiency and potential improvements.

Table1. FPC analysis for *dodol* production

No	Steps	Symbol					Description
		○	□	⇨	D	▽	
1	Start						Initiating the *dodol* production process by preparing ingredients and equipment (glutinous rice flour, sugar, coconut milk, wok, stove).
2	Ingredient Preparation	■					Measuring and preparing ingredients: 1 kg glutinous rice flour (30-40%), 0.8-1 kg sugar (30-35%), 1-1.5 liters

		■					coconut milk (25-30%), 5-10 grams salt. Time: 20-30 minutes.
3	Ingredient Transportation			■			Moving measured ingredients to the cooking area (wok or cauldron).
4	Cooking Coconut Milk	■					Cooking coconut milk until boiling (temperature 80-90°C) to extract coconut oil. Time: 10-15 minutes.
5	Melting Sugar	■					Melting brown/white sugar with 100-200 ml water to form syrup (temperature 110-120°C). Time: 10-15 minutes.
6	Mixing Ingredients	■					Mixing glutinous rice flour (dissolved in 200-300 ml water), coconut milk, and sugar syrup in a large wok. Initial temperature: 70-80°C. Time: 20-30 minutes.
7	Cooking & Stirring Dough	■					Cooking the dough over medium heat (temperature 80-110°C) while continuously stirring until thickened. Water reduction: 40-50% to 10-15%. Time: 8-12 hours (traditional) or 4-6 hours (modern).
8	Adding Additional Ingredients	■					Adding ingredients such as durian, sesame seeds, or jackfruit (10-20% of dough) when the dough is half-cooked. Temperature: 90-100°C. Time: 5-10 minutes.
9	Maturity Inspection		■				Checking dough texture (chewy, non-sticky, density 1.2-1.4 g/cm³) by taking a sample and cooling it. If not mature, continue stirring (additional 1-2 hours).
10	Transportation to Mold			■			Transferring hot dough (temperature 70-80°C) to a mold lined with banana leaves or plastic.
11	Molding	■					Pouring and leveling the dough in the mold. Time: 10-15 minutes.
12	Cooling				■		Cooling the dough at room temperature (25-30°C) until hardened. Time: 6-12 hours.
13	Cutting	■					Cutting *dodol* into small pieces (2x2 cm or 3x3 cm). Time: 15-30 minutes per 1 kg of *dodol*.
14	Packaging	■					Wrapping *dodol* in plastic, parchment paper, or leaves. Packaging: 250 g, 500 g, or 1 kg. Time: 30-60 minutes per 3-4 kg.
15	Storage					■	Storing *dodol* in a dry, cool place (temperature 25-30°C or 5-10°C in a refrigerator). Shelf life: 1-2 months (room temperature) or 6 months (refrigerated).
16	Finish						Process completed; *dodol* is ready for distribution or sale.

The *Flow Process Chart* outlines 16 steps in *dodol* production, with 14 activities categorized into five types based on standard ASME symbols. Operations dominate with 9 activities (64.29%), including ingredient preparation (20-30 minutes), cooking coconut milk (10-15 minutes), melting sugar (10-15 minutes), mixing ingredients (20-30 minutes), cooking and stirring dough (8-12 hours for traditional methods), adding additional ingredients (5-10 minutes), molding (10-15 minutes), cutting (15-30 minutes per kg), and packaging (30-60 minutes per 3-4 kg). Transportation consists of 2 activities (14.29%), namely moving ingredients to the cooking area and transferring hot dough to the mold. Inspection involves 1 activity (7.14%), checking dough maturity based on chewy texture and density of 1.2-1.4 g/cm³. Delay also consists of 1 activity (7.14%), cooling the dough for 6-12 hours at room temperature. Finally, storage includes 1 activity (7.14%), storing *dodol* at 25-30°C or 5-10°C with a shelf life of 1-2 months (room temperature) or 6 months (refrigerated). The total categorized activities are 14, with the "Start" and "Finish" steps excluded as they serve as process markers.

The dominance of operational activities (64.29%) indicates that *dodol* production heavily relies on labor-intensive manual processes, particularly the cooking and stirring stage, which takes up to 12 hours in traditional methods. The *delay* stage (cooling) is a critical bottleneck due to its significant time requirement (6-12 hours), while the relatively low number of transportation and inspection activities suggests that the process is focused on core production tasks. The activity distribution reflects the traditional nature of *dodol* production, which still depends on human labor and lengthy processing times. However, production efficiency is relatively good, with a yield of 2-2.5 kg of *dodol* per 1 kg of glutinous rice flour and material loss of only 5-10%. The *Flow Process Chart* helps identify steps that can be optimized to enhance productivity without compromising quality, while preserving the cultural value of *dodol* as an Indonesian culinary heritage.

3.2. Recommendation for Improvement

The *Flow Process Chart* (FPC) analysis of the dodol production process, which comprises 16 steps with 14 categorized activities (64.29% operations, 14.29% transportation, 7.14% inspection, 7.14% delay, 7.14% storage), highlights significant opportunities for enhancing efficiency while preserving cultural authenticity. The dominance of labor-intensive operations, particularly the cooking and stirring stage (8-12 hours in traditional methods), underscores the need for technological interventions to reduce manual effort and processing time. To address this, the adoption of automated mixers is recommended, as they can maintain consistent stirring at controlled temperatures (80-110°C), potentially reducing the cooking duration to 4-6 hours, as observed in modern methods. Additionally, standardizing the maturity inspection process (1 activity, 7.14%) with density or viscosity measuring tools (targeting 1.2-1.4 g/cm³) can enhance quality consistency, minimizing the need for additional stirring (1-2 hours) and ensuring the chewy, non-sticky texture characteristic of dodol.

The prolonged delay during the cooling stage (6-12 hours at 25-30°C), identified as a critical bottleneck (1 activity, 7.14%), presents another opportunity for optimization. Implementing industrial cooling systems or refrigerators can accelerate this process to 2-4 hours, significantly improving throughput while maintaining the traditional molding process using banana leaves or plastic. Furthermore, the two transportation activities (14.29%), involving the movement of ingredients to the cooking area and hot dough to molds, can be minimized by redesigning the production layout to create a more compact workspace. By colocating the ingredient preparation and cooking areas, unnecessary movements can be reduced, lowering energy expenditure and enhancing workflow efficiency without altering the artisanal nature of dodol production.

To support scalability and market competitiveness, the integration of modern ingredients, such as agar-agar, as practiced in Kandangandodol, is proposed to shorten cooking times to 4-6 hours while preserving the traditional flavor profile. This approach, combined with the aforementioned technological interventions, can improve yield efficiency (2-2.5 kg dodol per 1 kg glutinous rice flour) and reduce material loss (5-10%), making dodol production more economically viable. Crucially, these recommendations are designed to respect the socio-cultural values embedded in dodol's communal and artisanal production, ensuring that efficiency gains do not compromise its role as a cultural heritage product. By implementing these improvements, dodol producers can strengthen their competitiveness in local and global culinary markets, contributing to the sustainable preservation of this intangible cultural asset.

3.3. Limitation & Future Research

This study, while providing a comprehensive *Flow Process Chart* (FPC) analysis of dodol production, is limited by its focus on a single local artisan setting, which may not fully represent the diverse techniques and scales of dodol production across Indonesia, and by the absence of a cost-benefit analysis for proposed interventions such as automated mixers or industrial cooling systems. Future research should expand to comparative studies of dodol production in different regions (e.g., Garut, Betawi, Kandangan) to capture variations in processes and cultural practices, and evaluate the economic feasibility and environmental impact of adopting technologies like automated mixers or modern ingredients such as agar-agar, which could reduce cooking times from 8-12 hours to 4-6 hours. Additionally, exploring consumer preferences and market potential for optimized dodol products could further enhance scalability while ensuring the preservation of its cultural significance as an intangible culinary heritage.

IV. CONCLUSION

This study demonstrates that the Flow Process Chart (FPC) is an effective tool for analyzing and optimizing the *dodol* production process, balancing efficiency with cultural preservation. The analysis of 16 production steps highlights the dominance of labor-intensive operations (64.29%), particularly cooking and stirring (8-12 hours), and significant delays during cooling (6-12 hours). Proposed improvements, including automated mixers, industrial cooling systems, compact workspace designs, standardized quality checks, and modern ingredients like agar-agar, can significantly reduce processing times and labor demands while maintaining product authenticity. These enhancements improve yield efficiency (2-2.5 kg *dodol* per 1 kg sticky rice flour) and minimize material loss (5-10%), strengthening the economic viability of *dodol* production. Crucially, the recommendations respect the socio-cultural values embedded in *dodol*'s communal and artisanal nature, ensuring its role as a cultural heritage product. By bridging traditional practices with modern process management, this study not only enhances productivity but also supports the sustainable continuation of *dodol* in both local and global culinary markets, preserving its significance as an intangible cultural asset.

Conflict of interest
There is no conflict to disclose.

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