Enhancing the Effectivity and Efficiency of Production System using Discrete Event Simulation Approach (A Case Study in PT Solo Grafika Utama)

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Abstract

As a newspaper printing company, PT Solo Grafika Utama has the responsibility to be agile and produce on time so that customers could read the newspaper with an updated news early. This could be done with the implementation of balancing the system of production, system of distribution, and also system of content creation. Newspaper printing companies have several characteristics which are limited time of production, tight distribution schedule, and the unavailability of a warehouse. Aligned with its characteristics, in the real-world case, PT Solo Grafika Utama still faces some obstacles in balancing its system and operations, especially in its production system. In this study, Discrete Event Simulation approach is used to find the most effective and efficient combination of machine, layout, and resource to achieve a highly effective and efficient system of production by reducing idle value. By analyzing previous research and the actual production layout of PT Solo Grafika Utama, two solution scenarios were considered. Using the FlexSim software, the results show that the first scenario, “One Line One Operator” succeeded in reducing idle value and the second scenario, “One Source One Operator” also succeeded in reducing idle value from previous research Out of the two proposed solution scenarios, the second scenario was chosen as the most effective and efficient system of production that can be implemented.

Keywords
Discrete Event Simulation, Production System, Effective, Efficient, Idle Value.

1. Introduction

Supply chain management (SCM) is the balance of inventory flow, information and currency between the different drivers of supply chain (Mentzer et al. 2001). Every organization has supply chains depending on the size of the organization and the type of product manufactured. Supply chain processes consist of customer orders, order processing, inventory, scheduling, transportation, storage and customer service. Competition for market share is no longer between single firms but mostly between supply chains (Taylor 2003). All organizations have supply chains of varying degrees, depending upon the size of the organization and the type of product manufactured. Included in this supply chain process are customer orders, order processing, inventory, scheduling, transportation, storage, and customer service. Competition for market share is no longer between single firms but mostly between supply chains (Taylor 2003). The supply chain process in PT Solopos is run by four entities namely PT Aksara Solopos as the publisher company, PT Solo Grafika Utama as the printing company, supplier and newspaper agent and retailer. PT Aksara Solopos manages the content of the newspaper by doing news coverage, script writing, editing as well as forecasting the number of demands. PT Solo Grafika Utama manages the production process of the newspaper by purchasing materials from tint and paper suppliers, printing, controlling the quality of end, packaging, as well as handing the end product over to distributor agents who will distribute the product to retailers and end customers.

As a big company in Surakarta, PT Solopos attempts to continuously grow and compete in the industry. Several research have been done before in the attempt to better the distribution and production process of Solopos newspaper. Maisyaroh (2017) used supply chain operations Reference (SCOR) 11.0 to measure the performance of supply chain systems in Solopos with the goal of finding the effective supply chain system for the newspaper industry. Saraswati et al. (2017) used a sweep algorithm to identify the distribution route in Solopos. Putri et al. (2018) also used SCOR to enhance the supply chain performance in Solopos. Next, Jodinesa et al. (2019) used a joint delivery planning method with time windows to enhance the supply chain system as well as increase profit by reducing production and distribution cost. Febriandini et al. (2019) attempted to enhance the distribution process in Solopos by analyzing daily newspaper distribution in Solo using Agent Based Simulation method. Riskadayanti (2019) also tried to find the most effective and efficient production process in Solo Grafika Utama using a discrete event simulation method by reducing idle value time. Adam et al. (2020) attempted to solve the routing problem in Solopos, this time they used saving matrix methods and managed to find the shortest distribution time that cost only 1 hour with 16 kilometers of distance.

This research put more focus into PT Solo Grafika Utama as there was not a lot of research done before in this company, which we believe hold the most crucial process in the business, that is the whole production process of Solopos newspaper. As a newspaper printing and publishing company, PT Solo Grafika Utama has some unique characteristics where the quality of their services highly depends on the punctuality of the newspaper arrival to the customer hand. According to Riskadayanti (2019), newspaper printing companies do not apply the inventory system because the production moves fastly to chase the actuality of the news itself. One of the factors that affect punctuality is the balance of the production system. While doing the business process, the different needs of all divisions must be considered and be balanced. According to the production side, the production process must be done as fast as possible so the distribution process could be done earlier so the customer easily gets the product punctually (Ratnasari et al. 2018). When the distribution lateness occurs because of the production process that does not meet the target, the satisfaction of the customer will be decreased.

PT Solo Grafika Utama as the newspaper printing company often has some problems in the production process. Every year, the lateness in the production process reaches 10% (Arsyifa 2019). Some researches were conducted to identify and solve this problem. Ratnasari et al. (2018) have found that there was an infectivity in the form of unbalanced production process so an improvement strategy using SCOR and SCRIS methods was applied. Ratnasari et al. (2018) also used a two phase HOR method in the other research with the same goal. Other research by Aqidawati (2018) using an analytic model of integration of production and distribution to determine the optimal production amount and the proper distribution so the minimum cost would be gained. This problem in the production process highly resisted PT Solo Grafika Utama in their business growth. One of the ways to increase the business growth is by increasing the production effectiveness. The production effectiveness is highly affected by the interaction between the components within the production system. Without the right configuration of the components, the production process will not run efficiently. One of the examples in the improper production component configuration was found by Riskadayanti (2019). Riskadayanti (2019) found that there was a high idle machine value in the production process that affected the production time. This made the production time longer and also made the distribution process delayed. The delay of the distribution process highly affected the newspaper quality.

One of the methods that is widely used to increase the production process efficiency is discrete event simulation (DES). DES is a modeling method that is able to represent the interaction between all system components as one event. DES is used to identify the flow process of the raw material, identify the utility level of the machine, and identify the potential bottlenecks that could happen during the production process (Riskadayanti 2019). This research will try to improve the production process using DES to achieve a more effective production process. The objective of this research is to find the most effective and efficient combination of machine, resource, and operator to achieve a highly effective and efficient system of production by reducing idle value.

2. Literature Review

Discrete event simulation (DES) is a system modeling where the status of the system variables only change in some time point (Sulistyoningrum 2018). DES has been used widely for modeling the process in many industries. Dayarathna et al. (2019) applied DES to maximize the patient throughput in an outpatient clinic located at Mississippi State University. This research observed the system in the X-ray laboratory and manipulated the patient routing to see the impacts on the wait time and throughput of patients. The result was the new routing patient (40% patient follow normal route in X-ray laboratory with doctor 1, 30% patient rerouted to doctor 2, and 30% patient go to doctor 3) that decreased the waiting time and increased approximately 40% of the patient throughput. While in manufacturing sectors, Ishak et al. (2020) used DES in modeling the vise production and to identify the time required to finish a vise. The results of the time required to finish a vise was 2,09 hours.

In the newspaper industries, Riskadayanti (2019) has already applied DES by modeling the flow process of the raw material at PT. Solo Grafika Utama. The problem is the production process has a high machine idle value. DES was applied to solve this problem with the aim to reduce the idle value using FlexSim software by adding and reducing the amount of the machine. The results were three scenarios with an optimal scenario by adding one counter machine to the initial condition so there were three printing machines and three counter machines. The machine idle values from the optimal scenario were the most efficient among the other scenarios both in printing machine (40%, 13%, and 40% for printing machine 1, 2, and 3 compared to 5%, 52%, and 80% in the initial scenario) and counter machine (2%, 40%, and 14% for counter machine 1, 2, and 3 compared to 5% and 80% in the initial scenario). This study tried to expand the model from Riskadayanti (2019) to be more comprehensive. The previous study only focused on the amount of the machines while this study expanded the factors that affected the unbalancing of the production system not only the amount of the machine but also the task distribution of the workers.

3. Methods

Discrete event simulation (DES) is used to solve this problem. This study used FlexSim, a simulation software, for creating and modeling the newspaper production of PT. Solo Grafika Utama. The model is used to identify the flow of the raw materials, the machine utility, and where bottlenecks might occur. Once the bottleneck has been identified, some improvement scenarios would be constructed to eliminate the bottleneck and make the production process to be more effective and efficient. The method flowchart in this research is shown by figure 1.

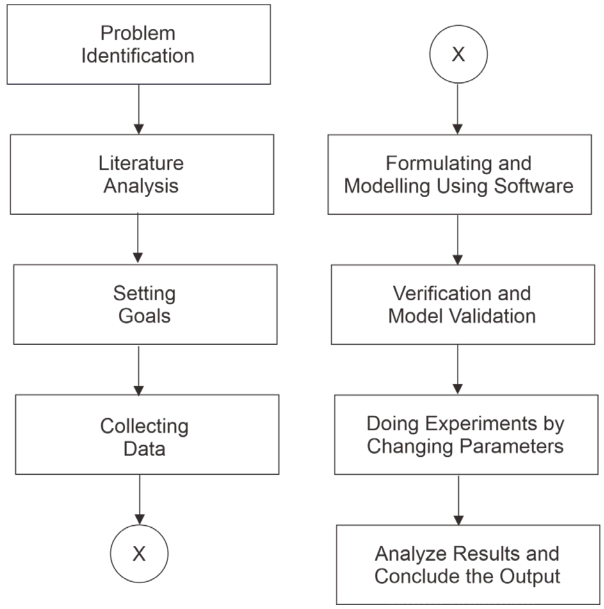

Figure 1. Methods Flowchart

Field observation in PT Solo Grafika Utama couldn't be conducted due to the Covid-19 pandemic. Hence, problem identification is done based on desk research or literature reading only. During problem identification, journals and articles related to the production efficiency of PT Solo Grafika Utama are reviewed. According to Riskadayanti (2019), newspaper printing companies do not apply the inventory system because the production moves fastly to chase the actuality of the news itself. While doing the business process, the different needs of all divisions must be considered and be balanced. According to the production side, the production process must be done as fast as possible so the distribution process could be done earlier so the customer easily gets the product punctually (Ratnasari et al. 2018). When the distribution lateness occurs because of the production process that does not meet the target, the satisfaction of the customer will be decreased. Arsyifa (2019) stated that the lateness in the production process reaches 10%. By that, it could be concluded that the production efficiency in PT Solo Grafika Utama needs to be improved.

In literature analysis phase, a deeper critical analysis of each paper is conducted to find the gap that needs to be filled or solved for present research. An interesting gap was found in the research written by Riskadayanti (2019). The DES method was used to solve the problem regarding the production efficiency in PT Solo Grafika Utama. However, the end result of the idle value was still considered high. Therefore, this study tried to expand the model from Riskadayanti (2019) to be more comprehensive and feasible. The previous study only focused on the amount of the machines while this study expanded the factors that affected the unbalancing of the production system not only the amount of the machine but also the task distribution of the workers. In setting goals phase, goals and objectives were prepared. The goal is to find the most effective and efficient combination of machine, resource, and operator to achieve a highly effective and efficient system of production by reducing idle value.

Due to the pandemic, this research is unable to collect the data on site so secondary data are used. Some of the data are the entities, resources, and events in the newspaper production process especially in PT Solo Grafika Utama. All the data that have been collected before are then used in formulating and creating the model so the model can represent the actual production system. This research uses FlexSim to create the model and to optimize it. FlexSim has 3D visualization in presenting the simulation so better understanding could be gained. The model that has been generated will be verified in order to make sure that the model can run perfectly based on all of the values that have been inserted. The next step is validating the model to make sure that the model can represent the real system. We conducted an experiment by changing the existing parameters in the production process so that there were two alternative improvements to the newspaper printing process. This study uses an improvement proposal from the previous paper with 3 printing machines and 3 counter machines as the basis for the newspaper printing process. This time, we balance the jobdesk of the three operators in the field with two scenarios to determine the best proposal. Finally, three scenarios were analyzed to determine which proposal is the best and can be applied in the printing process at PT. Solo Grafika Utama.

4. Data Collection

We used secondary data in this research especially in the newspaper production process. The primary source that is used is a paper by Riskadayanti (2019) titled "Discrete-Event Simulation of a Production Process for Increasing the Efficiency of a Newspaper Production". The data that are collected are entities, resources, and events. Entities are the objects that move through the system and in this research the entities are the raw materials (paper, ink, and plate). Resources are the objects that start and trigger the events. In this research the resources are machines and operators. While events are the processes that occur and in this research the events are the pre-printing and printing process. This research will put more focus on the printing process. The other data needed are the production hour, the processing time, raw material's arrival time, raw material's quantity in each arrival time, the production layout, and the engine capacity. After all the data is collected, the next step is data processing by simulating newspaper production using FlexSim software. The following figure 2 is a detailed data processing flowchart.

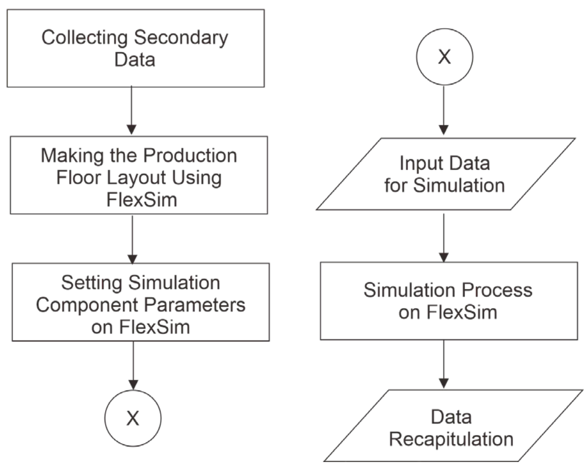

Figure 2. Data Processing Flowchart

5. Experiments and Results

5.1 Formulating Model in FlexSim

The machines used in the newspaper production process are three printing machines and two counter machines that function to count printed newspapers. However, in running the simulation there are several adjustments so that the machines used are of three types, namely processor, combiner, and separator. processor object, combiner object, and separator object are used as a resource that will combine all of the raw materials and produce copies of newspapers. quantity of newspaper calculated by processor objects. So, the standard time of each process on each machine is 0.01 minutes and can be described in the table 1.

Table 1. Standard Time of Each Processes

Machine	Processing Time
Combiner	0,01 minute
Separator	0,01 minute
Processor	0,01 minute

Arrival time of raw material varies but has been adjusted to real conditions which include time on pre-printing process and material transfer. The quantity of raw material has been calculated for the needs of three printing machines and can be described along with the arrival time of raw material in the table 2.

Table 2. Arrival Time and Quantity of Raw Material

Raw Material	Arrival Time	Quantity
Paper	78 minutes	9 rolls
Ink	79 minutes	6 pails
Plate	0 minute	6 plates
	3 minutes	10 plates
	6 minutes	10 plates
	9 minutes	10 plates

Engine capacity for each printing machine is 9000 copies of the newspaper, so the total with three machines is 27000 copies of the newspaper. The number of operators is three. Working hours of the printing process for the pre-printing section is 20.00 – 02.00 WIB while for the production part it is 21.00 – 04.00 WIB. Based on the actual production process in PT Solo Grafika Utama and all data that have been collected before, the actual production process model is built in FlexSim as shown in figure 3.

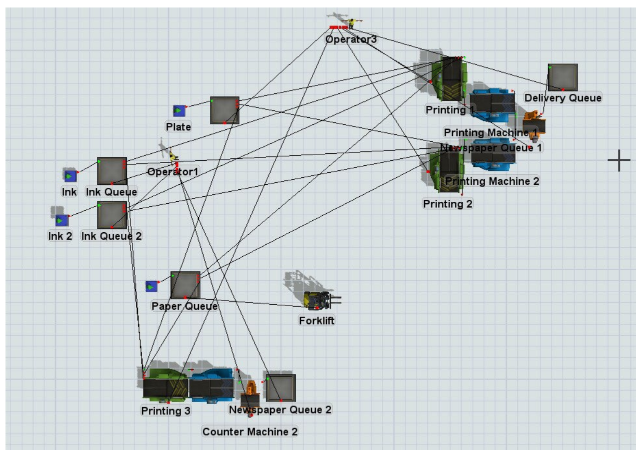

Figure 3. Actual Production Process Model

The printing machines are shown in combiner (green) machines and separator (blue) machines while the counter machines are shown in processor (orange) machines. Counter machine 1 is used to count the total number of newspapers produced by printing machine 1 and printing machine 2 while counter machine 2 is used to count the total number of products from printing machine 3.

5.2 Verifying and Validating Model

Verification is done by running the model to ensure that the model runs perfectly based on the parameter and value that have been adjusted. Here is the visualization of the verification results of the actual production process model, shown in figure 4.

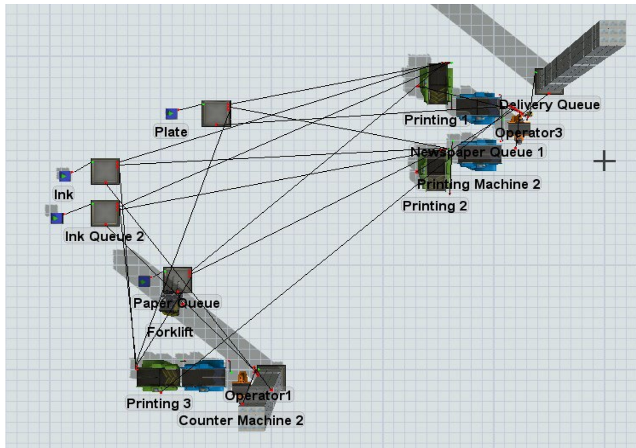

Figure 4. Verification Results by Running the Actual Production Process Model

Based on the verification results, it can be concluded that the model runs appropriately based on the parameter. There are no error notifications while running the model. The next step is validation that is done by replicating the model ten times. The previous research by Riskadayanti (2019) has already shown the results of the idle value in both printing machine and counter machine. All the results are shown in figure 5, figure 6, table 3, and table 4.

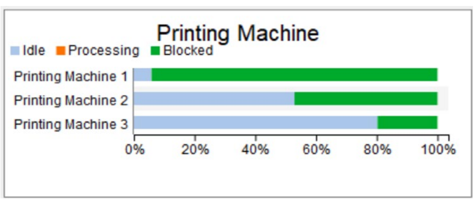

Figure 5. Process Data of Printing Machine in the Actual Model's Simulation
Source: Riskadayanti (2019)

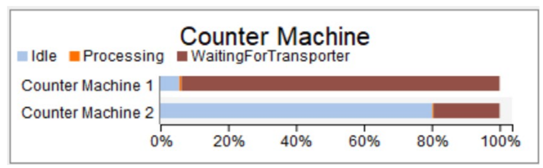

Figure 6. Process Data of Counter Machine in the Actual Model's Simulation
Source: Riskadayanti (2019)

Table 3. Idle Value of Printing Machine in Actual Model's Simulation
Source: Riskadayanti (2019)

Replication	PM1	PM2	PM3
1-10	5%	52%	80%

Table 4. Idle Value of Counter Machine in Actual Model's Simulation
Source: Riskadayanti (2019)

Replication	CM1	CM2
1-10	5%	80%

For the nomenclature, "PM" stands for printing machine and "CM" stands for counter machine. The result shows that there are some machines that have very high idle values reaching 80% (PM3 and CM2) and 52% (PM2) while the other machines have low idle value, only 5% (PM1 and CM1). This indicates that the production process is unbalanced. Some machines operate with high intensity while other machines do not. It highly affects the production process completion time. Longer the production process completion time, longer the delay for distributing the newspaper.

5.3 Creating Experiment's Scenarios

To solve the unbalanced idle value, the previous research by Riskadayanti (2019) and this research proposed some solutions that will be explained below.

A. The Best Solution in Previous Research

The previous research of Riskadayanti (2019) proposed a best solution in which another one counter machine was added. Thus, there are three counter machines in total. The model is shown in figure 7.

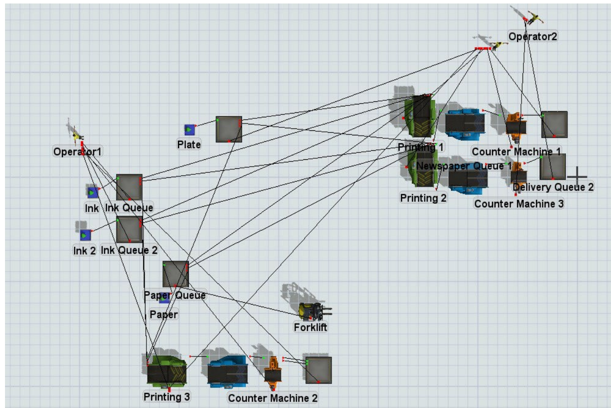

Figure 7. The Best Solution in Previous Research
Source: Riskadayanti (2019)

The addition of a counter machine was originally planned to fasten the material counting process, turns out this solution still doesn't change the number of newspapers produced meaning this solution still results in a total 27000 copies of newspaper just like the actual model with the same amount of production time. However, this solution could reduce the idle value of the counter machine process compared to the actual condition. All data and results are shown in figure 7, figure 8, table 5, and table 6.

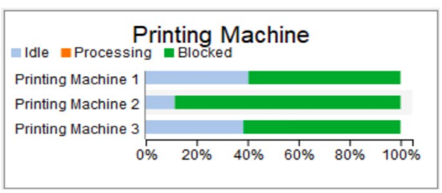

Figure 7. Process Data of Printing Machine in the Previous Research Solution
Source: Riskadayanti (2019)

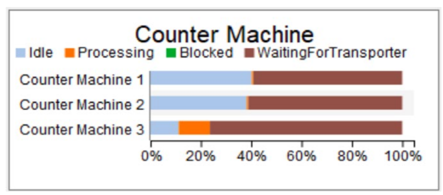

Figure 8. Process Data of Counter Machine in the Previous Research Solution
Source: Riskadayanti (2019)

Table 5. Idle Value of Printing Machine in the Best Solution of the Previous Research
source: Riskadayanti (2019)

Replication	PM1	PM2	PM3
1-10	40%	13%	40%

Table 6. Idle Value of Counter Machine in the Best Solution of the Previous Research
source: Riskadayanti (2019)

Replication	CM1	CM2	CM3
1-10	42%	40%	14%

Looking at the previous solution by Riskadayanti (2019), the idle value of both printing and counter machines is still considered high, reaching 40% in some machines. Besides, the idle distribution is not balanced yet because some operators in the previous solution have given a larger task in handling the machines and the sources while the others have just given the smaller ones. Thus, in this paper several production models were simulated in order to improve the solution given to PT Solo Grafika Utama.

B. Proposed Solution I (One Line, One Operator)

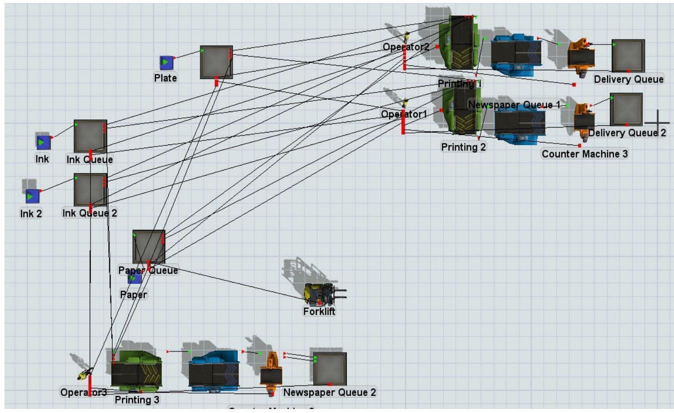

Figure 9. First Solution "One Line One Operator"

The first proposed solution is called "One Line, One Operator" as shown in figure 9. Each operator is responsible for handling one printing machine and one counter machine. This one operator in each line is also responsible for providing ink, paper, and plate to that one printing and counter machine. Results from this solution are explained in figure 10, figure 11, table 7, and table 8.

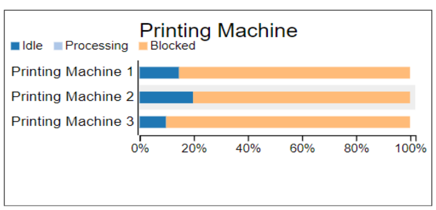

Figure 10. Process Data of Printing Machine in the First Proposed Solution

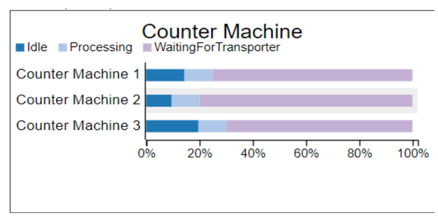

Figure 11. Process Data of Counter Machine in the First Proposed Solution

Table 7. Idle Value of Printing Machine in the First Proposed Solution

Replication	PM1	PM2	PM3
1-10	15%	20%	10%

Table 8. Idle Value of Counter Machine in the First Proposed Solution

Replication	CM1	CM2	CM3
1-10	14%	10%	20%

C. Proposed Solution II (One Source, One Operator)

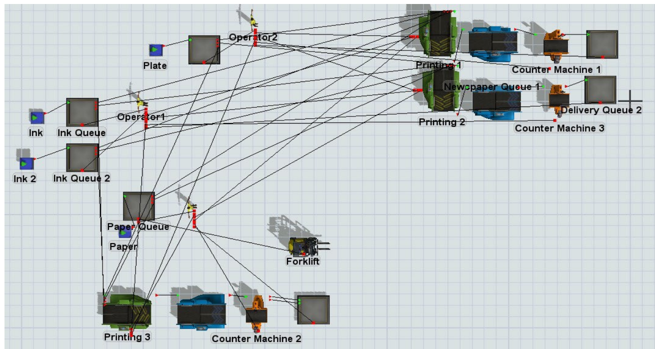

Figure 12. Second Solution "One Source One Operator"

The second proposed solution is called "One Source, One Operator" as shown in figure 12. Each operator is responsible for handling one raw material source (ink, paper, and plate) and providing it to every printing machine. Therefore, there are three operators, operator 1 provides ink, operator 2 provides plate, and operator 3 provides paper. In operating the counter machine, operator 1 is operating counter machine 3, operator 2 is operating counter machine 1, and operator 3 is operating counter machine 2. Here are the results of the second proposed solution, shown in figure 8, figure 9, table 9, and table 10.

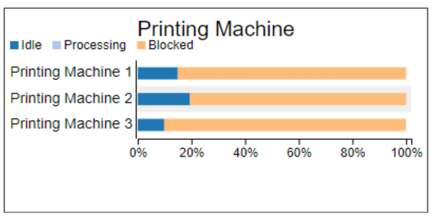

Figure 8. Data Process of Printing Machine in the Second Proposed Solution

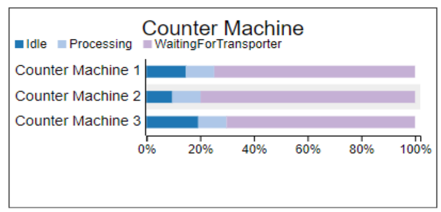

Figure 9. Data Process of Counter Machine in the Second Proposed Solution

Table 9. Idle Value of Printing Machine in the Second Proposed Solution

Replication	PM1	PM2	PM3
1-10	15%	19%	10%

Table 10. Idle Value of Counter Machine in the Second Proposed Solution

Replication	CM1	CM2	CM3
1-10	15%	10%	19%

5.4 Comparison

Based on the two proposed solutions, the idle value of both printing and counter machines is highly reduced compared to the one in previous research by Riskadayanti (2019). There are no idle values more than 20%, highly reduced compared to the previous research. This is caused by the equal task distribution to the operator. Both first and second solutions do not have a significant difference in the idle value. This implies that differentiating the tasks as long as they are equal did not give a great reduction in difference to the idle value (table 11). But according to the best solution, the second solution "One Source One Operator" was chosen because this solution shows lower idle value.

Table 11. Idle Value Comparison

Machine		Actual Process	Riskadayanti (2019)	Proposed Solution I	Proposed Solution II
Printing Machine	PM1	5%	40%	15%	15%
	PM2	52%	13%	20%	19%
	PM2	80%	40%	10%	10%

Counter Machine	CM1	5%	42%	14%	15%
	CM2	80%	40%	10%	10%
	CM3	-	14%	20%	19%
Average		44%	31,5%	14,83%	14,66%

6. Conclusion

This study implements DES to solve problems in making newspapers based on previous research conducted by Riskadayanti in 2019. This study has a weakness because the data used still uses data from the previous paper, and the limitation in this study is that the parameters that are changed are only related to the jobdesk of the operator. Two scenarios are proposed in this study, "One Line One Operator" where one operator are handling one line of machine and responsible for providing all of raw materials (ink, paper, and plate) in that line of machine, while the other scenario is "One Source One Operator" where one operator is handling one raw material only (e.g. operator A is responsible for the ink) and also responsible for assigning the raw material to each printing machine and handling one counter machine. It was proven that both of the two solutions give a highly reduced idle value compared to the previous solution in the research by Riskadayanti (2019). This study shows the importance of the equal distribution of the operator's task. We can conclude that by assigning the operator in the equal and proper task, the idle value will decrease. Based on the scenario that we have proposed, we suggest the company to use the proposed solution II which is the "One Source, One Operator" scenario with the consideration of the smallest average idle value among other scenarios with a value of 14.66%. We suggest further research to make changes and adjustments to the layout of the production process to reduce idle value.

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References

Adam, N. A. F. P., Sari, I. P., Tasya, A., Sutopo, W., and Yuniaristanto., Determination of Routes for Daily Newspaper Product Distribution with Saving Matrix Methods, *2nd International Conference on Materials Technology and Energy*, Sarawak, Malaysia, November 6-8, 2020.

Aqidawati, E. F., Sutopo, W., and Hisjam, M., The Integration of Production-Distribution on Newspapers Supply Chain for Cost Minimization using Analytic Models: Case Study, *The 4th Asia Pacific Conference on Manufacturing Systems and the 3rd International Manufacturing Engineering Conference*, Yogyakarta, Indonesia, December 7-8, 2018.

Arsyifa, Y. H., *Analisis simulasi rantai pasok berdasarkan system dynamics dan model supply chain operation reference (scor) 11.0 pada pt aksara solopos dan pt solo grafika utama*. Universitas Sebelas Maret, 2019.

Dayarathna, Vidanelage L. et al., A discrete event simulation (des) based approach to maximize the patient throughput in outpatient clinic, *Engineering Science & Technology Journal 1*, no. 1, 2019.

Febriandini, I. F., Yuniaristanto, Sutopo, W., and Hisjam, M., Analysis daily newspaper distribution in Solo by Agent Based Simulation, *11th ISIEM (International Seminar on Industrial Engineering & Management, "Technology and Innovation Challenges Towards Industry 4.0 Era"*, Makassar, Indonesia, November 27-29, 2019.

Ishak, A., Zubair, A. F, and Cendani, A. S., Production Line Simulation in Vise Using the FlexSim Application, *2nd International Conference on Industrial and Manufacturing Engineering (ICI&ME 2020)*, Medan, Indonesia, September 3-4, 2020.

Jodinesa, M. N. A., Yuniaristanto, Sutopo, W., and Hisjam, M., Joint delivery planning with time windows: A case study on supply chain in newspaper industry, *11th Curtin University Technology, Science and Engineering (CUTSE) International Conference*, Sarawak, Malaysia, November 26-28, 2019.

Maisyaroh, A. ANALISIS PERFORMANSI RANTAI PASOK MENGGUNAKAN MODEL SUPPLY CHAIN OPERATIONS REFERENCE (SCOR®) 11.0 STUDI KASUS RANTAI PASOK KORAN. Universitas Sebelas Maret.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. Defining supply chain management. *International Journal of Business logistics*, vol 22, no 2, 2001.

Putri, A. S., Sutopo, W., & Hisjam, M. Framework of supply chain simulation using SCOR model in newspaper industry. *IEEE International Conference : Industrial Engineering and Engineering Management*, 2018

Ratnasari, S., Hisjam, M., & Sutopo, W. Supply chain risk management in newspaper company: House of risk approach. *AIP Conference Proceedings*, vol 1931, no 1, 2018.
Riskadayanti, O., and M. Hisjam. Discrete-event simulation of a production process for increasing the efficiency of a newspaper production." In *IOP Conference Series: Materials Science and Engineering*, vol. 495, no. 1, p. 012026. IOP Publishing, 2019.
Saraswati, R., Sutopo, W., & Hisjam, M. Penyelesaian Capacitated Vechile Routing Problem Dengan Menggunakan Algoritma Sweep Untuk Penentuan Rute Distribusi Koran : Studi Kasus. *Jurnal Manajemen Pemasaran*, Vol 11, no 2, 41–44.
Taylor, D. A. (2003). Supply chains: A manager's guide. Pearson Education India.

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