

An efficiency improvement in warehouse operation using simulation analysis

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Abstract. In general, industry requires an efficient system for warehouse operation. There are many important factors that must be considered when designing an efficient warehouse system. The most important is an effective warehouse operation system that can help transfer raw material, reduce costs and support transportation. By all these factors, researchers are interested in studying about work systems and warehouse distribution. We start by collecting the important data for storage, such as the information on products, information on size and location, information on data collection and information on production, and all this information to build simulation model in Flexsim® simulation software. The result for simulation analysis found that the conveyor belt was a bottleneck in the warehouse operation. Therefore, many scenarios to improve that problem were generated and testing through simulation analysis process. The result showed that an average queuing time was reduced from 89.8% to 48.7% and the ability in transporting the product increased from 10.2% to 50.9%. Thus, it can be stated that this is the best method for increasing efficiency in the warehouse operation.

1. Introduction

Presently, warehouse maintenance is considered as one of the main factors in industry production. It can measure the efficiency of a factory, which is expressed in terms of economy and management. A factory with good ability to order and manage their warehouse is a factory with good management. There are a lot of warehouse problems in small factories due to the lack of ability in management and that causes a huge effect to the factory in terms of storage and unnecessary costs. Therefore, researchers are interested in warehouse management to increase storage efficiency and reduce costs in the factory.

2. Literature review

This study on using simulation in warehouse management has two main objectives. The first is having enough products in sufficient quantities to service the customers and to increase sales to maintain effective market penetration. The second is to reduce investment in product to decrease the costs of production, such as by keeping inventory as low as possible [1].

Warehouse management requires five main activities:

- The product (Receiving) is the process of obtaining the products.
- Storage (Put-Away) is the system that examines the size and area of storage.



- Converting units (Let-Down) is the unit conversion to facilitate distribution or stock management for increased convenience.
- Release of goods (Picking) is the process that allows products to be released.
- Warehouse count (Counting) is the way to check the amount of actual products in the stock [2]. Recently, the factory has increased value of products by making packaging for marketing and making the codes to be more flexible for transportation and counting [3].

At present, the factory must focus more on warehouse management due to the fact that the warehouse is one of the most influential factors to costs. Warehouse management can be either advantageous or disadvantageous, depending on how factories manage their warehouse. The objective is to deliver quality products in an optimal time with efficient service to the customers, while achieving the lowest costs in order to remain competitive with other providers [4]. Improvement and development in the warehouse means finding a way to optimize the warehouse by standardizing time in the transport of products from production to warehouse. Otherwise, bottlenecks can be created that lead to problems that will directly affect the costs of production [5].

The layout of the warehouse can be the main factor. By improving the positioning in the warehouse, a factory can maximize the use of space and have a better management in the system [6].

3. Research methods

3.1. Sources of information

According to the study on product transportation regarding data collection on product movement and interviewing staff about storage management, results showed that a significant amount of time is locked up in the transport of products. Thus, simulations were created to attempt to solve that problem.

3.2. Data analysis

The Figure 1, 2, 3 and 4 below show the data of transportation regarding.

Data Characteristic	Value
Source file	<edited>
Observation type	Real valued
Number of observations	30
Minimum observation	1.12000
Maximum observation	5.47000
Mean	2.63067
Median	2.36000
Variance	1.01004
Coefficient of variation	0.38204
Skewness	1.04913

Figure 1. Statistical data summary of inter-arrival time.

Relative Evaluation of Candidate Models			
Model	Relative Score	Parameters	
1 - Pearson Type VI	97.22	Location	0.00000
		Scale	1.00000
		Shape #1	27.77911
		Shape #2	11.55950
2 - Inverse Gaussian	92.59	Location	0.00000
		Scale	2.63067
		Shape	19.44826
3 - Pearson Type V	92.59	Location	0.00000
		Scale	19.01226
		Shape	8.20474

28 models are defined with scores between 0.00 and 97.22

Absolute Evaluation of Model 1 - Pearson Type VI

Evaluation: Good
 Suggestion: Additional evaluations using Comparisons Tab might be informative.

Additional Information about Model 1 - Pearson Type VI

"Error" in the model mean
 relative to the sample mean $-5.6801e-5 = 0.00\%$

Figure 2. Analysis of inter-arrival time data.

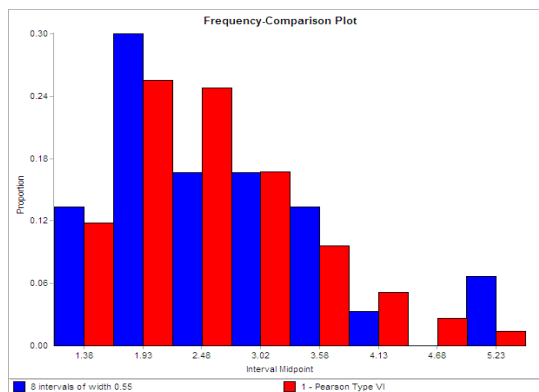


Figure 3. Probability of service time.

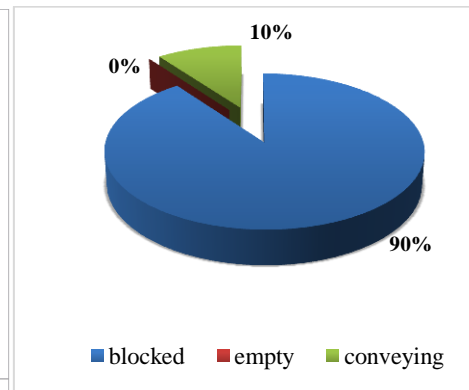


Figure 4. Working process in belt before improvement.

3.3. Modeling simulation

This research studied the unloading and storage of products using Flexsim® to solve the bottlenecking problem by focusing on the transportation of goods. The researchers offered three solutions. These solutions look at adding an additional worker in the transportation of products, adding a transportation belt to reduce queuing during transportation and adding both an additional worker and a transportation belt. In the warehouse, additional shelving can be added for additional space for storage. For transportation, the researcher used the principle of FIFO, in which the previously produced products will be sent to the client first. The simulation framework is shown in Figure 5.

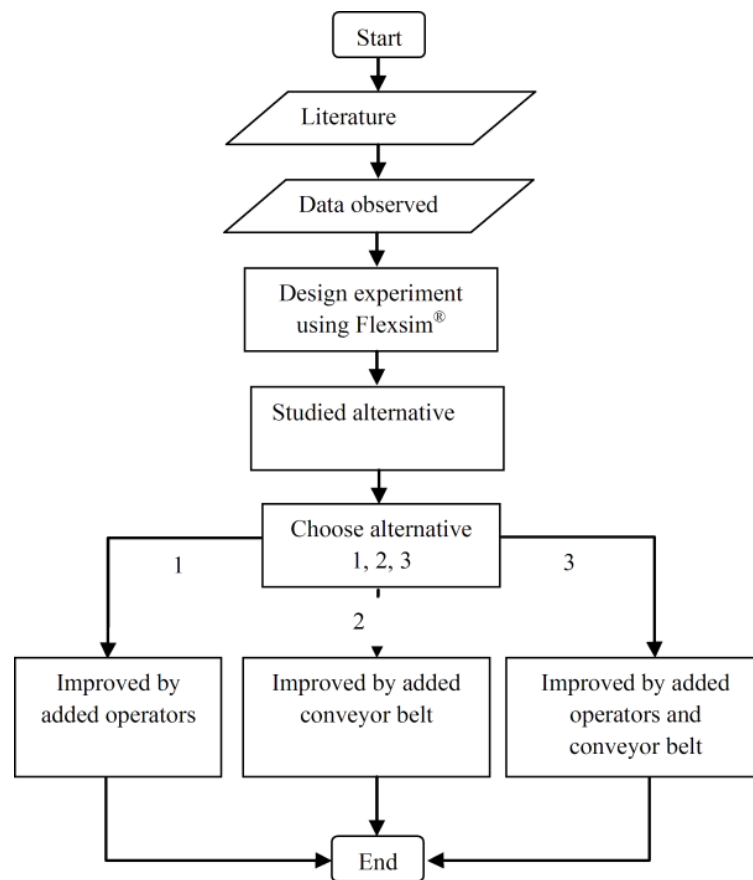


Figure 5. Working process.

The layout before improvement can be seen in Figure 6.

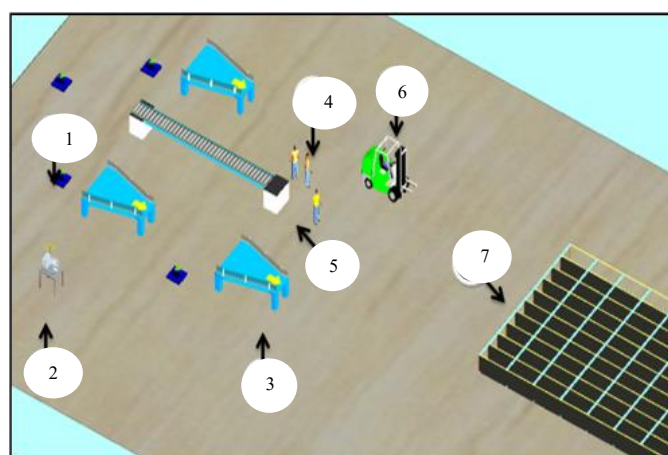


Figure 6. Modeling before improvement.

The data used in the models are explained in Table 1.

Table 1. Explanation of the simulation objects in Figure 6.

Number	Description
1	Released sacks of animal feed ready to be fed into the conveyor system
2	The dispatcher managing the work of the operator
3	Separator, which distributes sacks of animal feed onto the conveyor belt
4	The group releasing the pallets of sacks
5	The combiner, who combines the sacks of animal feed and the pallet for easy transportation
6	The conveyor, which transports sacks of animal feed
7	The conveyor, which transports sacks of animal feed
8	The transporter, who is responsible for transporting sacks of animal feed, which had been prepared onto a pallet, ready to be listed into the warehouse storage system
9	The operator who lifts the sacks of animal feed from the conveyor belt to the pallet

3.4. Instruments used in the study

The workers were interviewed by recording, taking note of the information from cited sources, including statistical information, documents, books, journals and research.

3.5. Scope of research

- To study warehouse management to optimize transportation.
- To improve warehouse efficiency.
- To reduce the time and cost of transportation.
- To study and analyze the possibility of improving shelving in the warehouse.

4. Results

The results of the simulation modeling analysis in each alternative are explained below.

4.1. Solution by the addition of an extra worker

To reduce queuing of product in between transportation, the addition of more staff was considered. However, the continuous and quick arrival of product was not consistent with the ability of the worker in transportation as shown in Table 2.

4.2. Solution by the addition of a conveyor belt

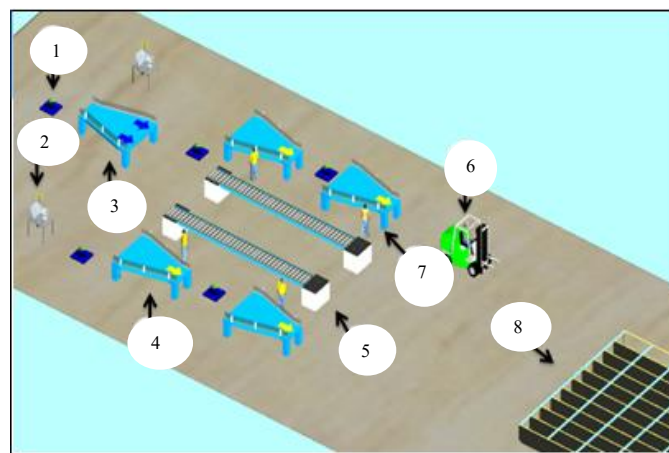
The addition of a conveyor belt adds increased distribution of the product to reduce queuing time. However, the ability of workers was not consistent with the ability of the added conveyor belt as shown in Table 2.

4.3. Solution by the addition of both an additional staff and conveyor belt

This simulation aimed to add both an additional worker and a conveyor belt to increase the workforce and capability of transport, as well as reduce queuing time through improved distribution of products on the conveyor belt. Results for this simulation can be seen in Table 2.

Table 2. Value of the operation from conveyor belt

Model Characteristics		Blocked	Empty	Waiting for transporter	Conveying
Original		89.8%	0.0%	-	10.2%
Addition of worker		90.3%	0.0%	-	9.7%
Addition of belt	Belt1	93.9%	0.3%	0.1%	5.8%
	Belt2	93.8%	0.3%	0.0%	5.9%
Addition of belt and worker	Belt1	50.2%	0.3%	0.2%	49.4%
	Belt2	47.2%	0.3%	0.2%	52.4%

**Figure 7.** Modeling after improvement

5. Conclusion

From modeling the simulation by Flexsim®, it was found that the best simulation on improvement in the warehouse is achieved by adding both an additional worker and a conveyor belt. Improving the conveyor belt system makes it more flexible and reduces queuing from 89.8% to 48.7%. Using this model, the ability of transporting products increases from 10.2% to 50.9%. The improvement makes the warehouse management more efficient.

6. References

- [1] Jitjong W 2009 *Logistics Thailand* **79** pp 34–38
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- [6] Tompkins J A, White J A, Tanchoco J M A and Bozer Y A 2003 *Facilities Planning* (USA: Wiley)