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Application of optimization techniques to maximize uniform sales profit using the Simplex Method

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Abstract

The uniform sales industry in Indonesia often faces challenges related to resource limitations that affect sales profitability. CV. Titis Konveksi experiences difficulties in optimizing uniform sales to maximize profit. This study applies the Simplex Method, a linear programming approach, to determine the optimal sales combination that generates maximum profit. In addition, this research develops a web-based information system to automate the optimization calculation, allowing users to easily determine the most profitable sales combination. The system is developed using Flask as the backend framework, with PHP for the user interface and MySQL for managing sales data, constraints, and optimization results. The data collected are primary data consisting of sales quantities from January 2022 to December 2023, selling prices and profits per product, raw material usage, machine capacity, and available working days. System evaluation was conducted by comparing calculation results from the developed system with manual calculations using Microsoft Excel and optimization results from QM for Windows V5. Functionality testing was also carried out using black box testing. Based on the results of the functionality testing, all of the system's main functions successfully operated as expected. According to the optimization results applied in the system, the optimal product sales combination to achieve maximum profit consists of 4.085 units of almamater blazers and 1.572 units of graduation gowns, generating a maximum profit of IDR 132,001,700. Compared to CV. Titis Konveksi's previous actual profit of IDR 102,859,000, the optimized sales strategy offers a potential increase of IDR 29,142,700. The developed web-based information system has been proven effective in improving CV. Titis Konveksi's profitability by providing more optimal sales recommendations.

Keywords: *Profit Optimization, Simplex Method, Linear Programming, Garment Industry.*

1 INTRODUCTION

The garment manufacturing industry in Indonesia plays an important role in meeting the clothing needs of the community while supporting the growth of the creative economy sector. As market demand increases, both for individual and institutional needs, competition in the uniform sales sector has become increasingly intense [1]. Business actors are required to optimize the utilization of available resources in order to obtain maximum profit. One of the main challenges faced is determining the most profitable product sales composition while considering resource limitations such as raw material availability, production capacity, and limited working days.

CV. Titis Konveksi is one of the micro, small, and medium enterprises (MSMEs) engaged in uniform production and sales. Established in 2009 in Mojokerto Regency, the company has served various uniform needs for schools, universities, and other institutions. However, in practice, CV. Titis Konveksi still faces difficulties in determining the production quantity for product sales to maximize profit. Until now, the determination of production quantity for product sales has mostly been carried out manually and based on estimates, without the support of accurate mathematical calculations. As a result, decision-making is often inefficient and fails to achieve maximum profit.

To address these problems, optimization techniques are needed that can systematically and accurately calculate production combinations for sales. Optimization is the process of finding the most efficient solution among various alternatives by maximizing the use of limited resources to achieve specific objectives. It involves maximizing outcomes while operating within defined constraints [2]. One method that can be used to solve sales optimization problems is linear programming [3]. Linear programming is a mathematical technique used to find the optimal solution to a problem with several constraints, such as raw material limitations, production time, and machine capacity [4]. One algorithm commonly used in linear programming is the Simplex Method. The Simplex Method allows for the systematic search for optimal solutions through iterative processes while considering various decision variables and resource constraints [5].

In addition to applying optimization methods, the development of information technology-based systems is also necessary to facilitate decision-making in uniform sales planning. With a web-based information system, optimization calculations can be performed automatically, quickly, and accurately. This system can assist users in determining the optimal sales combination based on actual sales data, available resources, and existing operational constraints.

Based on previous studies, profit optimization in the garment industry has been conducted using various mathematical optimization methods. One study applied the Branch and Bound method to determine the optimal production combination for sales [6]. In [6], the Branch and Bound method was applied to optimize t-shirt sales revenue at Rumah Kaos Lombok by considering raw materials, labor, and production time. The results showed that the optimal production combination consisted of 2 short-sleeved t-shirts without printing and 409 long-sleeved t-shirts without printing, generating a maximum revenue of IDR 35,992,920. In addition, another study [7] developed a batik production optimization application using the Simplex Method based on Excel Solver and Python. The results showed an optimal production combination of 4.05 dozen printed batik and 5.51 dozen handmade batik, with a maximum profit of IDR 652,530.

This research not only calculates the maximum profit manually, but also creates an information system to speed up the calculation process so that the decision-making process can be carried out quickly and accurately.

2 LITERATURE REVIEW

Several previous studies have applied mathematical optimization methods, particularly the Simplex Method, in an effort to optimize production for sales and maximize profits across various manufacturing industries. In the food industry context, study [8] was conducted to address production optimization problems faced by a bakery located at the University of Benin, Benin City, Edo State, Nigeria. The bakery experienced difficulties in determining the optimal production combination of large, medium, and small-sized breads due to limited raw materials. This problem was solved using a linear programming model with the Simplex Method through Linear Programming Solver (LIPS) software. The analysis results showed that, in order to achieve a maximum profit of ₦100,000 per day, the bakery needed to produce 667 large-sized breads daily.

In a similar study, research [9] examined production optimization for sales at an anonymous bakery in Alor Setar, Kedah, Malaysia, which produces five types of products: chicken loaf, spicy loaf, curry chicken bun, sausage bun, and donuts. By using the Simplex Method modeled mathematically and solved through Excel Solver, it was found that to achieve a maximum monthly profit of RM 38,200, the bakery should focus its production on chicken puff and curry chicken bun, while the production of other products should be reduced due to their minimal contribution to overall profits.

Furthermore, in the furniture manufacturing sector, study [10] was conducted on 3R Furniture, a company that produces doors, chairs, cabinets, tables, and frames. In this study, the Simplex Method was used to determine the optimal allocation of resources to optimize production for sales and maximize profits. Based on the analysis, a maximum profit of IDR 20,999,998 could be achieved by producing 30 units of tables.

Based on these studies, the application of the Simplex Method has proven effective in addressing profit optimization problems in various production sectors. However, most of the existing studies remain limited to manual or semi-automated data processing using general software, without the development of web-based information systems capable of automating the decision-making process. Therefore, this study aims to fill this gap by developing a web-based information system integrated with the Simplex Method to support optimal sales decision-making for uniform products at CV. Titis Konveksi, thereby achieving maximum profit.

3 RESEARCH METHOD

This study employs a quantitative approach with an optimization model using the Simplex Method to determine the maximum profit from uniform sales at CV. Titis Konveksi. In addition, this study develops a web-based information system designed to automate the production and profit optimization process. The main focus of this study is to solve linear programming problems involving production constraints, such as raw material availability, machine capacity, and working days. These factors directly affect production volume and operational efficiency. The optimization process aims to determine the most optimal production combination for sales in order to achieve maximum profit. This optimization also serves to enhance production planning decision-making and provide a technology-based tool to help CV. Titis Konveksi manage resources more efficiently.

3.1 Research Object and Scope

The object of this research is CV. Titis Konveksi, a micro, small, and medium enterprise (MSME) engaged in uniform production and sales, located in Bangkalan Regency, East Java, Indonesia.

3.2 Data Collection

The data used in this study are primary data. Data collection was conducted through direct interviews with the director and owner of CV. Titis Konveksi. The interviews aimed to obtain detailed information regarding net sales profit, the number of uniforms produced, raw material requirements for each type of uniform, machine production capacity, and the number of available working days during the research period. The data covers the period from January 2022 to December 2023. The collected data serve as input for the development of the web-based information system designed in this study, allowing optimization calculations to be performed automatically, presenting analysis results in an easily understandable format, and supporting more effective monitoring and production planning.

3.3 Research Design

The research design consists of the following stages:

1. Collecting primary data through interviews with the director of CV. Titis Konveksi.
2. Formulating a linear programming optimization model using the Simplex Method.
3. Developing a web-based information system to automate the optimization process.
4. Testing system accuracy by comparing system results with manual calculations (Microsoft Excel), and QM for Windows V5.
5. Conducting black box testing to evaluate system functionality.

3.4 Mathematical Model

The optimization problem in this study was formulated using linear programming and solved using the Simplex Method, with the objective of maximizing profit from uniform sales. The model consists of four decision variables representing the number of each type of uniform to be produced:

The objective function in this study is based on the profit obtained from each type of uniform produced. This profit is calculated as the difference between the selling price and the production cost per unit for each product. Therefore, the objective function in this linear programming model aims to maximize the total profit obtained from the production of the four types of uniforms. The objective function can be expressed as follows equation (1) :

$$Zmax = 18000X1 + 15000X2 + 25000X3 + 19000X4 \tag{1}$$

$X1$ = Number of school uniform sets produced
$X2$ = Number of sports uniform sets produced
$X3$ = Number of almamater blazers produced
$X4$ = Number of graduation gown sets produced
Zmax = Function Objective

In addition to the objective function, this study also considers three main constraints that limit uniform production: raw material availability, machine capacity, and the number of available workdays. The raw material constraint is based on the amount of material required to produce each type of uniform, ensuring that total material usage does not exceed the available supply. The machine capacity constraint is calculated based on the machine usage time required for each type of uniform, ensuring that total operational time does not exceed the available capacity. Meanwhile, the workday constraint is determined based on the available workdays divided by the daily production capacity for each uniform type. The constraints for raw material availability, machine capacity, and available workdays are equation (2) as follows:

$$3X1 + 3{,}45X2 + 2{,}5X3 + 2{,}05X4 \leq 13435 \quad (2)$$

$$3X1 + 2{,}5X2 + 4X3 + 2{,}08X4 \leq 157080$$
$$0{,}08X1 + 0{,}07X2 + 0{,}12X3 + 0{,}08X4 \leq 616$$
$$X1, X2, X3, X4 \geq 0$$

3.5 System Architecture and Workflow

The system developed in this study is a web-based application designed to optimize uniform production profitability using the Simplex Method. The system is built using a three-layer architecture, consisting of the Frontend, Backend, and Database components. The Frontend, developed using PHP, HTML, and JavaScript, serves as the user interface for data input and visualization of optimization results. The Backend, implemented with Python using the Flask framework, is responsible for processing the optimization calculations using the `linprog()` function from the SciPy library to solve linear programming problems. The Database, powered by MySQL, stores production data, user inputs, and optimization results, ensuring efficient data management and retrieval.

Integration between these components is facilitated through API-based communication, where the Frontend (PHP and JavaScript) interacts with the Backend (Flask API) via HTTP POST requests using cURL for data transmission. When a user accesses the optimization page, PHP retrieves production data from MySQL, converts it into JSON format, and sends it to the Flask API. The Flask API processes the data, performs the optimization, and returns the optimal production combination along with the maximum profit value in JSON format. The results are then forwarded to the Frontend and displayed to the user. The system workflow begins with data collection, which includes profit per product, actual production quantities, and production constraints such as raw material requirements, machine capacity, and available working days. This data serves as the foundation for the optimization process and must be regularly updated to ensure calculation accuracy.

After the data is collected, the system performs optimization calculations using the Simplex Method to determine the optimal production combination. The optimization results are presented in a table comparing actual and optimal production quantities along with their respective profits. To facilitate better understanding, the system also visualizes these results using bar charts generated with Chart.js, allowing for a clear comparison between current production conditions and the optimal state. This enables the company to analyze potential profit improvements and implement more efficient production strategies based on the optimization results.

3.6 Software and Tools

The development of this system involves a combination of hardware and software that supports implementation and testing with the following details table 1:

Table 1. Hardware and Software

Hardware	
Processor	Intel(R) Core(TM) i3-1005G1
RAM	12.0 GB
Software	
Operating System	Windows 11 Home
Programming Languages	PHP, JavaScript, and Python
Database	MySQL
Web Server	Apache

Text Editor	Visual Studio Code
Testing Tools	Microsoft Excel QM for Windows V5

3.7 Analysis Techniques and System Testing

The first stage involved testing the accuracy of the optimization calculations by comparing the system's results with manual calculations using Microsoft Excel and QM for Windows V5. Similar comparison approaches have also been widely used in several previous studies to validate optimization calculations [11], [12], [13]. The second stage involved testing the system's functionality using the black box testing method, which has also been applied in various previous system testing studies [14], [15]. This testing aims to ensure that all system functions operate according to the specified functional requirements [16], [17], [18].

4 RESULT AND DISCUSION

4.1 System Implementation

The developed system has several key features that support the production optimization process efficiently. Each feature is designed to meet specific needs in data collection, optimization calculations, and result analysis. The following is an explanation of the main features in the system:

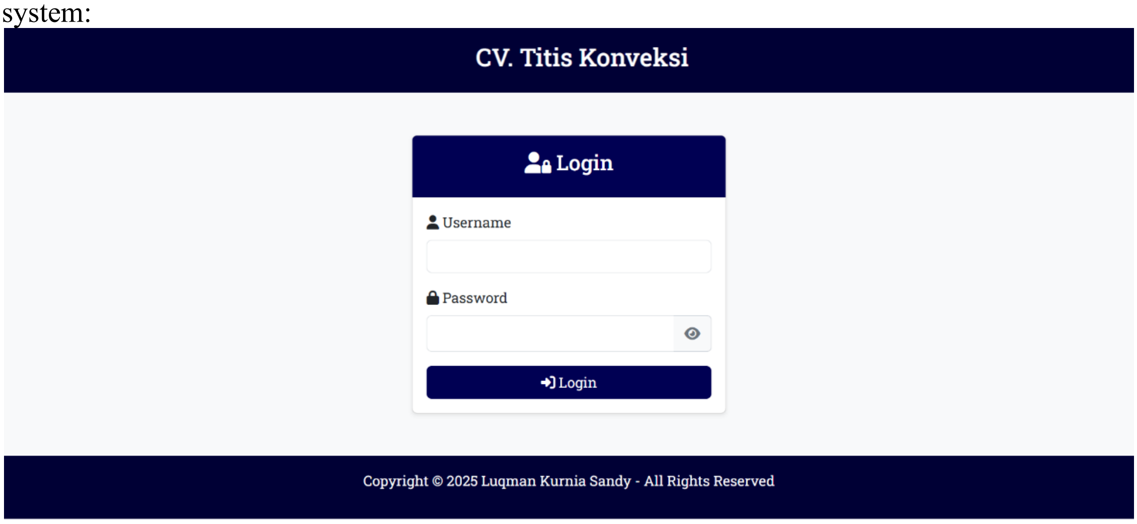


Figure 1. Login Page Interface

In Figure 1, the login page is displayed as an authentication gateway for users to access the system. When users enter their username and password, the system processes them by matching the credentials with the data in the database. If they match, the user will be redirected to the dashboard.

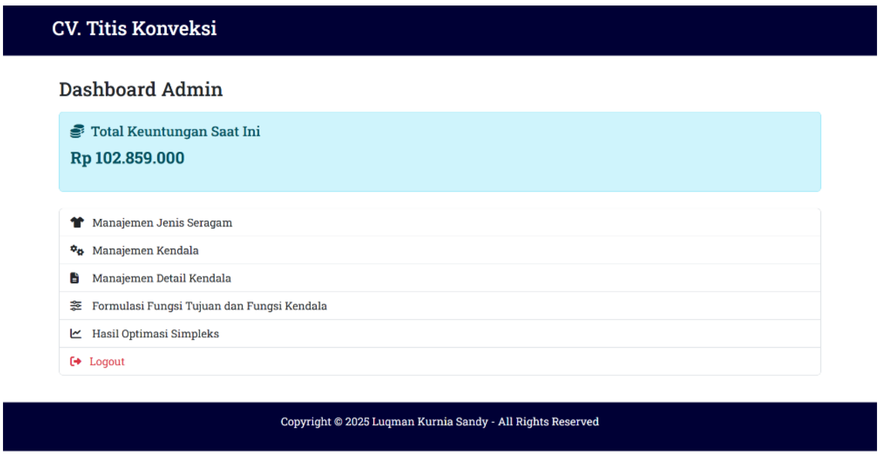


Figure 2. Dashboard Page Interface

In Figure 2, the dashboard page is displayed as the main page for accessing various business management features. From here, users can access uniform type management, production constraints, constraint detail management, optimization function formulation, and the results of the simplex method calculatio.

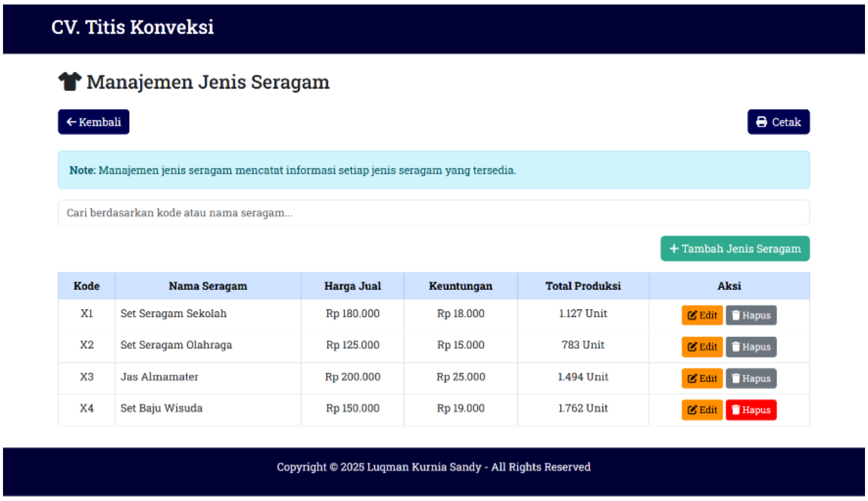


Figure 3. Uniform Type Management Page Interface

In Figure 3, the uniform management page is displayed, allowing users to record and manage information about various available uniform types. The data listed includes the uniform name, selling price per unit, profit per unit, and production quantity for each type. The features on this page include searching by uniform code or name, as well as options to add, edit, or delete uniform data. Additionally, there is a print button that enables the admin to print the uniform list for documentation purposes. At the top left corner, there is a back button that allows users to return to the previous page, which is the dashboard.

Figure 4. Constrains Management Page Interface

In Figure 4, the constraint management page is displayed, recording the maximum capacity of each constraint required in the simplex method formulation. Users can easily search for the desired constraint using the available search field and modify the data by clicking the Edit button next to it. The list of recorded constraints can also be easily printed using the Print button provided at the top of the page. At the top left corner, there is a back button that allows users to return to the previous page, which is the dashboard.

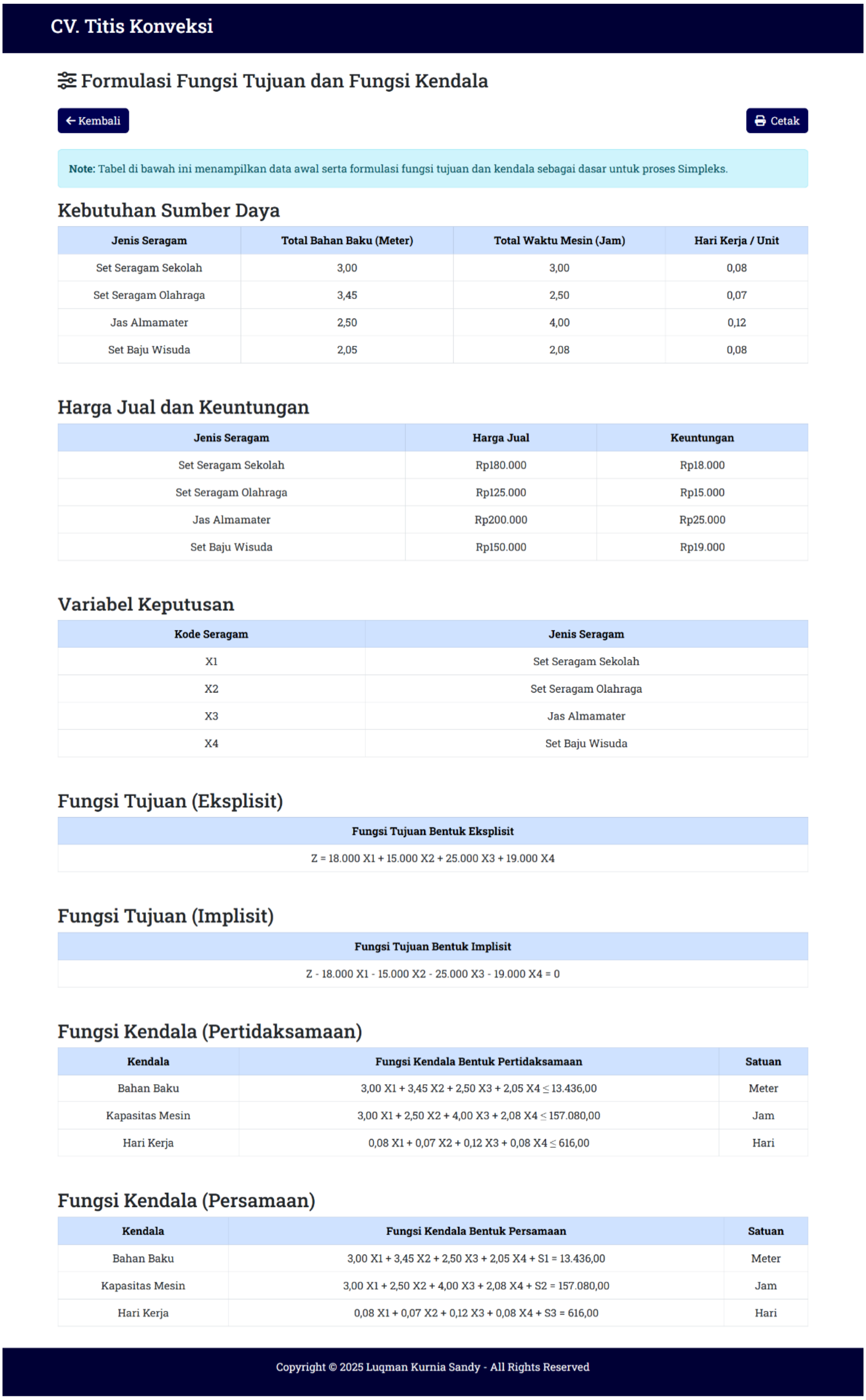
Nama Item	Set Seragam Sekolah	Set Seragam Olahraga	Jas Almamater	Set Baju Wisuda	Satuan	Aksi
Kain TC (Teteron Cotton) Oxford	1,75	0,00	0,00	0,00	Meter	Edit
Kain Drill	1,25	0,00	1,50	2,05	Meter	Edit
Kain BTM (Bahan Tenun Mikrofiber)	0,00	1,75	0,00	0,00	Meter	Edit
Kain Diadora	0,00	1,25	0,00	0,00	Meter	Edit
Kain Tetrex	0,00	0,00	1,00	0,00	Meter	Edit
Benang Jahit	1,00	1,00	1,00	1,00	PCS	Edit
Benang Obras (Ukuran Kecil)	2,00	2,00	2,00	2,00	PCS	Edit
Kancing Kemeja	10,00	0,00	0,00	0,00	PCS	Edit
Kancing Almamater	0,00	0,00	6,00	0,00	PCS	Edit
Trouser Hook (Pengait Celana/Rok)	1,00	0,00	6,00	0,00	PCS	Edit
Resleting	1,00	0,00	0,00	1,00	PCS	Edit
Pasta Karet	0,00	1,00	0,00	0,00	Ons	Edit
Karet Pinggang	0,00	0,45	0,00	0,00	Meter	Edit
Busa Bahu	0,00	0,00	1,00	0,00	Pasang	Edit
Total	3,00	3,45	2,50	2,05	Meter	-

Nama Item	Set Seragam Sekolah	Set Seragam Olahraga	Jas Almamater	Set Baju Wisuda	Satuan	Aksi
Mesin Pemotong Kain	10,00	10,00	15,00	10,00	Menit	Edit
Mesin Jahit	105,00	90,00	150,00	80,00	Menit	Edit
Mesin Obras	35,00	30,00	50,00	25,00	Menit	Edit
Mesin Neci	5,00	0,00	0,00	0,00	Menit	Edit
Mesin Sum	5,00	0,00	5,00	5,00	Menit	Edit
Mesin Lubang Kancing	5,00	0,00	5,00	0,00	Menit	Edit
Mesin Pasang Kancing	5,00	0,00	5,00	0,00	Menit	Edit
Mesin Pasang Aksesoris	5,00	0,00	5,00	0,00	Menit	Edit
Mesin Pasang Karet Pinggang	0,00	5,00	0,00	0,00	Menit	Edit
Mesin Overdeck	0,00	10,00	0,00	0,00	Menit	Edit
Setrika	5,00	5,00	5,00	5,00	Menit	Edit
Total	3,00	2,50	4,00	2,08	Jam	-

Nama Item	Set Seragam Sekolah	Set Seragam Olahraga	Jas Almamater	Set Baju Wisuda	Satuan	Aksi
Hari Kerja	86,00	52,00	185,00	138,00	Hari	Edit
Hari Kerja/Σ Produksi	0,08	0,07	0,12	0,08	Hari	-

Figure 5. Constrain Detail Management Page Interface

In Figure 5, the constraint detail management page is displayed, allowing users to manage and update production constraint data. This data includes raw material requirements, machine capacity, and the number of working days needed for each type of uniform. Users can update each constraint item using the Edit button, where they can modify the quantity of required resources for each uniform type, for example, adjusting the amount of TC (Tetteron Cotton) Oxford fabric needed for each uniform. Additionally, users can search for data using the search feature. There is also a Print option to document the information related to production constraint details.



CV. Titis Konveksi

Formulasi Fungsi Tujuan dan Fungsi Kendala

Kembali

Cetak

Note: Tabel di bawah ini menampilkan data awal serta formulasi fungsi tujuan dan kendala sebagai dasar untuk proses Simpleks.

Kebutuhan Sumber Daya

Jenis Seragam	Total Bahan Baku (Meter)	Total Waktu Mesin (Jam)	Hari Kerja / Unit
Set Seragam Sekolah	3,00	3,00	0,08
Set Seragam Olahraga	3,45	2,50	0,07
Jas Almamater	2,50	4,00	0,12
Set Baju Wisuda	2,05	2,08	0,08

Harga Jual dan Keuntungan

Jenis Seragam	Harga Jual	Keuntungan
Set Seragam Sekolah	Rp180.000	Rp18.000
Set Seragam Olahraga	Rp125.000	Rp15.000
Jas Almamater	Rp200.000	Rp25.000
Set Baju Wisuda	Rp150.000	Rp19.000

Variabel Keputusan

Kode Seragam	Jenis Seragam
X1	Set Seragam Sekolah
X2	Set Seragam Olahraga
X3	Jas Almamater
X4	Set Baju Wisuda

Fungsi Tujuan (Eksplisit)

Fungsi Tujuan Bentuk Eksplisit
Z = 18.000 X1 + 15.000 X2 + 25.000 X3 + 19.000 X4

Fungsi Tujuan (Implisit)

Fungsi Tujuan Bentuk Implisit
Z - 18.000 X1 - 15.000 X2 - 25.000 X3 - 19.000 X4 = 0

Fungsi Kendala (Pertidaksamaan)

Kendala	Fungsi Kendala Bentuk Pertidaksamaan	Satuan
Bahan Baku	3,00 X1 + 3,45 X2 + 2,50 X3 + 2,05 X4 ≤ 13.436,00	Meter
Kapasitas Mesin	3,00 X1 + 2,50 X2 + 4,00 X3 + 2,08 X4 ≤ 157.080,00	Jam
Hari Kerja	0,08 X1 + 0,07 X2 + 0,12 X3 + 0,08 X4 ≤ 616,00	Hari

Fungsi Kendala (Persamaan)

Kendala	Fungsi Kendala Bentuk Persamaan	Satuan
Bahan Baku	3,00 X1 + 3,45 X2 + 2,50 X3 + 2,05 X4 + S1 = 13.436,00	Meter
Kapasitas Mesin	3,00 X1 + 2,50 X2 + 4,00 X3 + 2,08 X4 + S2 = 157.080,00	Jam
Hari Kerja	0,08 X1 + 0,07 X2 + 0,12 X3 + 0,08 X4 + S3 = 616,00	Hari

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Figure 6. Formulation Page Interface

In Figure 6, the page displaying the formulation of the objective function and constraint functions is shown, containing data as the basis for production optimization using the simplex method. The first section presents the resource requirements, which include the amount of raw materials, total machine time, and working hours needed for each type of uniform. Next, there is a table of selling prices and profits, showing the selling price and profit per unit for each uniform type. The decision variables are explained through a table linking the variable codes to the corresponding uniform types.

The objective function is presented in two forms: explicit, which is an inequality derived from the profit per unit, as written in equation (1), and implicit, which is written as an equation set equal to zero. Additionally, the constraint functions are divided into two categories: inequalities, which correspond to equation (2) and indicate production limitations based on raw materials, machine capacity, and working hours, and equations, which represent constraints in equation form after adding slack variables so that all constraints are in the standard equation format for the simplex method. At the top of the page, there is a back button for navigation to the previous page and a print button to print the formulation of the objective function and constraints.

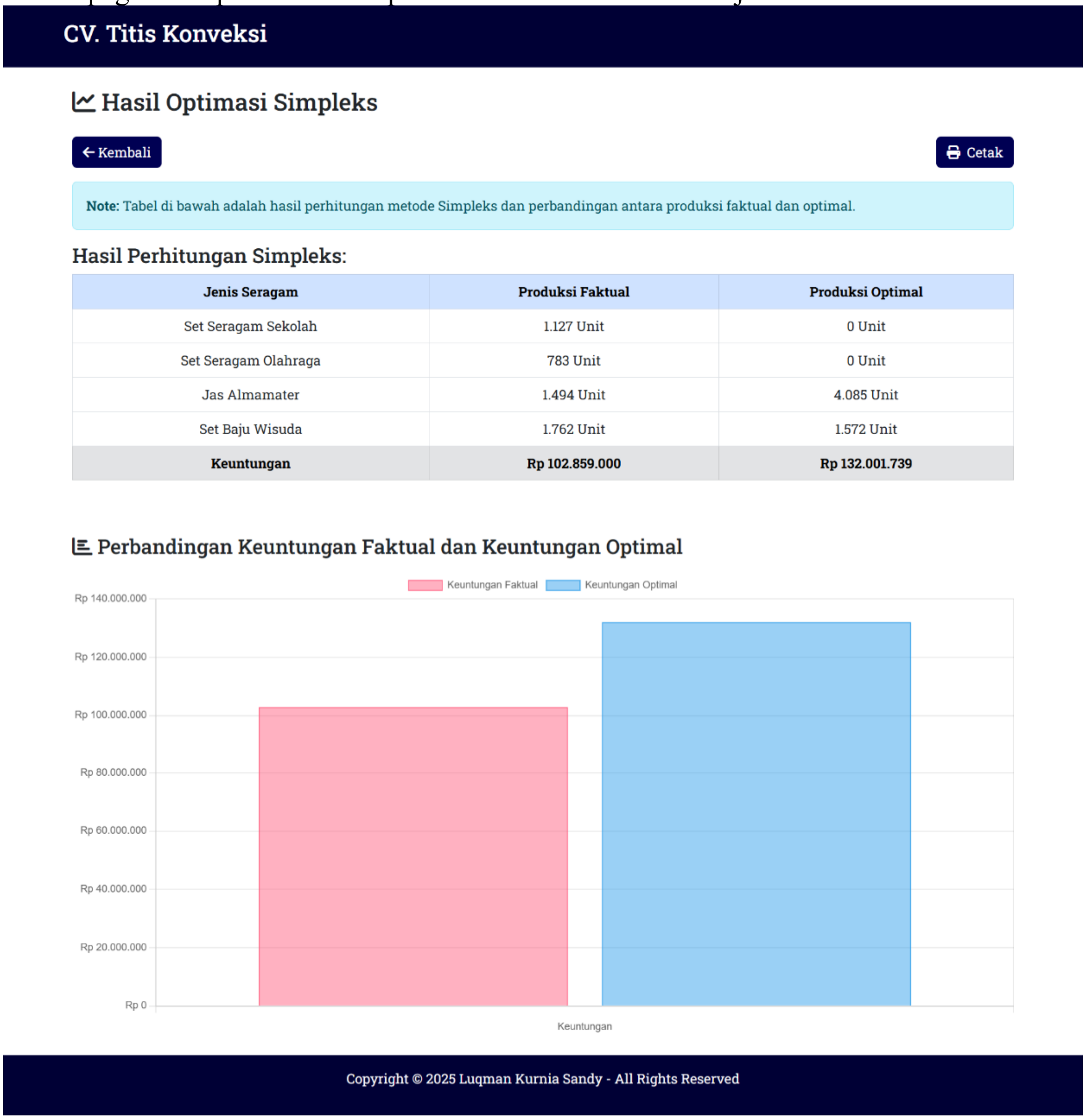

Figure 7. Result Page Interface

In Figure 7, the simplex optimization results page is displayed, presenting a summary of production calculations and profits based on the simplex method. The table shown allows the administrator to compare actual production quantities with the optimal production levels calculated using the optimization method. Each uniform type is displayed with its actual production quantity and the optimal quantity that should be produced to maximize profit.

Additionally, a profit comparison between actual and optimal conditions is visualized in a bar chart to facilitate analysis. Based on the system's calculations, the company's actual production is still not optimal. Previously, the company produced 1.127 sets of school uniforms, 783 sets of sports uniforms, 1.494 almamater blazers, and 1.762 graduation gown sets, with a total profit of IDR.102,859,000. However, after optimization using the simplex method, the optimal solution suggests that the company should produce only 4.085 almamater blazers and 1.572 graduation gown sets, while discontinuing the production of other uniform types. With this optimal production strategy, the company's profit increases to IDR. 132,001,739.

4.2 Results of Manual Calculation using Microsoft Excel

The optimization process was performed manually using the simplex method implemented in Microsoft Excel. The calculation proceeded through two iterations to reach the optimal solution. In the first iteration, variable X3 entered the basis, followed by variable X4 in the second iteration. After completing the second iteration, all objective function coefficients became non-negative, indicating that the optimal solution had been achieved. The final simplex table after the second iteration, which represents the optimal solution, is presented in Table 2.

Table 2. Final Result Simplex Optimization with Microsoft Excel

Basic Variables	Z	X1	X2	X3	X4	Slack Variables			RHS
						S1	S2	S3	
Z	1	6782.609	11706.522	0	0	6086.957	0	81521.739	132001739.1
X4	0	3.478	5.196	0	1	2.609	0	-54.348	1572.174
S2	0	2.374	3.215	0	0	1.530	1	-65.217	137469.009
X3	0	-1.652	-2.880	1	0	-1.739	0	44.565	4085.217

The optimal result shows that to achieve the maximum profit of IDR 132,001,739, CV. Titis Konveksi should produce approximately 4.085 units of blazers (X3) and 1.572 units of graduation gowns (X4).

4.3 Result of Calculation using QM for Windows V5

The optimization calculation using the Simplex Method was also performed with QM for Windows V5 to validate the results obtained from the manual calculation. The process was carried out by entering the objective function coefficients and production constraints into the Linear Programming (LP) module of QM for Windows V5. The calculation proceeded through several iterations. In the first iteration, variable X3 (almamater blazer) entered the basis, followed by variable X4 (graduation gown set) in the next iteration. After completing the iterations, all objective function coefficients became non-negative, indicating that the optimal solution had been reached. The iteration process results are shown in Figure 8.

Cj	Basic Variables	Quantity	18000 X1	15000 X2	25000 X3	19000 X4	0 slack 1	0 slack 2	0 slack 3
Iteration 1									
0	slack 1	13,436	3	3.45	2.5	2.05	1	0	0
0	slack 2	157,080	3	2.5	4	2.08	0	1	0
0	slack 3	616	0.08	0.07	0.12	0.08	0	0	1
	zj	0	0	0	0	0	0	0	0
	cj-zj		18,000	15,000	25,000	19,000	0	0	0
Iteration 2									
0	slack 1	602.6664	1.3333	1.9917	0	0.3833	1	0	-20.8333
0	slack 2	136,546.6662	0.3333	0.1667	0	-0.5867	0	1	-33.3333
25000	X3	5,133.3334	0.6667	0.5833	1	0.6667	0	0	8.3333
	zj	128,333,336	16666.67	14583.33	25000	16666.67	0	0	208333.3
	cj-zj		1,333.3333	416.6663	0	2,333.3333	0	0	-208,333.338
Iteration 3									
19000	X4	1,572.1734	3.4783	5.1957	0	1	2.6087	0	-54.3478
0	slack 2	137,469.008	2.3739	3.2148	0	0	1.5304	1	-65.2174
25000	X3	4,085.2179	-1.6522	-2.8804	1	0	-1.7391	0	44.5652
	zj	132,001,744	24782.61	26706.52	25000	19000	6086.96	0	81521.73

Figure 8. Simplex Method Iteration Results

Aside from the iteration process, QM for Windows V5 also provides the final optimal solution summarized in the Solution List. In this solution, the decision variables X3 (almamater blazer) and X4 (graduation gown set) are categorized as Basic variables, meaning they actively contribute to the objective function and have non-zero values. Conversely, X1 (school uniform sets) and X2 (sports uniform sets) are classified as NonBasic variables, which indicates that these products are not produced in the optimal solution, resulting in zero production quantities. The slack variables also reflect the remaining unused capacities in certain constraints. The Solution List summarizing these results is presented in Table 3.

Table 3. Simplex Method Solution List

Variable	Status	Value
X1	NONBasic	0
X2	NONBasic	0
X3	Basic	4085.22
X4	Basic	1572.17
Slack 1	NONBasic	0
Slack 2	Basic	137469.0
Slack 3	NONBasic	0
Optimal Value (Z)		132001700

The Solution List shows that the optimal production combination consists of 4.085 units of almamater blazers (X3) and 1.572 units of graduation gowns (X4), achieving a maximum profit of IDR 132,001,700. This result is consistent with the manual calculation. The slight difference from the iteration result (IDR 132,001,744) is likely due to rounding differences in the software's internal calculations, but it does not affect the validity of the obtained optimal solution.

4.4 Result of Black Box Testing

Black box testing was performed by executing multiple test scenarios to ensure that each system function operates according to the defined specifications. The testing focused on verifying whether the system correctly processed input data and produced expected output results in accordance with operational needs. The process involved evaluating various core functions of the system, including data input, optimization calculation, result visualization, and system interaction, covering both normal operations and potential boundary conditions to ensure stability and reliability. The testing was conducted directly by the director of CV. Titis Konveksi as the end user to evaluate the system's functionality and usability based on real business processes, including data entry forms, constraint inputs, optimization execution, result comparison, and report generation. The results of the black box testing are summarized in Table 4.

Table 4. Black Box Testing Result

No.	Test Case	Test Steps	Expected Result	Status
1	Login with valid credentials	Enter valid username and password, then click login	Login successful, redirected to dashboard	Successful
2	Display uniform types data	Click the "Manajemen Jenis Seragam" menu to view the results	Uniform types data stored in the database is displayed	Successful
3	Add uniform type data	Click "Tambah Jenis Seragam", fill in uniform name, selling price, profit, and total production, then save	Uniform data saved in the database	Successful
4	Edit uniform type data	Select data, click "Edit", modify uniform name, selling price, profit, and total production, then save	Uniform type data successfully updated and stored in database	Successful
5	Delete uniform type data	Select uniform data, click "Hapus", then confirm deletion	Data successfully deleted from database	Successful
6	Print uniform type data	Click "Cetak" on the uniform type data page	Prints uniform type data in PDF format	Successful

7	Display production constraints data	Click the "Manajemen Kendala" menu to view the results	Production constraint data stored in the database is displayed	Successful
8	Edit constraint data	Select constraint data, click "Edit", change capacity value, then save	Constraint data successfully updated and stored in database	Successful
9	Print constraint data	Click "Cetak" on the constraint data page	Prints constraint data in PDF format	Successful
10	Display detailed constraint data	Click the "Manajemen Detail Kendala" menu to view results	Detailed constraint data stored in the database is displayed	Successful
11	Edit detailed constraint data	Select detailed constraint data, click "Edit", change the required value per uniform type, then save	Detailed constraint data successfully updated and stored in the database	Successful
12	Print detailed constraint data	Click "Cetak" on the detailed constraint data page	Prints detailed constraint data in PDF format	Successful
13	Display objective function and constraint function formulation	Click the "Formulasi Fungsi Tujuan dan Kendala" menu to view the result	Displays the formulation of objective and constraint functions	Successful
14	Print objective and constraint function formulation	Click "Cetak" on the objective and constraint function formulation page	Print the decision variables, objective function and constraints in pdf format	Successful
15	Display simplex calculation results	Click the "Hasil Optimasi Simpleks" menu to view results	Displays results of the simplex method, including production combination recommendations and profit comparison in a bar chart	Successful
16	Print calculation results	Click "Cetak" on the calculation results page	Prints the calculation results in PDF format	Successful

Based on the test results shown in Table 4, all main system features functioned as expected. The system successfully processed input data, performed optimization calculations accurately, and presented output results clearly. No functional errors or system failures were detected during testing, indicating that the system is stable, responsive, and ready to support decision-making for production optimization at CV. Titis Konveksi.

4.5 Result Analysis

To validate the accuracy of the developed system, the optimization results were compared with manual calculations using Microsoft Excel, QM for Windows V5, and the web-based system. All methods produced identical production combinations: 4.085 units of almamater blazers (X3) and 1.572 units of graduation gowns (X4), while production of other uniform types was zero. Although minor differences were observed in the calculated profit values, these discrepancies were insignificant. Microsoft Excel and the web system both generated a profit of IDR 132,001,739, while QM for Windows V5 produced IDR 132,001,744 (Iterations) and IDR 132,001,700 (Solution List). These variations are likely due to rounding differences during iterations. Despite these small differences, the production decisions remain consistent across all methods. Overall, the testing confirms that the developed web-based profit optimization system produces accurate results and functions reliably for optimal production planning.

5 CONCLUSION

This study demonstrates that the developed web-based profit optimization system successfully implements the simplex method to support profit optimization for uniform sales production at CV. Titis Konveksi. Validation using manual calculations (Microsoft Excel), QM for Windows V5, and the web-based system produced consistent production combinations of 4.085 units of almamater blazers and 1.572 units of graduation gowns. Although minor profit differences occurred due to rounding, these variations did not affect production decisions. The system enables CV. Titis Konveksi to improve its profit by IDR 29,142,700 compared to previous actual profits, indicating that the system can serve as an effective decision-support tool in optimizing uniform sales production and maximizing profitability.

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