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Coconut Warehouse and Transportation Process Analysis Using Simulation Technique: The Case Study of a Coconut Manufacturer

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Abstract. This research studies and analyzes the coconut warehouse process (out-bound process), a case study of a coconut manufacturer. The objective is to reduce warehouse process time and determine the optimization of the warehouse process using the simulation technique. First, the data related to the transportation process was collected. Then, the simulation model was designed for problem analysis, and the three alternative improvement solutions were proposed to increase the productivity of the transportation process. For the first solution, the workstation for receiving process was added. The second was to rearrange the facility layout. Lastly, the coconut conveyer was added to the truck loading station for the final solution. These proposed solutions were evaluated via four key performance indicators, including productivity, Work in Process (WIP), process waiting time, and the number of transportation cycles. As the simulation analysis results, the third solution has provided the maximum values of all performance indicators. Compared with the current operation, the process productivity of the third solution increased by 10.28 percent. The amount of WIP is decreased by 34.72%. The average process waiting time and the number of transportation cycles are 45.35 minutes and 6.6 transportation cycles per day, respectively.

Keywords: Warehouse and transportation process, Simulation, Coconut manufacturer, Productivity improvement

1. Introduction

At present, the effective Logistics & Supply Chain Management is one of the key strategies to become a responsive and competitive organization. Therefore, both academic and industry researchers currently focus on reducing unnecessary costs incurred (i.e., transportation costs, storage costs, and order costs) and meeting an increasing customers' demand. Thus, efficient warehouse and transportation process can support not only customer satisfaction but also unnecessary cost reduction. For this reason, many manufacturers concentrate on improving and optimizing the efficiency of a warehouse and transportation operation.

In this research, the efficiency of warehouse and transportation process in the coconut manufacturer case study is investigated and improved. The out-bound process of coconut warehouse and transportation is started from a coconut meat picking from both an in-house warehouse and a supplier to a delivering to destination. The simulation technique is applied through the Flexsim simulation software tool, which is further described in the next section.

2. Theoretical Background

This research studies the efficiency improvement of coconut transportation system by using simulation technique. Simulation is activity that simulate the behavior of the real system. Decision making can be studied and analyzed by simulation models. Flexsim is a powerful and easy to use modeling and simulation software tool that allows the user to build a 3D computer simulation model of a real-world system and run experiments on the model [1]. Many researchers are focused in flexsim simulation for efficiency improvement. Flexsim have been widely applied in various objectives for practical industry. According to [2][3], flexsim were used for logistics operation. The researches indicated that flexsim is the effective approach for logistics operation. In warehouse processing, flexsim also applied for efficiency improvement [4]. The approach could be reduced the average queueing time. Moreover, the ability in transportation of goods was increased. For layout problem, flexsim were adopt in practical manufacturing [5][6]. Alternative layouts were proposed to find the best solution. According to [7], the method was applied to carry out the optimization of machine shop layout. While [8] applied flexsim to solve the problem in production line of vise manufacturing. Furthermore, [9]

were analyzed the work sequence. The waking path has been minimized in this research. According to [10], the approach was applied in the FMS with alternative machines with makespan minimization. Therefore, Flexsim is more efficient tool to simulate and analyze the real-world system for efficiency improvement.

3. Research Methodology

This section provides details for the coconut warehouse process analysis using simulation technique that shown as the following steps:

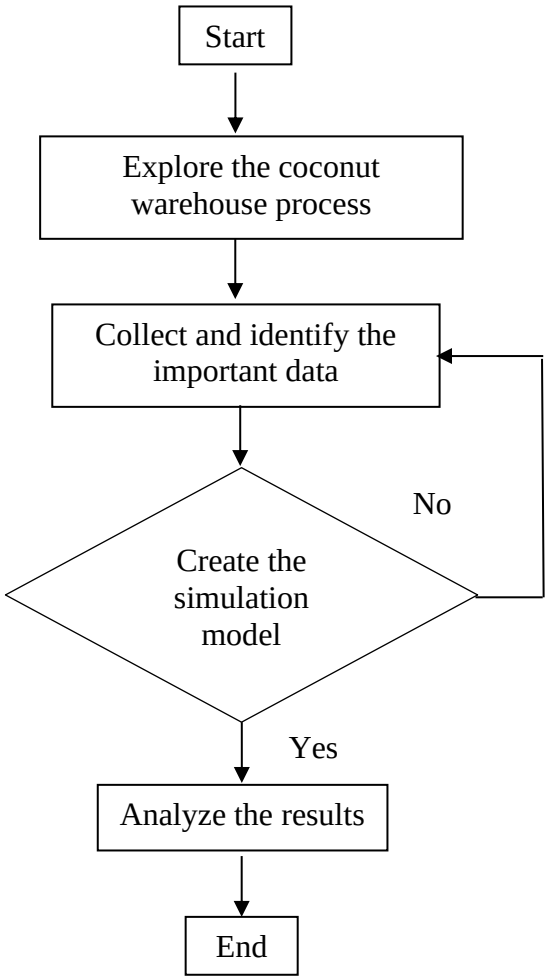

Fig. 1. The research methodology.

3.1. Coconut warehouse process: the case study of coconut manufacturer.

The coconut warehouse case study is collected from a coconut manufacturer in Prachuap Khiri Khan, Thailand. The main product are the coconut meat and coconut water. The coconut meat is the highest value product of this factory. The products are delivered to coconut milk manufactures. Thus, this research focuses on the warehouse process of coconut meat processed. The warehouse and transportation process in this study is depicted in Fig.2:

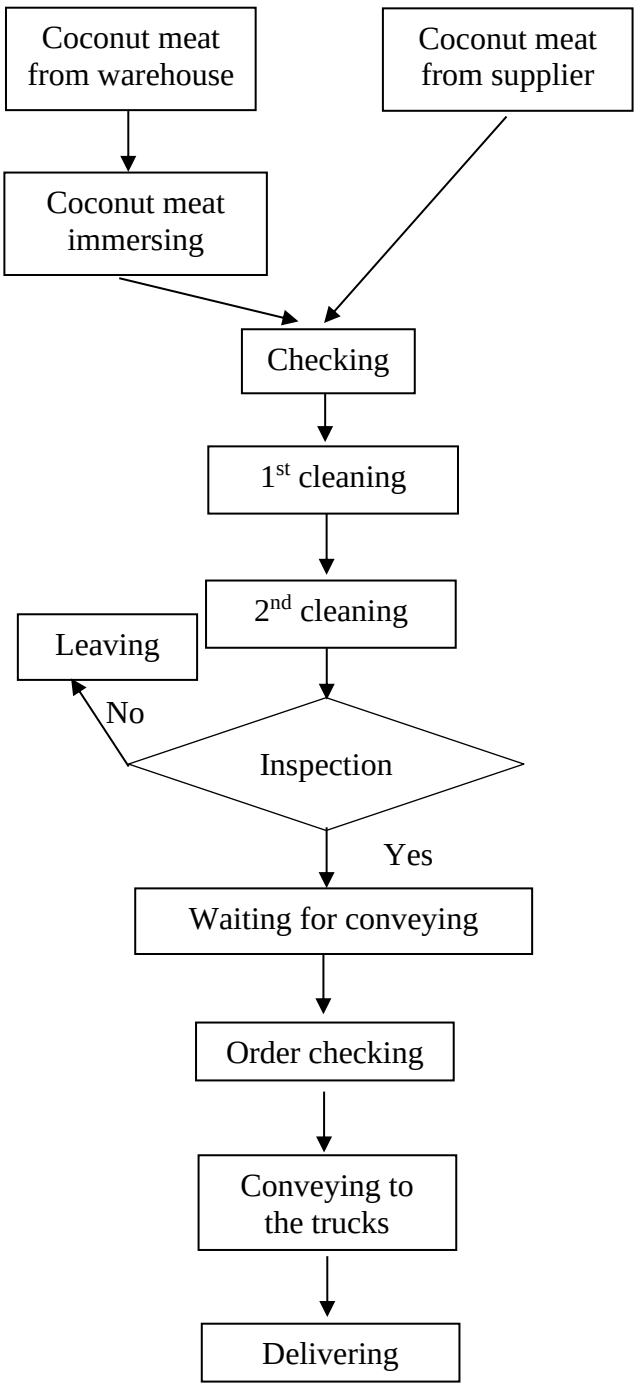

Fig. 2. Coconut meat warehouse and transportation process.

3.2. The simulation modeling by Flexsim software

Warehouse and transportation process was analyzed. Regarding the data collection on process movement and all interviewing staffs were statistical tested in ExpertFit Function in Flexsim. The ExpertFit is the statistical analysis to validate the inter arrival time, processing time, transportation time and so on.

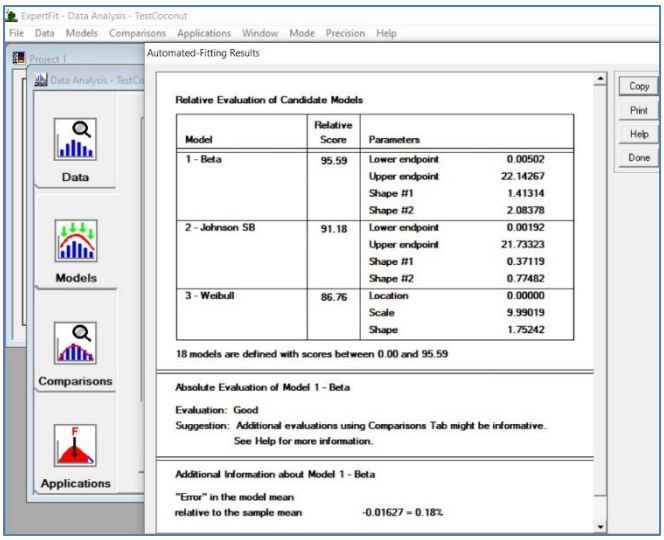

Fig. 3. Data validation of inter arrival time.

Fig. 3 demonstrates the data validation of inter arrival time of the process by using ExpertFit. After the data validation, the model was built to analyze the problem. To validate to simulation model, 30 results of average waiting time in queue of truck from model and current situation are compared by using the t-test hypothesis analysis which alpha is 0.05. If p-value is greater than 0.05 that means it has no different between present situation and the model. As the analysis result, p-value of this case is 0.123 that greater than 0.05. Therefore, this simulation model can be represented the real system in this study.

The model of coconut meat warehouse and transportation process was shown as Fig. 4 and the details were explained in Table 1.

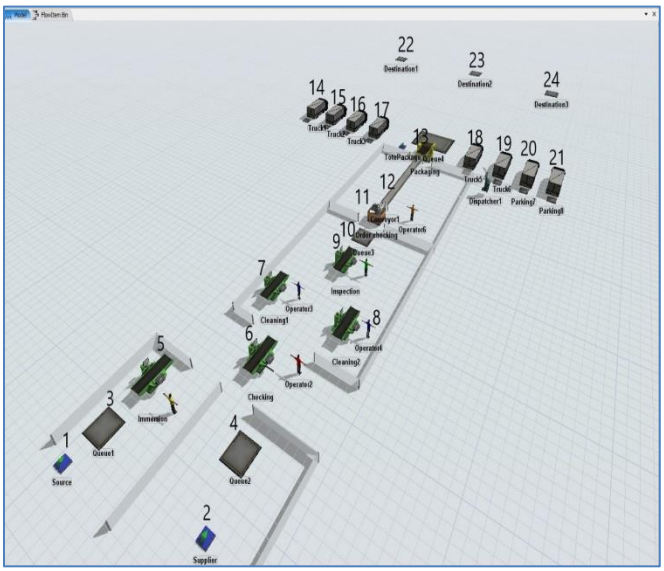

Fig. 4. Simulation model of current situation.

Table 1. Details of the modeling.

Object	Descriptions
1-2	Coconut meat from warehouse and supplier, respectively.
3-4	Waiting area of coconut meat from warehouse and supplier, respectively.
5	Coconut meat immersing station
6	Checking station
7-8	Cleaning station
9	Inspection station
10	Waiting area for conveying
11	Order checking station
12	Conveying belt
13	Packaging station
14-21	Coconut delivered Trucks
22-24	Destinations

3.3. Model Testing

The simulation model was designed for problem analysis and the three alternative improvement solutions were proposed to reduce warehouse process time and increase the productivity of the warehouse and transportation process. These proposed solutions were evaluated via four key performance indicators, including productivity, Work in Process (WIP), process waiting time, and the number of transportation cycles. The model is constructed to study and analyze the bottleneck processing of waiting queue at each buffer of procedures. Three alternative approaches were proposed. For the first alternative, the workstation for receiving process was added to reduce bottle neck of receiving process.

The second was to rearrange the facility layout and machine position between checking station to inspection station by using the ECRS principal. Lastly, the coconut conveyer was added to the truck loading station for the final procedure to reduce the waiting time of each truck. The models were illustrated in Fig. 5-7.

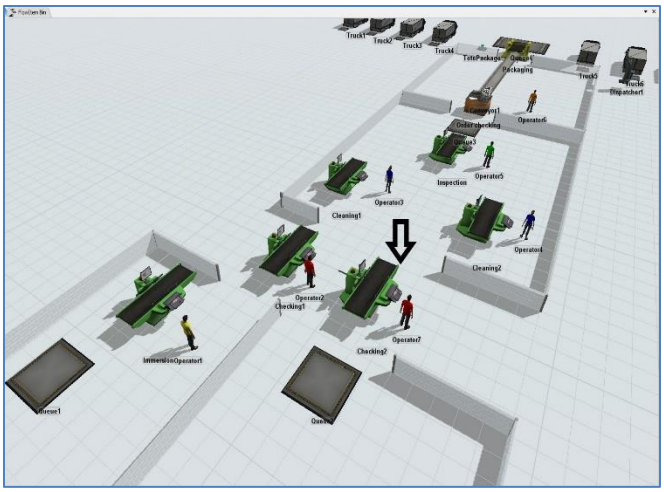

Fig. 5. Simulation model for alternative 1.

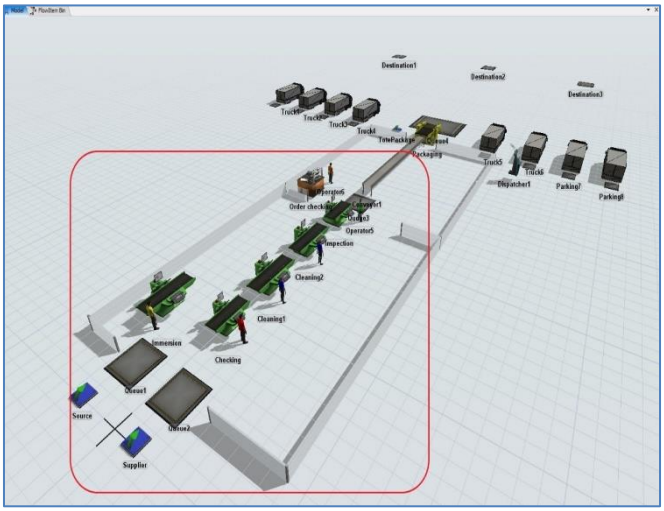

Fig. 6. Simulation model for alternative 2.

Fig. 7. Simulation model for alternative 3.

Table 2. Numerical summarize.

Performance indicators	current	Alter.1	Alter.2	Alter.3
Average percentage of productivity	77.29	83.94	81.38	85.24
Average work in process (Basket)	88.7	61.3	70.7	57.9
Average waiting time in queue of the trucks (Minutes)	62.14	52.29	50.41	45.35
Average transportation times of coconut meat delivery (Cycles)	4.8	5.7	6	6.6

4. Results and discussions

The simulation model is carried out via Flexsim running simulator version 2019. Thirty replications were evaluated which four key performance indicators. Computational time was five hours (10.00 am. to 3.00 pm. as real-case study situation). The computational results were shown as Table 2.

When considering the productivity and the average work in process, alternative 3 is the best choice, with the process efficiency being 85.24%, up from the current situation to 10.28%, and the average workpiece volume in the process being 57.9 cases, down from the current situation to 34.72%.

Considering the average waiting time of the truck and the number of cycles in transportation. It found that alternative 3 remained the most effective approach, with the average waiting time for each truck being 45.35 minutes, down from the current situation to 27.03%, and the number of cycles in transport being 6.6, up from the current situation to 37.5%.

Although the alternative 3 performs best approach. It might not be considered to apply for this problem because the conveyor added provides high cost. Therefore, to decide on any way to improve productivity, the decisions choice is depending on other factors related to the company, such as whether the cost of improvement using the alternative is inflated, whether the employee the company has is sufficient to improve,

etc. However, it is found that modeling to view the situation using flexsim allows for a clear point of the changes and does not affect the actual operation, and is easy to consider for implementation.

5. Conclusions

This research studied and analyzed in coconut transportation processing for the coconut industry. A case study of coconut manufacturer in western of Thailand, with the aim of studying operational process and finding ways to improve and develop coconut transportation processing using flexsim simulation software. It then presents guidelines for improving and solving operational problems. It offers three alternative approaches to improve the operating process: alternative 1: adding a workstation to the inspection process, alternative 2, rearrange the plant facility to ensure the flow of processes, and alternative 3 offering to increase the channel of transporting coconuts to the truck. The results showed that all three proposed alternatives were more effective than the methods in the current situation. Especially, alternative 3 performs the best approach for this case.

Further research may include further studies on the various costs involved. If each option is implemented, it is possible to compare the cost of expenses and be informative in deciding the operational process for the manufacturers.

Acknowledgement

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