EVALUATING CAPACITY OF PALM OIL MILL USING SIMULATION TOWARDS EFFECTIVE SUPPLY CHAIN – A CASE STUDY

Fazeeda binti Mohamad, Razman bin Mat Tahar, Norhanom binti Awang
adeezaf@gmail.com, razman779@yahoo.com, anumjp@yahoo.com

Faculty of Technology Management
Universiti Malaysia Pahang

ABSTRACT

The purpose of this study is to evaluate the current capacity of the palm oil processing mill using simulation. We choose to simulate the current facility in order to analyze the processing operations of the mill and determine the capacity planning measures to be undertaken in the future in meeting the increase volume . The operations including the downtime due to machine breakdown or any mechanical problems will be evaluated. Simulation will be used in identify the key failure of components or machines during operations. It is expected that this simulation will help mill manager to identify how the system would handle future forecast of production with the current capacity and the increase volume in supply of fresh fruit bunches to the mill.

Field of Research: Capacity, Simulation, Downtime, Supply chain, Palm oil mill

1. INTRODUCTION

Malaysia is among the top leaders in palm oil industry to the world. As the main exporter to the world, providing the effective supply chain is needed. Supply chain of palm oil begins from the estate or plantation to the mill, mill crusher, refiners, manufacturers and users. Each of the chain plays an important role in providing the most quality products with high productivity. In the mill, the production capacity can be divided into several stages which range from 20mt/hr up to 90mt/hr. However the production capacity at the mill at this point is below the actual capacity. This is due to several factors which include the machine breakdown which led to downtime and lack of fresh fruit bunches (FFB) supplied to the mill mainly due to replanting, seasonal factors and labour shortage.

The palm oil mill experienced few problems of working at full capacity because of the few scenarios they are facing which are due to machines breakdown that create downtime and lack of materials or input supplied to them. The main purpose of this case study is to show the downtime occur in the operation system that effect work performance which is currently below capacity.

Downtime may occur either planned or unplanned. Planned downtime may refer to any schedule downtime controlled by the management while the unplanned downtime refers to unplanned shutdown or stoppage happened to the operation due to the equipment or mechanical problems. These failures may create disruptions to production, loss of productivity, and higher costs (Babbs and Gaskin, 2008). Downtime thus can create losses to

company in many subjects. Research done by CA Technologies (2010) reported downtime in their IT operations have significant impact on the ability of a company in generating revenue.

Downtime also may and often lead to loss of throughput in manufacturing system (Enginarlar et al.,2002). Downtime may occur at any unplanned events thus create disturbance to the overall production process. Downtime, however can be minimize through understand the critical components and implement the new components, inventory control and preventive maintenance policies for critical components involved (Sharda and Bury, 2008).

1.1 OBJECTIVES OF STUDY

The aim of the study intends to meet the objectives below in meeting the increase volumes of future demand in palm oil industry.

1. To model the palm oil mill operation.
2. To evaluate the current capacity of the palm oil mill.
3. To propose the improvement configuration of the palm oil mill operation system.

2.0 CAPACITY AND SIMULATION

In any organization, the capacity of the company can be evaluated and measured by looking at how it combines and utilizes the capacity it has purchased to perform work. In management, the capacity of an operation was determined by its time standards, and operational standards, and the time that the operation was available. Capacity entities can be divided into five which are space, labour, equipment, information technology and materials (Yu Lee, 2002). As in this study, factor of equipment is one of the problems as the machine used during operations facing the problem of breakdown that create the downtime in operation. Other than that, they experienced shortage of FFB which then effects the processing hours and their performance. Capacity then can be measured by using simulation and looking at the operation of the organization or manufacturing system.

Simulation is a method of mimic the real process or operations in any organizations as it may reduce times and cost savings. Simulation can be highly effective method which involves mapping a business, constructing it on a computer or creating "what if" scenarios to learn how we can improve the system. Any business which deals with problems involving productivity, quality and convoluted processes can be simulated and modelled (Doll and Riley, 2001).

Current literature mentioned the useful of simulation in an organization. Simulations allow users to save time and money while maximizing profit of the mill (Kim, 1996). Kumar and Phrommathed (2006) in their study demonstrate that process improvement can be effectively accomplished with an integrated approach of using proposed computer-based tools such as simulation.

3.0 INDUSTRIAL CASE STUDY

This paper focussed at only one palm oil mill at Pekan, Pahang. As the name and profile of the company remains confidential, only data then were provided in analyze and evaluating the capacity and performance of the company. The internal supply chain and operations of the mill begins when the fresh fruit bunches (FFB) arrived and being processed until the production of Crude Palm Oil (CPO) and Palm Kernel (PK).

The working hours of the mill are 16 hours per day with two shifts and 6 days per week. As the available working hours is 16 hours per day, the mill however did not manage to use the 16 hours provided as the problems they are facing as mentioned earlier. Due to this, the mill is working below capacity on which effect the costs, the production and processing time.

3.1 SYSTEM DESCRIPTION

The process at the mill can be divided into four main phases. The first phase begins with the inspection or grading the fresh fruit bunches before loading it into the ramp and transferred it using cages into steriliser line. Then crane were used to lift the cages and pour the fruit bunches into the hopper to separate the fruit equally into the conveyor. This is the most important step where it will determine the throughput of the operation.

The second phase is by threshing to loosen the loose fruit from it bunches and processed using digester to separate the fibres from its nut and to extract oil from fruitlets. Then, screw press were used to press the digested fruit to extract the oil that contain in the mesocarp where it produce two main products which are categorized as crude oil and the other is fibre, nut, shell and kernel. The fibres, nuts and small portion of kernels and shells were transfer into cake break conveyor and undergo the next process and the crude oil undergo the vibrating screen process to sieve the sludge from the crude oil.

Then, in the third phase, the crude oil was transferred into vertical clarifier tank and was stored to undergo sediment process to obtain clarifier oil. Pure oil were then stored into pure oil tank and purify the oil before enter the oil storage tank.

While the final phase would be separating fibres, nuts and small portion of kernel and shell in getting kernel as another output other than crude palm oil. The kernel that finished undergoes the whole process will then be stored into kernel bunker. The flow diagram of palm oil operations is shown in figure 1.

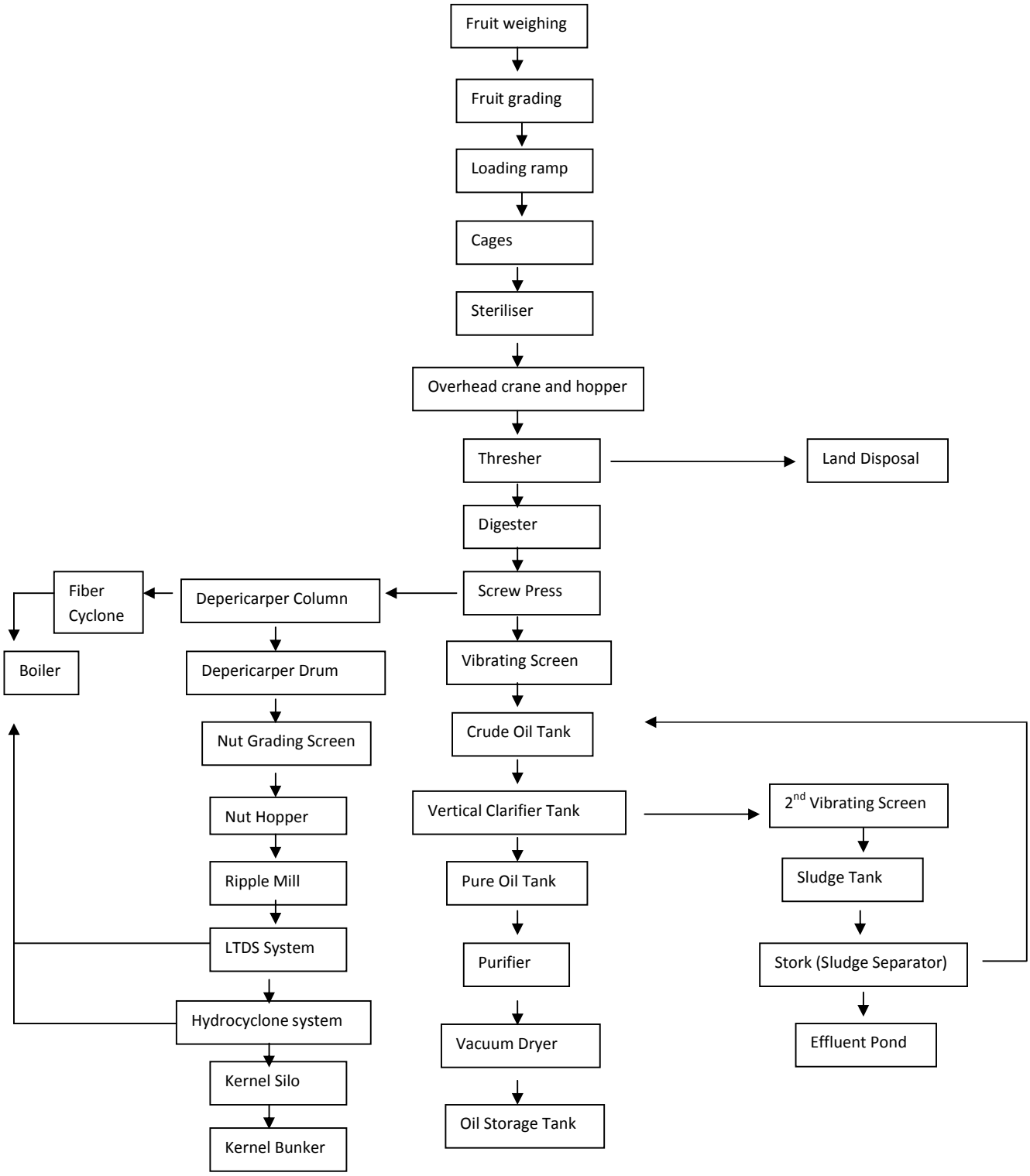


Figure 1: Process Flow of Palm Oil Mill

3.2 CASE STUDY METHODOLOGY

Data were collected from the palm oil mill as the input data. The data collected was on the processing hours of the mill. The daily performances of the mill were calculated by dividing the difference of the available and actual processing hours and by looking at the reasons of why the difference exists.

Interview session was also done as to understand the process flow and operation in the palm oil mill. The interview involved the mill manager and the lab assistant in getting the information related to this paper.

3.3 BUILDING THE MODEL

Introducing simulation at first time is always no easy task. Getting familiar with the real process and knowing every stages of the process could become a challenging task. A model must be accurate in representing the real flow or the business process. In getting the accurate process as to imitate using simulation, two aspects should be certified – verification and validation. Verification is the process of identifying the model built as one as intended it to build, whereas, validation is the process of insuring that the model developed represent the real world (Centeno and Carrillo, 2001).

The steps and decisions for a simulation study are incorporated into a flowchart as shown in Figure 2.

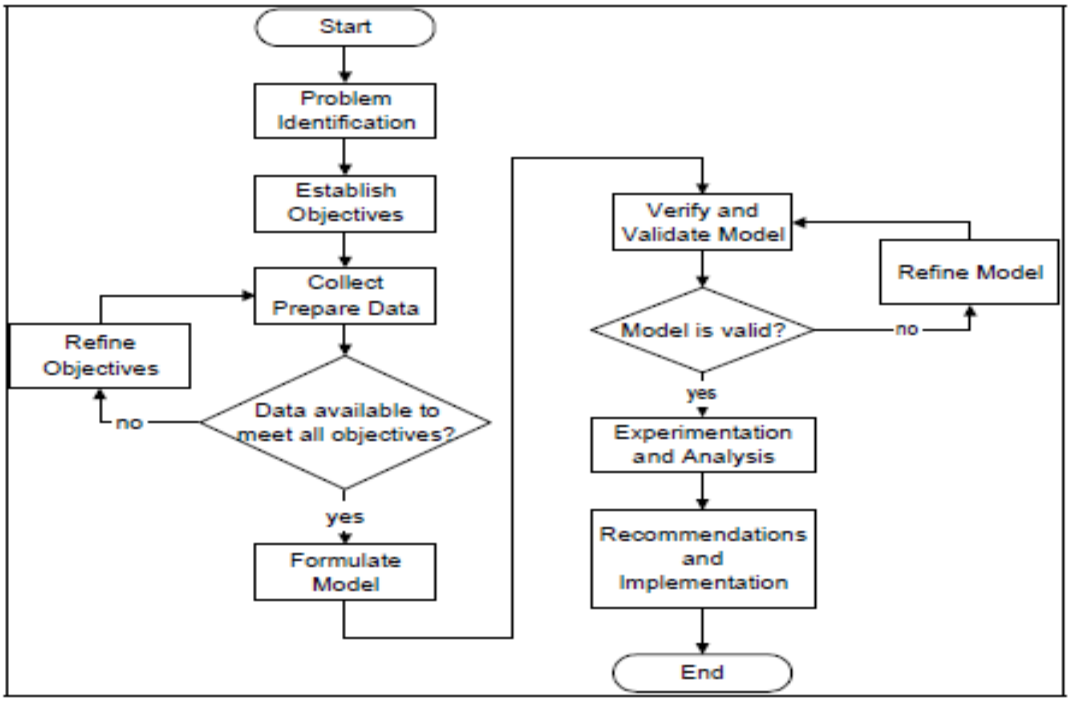


Figure 2: Steps and Decisions for Simulation Modelling Process
Source: Centeno and Carrillo, 2001

The steps begin with the problem identification and established the objectives. Then the relevant information or data related to the study will be collected. As in simulation, data such as waiting time, inter arrival time, number of entity, resources and few others more need to be identified. All the data collection must be relevant to the real system operated. Then only, model will be formulated.

As simulation is mimicking a real process, accurate representation is needed or else it may be questionable. As mentioned earlier, the model formulated must be verified and validate. Once the model is considered to be valid, the experimentation or simulation may begin. It must be based on the purpose or objectives of the study. The nature of the process being of the system under study become the altered process when it is simulate accordingly which then become the system under study and the cycle repeats.

The system does not end after each of the simulation, but it will be reviewed from time to time in order to check the system's response to variability experienced by the real system. It is important as to find the suitable solutions for different problem occur and do recommendations for the implementation.

3.4 DATA COLLECTION

Data collected to explain the differences exist between the available and the actual processing hours, the reasons of the gap were written as remarks. It normally can be classified into technical issue, quality issues and materials shortage issues. A sample of data collected for 7 working days is shown in figure 3. It shows the downtime occur due to machine problems before and during operations.

Date (October 2009)	Available Processing Hours	Actual processing Hours	Variance in Hour	Performance (%)	Remarks
1	16	10	6	62.5	
3	16	0	16	0	Setting new turbine and boiler
4	16	12	4	75	Welding steam
5	16	12	4	75	Wet kernel elevator chain break
6	16	12	4	75	
7	16	10	6	62.5	
8	16	12	4	75	Problems with nut elevator

Figure 3: Performance of working hours of the Palm Oil Mill in 7 working days

4.0 AN APPROACH FOR IMPROVEMENTS IN MILL OPERATION SYSTEM

It is important in any kind of study to determine the benefits of using certain method in their study. For this study, there is a need to use simulation in improvises the current method being applied in the capacity planning. Basically, in measuring the capacity it may involve three basic steps as shown in figure 3. It begins with the determination of service level requirement in categorizing the work done by the system. The second step is to analyze the current capacity to determine how the system meet the needs the performance of the system. The final step would be planning for the future. This is to ensure the capacity can meet the future requirements and do the forecasts for the management.

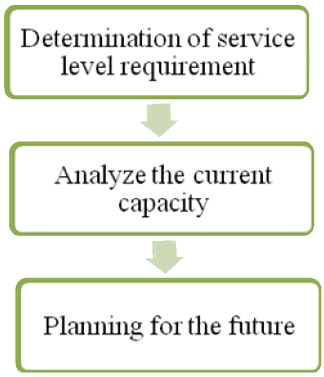


Figure 4: Three Steps for Capacity Planning
Source: Teamquest Corporation

A great contribution of using simulation in capacity planning would be the undesired of interrupting the real system especially when it involved such a complex system. Other than it might not involve higher costs, it may also help to understand the system better and do certain kind of alterations in doing forecasting for the future of the operations. The measurement and decision for any kinds of possible situation that may occur can be tested by using simulation thus may help to improve performance and achieve better and effective operations.

As downtime effect the capacity of the operation and performance, simulation model may help to identify the possible action that can be taken in reducing or eliminating the current problem occur to see the effect towards the production and capacity of the mill operation. An improvement need to be done in meeting the better process in the capacity planning that may help the mill to operate efficiently. For that, figure 4 shows how does simulation may help in identifying the key failure and do improvement to see better result.

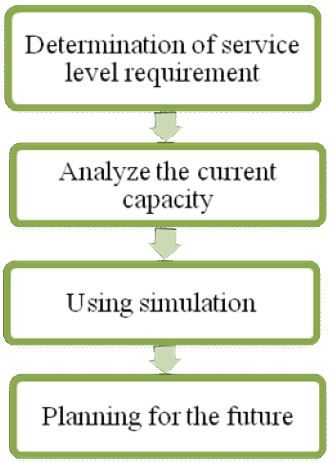
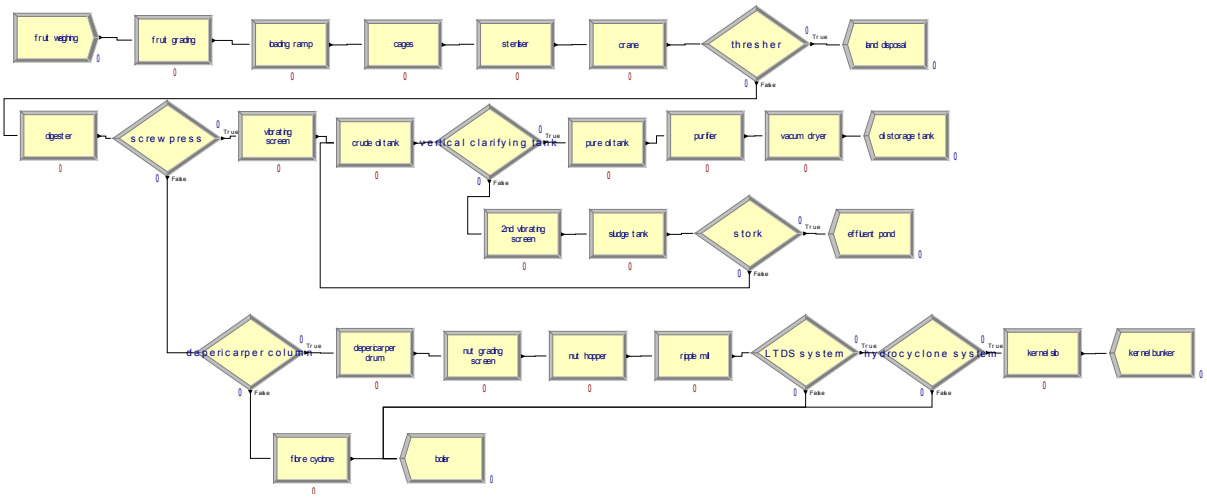


Figure 4: Using simulation in capacity planning

5.0 MODEL DEVELOPED USING ARENA SIMULATION



As simulation is known as a process of imitate the real system, thus this model were developed as it is using Arena software. By using Arena, this model is highly hoped to help this case study in analyzing the problems and the capacity of the mill operation. Arena model can be use as a platform for virtual experiments to find a best solution through different approach (Abed, 2008). The result may help to reveal the unused capacity and the downtime of overall operation.

6.0 EXPECTED RESULT

Simulation is well known as a powerful tool to process and evaluate performance of wide business operations and identify important constraint exists in operations. It is believed that the mill operation can be measured with no doubt. It may also reduce downtime and improve performance in order to regain loss capacity. Simulation does not only help in terms of evaluate process flow but as well as bottlenecks, throughput, delays and capacities (Dijk et al, 2005). These can be done without disrupting the real process or operation.

By using simulation, "what if" situation will be applied. By using this, we can make assumptions on what will happened when we assume no longer have machine failure occurred during the operations and the result would be by looking at the mill performance. Other than that, we can also make assumptions on if the FFB being supplied accordingly, will the mill meet the capacity and how do they cope with the situation if there is a huge number of increment in FFB supplied.

7.0 CONCLUSION

Simulation may help in terms of identifying at which stage the operations normally facing difficulties which affect the capacity of the mill. It also may help the mill manager to understand the process better and providing them an effective tool to evaluate their system and planning in short and long term period. Simulations again can help management to evaluate critical factors while discarding any irrelevant things might occur during operations.

The expanded model will allow the managers to analyze their operations better. Further, through model developed and simulation, the capacity of the mill and their operations can be measured efficiently in making the supply chain in the industry become more effective. It is important as it may help the management to determine whether the current system can meet the increase of demand in palm oil industry in the future.

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