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System Modeling to Optimize the Production Quantity of Men's and Women's Jackets and Achieve Maximum Profit: A Case Study at Konveksi ABC Cikarang Using Linear Programming

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Abstract

This study aims to develop an optimal production strategy for Konveksi Jaket ABC Cikarang, a garment manufacturer specializing in men's and women's jackets. The company faces significant challenges in resource allocation, particularly in managing limited material supplies and production capacity. To address this, a Linear Programming approach is applied to determine the most profitable production combination. The model incorporates two decision variables representing the quantities of men's and women's jackets and is constrained by real-world resource limitations. The objective function is designed to maximize profit, and the model is solved using IBM ILOG CPLEX software. The results indicate that the optimal production decision is to produce 125 units of women's jackets and none of the men's jackets, resulting in a maximum profit of IDR 8,125,000. These findings demonstrate that mathematical optimization can serve as an effective decision-support tool for improving production planning and efficiency in resource-constrained environments.

Keywords: production optimization; linear programming; garment industry; men's and women's jackets; CPLEX Solver; JIEHIS

INTRODUCTION

In the current era of competitive industrial development, manufacturing companies are required to optimize every aspect of their production process to remain sustainable and profitable. The garment industry, particularly in Indonesia, plays a significant role in the economy and faces increasing challenges related to fluctuating demand, limited resources, and operational efficiency. Konveksi Jaket ABC Cikarang, a medium-scale garment manufacturer located in West Java, specializes in the production of men's and women's jackets. Despite its commitment to product quality, the company often struggles with determining the ideal quantity of each jacket type to produce under constrained resource conditions.

These challenges stem from the complexity of managing multiple types of materials such as canvas fabric, lining, zippers, and accessories, all of which must be allocated efficiently to meet production goals. In recent months, Konveksi Jaket ABC has also experienced frequent overstock of certain jacket types, resulting in increased inventory holding costs and limited warehouse space. Moreover, inefficient resource allocation has led to low profit margins and idle production time, especially during periods of low men's jacket demand. Traditional estimation methods often fail to yield optimal results, highlighting the need for a more structured and data-driven approach to production planning.

Recent studies in Indonesia have confirmed the effectiveness of Linear Programming (LP) as a decision-support tool in similar manufacturing contexts. Research by Aulia and Prasetyo (2021) demonstrated that LP could significantly increase profit margins by optimizing production levels in a garment company. Similarly, Sari and Hidayat (2022) applied LP in the snack food industry and found that production plans aligned with LP recommendations resulted in lower production costs and higher output efficiency. Furthermore, Rahmawati and Zain (2023) showcased the use of LP in footwear manufacturing to allocate limited material and labor resources for maximum financial returns. Maulana and Kurniawan (2020) emphasized the role of LP in textile production scheduling, improving on-time delivery performance and machine utilization. Meanwhile, Yuliana and Handoko (2021) compared various solver tools for LP, confirming that structured modeling through software applications improves solution accuracy and operational feasibility in manufacturing environments.

Building on these findings, this study adopts a Linear Programming model to determine the optimal number of men's and women's jackets that should be produced to maximize profit. The model is constructed based on actual resource availability data and is solved using IBM ILOG CPLEX software. The results of this study are expected to contribute practical insights for small to medium enterprises in the garment industry seeking to improve production planning and operational efficiency. The garment industry, particularly in Indonesia, plays a significant role in the economy and faces increasing challenges related to fluctuating demand, limited resources, and operational efficiency. Konveksi Jaket ABC Cikarang, a medium-scale garment manufacturer located in West Java, specializes in the production of men's and women's jackets. Despite its commitment to product quality, the company often struggles with determining the ideal quantity of each jacket type to produce under constrained resource conditions.

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Several recent studies in Indonesia have demonstrated the effectiveness of Linear Programming (LP) in optimizing production planning within various manufacturing sectors. Aulia and Prasetyo (2021) showed that LP significantly improved profit margins and production efficiency in a garment company by determining optimal product combinations. Sari and Hidayat (2022) successfully applied LP to minimize production costs in the snack food industry. In the footwear sector, Rahmawati and Zain (2023) implemented LP to allocate limited material and labor resources, leading to higher operational efficiency. Maulana and Kurniawan (2020) utilized LP for production scheduling in a textile company, resulting in improved machine utilization and on-time delivery. Furthermore, Yuliana and Handoko (2021) demonstrated that using LP in conjunction with software tools like LINGO and Excel Solver enhances the accuracy and speed of optimization results.

These benchmark studies validate the relevance of LP as a powerful tool in constrained production environments. Building on these findings, the present study applies LP to optimize the production of men's and women's jackets at Konveksi Jaket ABC Cikarang. By incorporating real-world resource constraints and solving the model using IBM ILOG CPLEX software, this research aims to provide a practical decision-support model for small to medium-scale garment manufacturers in Indonesia.

These challenges stem from the complexity of managing multiple types of materials such as canvas fabric, lining, zippers, and accessories, all of which must be allocated efficiently to meet production goals. Traditional estimation methods often fail to yield optimal results, leading to suboptimal profits and underutilized capacity. To address these issues, an optimization approach using Linear Programming (LP) is proposed in this study.

Linear Programming is a mathematical modeling technique that can assist in decision-making by identifying the best possible outcome under given constraints. This research applies LP to determine the optimal number of men's and women's jackets that should be produced to maximize profit. The model is constructed based on actual resource availability data and is solved using IBM ILOG CPLEX software. The results of this study are expected to contribute practical insights for small to medium enterprises in the garment industry seeking to improve production planning and operational efficiency.

METHODS

Model Assumptions

To simplify the production planning problem and make it solvable using linear programming techniques, several assumptions are made in this study:

- Fixed and Sufficient Material Availability

All materials listed in the availability table (e.g., canvas fabric, lining, foam) are assumed to be fully available in the stated quantities during the planning period. There are no delays or shortages in procurement.

- Unlimited Product Demand

It is assumed that all jackets produced—both men's and women's—will be sold, with no consideration for demand constraints or market saturation.

- Constant Unit Profit

Profit per unit is treated as constant, specifically IDR 70,000 for men's jackets and IDR 65,000 for women's jackets, with no adjustments for market pricing, volume discounts, or variable production costs.

- No Switching or Setup Costs

The model assumes that changing production from one product type to another does not incur additional costs or require downtime.

These assumptions allow for a tractable and efficient optimization model, although they may limit the model's realism in more dynamic and uncertain business environments.

The profit per unit used in this study—IDR 70,000 for men's jackets and IDR 65,000 for women's jackets—was determined based on the average historical sales margin reported by the finance department of Konveksi Jaket ABC. These figures represent the difference between the average selling price and the total estimated production cost per unit, including direct material costs, direct labor costs, and a fixed portion of factory overhead. However, the model assumes that these costs remain static throughout the planning period and does not account for dynamic factors such as fluctuating raw material prices, machine maintenance expenses, or overtime labor costs. For modeling simplicity, variable overheads and non-production costs (e.g., marketing, logistics) are excluded.

This research was conducted using a quantitative modeling approach, specifically by applying the Linear Programming (LP) method. The purpose of this method is to determine the optimal number of products to be manufactured, based on available resources and aimed at maximizing the total profit generated by the company. The case study in this research focuses on Konveksi Jaket ABC Cikarang, which produces two main types of jackets: men's jackets and women's jackets.

The LP model uses two decision variables:

x_1: the number of men's jackets to be produced

x_2: the number of women's jackets to be produced

The objective function is constructed to maximize profit, as follows:
Maximize $Z = 70{,}000x_1 + 65{,}000x_2$

To achieve this, the company must manage the usage of various raw materials with specific constraints. The materials used in the production process include: Canvas fabric, Furring (lining), Rib knit fabric, Foam padding, Sewing thread, Zippers, Snap buttons, Embroidered labels, Scuba lining, Fabric glue, Waistband elastic, Velcro strips, Decorative accessories, Size labels, Cotton fabric for combination, Plastic packaging, Product tags.

Table 1. Material Requirements for Jacket Production

Material Name	Requirement per Men's Jacket	Requirement per Women's Jacket	Available Stock
Canvas Fabric	3,500 cm²	3,000 cm²	6,000,000 cm²
Lining Fabric	2,000 cm²	1,800 cm²	4,000,000 cm²
Rib Fabric	600 cm²	500 cm²	900,000 cm²
Thin Foam	800 cm²	700 cm²	1,200,000 cm²
Sewing Thread	0.03 spool	0.02 spool	30 spools
Zipper	1 piece	1 piece	2,000 pieces
Snap Button	6 pieces	4 pieces	5,000 pieces
Embroidered Label	1 piece	1 piece	1,500 pieces
Scuba Lining	1,200 cm²	1,000 cm²	2,000,000 cm²
Fabric Glue	0.05 kg	0.05 kg	100 kg
Waist Elastic	100 cm	80 cm	10,000 cm
Velcro (Fastener)	20 cm	15 cm	2,000 cm

Material Name	Requirement per Men's Jacket	Requirement per Women's Jacket	Available Stock
Decorative Accessories	1 set	1 set	600 sets
Size Label	1 piece	1 piece	1,000 pieces
Cotton Combination Fabric	1,000 cm²	900 cm²	1,800,000 cm²
Plastic Packaging	1 piece	1 piece	2,500 pieces
Product Tag	1 piece	1 piece	2,000 pieces
Profit per Jacket	**Rp70.000**	**Rp65.000**	-

Each material has a fixed amount available in stock, and each jacket type consumes a different quantity of each material. A total of 17 material constraints are formulated in the model, such as:

$3{,}500x_1 + 3{,}000x_2 \leq 6{,}000{,}000$ (canvas fabric in cm²)

$2{,}000x_1 + 1{,}800x_2 \leq 4{,}000{,}000$ (furring in cm²)

$600x_1 + 500x_2 \leq 900{,}000$ (rib knit in cm²)

$800x_1 + 700x_2 \leq 1{,}200{,}000$ (foam padding in cm²)

$0.03x_1 + 0.02x_2 \leq 30$ (thread in spools)

$1x_1 + 1x_2 \leq 2{,}000$ (zippers)

$6x_1 + 4x_2 \leq 5{,}000$ (snap buttons)

$1x_1 + 1x_2 \leq 1{,}500$ (embroidered labels)

$1{,}200x_1 + 1{,}000x_2 \leq 2{,}000{,}000$ (scuba lining in cm²)

$0.05x_1 + 0.05x_2 \leq 100$ (fabric glue in kg)

$100x_1 + 80x_2 \leq 10{,}000$ (waistband elastic in cm)

$20x_1 + 15x_2 \leq 2{,}000$ (Velcro in cm)

$1x_1 + 1x_2 \leq 600$ (decorative accessories)

$1x_1 + 1x_2 \leq 1{,}000$ (size labels)

$1{,}000x_1 + 900x_2 \leq 1{,}800{,}000$ (cotton fabric in cm²)

$1x_1 + 1x_2 \leq 2{,}500$ (plastic packaging)

$1x_1 + 1x_2 \leq 2{,}000$ (product tags)

The model was solved using IBM ILOG CPLEX Optimization Studio, which provides powerful features for solving large-scale linear optimization problems efficiently and accurately. The input data for the objective function and constraints were encoded using the OPL (Optimization Programming Language) environment within CPLEX.

Steps in Operating IBM ILOG CPLEX Optimization Studio

To solve the production optimization problem at Konveksi Jaket ABC Cikarang using Linear Programming, IBM ILOG CPLEX Optimization Studio was utilized. The following steps were taken to construct and execute the optimization model:

1. Launching the CPLEX Application

Start IBM ILOG CPLEX Optimization Studio and create a new project. This is done by navigating to ***File* > *New* > *OPL Project***. A dialog box will appear to enter the project name and select the location for saving the files.

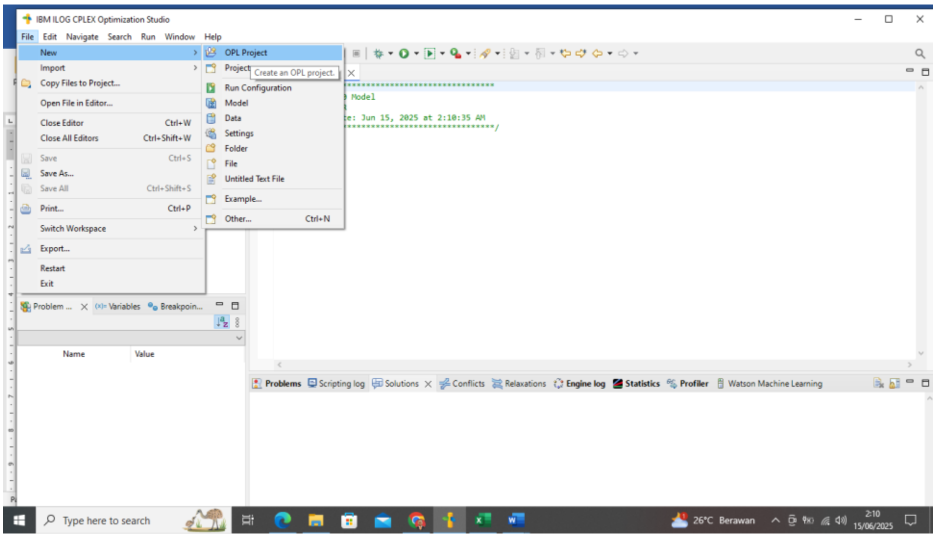

Figure 1. Launching the CPLEX Application

2. Creating a New Model File

After the project is created, right-click on the source folder in the project directory and choose ***New* > *OPL Model File***. This file is used to input the mathematical model, which includes the objective function, decision variables, and constraints.

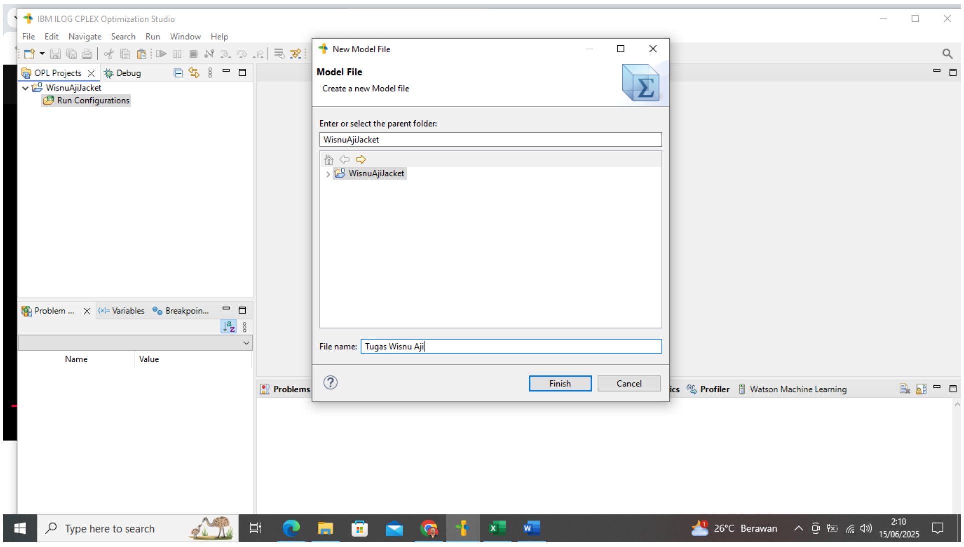

Figure 2. Creating a New Model File

3. Declaring Decision Variables

In the model file, two integer decision variables are declared to represent the number of men's **jackets (x1) and women's jackets (x2)** to be produced:

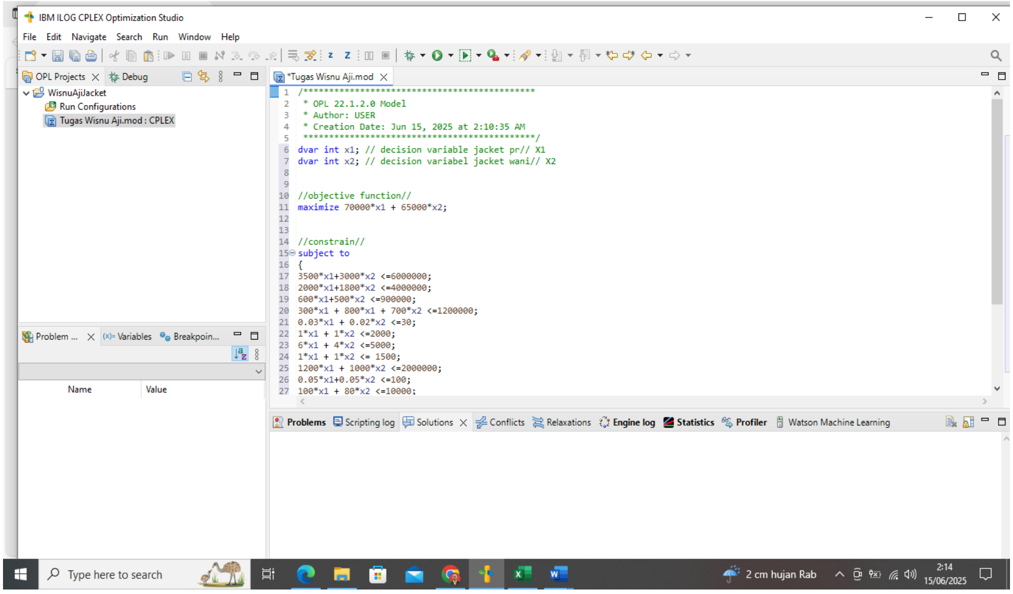

Figure 3. Declaring Decision Variables

4. Formulating Constraints

Each material used in production has a limitation based on inventory data. Constraints are added as follows (example shown for several materials):

```
/*********************************************
 * OPL 22.1.2.0 Model
 * Author: USER
 * Creation Date: Jun 15, 2025 at 2:10:35 AM
 *********************************************/
dvar int x1; // decision variable jacket pr// X1
dvar int x2; // decision variabel jacket wani// X2


//objective function//
maximize 70000*x1 + 65000*x2;


//constrain//
subject to
{
3500*x1+3000*x2 <=6000000;
2000*x1+1800*x2 <=4000000;
600*x1+500*x2 <=900000;
300*x1 + 800*x1 + 700*x2 <=1200000;
0.03*x1 + 0.02*x2 <=30;
1*x1 + 1*x2 <=2000;
6*x1 + 4*x2 <=5000;
1*x1 + 1*x2 <= 1500;
1200*x1 + 1000*x2 <=2000000;
0.05*x1+0.05*x2 <=100;
100*x1 + 80*x2 <=10000;
20*x1 + 15*x2 <=2000;
1*x1+1*x2 <=600;
1*x1+1*x2 <=1000;
1000*x1 + 900*x2 <=1800000;
1*x1+1*x2 <=2500;
1*x1+1*x2 <=2000;
x1>=0;
x2>=0;
}
```

5. Creating a Run Configuration & Running the Model

After the model is complete, create a run configuration to execute it. Right-click the project and select New **Run Configuration**. Ensure the model file is selected and linked correctly to the run configuration.

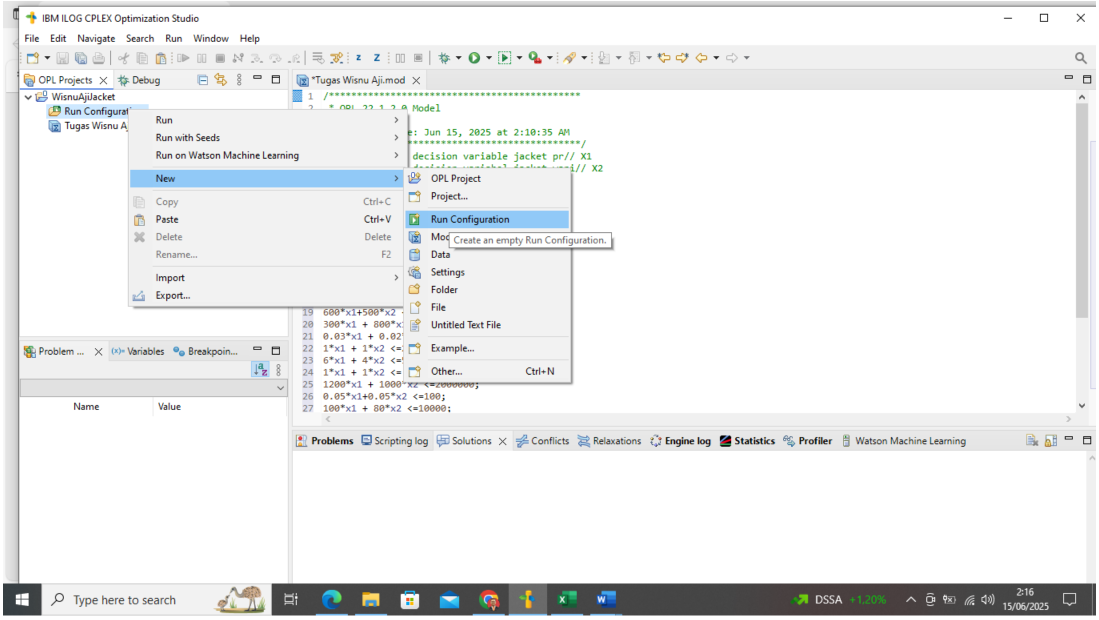

Figure 4. Creating a Run Configuration & Running

6. Reading the Output

Once the solver has finished, the console displays the optimal values for x1 and x2 as well as the maximum objective value. Based on the project:

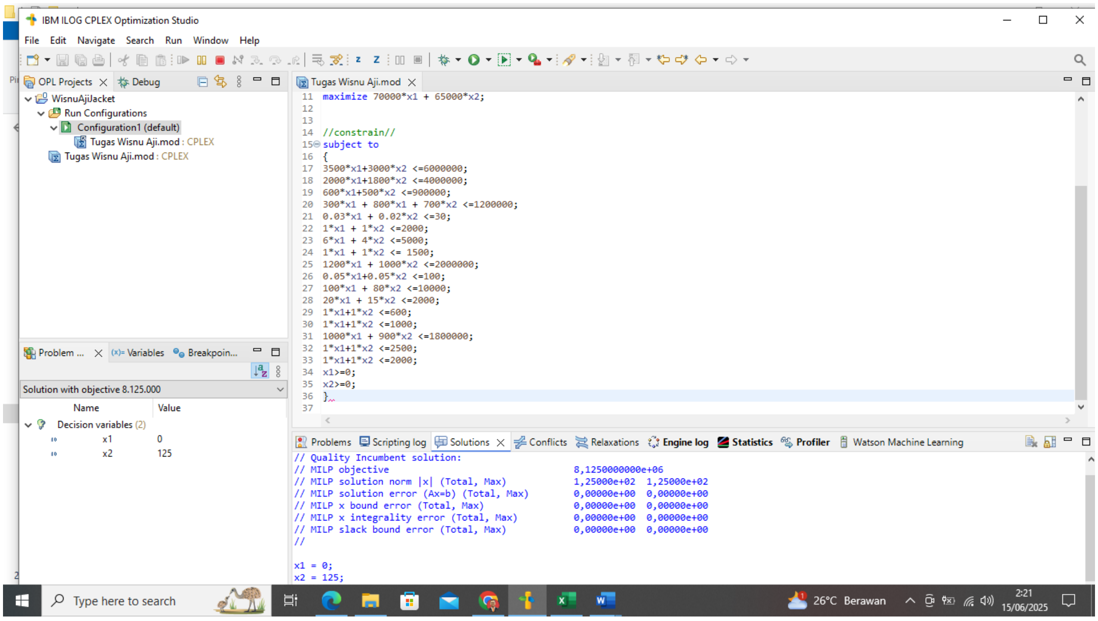

Figure 5. Reading the Output

7. Validating Results

Verify the solution by plugging the values into each constraint to confirm that none of the resource limits are exceeded. This step ensures model feasibility and correctness.

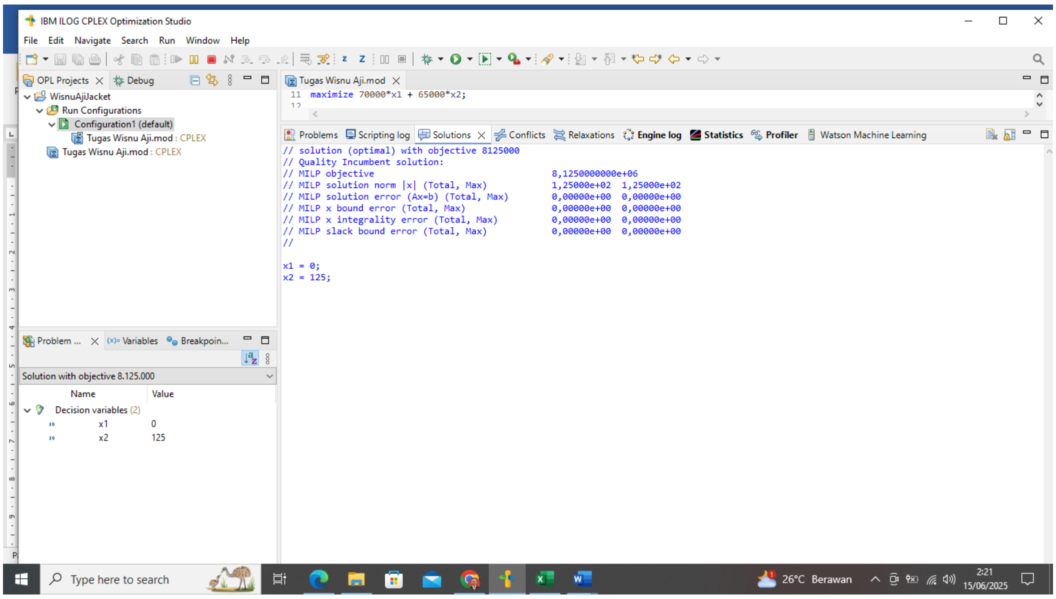

Figure 6. Validating Result

Based on the calculation of material availability above, the optimal values obtained are $x_1 = 0$ and $x_2 = 125$. These values are then substituted into the objective function as follows:

Maximize $Z = 70{,}000x_1 + 65{,}000x_2$
Maximize $Z = 70{,}000(0) + 65{,}000(125)$
Maximize $Z = 0 + 8{,}125{,}000$
Maximize $Z = 8{,}125{,}000$

This study employs IBM ILOG CPLEX as the optimization solver due to its high reliability, computational efficiency, and industrial-grade capability in solving large-scale linear programming problems. CPLEX offers a user-friendly development environment via the OPL (Optimization Programming Language) interface, which simplifies model formulation and allows integration of both model and data in a structured format. Compared to alternatives like LINGO, CPLEX provides more advanced features, robust pre-solve algorithms, and superior support for commercial applications. While open-source solvers such as PuLP and GLPK are useful for academic or lightweight use, they may face limitations in speed, scalability, and solution diagnostics when handling multiple constraints and complex industrial datasets. The selection of CPLEX thus aligns with the objective of generating a precise, reproducible, and industry-relevant production optimization model.

In addition to the manual validation process where the decision variable values are substituted back into the constraints to verify feasibility the model's robustness can be further enhanced by utilizing diagnostic features available in IBM ILOG CPLEX, such as sensitivity analysis and post-optimality analysis. Sensitivity analysis provides insights into how much the parameters (e.g., unit profits or material availability) can change without altering the optimal solution. This includes identifying shadow prices for each constraint, which reflect the marginal value of relaxing a resource limitation. These diagnostics not only confirm the solution's feasibility but also offer valuable strategic insights regarding the stability and resilience of production decisions under input uncertainty. Incorporating such analysis would strengthen the model’s usefulness for long-term planning and decision-making in dynamic industrial environments.

Although the model solution suggests producing only women’s jackets for maximum profit, this does not imply that men’s jackets are inherently unprofitable. The decision is a consequence of the current resource constraints and profit structure. A sensitivity analysis would be useful to determine how changes in unit profits or material availability could affect the optimal mix. Additionally, if a minimum production requirement for men’s jackets were enforced for instance, due to market commitments or product variety goals the model would adapt accordingly, potentially reducing overall profit but satisfying broader business constraints.

Despite the mathematical elegance of the optimal solution, several real-world barriers may hinder its full implementation. These include supply chain uncertainties, such as material delays or shortages; unpredictable market demand that could result in overstock; and production switching costs not accounted for in the model. Furthermore, operational factors such as labor availability, machine capacity, and company policies on product diversification may also influence the final production plan. Hence, while the linear programming model provides valuable insights, practical constraints must be integrated into planning to ensure feasible and sustainable implementation.

CONCLUSION

This research successfully applies Linear Programming as a decision-support tool to optimize the production planning of jackets at Konveksi Jaket ABC Cikarang. By incorporating real data on material availability and profit margins, a mathematical model was constructed and solved using IBM ILOG CPLEX Optimization Studio. The model aimed to determine the most profitable production combination between two product types: men's jackets and women's jackets.

The optimization results indicate that the maximum profit of IDR 8,125,000 is achieved by producing 125 units of women's jackets and none of men's jackets. This outcome is based on the fact that women's jackets consume less material per unit, allowing for a larger production volume within the same resource constraints.

All 17 production constraints were satisfied in the solution, confirming its feasibility. The results demonstrate the effectiveness of Linear Programming in managing limited resources, reducing production inefficiencies, and increasing profitability.

This study highlights the potential for small to medium-sized manufacturing enterprises to adopt mathematical modeling techniques in their operational decision-making processes. Future research may enhance the model by introducing multiple objectives, uncertain demand scenarios, or dynamic material cost variables to further support flexible and adaptive production planning.

Future research could explore a multi-objective optimization approach, where profit maximization is balanced with other important objectives such as equitable resource utilization, lead time minimization, or product mix diversity. In real-world manufacturing environments, decision-makers often face trade-offs between financial performance and operational efficiency. Implementing a multi-objective linear programming model or using goal programming techniques could provide more holistic and practical decision-support tools for small to medium enterprises. Such models would better reflect the complexity of manufacturing systems and support more sustainable and resilient production strategies.

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