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Optimizing the use of sewing materials to maximize production output

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ABSTRACT

This Community Service Program aims to optimize the use of sewing materials to maximize production output at Rumah Jahit Nila through the application of a linear programming model in the allocation and use of sewing materials in planning and maximizing production output. The implementation methods include mapping processes and data requirements and formulating a linear programming model relevant to the scale of Nila Sewing House MSMEs, as well as training and live demonstrations using QM as software to determine optimization solutions. The evaluation was conducted on 15 participants using a 1–4 Likert scale instrument with four assessment indicators, namely, training content, presenter's subject-matter expertise, event facilities, and benefits of the program. Descriptive analysis showed an overall average of 3.43 on a scale of 4, with a percentage level of 85.8%, which is in the Very Good category. In order, the indicator achievements are Presenter's Subject-Matter Expertise = 3.53 (88.33%), Benefits of the Program = 3.47 (86.67%), Training Content = 3.40 (85.00%), and Event Facilities = 3.33 (83.33%). These results confirm that the competence of the speakers and the relevance of the benefits are the main strengths, while the content and facilities of the activities are areas for priority improvement. This program has successfully improved participants' technical capacity in modeling and implementing linear program-based raw material optimization, while also providing a foundation for operational implementation to reduce waste and increase throughput.

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1. INTRODUCTION

Rumah Jahit Nila MSME is a small and medium-sized enterprise (SME) in Medan, North Sumatra, engaged in the production of clothing, particularly Muslim clothing, especially clothing for Muslim women. They produce various types of clothing, ranging from traditional clothing to clothing for Muslim women. As a small and medium enterprise, Rumah Jahit Nila plays an important role in supporting creative economic growth and women's empowerment in the home industry sector. However, like other small and medium enterprises in the garment sector, this business faces major challenges in terms of the efficient use of fabric raw materials, which is one of the largest production cost components in the production process.

One of the fundamental problems faced by Rumah Jahit Nila is the high level of fabric waste due to manual cutting patterns and the excessive use of leftover materials (Kinda & Sezgin, 2025). In practice, fabric cutting is based on the experience of workers, so the estimated use of raw materials for clothing production is poorly considered. Such waste certainly has a significant impact on the size of the pieces, the width of the fabric, and the requirements of each clothing model produced. As a result, many pieces of fabric are not used optimally, which has a direct linear impact on increasing raw material costs and reducing profit margins.

In addition, problems also arise in planning the use of raw materials that are not yet integrated with demand data or production model variations. Rumah Jahit Nila often produces various sizes, designs, and colors. However, the calculation of material requirements for each variation has not been carried out systematically. This situation has an impact on the quantity of orders or fabric supplies as raw materials for clothing production (Dong, 2022). This scenario has the potential to cause various obstacles, such as stock shortages that hinder production or excess stock that is not immediately used. This condition indicates inefficiency in inventory management, which has an impact on increased operational expenses and the potential for dead stock (Stolyarov, Pásztorová, Zos-Kior, Hnatenko, & Petchenko, 2022).

Another challenge faced is the limited capacity of data-based production planning, where decisions on material usage and work patterns still rely on intuition and experience. In the context of the garment industry, a quantitative approach using mathematical optimization models can help determine the best combination of decisions while considering resource constraints (Janssen et al., 2025). For example, by applying Linear Programming (LP) or Cutting Stock Problem (CSP) Stochastic Dual Dynamic Programming (SDDP) (Sütçü & Yıldız, 2025), businesses can design fabric cutting strategies that minimize material waste and allocate fabric optimally for various product sizes and designs.

Several relevant studies and activities that have been conducted can be described as follows:

A study conducted by (Aguado, Tostado-Véliz, Desideri, & Jurado, 2025) reviewed the optimization framework for dynamically adjusting pressure and temperature using Mixed-Integer Linear Programming (MILP) and McCormick in solving nonlinear problems. The research is oriented towards reducing operational costs by prioritizing hydrogen savings. Control considerations are made by optimizing the temperature and pressure at the flow density. The results of the proposed optimization model implementation show a 12.5% reduction in operational costs. This will be very beneficial in the long-term planning and evaluation of hydrogen production and storage systems.

Research conducted by (Bang, Kim, Park, & Kim, 2025) focused on the problem of cutting complex raw materials for steel pipe manufacturers. The main features presented include raw material feasibility, multi-period constraints, and inventory aspects. Therefore, we can effectively plan the allocation of product orders to raw materials on a production schedule across multiple time periods. The model proposed in the study uses a large neighborhood search algorithm integrated with heuristic initial solution construction. The proposed model describes a 24.8% reduction in costs and a 14.0% improvement in inventory optimization compared to the company's current operations.

Furthermore, research conducted by (Zhao, Rong, Ma, Liang, & Long, 2025) proposed the implementation of Multi-Stage Stochastic Programming (MSSP) with a combination of linearity and data augmentation techniques through Wasserstein Generative Adversarial Network (WGAN) in providing solutions in the energy conversion sector and optimizing the ethylene production process under

conditions of uncertainty. The optimization results indicate a 3.9% increase in profits from ethylene production. In addition, there is a 6.5% reduction in utility system costs compared to conventional methods.

Then, research conducted by (Yik, Hvarfner, Sjölund, Berg, & Zhang, 2025), implemented Bayesian optimization in determining the strategy for selecting experimental methods based on the results of experiments that had been carried out. The results of the research indicate that the application of this method provides a description of the selection of experimental strategies that can increase the efficiency of the coulombic cycle by up to 94%. This result was achieved by combining autonomous cell Bayesian experiments with the addition of a new electrolyte design in next-generation batteries.

The study conducted by (Korotaj, Novak, Hure, Uliarte, & Vašak, 2025) used a linear programming approach to describe in detail the costs and all constraints relevant to the drinking water treatment plant installation process. The application of this method compared to conventional methods is more efficient, as indicated by a 45% reduction in costs. This has the potential to be used to support decision-making for operators by considering the complexity and work procedures involved in installing water treatment facilities.

The application of optimization approaches is not only relevant from a technical standpoint but also provides economic and environmental benefits. Economically, raw material efficiency has an impact on increasing production capacity and business profits. Environmentally, reducing fabric scraps helps reduce textile waste that is difficult to decompose. Thus, it is important for Rumah Jahit Nila to obtain operational research-based assistance to be able to implement the principles of efficiency and sustainability in its production processes.

In this community service project, we will use a mathematical optimization method as an easy and effective way to enhance the production performance of Rumah Jahit Nila. By involving them in the process, small business owners will learn how to figure out the best amount of materials they need, create better fabric cutting plans, and run simulations for planning production based on data.</sent This effort is expected to be the first step for Rumah Jahit Nila to transform into a modern, productive, resource-efficient, and sustainability-oriented garment SME.

2. METHODS

We carried out the community service activity at the Rumah Jahit Nila MSME, located in Medan, North Sumatra Province. This location was chosen based on the characteristics of the partner business, which is engaged in the manufacture of Muslim women's clothing, traditional clothing, and various other types of clothing. Rumah Jahit Nila faces real challenges in managing and efficiently using fabric raw materials. Rumah Jahit Nila is one of the growing MSMEs in the Medan area with a relatively limited number of workers but has considerable production potential. This condition makes Rumah Jahit Nila an ideal partner for the application of mathematical optimization concepts in production management directly in the field.

In general, production activities at Rumah Jahit Nila include fabric cutting, sewing, finishing, and quality control, which are carried out on a small scale with a made-to-order system. However, the conventional fabric cutting system often results in high levels of fabric waste, requiring scientific intervention in the form of assistance in implementing simple and applicable optimization methods.

This community service activity was carried out on October 4, 2025, with several main stages:

1. Preparation stage
   Coordination with partners, field surveys, and initial data collection related to the use of raw materials and production processes. In collecting data, the Mathematics Master's Program community service team conducted interviews with the owner of Rumah Jahit Nila regarding the needs of partners and the operational problems currently faced by partners. In addition, the preparation stage also included administrative requirements such as activity permits, location, and participants who would be included in the activity.

2. Implementation Stage
   This stage includes training activities, technical assistance, simulation of optimization model application using Excel Solver, and analysis of fabric cutting patterns. The implementation stage is divided into several sessions, including :
   a. Presentation of material
      Material delivery is carried out by the community service team of the Mathematics Master's Program. Table 1 provides illustrations of the material and descriptions of the methods used.

Table 1. Description of Training Materials, Methods, and Media

No	Materials	Method	Training Media
1	Mapping of Production Processes and Data Requirements in Sewing Raw Material Optimization	Lectures, discussions, question and answer sessions	Presentation Slides, Training Module
2	Formulation of Linear Programming Models for Material allocation	Lectures, discussions, question and answer sessions	Presentation Slides, Training Module
3	Implementation of Linear Programming for Sewing Raw Material Optimization using QM Software	Demonstration	QM Computing Applications and Training Modules
4	Price Sensitivity Analysis: Purchasing Priorities and Sewing Raw Material Stock Policy	Lectures, discussions, question and answer sessions	Presentation Slides, Training Module
5	Integration of Optimization Results with Production schedules	Lectures, discussions, question and answer sessions	Presentation Slides, Training Module
6	Content Design Strategy for Digital Marketing	Lectures, discussions, question and answer sessions	Presentation Slides, Training Module

   b. Operational Assistance for Models using Applications
      Assistance in using applications in the implementation of linear programming models is provided through demonstrations. Training participants receive assistance starting from the process of installing the QM application, operating the model, inputting raw materials, and determining important parameters in the operational model used.
   c. Discussion and Question and Answer Session
      A discussion and question-and-answer session was held to ensure the transfer of knowledge during the event. The speakers asked questions related to the material presented. The workshop was followed by a special session for participants to discuss topics related to the theme of the event.

3. Evaluation Stage
   This activity describes the collection of implementation results in the field, analysis of the level of efficiency achieved, and preparation of activity reports. In addition, the evaluation of activities is also oriented towards the achievement of the benefits of activities felt by partners in community service activities. The collection of partner satisfaction is captured in a survey instrument distributed through the Google Forms platform. The activity evaluation instrument includes training materials, mastery of subject matter by resource individuals, activity facilities, and the benefits of activity

implementation. The activity evaluation rating scale is adapted from the Likert scale with intervals of 1-4. The rating scale categories are described in Table 2 (Madi, Hadiwidodo, Tuswan, & Ismail, 2020).

Table 2. Assessment Criteria Scale

Numerical Scale	Criteria
1	Very Poor
2	Poor
3	Good
4	Very Good

Meanwhile, the average evaluation results for the implementation of activities were determined by adapting the quantitative data analysis formula for each instrument variable. The average evaluation results can be computed using Equation (1)

$$Average_{Ev} = \frac{Participant_{Assessment}}{Max_{Score}} . 100\% \quad (1)$$

Description :
$Average_{Ev}$: Average evaluation results
$Participant_{Assessment}$: Accumulated number of participant assessments
Max_{Score} : Accumulated maximum assessment scores

In determining the evaluation result categories, adjustments were made to the index through the intervals for assessment of evaluation results. These adjustments ensure a more accurate reflection of performance levels, allowing for a clearer understanding of both strengths and areas needing improvement. As a result, stakeholders can make more informed decisions based on the refined data. The assessment result categories in percentage units can be described in Table 3. (Erinsyah, Sasmito, Wibowo, & Bakti, 2024).

Table 3. Assessment Category Percentage Interval

No	Numerical Interval	Assessment Categories
1	0% - 24,9%	Very Poor
2	25%-49,9%	Poor
3	50%-74,9%	Good
4	75%-100%	Very Good

By engaging in activities directly at partner locations, MSME players can learn through hands-on experience, observe how optimization methods function in real-world scenarios, and receive immediate benefits such as improved efficiency in raw material usage.

3. FINDINGS AND DISCUSSION

The implementation of community service activities carried out by the community service team of the Mathematics Study Program Master's Program aims to optimize the use of raw materials for clothing production at the Nila Sewing House MSME, increase the production of Muslim clothing through the proportional use of raw materials, and optimize the use of raw material leftovers from clothing production, as well as empower and facilitate Nila Sewing House SMEs in understanding the basics of data-based production planning. Overall, the activities proceeded smoothly and received positive feedback. There were 15 participants in the training activity, who were workers at Rumah Jahit Nila, and they showed great enthusiasm throughout.

This enthusiasm was evident in the participants' active participation in the discussion sessions. The speakers who presented the training material also described the training material in a communicative manner, and the training was conducted using a two-way communication system. Several illustrations of the material delivery during the training activity can be seen in Figure 1.

Figure 1. Documentation of Material Delivery Activities

The process of delivering training materials was carried out at the initial stage of community service activities. The exercise was done with the aim of providing education and information related to mapping the production process and data requirements needed to describe the mechanism of raw material optimization using a linear programming model. The training session was followed by a presentation of material related to the formulation of a linear programming model focused on optimizing sewing raw materials, which are a basic production requirement for Rumah Jahit Nila. The training material delivery process was also carried out as an effort to introduce the role of fundamental data in industrial needs. As a result, the owner and workers at Rumah Jahit Nila are able to describe the sewing raw material requirements proportionally and have a basis for mapping the use of raw materials in the production process. In line with this, the material provided is oriented towards the use of raw materials that are not only determined or decided based on experience alone but also provide an adaptation of perspective in data-based raw material management.

The activity continued with a demonstration of production calculations using sewing raw materials. The demonstration process began with the installation of the QM application on the user's device. This was followed by testing the input of sewing raw materials through the application and calculating the sewing raw materials needed to produce a number of clothing designs. The documentation of the linear programming calculation demonstration process can be described in Figure 2.

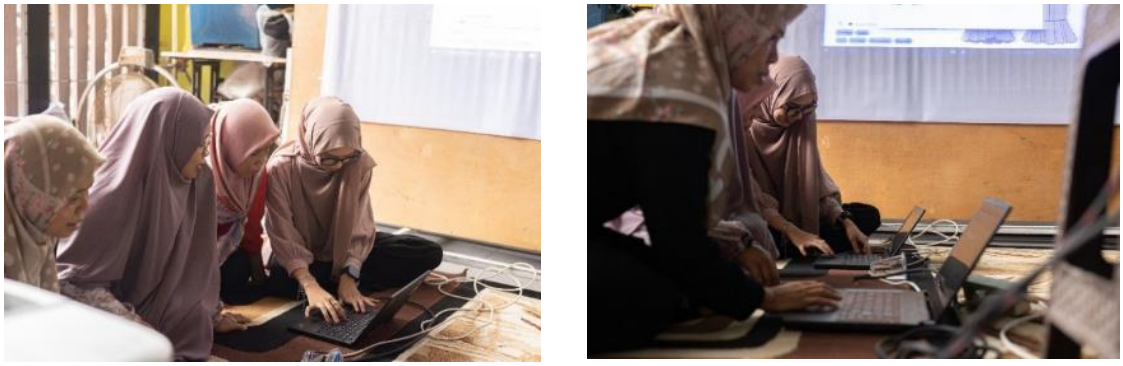

Figure 2. Demonstration Session Documentation

The activity continued with a demonstration of production calculations using sewing raw materials. The demonstration process began with the installation of the QM application on the user's device. This procedure was followed by testing the input of sewing raw materials through the application and

calculating the sewing raw materials needed to produce a number of clothing designs. The documentation of the linear programming demonstration can be described in Figure 2.

Figure 3. Discussion Session Documentation

The session was closed with the presentation of souvenirs to the activity partners and continued with a group photo with the community service team of the Mathematics Master's Program. Figure 4 documents the souvenir presentation and group photo.

Figure 4. Documentation of the Closing Session Group Photo and Presentation of Souvenirs to Community Service Partners

In compiling the evaluation of community service activities that have been carried out, the results of the evaluation were obtained by distributing evaluation instruments via Google Forms. Each evaluation instrument was filled out by training participants, according to the conditions and benefits obtained during the activity. The instruments evaluated included: training content, presenter's subject-matter expertise by resource persons, event facilities, and benefits of implementing the activity. The description of the activity evaluation results can be seen in Figure 5.

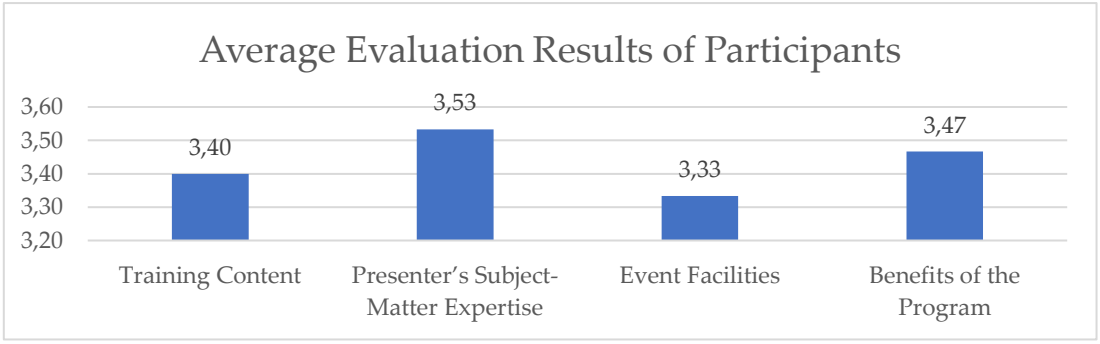

Figure 5. Graph of Average Participant Evaluation Results

According to the description in Figure 5, the average participant rating was 3.43 out of 4, which categorizes the program as Excellent based on the 75–100% rating scale outlined in Table 3. The scores indicate a consistently positive learning experience across all aspects of the training evaluated. Several improvements in the implementation of activities generally lie in the aspects of timing and duration of implementation. In addition, improvements were also made in terms of the completeness of facilities that can be improved and enhanced in the future as part of the preparatory stages for implementing activities. Figure 6 illustrates the evaluation results of the training activities.

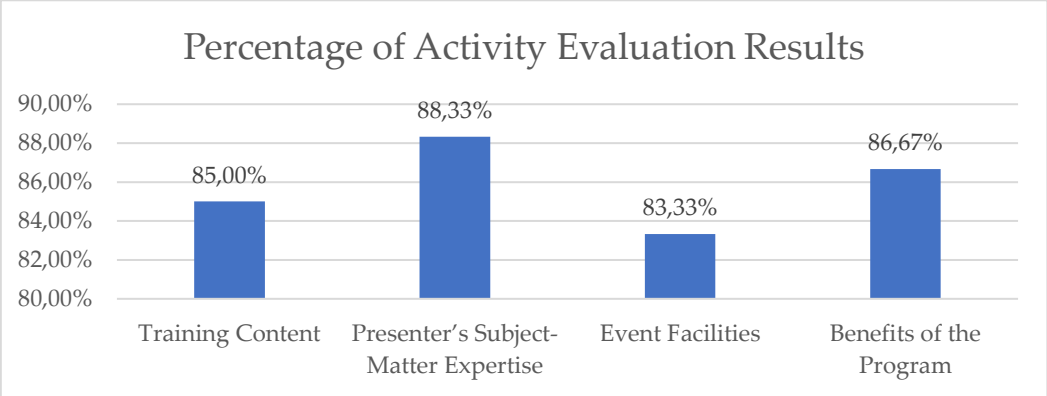

Figure 6. Percentage Chart of Activity Evaluation Results

The presenter's subject-matter expertise scored 88.33% (Excellent) and was the main strength of the program; this confirms that the selection of speakers and the depth of the material presented were appropriate. The benefits of the program were scored at 86.67% (excellent), indicating that participants felt they gained significant practical benefits, although there is still room for improvement in terms of transferring these practices to the workplace. Training content scored 85.00% (Very Good); the content was considered high quality but could be deepened by adding contextual case studies and hands-on exercises using participant data. Event Facilities scored 83.33% (Very Good), but this was the lowest relative score; this indicates the most priority areas for improvement, such as the readiness of the facilities used during the implementation of the activities. Thus, overall, the implementation of the activities had an average evaluation score of 85.83%, which falls into the very good category.

4. CONCLUSION

The Community Service Program entitled "Optimizing the use of sewing materials to maximize production" was held at Rumah Jahit Nila with 15 participants and was received positively and with great enthusiasm. This can be described through the evaluation results using a percentage interval assessment category. The evaluation was conducted using a 1–4 Likert scale, which was adopted in the evaluation instrument assessment via Google Forms. The aggregate results of the activity were in the Very Good category, with the average participant assessment at a level of 3.43 on a scale of 4, resulting in a satisfaction index value of 85.8%. The highest indicator ranking in the activity evaluation placed Presenter's Subject-Matter Expertise as the main strength, with the average participant rating at a level of 3.53, or touching a percentage level of 88.33%, followed by Benefits of the Program with an average rating of 3.47, or a satisfaction percentage of 86.67%. Meanwhile, the Training Content category had an average evaluation score of 3.40 with a satisfaction index reaching 85.00%. The evaluation of event facilities obtained the lowest score at 3.33 with a satisfaction index of 83.33%. This consistency confirms that the competence of the resource persons and the relevance of the training benefits have been well received by the participants, while the content and especially the facilities for the activities still leave room for improvement in order to optimize the learning experience. From the perspective of the community service objectives, the training has provided participants with practical knowledge to model and implement raw

material optimization based on linear programming, which is relevant to the context of MSME-scale garment production. Participants rated the program's benefits highly, demonstrating an initial readiness to apply optimization thinking, such as material allocation, cutting patterns, and decision-making that is not only determined by experience but can also be done analytically and based on data that can support daily operational activities.

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