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The Performance Analysis of Industrial Production Process Using *Flexsim 6* Tools Simulation: Study Case of Production Floor of Ceos Essential Oil in Yogyakarta

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Abstract: Indonesia is one of agrarian Country that has vast natural resources; one of the real examples is the utilization of plants as the raw material of food products, beverages, as well as medicine. There are several studies that mentioned certain plant type that is used as raw material of perfume, which is essential oil. Essential oil is every concentrate form and hydrophobic liquid that contains scented compounds obtained from some plants such as leaf, flower, fruit and root through extraction process using dissolution technique. The increasing of world demand on essential oil phenomenon urges Indonesia to export the essential oil for about 1,2 million USD on 2013 with the market share 1,71% from total Indonesia export to Swiss market. According to the Swiss Press Confederation 2014 there are ten destination countries for Essential Oil products, including Singapore, Thailand, and Europe Country such as Spain. The large number of demand on Indonesia's essential oil encourages us to increase the production performance of Essential Oil to promote Indonesia to international market. Because of that's we did the research based on the case study in one of production floor at CEOS Essential Oil Production, KaliUrang streets KM. 14.5 Yogyakarta. The approach used was *FlexSim 6* Tools Simulation, to find out the production performance of essential oil from the processing flow as well as its scheduling aspect. According to Shannon (1976), Simulation is a design process with simulation model from its system as well as experimenting with the model in order to understand the system concept and evaluate the operating strategy variation. Based on result there was big idle result in each of its machine one of its causative factor is the scheduling and material flow were slow, so this problem needs alternative approach using experimental design on *FlexSim 6* to increase the productivity.

Keywords: Essential Oil, Performance, Productivity, *FlexSim 6* Simulation.

1. Introduction

Being one of the countries with many natural resources, Indonesia is one of the countries that have potential to develop its natural resources as the tool to improve the country's economy. One of the examples is the utilization of plants as medicine, food, and cosmetic. One of the plants' processing that is vastly discussed by several press conferences is essential oil. Essential oil is every concentrate form and/or hydrophobic liquid that contains scented compounds obtained from some plants such as leaf, flower, fruit, seed, trunk and root through extraction process using dissolution technique. Based on Global Trade Atlas on Indonesia's Essential Oil Market Confederation in Swiss – 2014. Global import of essential product in 2013 is 2 billion USD, with its growth reaching 8 percent for five years between year 2008 to 2013/ Indonesia exported 1,2 billion USD of essential oil in 2014 with market segment 1,71% from all of Indonesia exports to Swiss markets. Based on the Press Swiss Confederation, in 2014 there are ten destination countries for essential oil exports from Indonesia, i.e. Singapore (122 billion), Thailand (54 billion), Philippines (47 billion), Malaysia (44 billion), United Arab Emirates (31 billion), United States (24 billion), India (21 billion), Vietnam (15 billion), Spain (6 billion), and Hong Kong (13 billion).

The area that has been one of production centers of essential oil main export commodity Central Java and West Java. Both are the areas that have exported to the other countries the most. To fulfill the world's demand on Indonesia's essential oil production, several steps are needed in improving the production performance of essential oil, starting from the main raw materials until packing process. This research will focus on the case study in production floor of CEOS, located in Kali Urang KM 14.5 Yogyakarta. The production floor produces essential oil using clove as its raw material that has 5 small capacity distilling tools and one big capacity distillation tool. By using simulation approach and *FlexSim* 6 tools, this research becomes one of the parameters whether the performance of production floor and scheduling aspect inside is appropriate, so the researcher are going to do experiment to improve the performance of production floor CEOS.

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2. Basic Theories

2.1 Essential oil

Essential oil is one of the smelly main substances found in the plants. Because its specific nature, that easily evaporate in normal temperature in the air, the substance is often called by volatile oil, ether oil, or essential oil. Essential oil can be found in various plants and their parts such as flower, fruit, seed, stem, root and bark (Agusta, 2000). Statistical data of global export-import shows that the essential oil consumptions and its derivate are increasing about 10% year to year. This increasing mainly caused by the development in needs for food flavoring industry cosmetic and perfume industries (Polontalo, 2009).

2.2 FlexSim 6 Software

FlexSim is the Modeling and Discreet Simulation software developed by Software product *FlexSim*, Inc. It is a simulation application software PC based used for modeling, simulation, and visualization of business process. According to Shannon 1976 on Lusiani, simulation is a designing process with simulation model based on a real system and making an experiment based on that model which aims to understand a system concept and evaluate the operation strategy variation.

2.3 Extraction of essential oil

In essential oil, the extraction and curing time will affect the yield produced. Generally, the curing will take 4 days on its process and extraction process will take 3 hours to make an essential oil with 1,983% yield, favorable value for scent 5,2 (between like and very like) and scent strength 6,4. The substance in essential oil of fragrant leave are arranged by 36 substances, 20 identified substances and 16 unidentified substances consisted of alkanes, alkenes, aldehydes and unidentified substances (adiyasa, 2015).

3. Research Method

3.1 Time and Place of the Research

This research took place in the production floor of essential oil in CEOS Yogyakarta, and the data processing is assisted by the modeling and simulation laboratory DELSM, Faculty of Industrial Technology, Department of Industrial Engineering, Islamic University of Indonesia in October to December 2017.

3.2 Tools and Materials

This research is assisted by *FlexSim* 6 tool/application as the modeling and simulation software. The using of the application is to conduct the experiment that will be done to the model that has been made. The simulation of essential oil production floor CEOS making process needs several data consisted of human resources, raw material, processing time, break time, machine capacity, scheduling, and processed material flow. The benefit of such data is to make a model that represents a real system to do the simulation to improve its performance.

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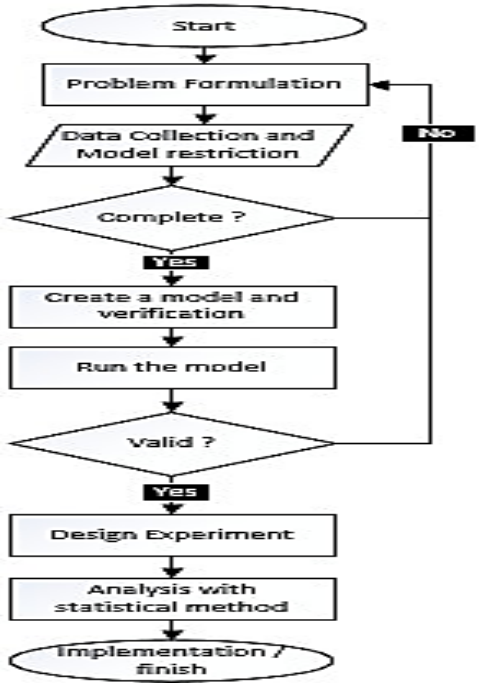
3.3 Procedur of Research

Figure 1: Flowchart of modeling and simulation flow



The first step of this research began by determining the purpose of modeling and collecting the data, including processing time, raw material scheduling, and those related to the real system or actual condition on the production floor. Further, the validation test of the input was done to see whether the data was sufficient, see the data distribution, data uniformity and the actualization of other variables. If the data is sufficient, the model will be created with the help of *FlexSim* 6 software while doing verifications in model making process. Then the model will run until it gives output that will be continued by the output validation on the model, validation of simulation model was done using statistic tests such as average test, 2 variance test and chisquare. If the data is valid, it will be continued to the experimental stage. This stage aims to find out the best experiment design. The alternative of the experiment design result will be chosen, and anova/banferoni test will be done to make sure the chosen test is the best result. The last stage is the implementation proposal of the simulation result to the real system.

4. Result And Discussion

4.1 Operation process

On its production floor, CEOS has six processes that must be passed, started from the arrival of raw materials which is the cloves, weighing, storing on the rack of raw materials, extraction, packaging and the storing of the final product. Based on the interview, there are problems that occur during production process that often forgotten because of the complexity of the work environment, so simulation can be the way to analyze and solve those problems? Below is the description of the resources and production processes that will be simulated:

a. The arrival of the raw material, the cloves. The activity done in this process is the inspection and storing of the material. Each week has total five working days with the total arrival 500 kg.

b. The weighing of raw material. In this process, the materials are divided into 5 kg capacity extraction tool and 100 kg capacity extraction tool.

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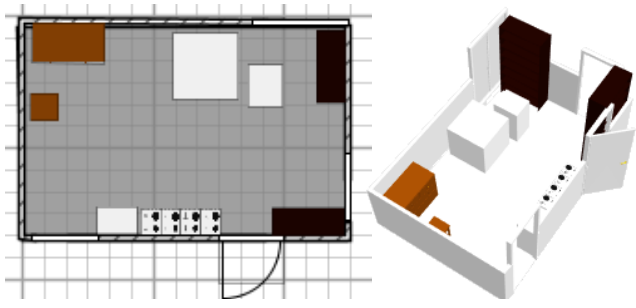
c. The storing rack of raw materials. After the raw materials are divided, they will be stored in raw materials storing rack waiting to be processed.
d. To get the essential oil from clovers, an extraction will be done for 4 hours time period for 5 kg capacity and 8 hours time period for 100 kg capacity.
e. The essential oil then will be packaged using 1 liter bottle.
f. The packaged essential oil will be stored in a 4 m x 7m rack with storing capacity of 28 liters.

4.2 Simulation and analysis of result

As a production floor that produces one of export goods, essential oil, this simulation has two targets, which are to increase the output and to determine the appropriate amount of raw materials. The main focus is volume and processing time of each resource that will be the ability indicator in producing the essential oil, so we may find out the obstacle in current operating system, and we may improve the balance of the upcoming process.

Figure 2: The view of *CEOS* production floor



The simulation model making need several assumptions such as items produced is considered discrete, the arrival of the material is done every day, the processing time uses normal distribution, there is no difference made for materials such as stem, leaves, and flower and this simulation model will use the real layout from the actual system of CEOS production floor. The simulation time will be set to 5 working days, 8 hours per day. Units used in model *FlexSim* 6 are minutes for units of time, liter for units of volume, and meter for units of measure. This figure below shows the entity elements in the model:

Figure 3: Model of CEOS production floor

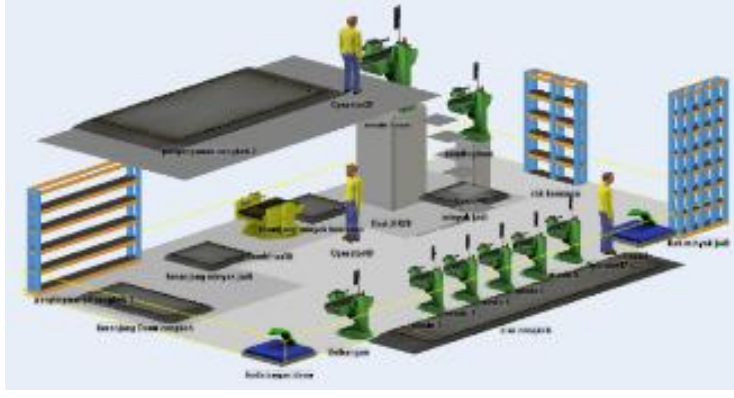


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Table 1: Summary and state report of CEOS model

Object	% idle	stats_input	stats_output	idle	blocked
Rack of Product	0.00%	12	0	0	0
machine 5	38.10%	0	0	2400	0
machine 4	38.10%	0	0	2400	0
machine 3	38.10%	0	0	2400	0
machine 2	30.49%	8	8	1921.11	0.216922
machine 1	13.43%	92	92	845.8559	60.35318
weight	29.63%	500	500	1866.698	0
big machine	13.54%	400	400	853.2804	0
cooling machine	28.89%	400	400	1819.966	0
Operator37	34.30%	600	600	2161.127	0
Operator39	34.75%	407	407	2188.995	0
Operator40	35.29%	25	25	2223.257	0

From the simulation result, the number of essential oil ready for sale is only 12 liter. From table 2, the simulation of system modeling of CEOS essential oil production floor found a big idle result in each of its machine, especially in machine 3 and 5 with p38.10% percentage, or hardly working at all, because one of the factors which is the scheduling of material arrival is only 100kg per day. The small work efficiency is also shown from the overall idle operator level, which is very high, this is because the operator only does several work such as removing the remaining extraction from the tool, inserting oil in the bottle, and other work that is not too time consuming. The actions that were taken in increasing the output and optimized the simulation were increasing the raw material capacity and changing the extraction standard time, as well as functioning all of the available machines. The experiment design and alternative selection of the essential oil model problem were done using several experiments: change the processing time from around 4 hours of processing to 3 hours for a single process in the 5 kg capacity extraction tool, this policy is consistent with the statement that the 3-hours extraction process is the most appropriate treatment to produce the best essential oil that is yield 1,983%, with favorable value for the scent 5,2 (between like and very like) and scent strength 6,4. Here shown the output:

Table 2: Summary output Design Experiment and Alternative Selection (DE&AS)

Groups	Count	Sum	Average	Variance
Model	30	314	10.46667	7.291954
Secenario 1	30	403	13.43333	18.11609
Secenario 2	30	433	14.43333	15.77126

From the table above, it is obtained the average output is 10 liter essential oil with several changes, especially at the time processing and the ordering of raw materials for the first scenario is 120 kg and 140 kg for the second scenario. The result is 13 liters and 14 liters with the treatments from the modelers that the tools or machines that will be used were the idle machines in the previous work.

Table 3: Design Experiment and Alternative Selection (DE&SA) Anova test

Sourceof Variation	MS	F	F crit
Between Groups	127.6778	9.301597	3.101296
Within Groups	13.72644		

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Then Form the statistical test using Anova test, it is shown that there is an average difference between the initial with the scenarios by comparing the variance. This is proven by the F arithmetic is greater than F crit. After performing anova test, MCA testing was performed using Banferoni method.

4.3 Alternative Selection Statistical Test

Table 4: t-Test, Two-Sample Assuming Equal Variances

	Com. 1		Com. 2		Com. 3	
	Model	SC 1	Model	SC 2	SC 1	SC2
Mean	10.5	13.4	10.5	14.4	13.4	14.4
Variance	7.3	18.1	7.3	15.8	18.12	15.8
P(T<=t) two-tail	0.00208		3.0666		0.35066	

In the banferoni test or t-Test Two-Sample Assuming Equal Variances by comparing each group data with the acceptance area limitation or alfa/n 0.01667 compared with P(T<=t) two-tail it is obtained that on each scenario, there was significant output difference because P(T<=t) two-tail was smaller than alfa/n while for each alternative, there was no significant different because P(T<=t) two-tail showed 0.351 value. From the experimental design result it can be done an alternative choice that the first and second scenario can give added value to its output by changing the extraction process and raw material amount. The CEOS party may take several considerations for the first and second scenarios to be applied, because the result obtained from the scenario are significantly improved the output compared to the initial model.

5. Conclusions

From the simulation result done in the production floor of essential oil, there are several problems that need to be solved, such as the idle that occurs in the 5 kg capacity extraction machine. The initial model can only produce 10 liter of essential oil, and this can be the parameter that the production system can be optimized still by doing several experimental design, such as increase the raw material up to 140 kg per day, and the time processing are reduced to 3 hours, and the result was the increasing of output to the 14 liter each week. The author recommends that the improvement steps to be implemented in the CEOS essential oil production floor are scheduling the arrival of raw material, and the determining of raw material capacity to reduce the extraction time so it can improve the output of production floor.

6. Acknowledgements

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