
| RESEARCH ARTICLE

Interior Design Production Plan Simulation Modeling with Dynamics System: A Case Study of PT. Panutan Sejati

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| ABSTRACT

This research was to make interior design production planning more controlled and optimal. The simulation method was considered able to represent the dynamic form of the system and can find scenarios to solve the problems at PT Panutan Sejati. The qualitative research was at PT. Panutan Sejati models located at the Workshop: Jl. Kartini Health Center No. 113 Kalisari, East Jakarta from June to September 2021. The results showed that from the modeling designed based on existing conditions, in the design production planning at PT Panutan Sejati, the factors influencing production planning were: market demand and the production process. While the factors that affected profit were production costs, labor resource costs, overhead costs, commercial costs, and net revenue. It was necessary for improving the proposed system improvement to create and implement scenarios to fulfill effective and efficient production planning to get increased profits. The scenarios included adding workers and creating a design division. The scenario that gave optimal results in increasing profit was scenario 1. This scenario changed the parameter value of the workforce. Based on changes in labor parameters as a variable in the model, if the percentage of labor was set to 45%, then production costs would decrease every year. It was predicted to reach 21.40% and an increase in profit by 13%, with an average decrease in production costs until 2026.

| KEYWORDS

Simulation Modelling, Production Planning, Interior Design, Dynamic Systems

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1. Introduction

The optimization of Indonesia's creative industry can be in various ways. Indonesia's 2016 Gross National production was the culinary industry, clothing, crafts, architecture, and others. This creative industry can be present with a creative economy (Daubaraitė & Startiene, 2015) which attracts the attention of the cultural economy, which is the main attraction for local and regional economic development (Granpayehvaghei, Bonakdar, Zandiatashbar, & Hamidi, 2019). In the creative industry, creativity is the input, while content or intellectual property is the output (Potts & Cunningham, 2010). The concept of the creative industry is made operational by describing a series of activities in which creativity is valuable (Boix-Domènech & Rausell-Koster, 2018). Initially, this creative industry discourse was developed as a political-economic project at the Department of Culture, Media and Sport (DCMS) by Chris Smith's team at the ministry in the UK around 1997-1998 (Schlesinger, 2017). Based on Madelan's research (2020), the distribution of creative economy products affected export selling prices. It was necessary to increase export demand behavior, compared to export offers of creative economy products. It showed that this creative industry presents enormous potential for developing countries searching to diversify their economy and jump into one of the world's most dynamic economic sectors (Guilherme, 2017). Effective distribution channels can be a source of strategic advantage for, for example, companies (Mulky, 2013). Moreover, the creative economy themes that are relevant to the media cover the extraordinary economic characteristics of cultural and creative content, production, and market activities (Doyle, 2015). The main objectives are the production or reproduction, promotion, distribution, and/or commercialization of goods, services, and activities of a cultural, artistic, or heritage nature (Gerlitz & Prause, 2021). The absorption of labor improvement could optimize the Indonesian creative industry's excess exports products. Creative industry companies working with the government need to increase creative products and absorb Indonesian creative industry

workers(Madelan, 2020). Employment absorption is theoretically complex and broadly empirical. Its interpretation plays a fundamental role in legitimizing and normalizing work practices and employment dynamics in global and local job markets(Rodriguez, Johnstone, & Procter, 2017).

Companies that are competitive to increase market reach require ambitious management to develop effective strategies for their development. The competitive environment affects the company's innovative activities (Huse, Neubaum, & Gabriellsson, 2005). In addition, it is significant to choose the company's strategy correctly because if the company comes to have the same strategy as competitors, it is the same as not having one (Svarova & Vrchota, 2014). In addition, identifying competitive advantage factors can help managers reduce decision-making risk(Hosseini, Soltani, & Mehdizadeh, 2018). Open innovation can be related to competitive advantage through product innovation (Lee & Yoo, 2019). With dynamic or changeable management, especially when describing the effectiveness of performance within the organization(Azad et al., 2017).

It is supported by the rapid development of human needs in Indonesia's creative industry. According to the Indonesian Ministry of Trade (2007), the creative industry is an "industry originating from the utilization of individual creativity, skills, and talents to create prosperity and employment opportunities by generating and exploiting the creative and creative power of the individual". The creative industry can give birth to architects, photographers, fashion designers. One of the fields that are closely related is interior design. This professionalism is not only about organizational rules but also about the development of society. It affects systems and work(Egetenmeyer, Breitschwerdt, & Lechner, 2019). In the context of interior design, professionalization here refers to the process of developing an activity into a generally recognized profession through organizational establishment, articulation, and monitoring of standards and codes of ethics(Lees-Maffei, 2008). Meanwhile, the customers are looking for a strong knowledge designer and background in research methodologies that influence design results(Haddad, 2014).

With the development of design style, the mindset of people who initially arranged their room furniture changed and moved more modern, choosing to use interior design contractors, especially for the upper-middle-class community. Interior design service businesses start from drawing services furniture production to installation to make it easier for people to organize the room(Simon, 2013). It leads to the evolution of design, such as sustainable design (Ceschin & Gaziulusoy, 2016). In addition, designers generate design ideas from emerging inspiration, lifestyle, or even their personal feelings(Lee & Jirousek, 2015). For example, a universally designed concept will provide comfort, adaptability, and flexibility that can help reduce the impact of the human life cycle and encourage citizen participation in society(Kadir & Jamaludin, 2013). Like problem-solving, design is a natural and ubiquitous human activity(Razzouk & Shute, 2012).

In the preparation of interior design planning, it is necessary to consider optimization. So that achieved the lowest cost level for the implementation of the process. For example, it significantly saved computational time during the simulation and optimization process(Su & Yan, 2015). Optimization is not to find one or several optimal plans but to provide a systematic picture related to the decisions made by planners(Schuler, Cajot, Peter, Page, & Marechal, 2018). In addition, a common interior component design concept is resource-efficient and effective in waste management(Celadyn, 2019). A designer also typically moves back and forth through different phases(Soliman, 2017). Meanwhile, production planning is an amalgamation of various production elements, from the daily activities of staff to the ability to realize accurate delivery times for customers. The production planning aimed for the overall production plan formulation and distribution (Zheng, Gao, & Xu, 2019). For example, simulations and genetic algorithm tools evaluate several non-parameter strategies and optimize the two parameterized strategies(Xu & Song, 2020). Production planning and scheduling seek to allocate resources efficiently while meeting customer requirements and market demands which often have conflicting objectives(Clark, Almada-Lobo, & Almeder, 2011). Any manufacturing process can exploit its full potential with effective production planning operations at its core(Kiran, 2019). One of the production planning problems is complex optimization. It involves nonlinear chemical/industrial processes, discrete variables to support the decision-making process, large dimensions due to detailed and complex models of many factories, and uncertainty due to fluctuations and volatility in market demand. In production planning, the process of determining the type and quantity of products produced depending on the period ultimately maximizes demand satisfaction and revenue. Good production planning should utilize all limited resources to increase revenue and take the uncertainty of the market and factory into consideration. Thus market developments and unexpected problems in the factory could adapt to the production flexibility (Sun et al., 2020).

To ensure a cost-effective and robust production plan that considers various factors, three main tasks are involved and repeated discussions with domain experts from industrial collaborators. Some of his duties are as follows(Mula et al., 2006; Sun et al., 2020):

- The first task is resource allocation and production assignment, which is the basis of production planning.
- The second task is to compare production plans at various levels of detail because production planning practitioners (i.e., planners) and plant managers usually need to compare and find the optimal one.

Changes may arise due to uncertainty in supply, production, and demand. It is also necessary to explore the effects and disadvantages.

PT Panutan Sejati is a contractor company engaged in interior design and construction. In the last three years, PT Panutan Sejati has seen an increase in demand for its interior products. This company carries out the production process based on market demand. As a customer places an order, this company will collect information to immediately make designs and manufacture products (furniture) according to the draft design. Such a production system can be called a make-to-order system. The biggest obstacle of this system is that company is hard to schedule and target revenue. Design of project work When no orders come in, this company continues to do interior design with the available team in this condition; the company has excess manpower and can result in soaring production costs with low income. When the company gets a high demand, production resources are not available and cannot be completed at one time. That time, the company can be said to lack manpower. The company must subcontract the work to improve work efficiency, transfer risk, and reduce project complexity. Manpower utilization is indeed one of the factors contributing to production efficiency apart from engine efficiency (Subramaniam, Husin, Yusop, & Hamidon, 2008). The two conditions above indicate an incomprehensive interior design production plan. It results in difficulties for the company to optimally utilize its capacity and resources so that the interior design process that occurs in the company is less effective and efficient, which indirectly impacts the number of production costs (Dzikrillah et al., 2017).

Table 1. Value of True Role Model Interior Design Planning for 2018-2020

Year	Job Value	Profit
2018	150.000.000,-	50%
2019	435.000.000,-	30%
2020	1.575.000.000,-	25%

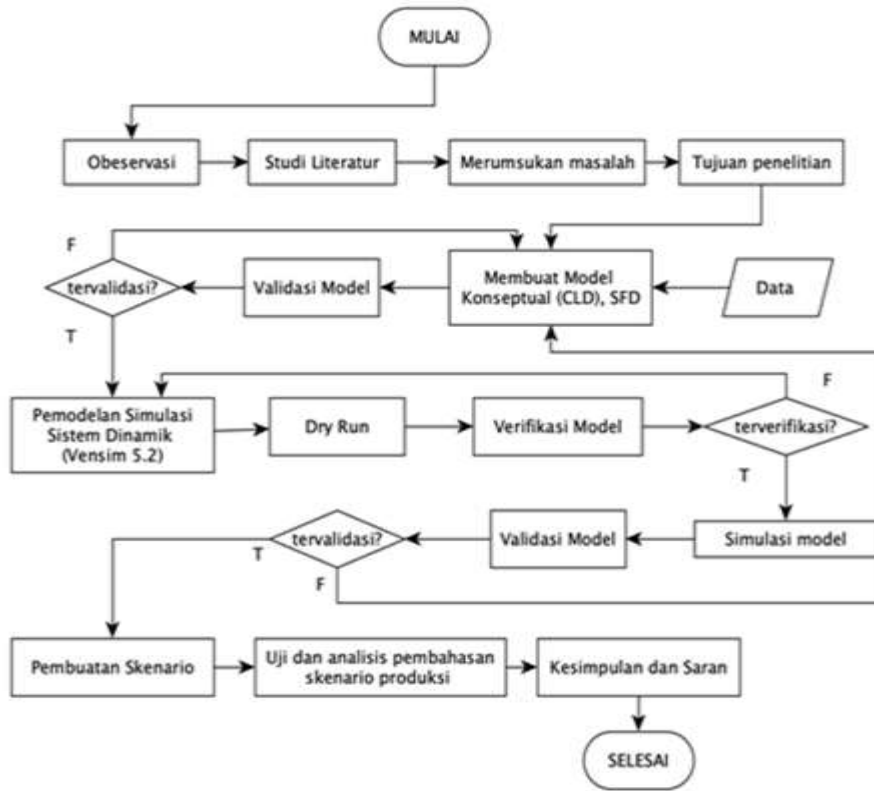
Source: Data Processing Result, 2021

Research conducted by (Purnomo & Izza, 2020) entitled Dynamic System Model of Raw Material Planning for Veneer Products at PT XYZ uses simulation modeling to solve complex company problems and finds policies applied in the production process. This study used three (3) simulated scenarios, namely optimistic, pessimistic, and moderate scenarios. Simulations were formed for a dynamic production planning system based on normal demand predictions, with schemes for raw materials, production personnel, and others. Several recommendations were to minimize the possibility of raw materials being out of stock.

Based on the case at PT Panutan Sejati, this research will create a more controlled and optimal interior design production plan. The author considers that the simulation method can represent a dynamic system and find scenarios to solve the problems described above. The author is interested in researching: "Interior Design Production Planning Simulation Modeling with Dynamic Systems (Case Study: PT. Panutan Sejati)". This planning simulation method is expected to play a role in obtaining policies that can optimize time and streamline production costs for the company.

2. Methodology

The method used in this research was quantitative. The location of the research was at PT. Panutan Sejati models located at the Workshop: Jl. Kartini Health Center No. 113 Kalisari, East Jakarta. The research was from June to September 2021. The data collection technique was by observations and interviews in the field. The flow chart of this research can be seen in the following diagram:



3. Results and Discussion

3.1 Dynamics System Analysis

1. System Identification

a. Production Process Flow

The production process at PT Panutan Sejati begins with a request from a customer. The Marketing Department then records product requests. The product demand is also called PO (purchase order). After recording the PO, the Production Administration Section makes a plan. It contains the design team workforce who will work, the use of design work tools, and processing time by considering the efficiency of the work tools and design team workforce, the expected output, and the level of waste required. The Procurement Section received the submission of the needed auxiliary materials and the materials of all departments, then requested the disbursement of funds to the finance department. The procurement process could begin after obtaining funds. The production process started when the design team was ready as the necessary tools were available. Processing of design concepts into representative designs was by sketching images on paper, PC drawing tools, drawings. At each stage of the process, the senior designer checks. The finished design was sent to the customer after going through the checking drawing process. Customer paid after the product design was received.

b. Variable Identification

Identification of variables was through literature study, interviews, observations, and brainstorming with related parties, such as Production and Engineering Managers, Finance and General Managers, and Assistant Finance Managers. They obtained variables contained in the company's production system.

Table.2 Variable Data Processing Results on Company Production System 2021

No	Variable	Type
1	Production Planning	Stock
2	Market Demand	Constant
3	Production process	Auxiliary
4	Profit	Stock
5	Net Revenue	Auxiliary

6	Gross Revenue	<i>Auxiliary</i>
7	Selling price	<i>Constant</i>
8	Tax	<i>Constant</i>
9	Commercial Expenses	<i>Auxiliary</i>
10	Administrative costs	<i>Constant</i>
11	Marketing fee	<i>Constant</i>
12	Production cost	<i>Auxiliary</i>
13	Production Resources	<i>Auxiliary</i>
14	Labor	<i>Constant</i>
15	Working tool	<i>Constant</i>
16	Overhead Cost	<i>Auxiliary</i>
17	Freelance Workforce	<i>Constant</i>
18	Place Fee	<i>Constant</i>
19	Electricity cost	<i>Constant</i>

c. Interaction between Variables

After identifying the variables, the next step was identifying the interactions between variables in the system. In a production system, several variables were related and interacted with each other.

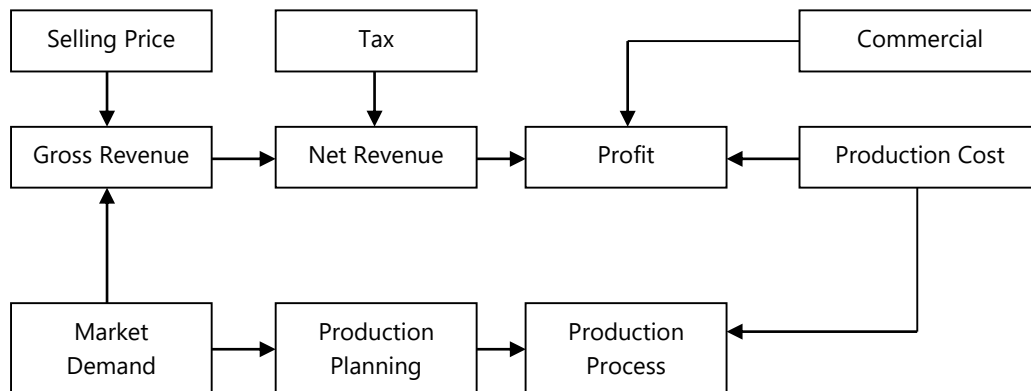


Figure 1. Interaction between Variables

2. System Conceptualization

a. Causal Loop Diagram

Making Causal Loop Diagram (CLD) aims to determine the pattern of behaviour and the relationship between variables in the simulation conceptually. Thus it can be useful in determining the suitability of the model with behaviour in life. Causal diagrams were by determining the influential variables in the system. This diagram illustrates the relationship between positive (+) and negative (-) effects on the system. Then it is also described in a Causal Loop Diagram (CLD).

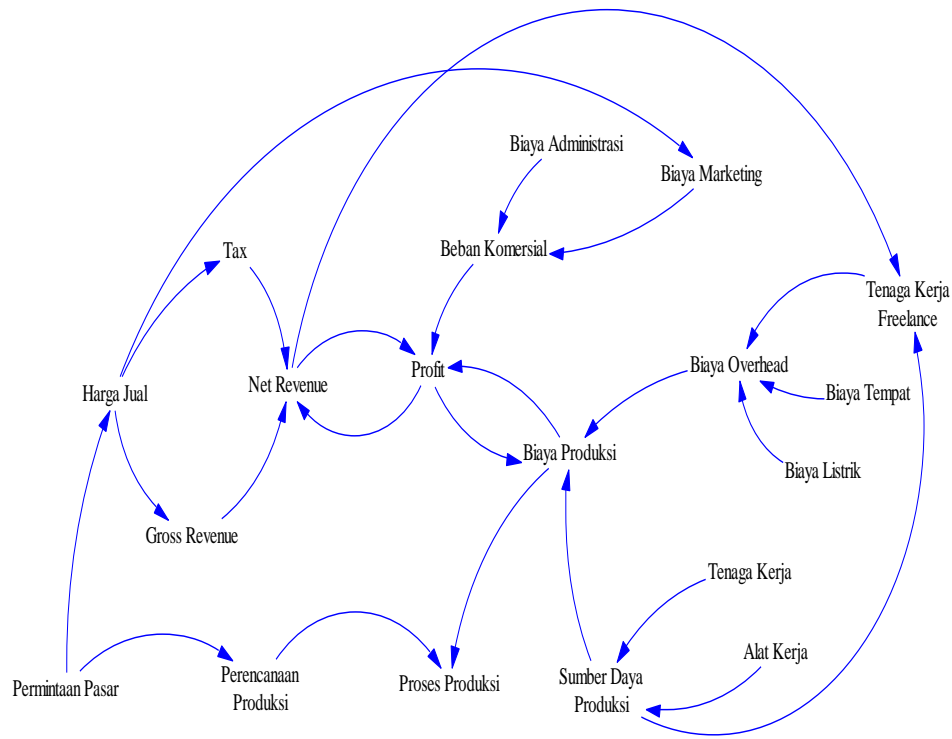


Figure 2. Causal Loop Diagram Existing

b. Stock and Flow Diagram

Stock and flow diagrams are based on causal loop diagrams with the main variables of production planning. The profit was based on the modeling objectives. The types of variables described are per the results of the identification of variables and the types of variables (stock, auxiliary, constant, or data). After describing the variables according to their type, the stock and flow diagram also describes the relationship between the previously identified variables.

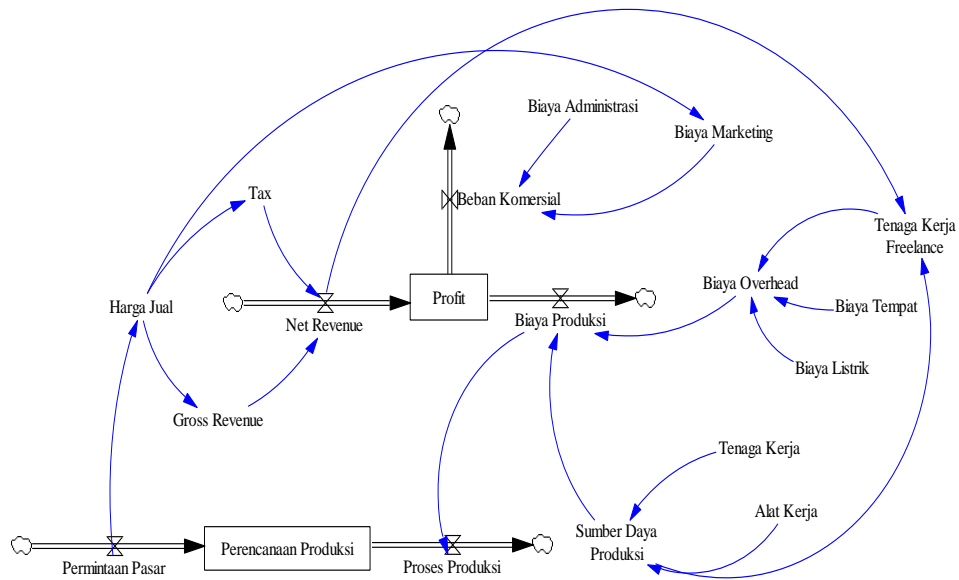


Figure 3. Stock and Flow Diagram Existing

3. Model Simulation

a. Model Verification

Verification is the translation of the conceptual simulation model (flow diagram and assumptions) that have been made in the previous stages into a programming language correctly. Verification was done by checking the error rate. To check whether the model is free from errors or not. The goal is to examine and test the simulated model. It has become a representative concept correctly or not with the current conditions in reality (actual conditions). After making the model and entering the calculation parameters, the next step is to run the model using the Ventana Simulation (Vensim) application to display the simulation results. If the model described does not match, Vensim will display an error warning and vice versa. If it does not show an error message, then the model can be said to be verified (error-free). Before running the model, it is necessary to make adjustments or settings first. One of them is to set the length/duration of the simulation run time. The duration is adjusted according to the data obtained along with the time interval, either days, months, or years.

b. Model Validation

After the model has been created, the next step is to test or validate the model whether it is an accurate representation of the modeled real system. Model validation is done by comparing the suitability of historical data (obtained from sources) with simulation results. This comparison proves that the data from the simulation results are historical data so that the model made can be declared valid. The graphs show comparisons between historical data from the simulation results of the base model.

To validate is through a behavior validity test to check whether the model created has produced acceptable behavior (behavior output). The variables that need to be validated are those affecting the purpose of the simulation. The validation results show that the production and profit planning of PT Panutan Sejati has been valid.

4. Scenario Formation and Result Analysis

a. Scenario Design

After the base model has been validated and verified, the next stage is scenarios. The scenario becomes a proposed system improvement, per the initial goal of making a dynamic system model for the production planning design of PT Panutan Sejati. Scenario creation could be by adding variables and parameters that have a dominant influence on the overall base model, furthering determining the impact of these changes on other variables. There are two types of scenarios, namely a structured scenario and a parameter scenario. The structural scenario is by changing the structure of the model by adding or subtracting variables. The parameter scenario is by changing the parameter value of a variable that affects the model. Both structured and parameter scenarios provide suggestions for improvements to make a dynamic production planning system of PT Panutan Sejati. It is to increase profit and efficiency in production planning. The base model can be developed into a model scenario if the model requirements, namely verified and valid, have been met. There are two scenarios made to fulfill the purpose of this thesis, namely the scenario of adding a workforce and the scenario of adding a design division.

b. Scenario Implementation

The outcome of Scenario 1: Adding Manpower

Implementing a parameter scenario, namely changing the yield value by adding more workers, can reduce the freelance workforce. The following is a graph showing the total cost of production:

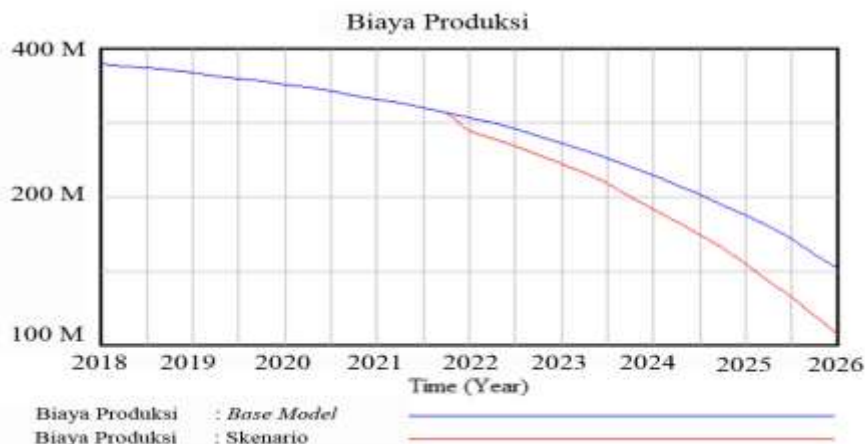


Figure 4. Scenario 1 Adding Labor Production Costs

According to the graph shown above, the total cost of production in the base model decreased more when using the scenario. At the beginning of the period, the amount was almost the same. Both had the same variables in the upgraded scenario in the model up to 2022, resulting in a decrease in production costs from the base model to the scenario by 21.4%.

With the decrease in production costs, there is also a change in the company's profit shown in the following figure.

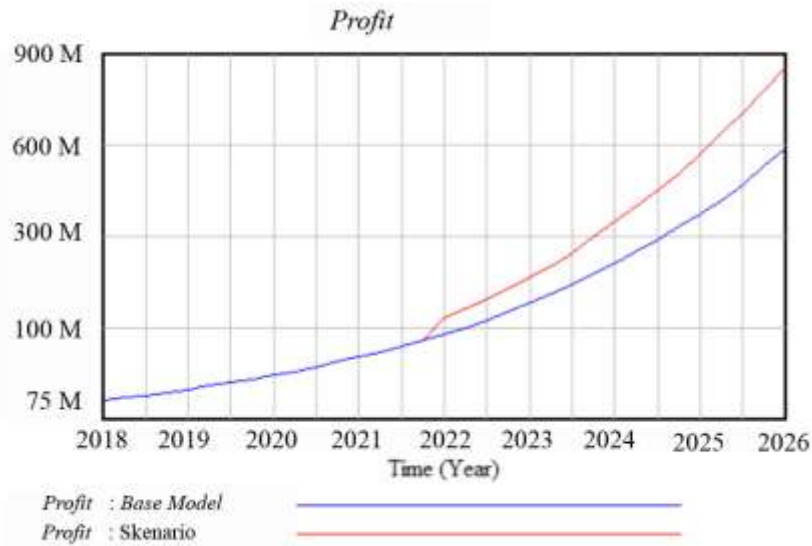


Figure 5. Reducing the Freelance Workforce Scenario 1: Increasing Profit Value

When the freelance workforce decreases, the company's profit will increase. This is also shown by the graph in the picture above that Profit has increased from the base model. There is an increase in the fulfillment ratio from the base model to the scenario in this scenario, which is calculated by 13%.

3.2 Scenario Outcome 2: Creating a Design Division

Implementing a structural scenario adding a design division variable to the model can eliminate freelance workers to increase company profits. The graph shows the total production costs in the following figure:

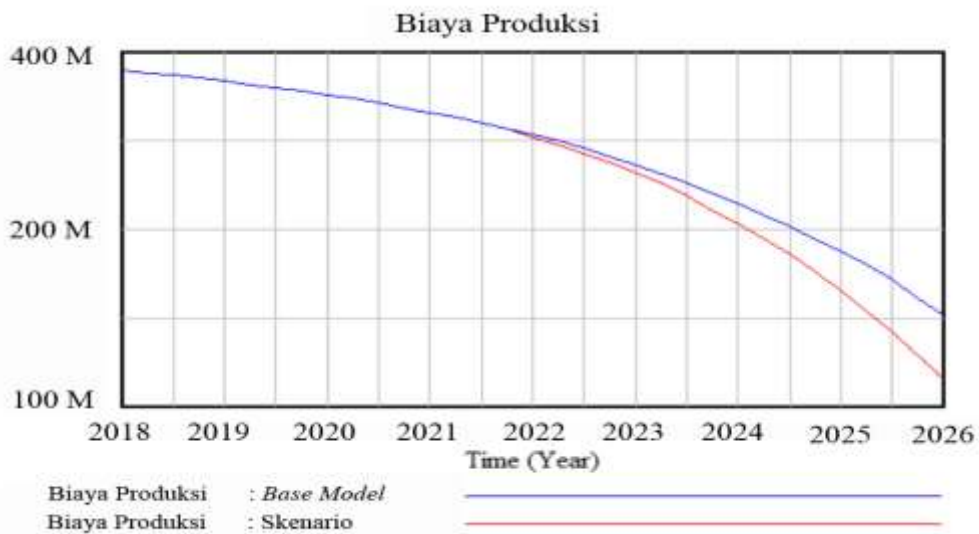


Figure 6. Scenario 2 Production Costs: Create a Design Division

According to the graph shown in the image above, the total design production cost in the base model with scenarios decreases more when using scenarios. There is a decrease in design products from the base model to the scenario by 12.71%. With the increase in the production of dining designs, there is also a change in the company's profits.

**c. Analysis of Scenario Implementation Results
Production Cost**

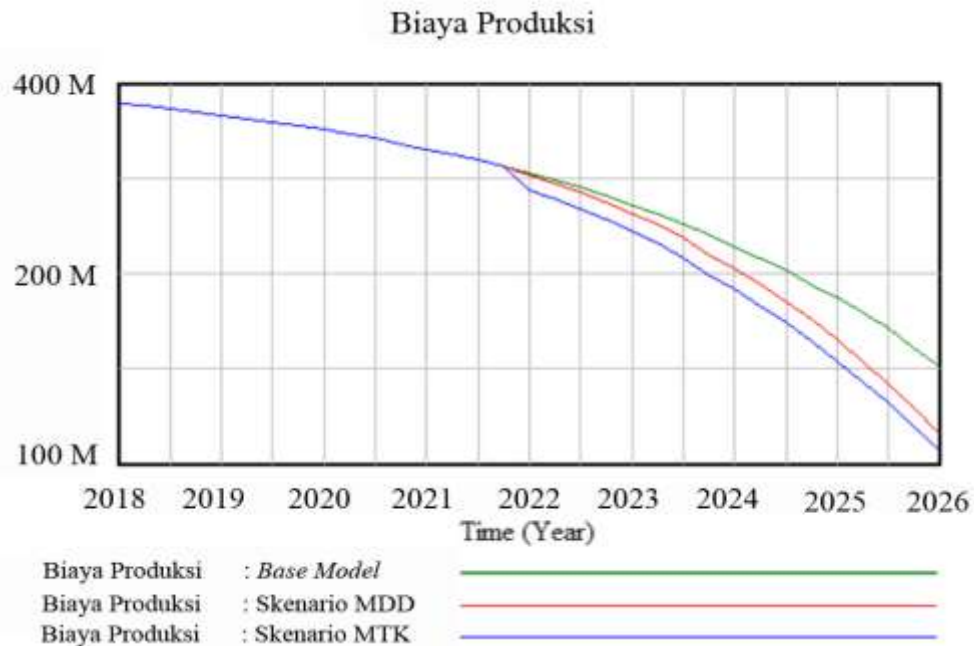


Figure 7. Production Cost Scenario Comparison

The graph in Figure 4.21 explains the number of production costs each year by implementing the two scenarios discussed. According to the graph, using the scenario of adding more workers (scenario 1) results in the lowest production cost among the others. The overall scenario has increased from year to year. In addition, the use of the second scenario, which is to create a design division, also results in lower production costs. The difference in comparison between scenario 1 and scenario 2 reduced design production costs is 21.40%, 8.69% higher than scenario 2. The following is a comparison table for the predicted total design production costs per year until 2026 in table 4.14.

Table 3. Comparison of Design Production Cost Scenario Results

Year	Scenario 1	Scenario 2
2022	319277217	293750315
2023	268630830	247153216
2024	209311199	192576317
2025	125401385	115375274
2026	60187387	55375276
2022-2026	982808020	904230398

Source:Data Processing Result,2021

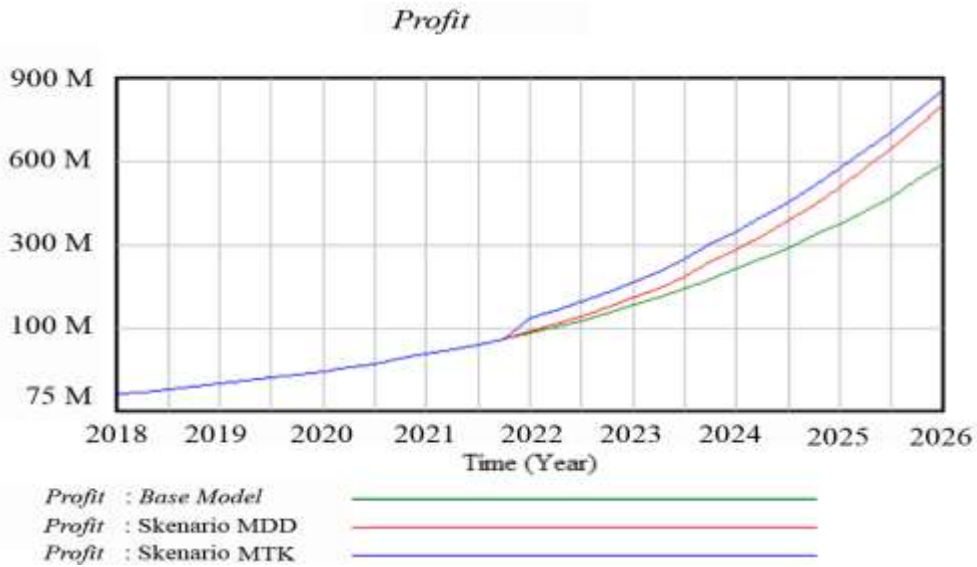


Figure 8. Profit Comparison of Profit Scenario

The graph in the picture explains the amount of profit each year by implementing the two scenarios discussed. From the graph, the scenario of adding more workers (scenario 1) produces the highest profit among the other scenarios. The overall scenario has increased from year to year. In addition, the use of the second scenario, which is to create a design division, also generates quite an increasing profit. The difference in comparison between scenario 1 and scenario 2 used to increase profits is 13%, 5.88% higher than scenario 2. The following is a comparison table for the number of predicted profits per year until 2026, which is shown in the following table:

Table 4. Comparison of Profit Scenario Result

Year	Scenario 1	Scenario 2
2022	122052523	115274389
2023	185668543	175357521
2024	346760881	327503665
2025	630382594	595374569
2026	937046039	885007593
2022-2026	2221910580	2098517737

Source:Data Processing Result,2021

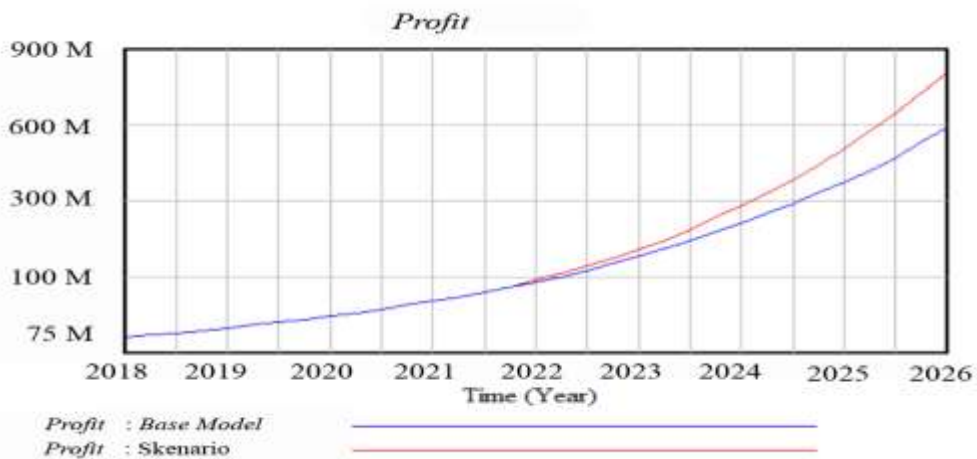


Figure 9. Adding Division of Design Scenario 2: Increase Profit Value

When the regular production costs and freelancers are lost, the company's profit will increase. Profit has increased from the base model. There is an increase in the fulfillment ratio from the base model to the scenario in this scenario, which is calculated at 7.12%.

d. Scenario Implementation

Based on the scenarios that have been made, then convey some of these scenarios to provide a more comprehensive picture, which is in the following table

Scenario	Scenario Description	Results
Adding Labor	This scenario changes the parameters of the labor yield variable to see if the amount of production costs carried out is more optimal.	Based on changes in labor parameters as a model variable, if it was assumed with the 45% equation, the production cost has decreased every year. With an average reduction in the freelance workforce until 2026, it is predicted to reach 21.40%. So this scenario also increases profit by 13%.
Making Design Division	This scenario changes the structure and parameter variables in the model. The added variable is the design division, while the parameter changed is freelance labor.	The production costs can be reduced by 12.71% and increase profit by 7.12% through creating a design division, then based on the simulation results using the variables and parameters above.

Source: Data Processing Result,2021

4. Conclusion

From the model designed based on existing conditions, in the design production planning at PT Panutan Sejati, the factors that influenced the production planning were the market and the production process. The factors that affected profit were production costs, labor resource costs, overhead costs, commercial costs, and net income. Scenarios were made and implemented to fulfill effective and efficient production planning, increasing profits to improve repair offers. The scenarios carried out included adding workers and making divisional designs. Scenario 1 gave optimal results in increasing profit. This scenario changed the parameter value of the workforce. Based on changes in labor parameters as a variable in the model, as the percentage of labor was set to 45%, then production costs would decrease every year. The average decrease in production costs until 2026 is predicted to reach 21.40% and an increase in profit by 13%.

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