ISSN: 2456-3676

Simulation Model Design and Improvement of Raw Material ware house layout with class-based storage method: A case study

Aniesa Amalia Laila Fitri[1], Parwadi Moengin[2], Fani Puspitasari[3]

[1]Department of Industrial Engineering, Trisakti University,
Jln. KyaiTapa No.1Jakarta11440, Indonesia

[2]Department of Industrial Engineering, Trisakti University,
Jln. Kyai Tapa No. 1 Jakarta 11440, Indonesia
parwadi@trisakti.ac.id (corrspnding author)

[3]Department of Industrial Engineering, Trisakti University,
Jln. Kyai Tapa No. 1 Jakarta 11440, Indonesia

doi: 10.51505/ijaemr.2022.8103 URL: http://dx.doi.org/10.51505/ijaemr.2022.8103

Abstract

This paper presents a simulation model design and improvement of raw material warehouse layout with class-based storage method at a company, namely PT XYZ. The identified problem lies in the raw material warehouse, namely the placement of raw materials is not in accordance with the type of class of raw materials and has not implemented the FIFO system. The total time for moving raw materials is 100.79 minutes which exceeds the time that the company has prepared for moving by 60 minutes. This study aims to design simulation model and make improvements to the raw material ware house layout of the company by using Class Based Storage method and ProModel software. Identify problems using a check sheet by looking at the actual state of the raw material warehouse. The initial simulation was made by looking at the average observation data of incoming raw materials per month and the cycle time of 30 days. There are 15 types of raw materials stored in the raw material ware house with 3 different storage areas. The initial raw material ware house layout simulation results with a total of 246 pallets get a time of 91.14 minutes. Furthermore, calculations are carried out using the Class Based Storage method and then forming classes according to the frequency of the moves, namely Area 1 with a total moving frequency of 68.21% which is placed close to the In/Out Area and Area 2 with a total moving frequency of 31.79%. After that, 2 improvement scenarios were made, the first scenario, namely layout improvements using the Class-Based Storage method, obtained transfer time of 85.17 minutes. The second scenario is the layout improvement and the addition of 1 forklift and the displacement time is 43.19 minutes. Based on the selection of proposed improvements using the Bonferroni Test, the best proposal was obtained, namely the second proposal with a reduction percentage of 52.6%.

Keywords: ware house layout, class-based storage, minimizing time, utility

1. Introduction

1.1 Introduce the Problem

PT XYZ is a company engaged in the manufacture of corrugated carton boxes or card board boxes which was founded on August 11, 2011. This company is located at Jl. Raya Kedaung No.10 Cimuning, Mustika Jaya, Bekasi City, West Java. The products offered include file boxes and regular boxes which are usually used as packaging for goods such as food, drinks, medicines, and others. The card board produced by the company itself is divide din to two types, namely single wall and double wall. The placement of raw materials with various types in the company storage area is still mixed between one type and another. Sometimes, the type of raw material you want to use is located in the back most position in a storage area, making it difficult for operators to reach the raw material.

The problem identified at the company lies in the raw material warehouse. The placement of raw materials is irregular, has not been placed according to the type of raw material class, and has not implemented the FIFO (First in First Out) system when retrieving raw materials in the warehouse. Currently, the company still uses the randomized storage method for the placement of its raw materials so that operators often find it difficult to find the raw materials needed and take more than the time that has been prepared for one hour to move raw materials from the warehouse until the raw materials arrive on the production floor. This causes the production process at the company to not be optimized.

1.2 Importance of the Problem

Based on the problem identified, it is necessary to improve the layout of the raw material ware house using the Class-Based Storage method and ProModel simulation. The Class Based Storage method is suitable in this problem because it can classify raw materials by class according to the criteria for the amount or level of use [1]. The purpose of this research is to evaluate the current layout of the raw material warehouse using check sheets to see the actual state of the warehouse. Then design an improvement simulation model for the raw material ware house layout using the Class Based Storage method. This research is conducted with cost restrictions due to limited information from the company, this research is also only focused on raw material ware house activities. The material handling used will be operated simultaneously.

2. Method

Research methodology is an integrated method of thinking through scientifically organized stages that will be carried out during the research process. There search methodology is made so that the research process can be carried out in a structured manner to achieve a research goal. Flow chart itself can be interpreted as a graphic depiction of the stages of the research methodology. Figure1 shows the research methodology flow chart and simulation flow chart.

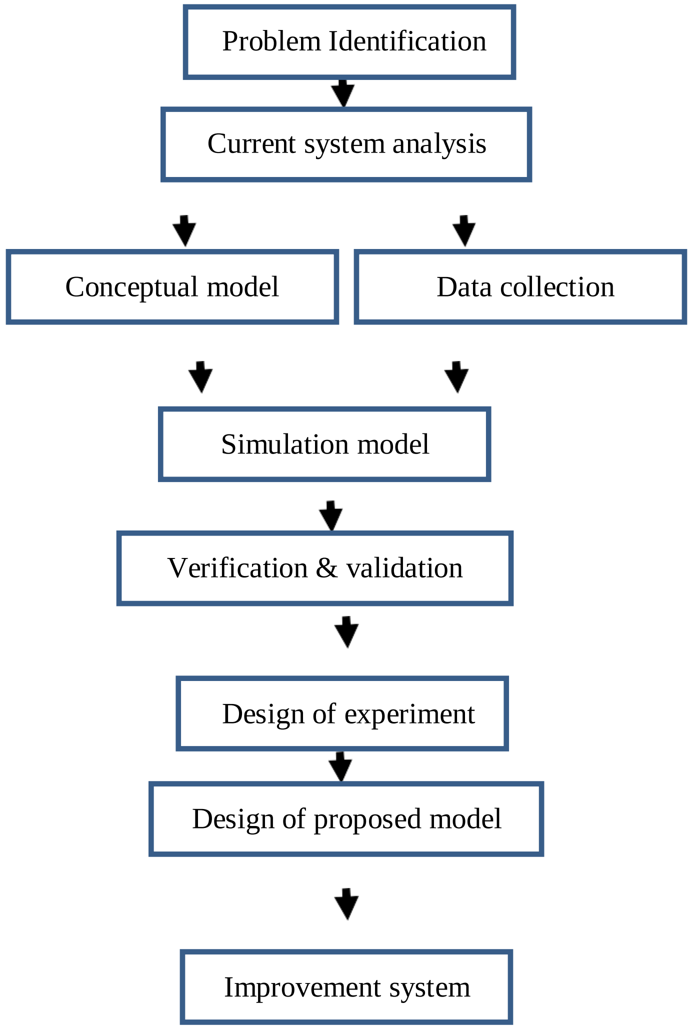

Figure1. Research Methodology Flowchart

3. Results and Discussion

The company only has one raw material ware house that is adjacent to the production floor. This raw material warehouse is headed by a warehouse leader whose job is to supervise and control all goods entering and leaving the raw material warehouse in accordance with the established SOP. The raw material warehouse area is 593, 74 m^2 which is divided into 3 storage areas and material handling areas. Each storage area is not adjusted to the grouping of the types of raw materials available, sometimes stacking pallets is also different between the lower pallet and the upper pallet. This results in the mixing of one type of raw material with another type. In the raw material warehouse there is also only one type of raw material, namely forklifts. As shown in Table 1 and Table 2 regarding the check sheet evaluation of raw material conditions and material

Vol. 8, No. 01; 2023

ISSN: 2456-3676

handling at the company before improvement. Check sheets are often used to evaluate a factory layout by adjusting the real conditions [2]. The check sheet itself is useful for facilitating data collection by describing the actual layout conditions of the raw material ware house and material handling [3]. It can be seen that the check sheet results for the raw material warehouse have 7criteria that are not met while for the material handling check sheet there are 4 criteria that are not met.

Table 1. Material Handling Check sheet

Material Handling Checksheet (Before Improvement)				
No	Criteria	Yes	No	Description
1	Load/Unload is done using material handling	✓		
2	Material handling is adequate for moving raw materials	✓		
3	The amount of material handling causes delays in moving raw materials to the production floor		✓	Available material handling is only 1 piece
4	The movement of raw materials does not interfere with the smooth production process		✓	The movement of raw materials at PT XYZ should be done at 8.00-9.00 WIB but because it exceeds 60 minutes, the production time production time which should be done at 9.00 becomes late
5	The movement of raw materials is done in a short time short time		✓	The total time of moving raw materials for 100.79 minutes which exceeds the time that has been prepared by the company for 60 minutes
6	Raw materials are easily transported by material handling	✓		
7	Raw materials are stable and do not fall easily when moving process	✓		
8	There are no sharp edges or other potential hazards on the material handling on the material handling	✓		
9	Material handling does not transport raw materials with overload conditions	✓		
10	The movement of material handling has no obstacles and is carried out freely		✓	There are no aisles between pallets as access for forklifts to move
	Presentase	60	40	

Table 2. Raw Material Ware house Check sheet

Raw Material Warehouse Layout Checksheet (Before Improvement)				
No	Criteria	Yes	No	Description
1	There is a rack with special naming for placement of raw material pallets		✓	The placement of raw materials is done by flooring and using the blockstacking method where stacks of raw materials are sometimes still not the same
2	The placement of raw materials is in accordance with type of raw material		✓	The placement of raw materials in an area is still stacked with different types of with different types and have not adjusted with the type of raw material class
3	The placement of raw materials is in accordance with type of raw material		✓	*Raw material pallets are still placed close together and disorganized so that the forklift has difficulty moving because of lack of access*
4	The company applies the FIFO method in warehousing		✓	Operators often take raw material pallets that are at the forefront or the pallet that is first reached by the operator
5	The floor surface of the raw material warehouse is flat and safe for material handling paths	✓		
6	The raw material warehouse has adequate light	✓		
7	Pallets are placed in an organized manner		✓	The stacking of 2 pallets in an area is sometimes still of different types
8	The raw material warehouse is integrated with the production floor production floor		✓	The raw material warehouse of PT XYZ is not located in one area with the production floor area with the production floor
9	Air circulation in the raw material warehouse good	✓		
10	Raw material allocation is done well		✓	The same type of raw material is not placed close together and the stacking between pallets is still different types
	Presentase	30	70	

3.1 Process Mapping of Raw Material Warehouse

Process mapping in the raw material ware house of PT XYZ is carried out using a Process Flow Map to analyze the time and activities that occur in the raw material warehouse [4]. The placement of raw materials in each area is not yet based on the grouping of existing types of raw materials. The process flow map in Figure 2 describes the activities that occur in the Raw Material Warehouse. In observing the activities that occur using the process flow map, there are system limitations that limit this observation to be carried out only in the raw material ware house. In each process of moving raw materials, material handling is used in the form of a forklift that is capable of transporting 500 pcs of single wall raw materials and 250 pcs of double wall raw materials.

Peta Aliran Proses

Ringkasan								
Uraian		Sekarang		Usulan		Perbedaan		Pekerjaan : Penyimpanan dan Pengambilan Bahan Baku di GBB
		jumlah	waktu	jumlah	waktu	jumlah	waktu	
●	Operasi	4						
■	Pemeriksaan							Operator / Bahan ✓
➡	Transport	4						Sekarang ✓ / Usulan
◗	Menunggu							Dipetakan oleh : Aniesa Amalia Laila Fitri (063.18.069)
▼	Storage							
Jarak Total								Tanggal dipetakan : 7 Juni 2022

No	Uraian Kegiatan	Lambang ●	Lambang ■	Lambang ➡	Lambang ◗	Lambang ▼	Jarak	Jumlah	Waktu	Analisa: Apa	Dimana	Kapan	Siapa	Bagaimana
1	Operator menjalanankan *forklift* menuju area in/out barang			●					0.52	Operator menggerakan mesin *forklift* menuju area *in /out* barang	Area Penyimpanan	Saat proses *unloading* barang	Operator	Operator membawa mesin *forklift*
2	Operator melakukan proses *unload* bahan baku	●							1.01	Operator melakukan proses *unloading* barang	Area in/out barang	Saat proses *unloading* barang	Operator	Operator membongkar bahan baku dari truk muatan barang
3	Operator membawa bahan baku menuju area penyimpanan			●					1.49	Operator membawa bahan baku yang menuju area penyimpanan	Area Penyimpanan	Proses penyimpanan bahan baku	Operator	Operator membawa bahan baku menggunakan *forklift* menuju area penyimpanan
4	Operator meletakkan bahan baku di area penyimpanan	●							1.02	Operator meletakkan bahan baku ke area penyimpanan yang masih tersedia	Area Penyimpanan	Proses penyimpanan bahan baku	Operator	Operator meletakkan bahan baku setelah proses *unloading* barang dan diletakkan di area penyimpanan yang masih tersedia/kosong
5	Operator mencari bahan baku bahan baku di area penyimpanan	●							6	Operator mencari bahan baku yang dibutuhkan pada area penyimpanan secara manual	Area Penyimpanan	Proses pencarian bahan baku	Operator	Operator mencari bahan baku dengan cara mengeluarkan bahan baku terdepan untuk dapat mengambil bahan baku yang tersimpan di bagian belakang area penyimpanan
6	Operator mengambil bahan baku bahan baku di area penyimpanan	●							18.61	Operator mengambil jenis bahan baku yang telah ditemukan setelah proses pencarian bahan baku	Area Penyimpanan	Proses pengambilan bahan baku	Operator	Operator mengambil bahan baku menggunakan *forklift*
7	Operator memindahkan bahan baku dari area penyimpanan ke area in/out		●						62.85	Operator memindahkan bahan baku ke area in/out untuk selanjutnya dilakukan proses pemindahan bahan baku ke lantai produksi menggunakan truk	Area Penyimpanan	Proses pemindahan bahan baku ke area in/out	Operator	Operator memindahkan bahan baku ke area in/out menggunakan mesin *forklift*
8	Operator memindahkan bahan baku ke lantai produksi menggunakan truk		●						9.3	Operator melakukan proses loading bahan baku ke dalam truk untuk selanjutnya dipindahkan ke lantai produksi	Area *in/out* barang	Sebelum proses produksi	Operator	Operator mengangkut seluruh bahan baku yang dibutuhkan untuk proses produksi menggunakan truk

Keterangan
Jarak (meter)
Waktu (menit)
Jumlah (pcs)

Figure2. Process Flow Map

3.2 Analysis of Current System

Currently, the company has a raw material ware house with an area of 593, 74$m2$ which is located across the production floor. This raw material warehouse serves to store raw materials intended or the production process with a ware house length of 33.3 meters and a ware house width of 17.83 meters. The capacity of the storage area in the ware house is currently±250 pallets of raw materials where 1 pallet has a capacity of 500 pcs of single wallpaper or 250 pcs of double wallpaper.

The raw material pallet itself has dimensions of 150 cm x 145 cm x 15 cm. Pallet placement also uses the block stacking method where pallets can be stacked with a maximum of 2 stacks. Each storage area also has a different area and capacity which can be seen in Table 3.

Table 3. Size and Capacity of Storage Area

No	Storage Area	Area Size (m2)	Storage Capacity (pallet)
1	Area1	35.55	32
2	Area2	115.44	106
3	Area3	118.16	108

3.3 Conceptual Model

The initial stage in building a simulation is to create a conceptual model. The conceptual model is a non-software specific description of the simulation model that has been developed which describes the objectives, inputs, outputs, contents, assumptions and simplifications of the model [6]. The conceptual model is created to determine the basis of simulation development. The conceptual model consists of control variables and uncontrolled variables. Control variables are variables that can be controlled, for example, such as the layout of the raw material ware house, while uncontrolled variables are variables that cannot be controlled or are not fixed, for example, the amount of raw material demand. Figure 3 is a conceptual model.

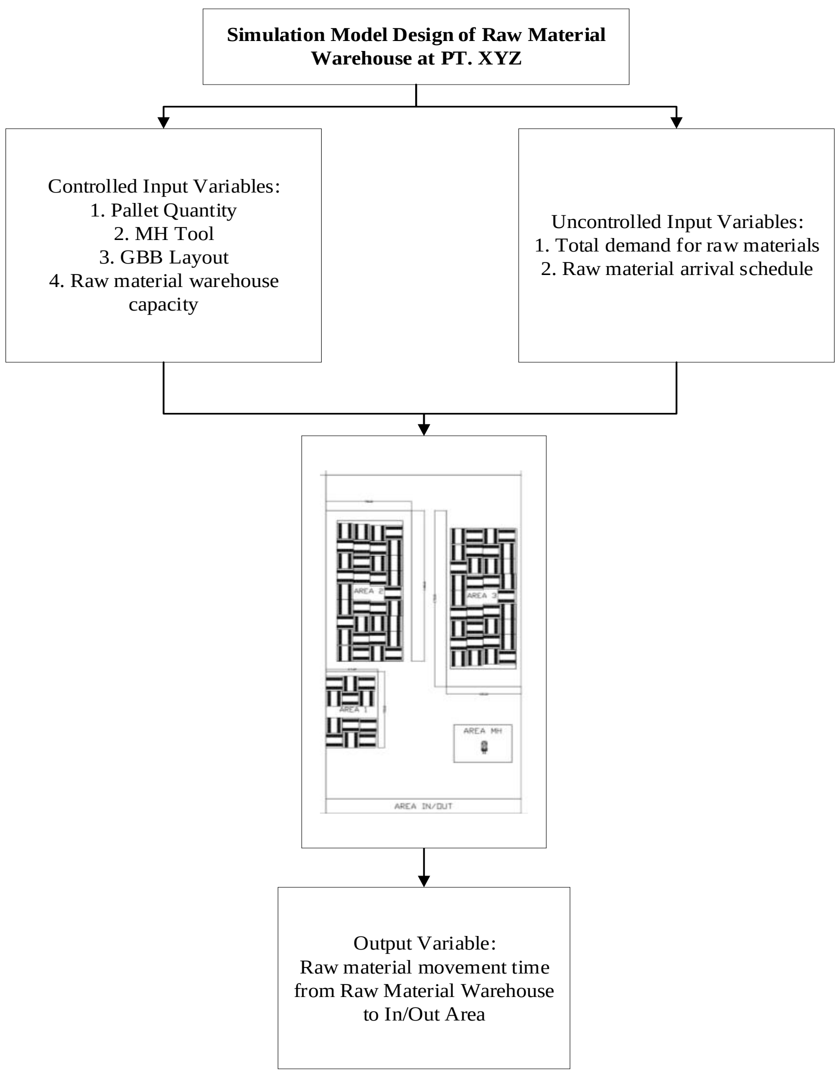

Figure 3. Conceptual Model

3.4 Model Verification

Before the validation test is carried out, a verification test is carried out first on the simulation model that has been built. The verification test is carried out to see whether the simulation model can be run (running simulation) without any errors [8]. The following are verification techniques [9]. Verification process conducted by using animation, trace & debug, model code review, statistical review

3.5 Validation of Current Model

The next step of the model verification test is the validation test where this validation test aims to see whether the simulation model that has been built has represented the real system correctly [9].In the validation test there are two ways, namely by:

1. Watching for the animation at a visual test, which is running the animation of the real system model that has been built. Then see from each process whether it has represented the activities of the real system.

2. Comparing with actual system comparing real time with the time the simulation model is run whether there is a difference between them and see if the model built has been validated. Visual test is done by looking at the output of the model whether the model run has represented real activities. Then for time comparison, the simulation model is replicated first 5 times.

3.6 Improvement of Raw Material Warehouse Layout Using Class Based Storage Method

From the results of the analysis of the raw material warehouse layout of PT XYZ using the check sheet mentioned in Table 1 and Table 2, it is necessary to improve the layout of the raw material warehouse using the Class Based Storage method where storage in the raw material ware house will be categorized based on classes [10].

3.7 Evaluation of Improvement Scenarios

Evaluation of the improvement scenario is carried out on ProModel by building a simulation of the proposed improvement scenario that has been designed. In this study, two proposed improvement scenarios were made. The result of the simulation will be the simulation time of the improvement scenario.

• Evaluation of Proposed Improvement Scenario 1

The first proposed improvement scenario uses layout improvements with the Class Based Storage method which has been divided into two classes in the previous calculation. The placement of raw materials in this proposed improvement will be placed in the proposed area that has been determined.

• Evaluation of Proposed Improvement Scenario 2

The second proposed improvement scenario combines the lay out improvement of the class-based storage method and the addition of material handling in the form of 1 forklift. The addition of material handling is made with the intention of making it easier for operators to take raw materials in large quantities.

3.8 Identification of Raw Material Warehouse Layout after Improvement

After previously identifying the condition of the raw material ware house layout using a check sheet, a check sheet is then made regarding the condition of the raw material ware house lay out after improvement to see the comparison of the real system and the proposed improvements that have been made. Table 4 is a check sheet for the layout of the raw material ware house after the improvement, it can be seen that before the improvement there were 7 criteria that were not met but after the improvement only 2 criteria were not met.

Table 4.Check sheet for Raw Material Warehouse Layout (After Improvement)

Raw Material Warehouse Layout Checksheet (After Improvement)				
No	Criteria	Yes	No	Description
1	There is a rack with special naming for placement of raw material pallets		✓	
2	The placement of raw materials is in accordance with type of raw material	✓		The placement of raw materials has been categorized according to the type and frequency of movement
3	The placement of raw materials is in accordance with type of raw material	✓		There are aisles for forklift access
4	The company applies the FIFO method in warehousing	✓		The company has taken the raw materials the first time it enters the warehouse to carry out the production process
5	The floor surface of the raw material warehouse is flat and safe for material handling paths	✓		
6	The raw material warehouse has adequate light	✓		
7	Pallets are placed in an organized manner	✓		The stacking of raw materials using the blockstacking method is in accordance with the type of raw material type of raw material
8	The raw material warehouse is integrated with the production floor production floor		✓	
9	Air circulation in the raw material warehouse good	✓		
10	Raw material allocation is done well	✓		Types of raw materials with a large frequency of movement have been placed near the in/out area
Presentase		80	20	

3.9 Analysis of the Selection of the Best Warehouse Layout Proposal Results

After making two proposed improvement scenarios and getting the time difference in each scenario, the Bonferroni Test will the n be carried out to determine the results of the best proposed scenario for the raw material ware house from several proposed scenarios [9]. Table 5 shows the comparison of the percentage reduction of the two improvement scenarios.

Table5. Percentage of Decrease in Movement Time

Scenario Model	Description	Time	Percentage of Decrease
Initial Model	Real System	91.14	-
Scenario1	Layout Improvement Using	85.17	6.6%
Scenario2	Layout Improvement Using Class Based Method Storage and Addition of MH in the form of 1 forklift	43.19	52.6%

Based on the comparison of the percentage of decrease in movement time, the best proposed scenario is scenario 2 where the decrease obtained is 52.6% with a movement time of 43.19 minutes. From the addition of a forklift, the two forklifts will be operated simultaneously to carryout raw material transfer activities that occur in the raw material ware house.

4. Conclusion

Based on the improvement of the layout of the raw material ware house using class-based storage which resulted in 2 proposed improvement scenarios, it was found that both scenarios decreased the time to move raw materials of the two scenarios, the best proposal is scenario 2 with a decrease of 52.6% with a transfer time of 43.19 minutes.

Acknowledgments

The authors realizes that there are many short comings in the preparation of this paper. However, thanks to and the department and the help of various parties, these obstacles can be overcome. On this occasion, the author would like to thank the honorable employees of the company who have helped in the research.

References

B. Bahrami, H. Piri, and E.-H. Aghezzaf, “Class-based storage location assignment-an overview of the literature.”

L. Gozali, I. A. Marie, and P. Andriani, “Factory Plastic Bag Layout Design in Elite Recycling Indonesia Extension,” in Proceeding 8 th International Seminar on Industrial Engineering and Management, 2015.

P. Moengin, R. Renanda Riyadina, and D. Kemala Sari, “Perbaikan Tata Letak Lantai Produksi Menggunakan Metode Simulasidan Systematic Layout Planning untuk Meminimasi Waktu Produksidi PT. Lestari Teknik Plastikatama,”Jurnal Teknik Industri, vol.9, no. 3, Nov. 2019.

F. Astuti, W. Wahyudin, and F. N. Azizah, "Perancangan Ulang Tata Letak Area KerjaUntuk Meminimasi Waktu dan Jarak Aliran Proses Produksi," Performa: Media Ilmiah Teknik Industri, vol. 21, no. 1, p. 20, Apr.2022.

B. Tiaji Putri, S. Adisuwiryo, and I. Anne Marie, "Perancangan Model Simulasi TataLetak Gudang Bahan Baku Menggunakan Promodel Pada PT. Korma Jaya Utama," Universitas Trisakti, Jakarta, 2021.

P.Moengin, Pemodelan dan Analisis Simulasi Sistem. Jakarta: Usakti, 2019.

N.Gupta and S. Grover,"Introduction to Modeling andSimulation," International Journal of IT, Engineering and Applied Sciences Research (IJIEASR), vol.2, no.4, Apr. 2013, [Online]. Available:www.irjcjournals.org

R. Shabrina, "Perancangan, Validasi, dan Verifikasi Model Simulasi Proses Produksi Botol Saus Plastik Eksisting Menggunakan Software Pro Model," Telkom University.

C. Harrell, Simulation Using Pro Model, 2nd ed. Boston McGraw-Hill, 2004.

S. N. A. Sahara and A. Bakhtiar, "Perbaikan Tata Letak Penempatan Material di AreaGudang Penyimpanan Material Berdasarkan Class Based Storage Policy (Studi Kasus : Gudang PT. Timatex Salatiga),"Universitas Diponegoro, Semarang.