Modeling Analytical Hierarchy Process and Fuzzy Inference System Tsukamoto for Crude Palm Oil Production Planning

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Abstract

Decision making has become a routine activities carried out by the production manager at Sindora Palm Oil Mill. The decision making process does not always run smoothly, sometimes arisen obstacles because uncertainty and vagueness. The obstacles come from various factors of production such as capital, labor and raw materials and machine, and as well as other factors such as, suppliers, inventory and market demand. These obstacles can be cause major problems if not dealt with quickly and accurately. One of the problems that will arise is the decline in production quantity. Therefore, this study intended to help the company to determine the optimal amount of crude palm oil production and to determine the order of priority factors influencing the decline in production quantity and also apply the Analytical Hierarchy Process (AHP) and Fuzzy Inference System Tsukamoto (FIS Tsukamoto) methods in the production planning the company to assist and facilitate the decision-makers in making decisions. FIS Tsukamoto is a method for decision making that using monotone reasoning. The data input obtained from documentation like inventory, demand and production data. In addition, AHP also is a method for decision making and the data obtained from interviews and questionnaire. The results of this study is the total production and inventories of Crude Palm Oil by the year 2014 turned into optimal and stable; profit is higher than previously; then, the plot data also showed that the total production in 2014 is not stable because there are still decreased. Then, the main factors affecting the decline of total production is internal factors. The Order of priority of the internal factors is factor capital, labor, raw materials and technology & machines. This study is particular suited if used in crude palm oil company like Sindora Palm Oil Mill, because give more benefit to the company.

Keywords
Fuzzy Logic, Decision Making, Production, Planning, Fuzzy Inference System Tsukamoto, Crude Palm Oil

1. Introduction

Nowadays, the company of manufactures act in the environment and unpredictable of a competitive market. Products and production technology is changing rapidly, causing a period of time between new product innovation

becomes shorter. The increasing market demands in line with the growth of new variations of product with higher complexity (Nachtwey *et al*., 2009 & APICS, 2001). To stay competitive, companies have to quickly adapt to market changes. Using the newest technology and production facilities are needed. This new situation requires a higher production planning frequency and planning methods adapted for design of production system (Nachtwey *et al*., 2009). Determination of the optimal number of production became one of the key to realizing a successful production planning. This relates to the level of success of the company to meet consumer demand (Wilson, 2001). Every company hopes to avoid shortages and excess of their output. If the output is less, then it can result in the loss of opportunity to sell the products in accordance with customer demands and reduced customer trust. Meanwhile, if the result of a production is excessive, it will result in increased inventory costs.

Every company generally established with the aim to gain profit and maintain its viability. In an effort to maintain its existence, the company strives to meet the maximum demand of the consumers. One of the efforts to realize the company goals is, needed to arrange the production with good planning. Production planning is a very important area in the company's strategic decision-making level, particularly in manufacturing. Production planning as a plan that aims to provide tactical decisions based on the resources of the company to meet consumer demand (Nasution, 1999). The role of a production manager is very important in this case the decision is very influential for the survival of the company.

A production manager is often confronted with problems in decision making related to production. Start from the onset of some problems of production factors such as, internal factors comes from the availability of resources such as machinery, raw materials, labour and capital need to be optimized and external factors such as market demand, supplier relationships and inventory in the warehouse (Pebriana, 2009). In addition to the factors of production, the production manager will be faced with some uncertainty. Uncertainty can be categorized into two kinds of environmental uncertainty and uncertainty of the system or internal (Grote, 2009). Environmental uncertainty refers to the uncertainty that would be beyond the scope of control of the production process, such as demand uncertainty and supply uncertainty. While the system uncertainty refers to the uncertainty associated with the production process, such as output uncertainty, uncertainty of production time, quality and production failure (Mula *et al.*: 2006, Ho: 1989).

1.1 Research background

Crude palm oil industry is the manufacturing industry that requires precise and accurate decisions in production planning. Previously we have seen that the crude palm oil industry is an increasingly rapid growth in Malaysia, this is in line with the increasing market demand. Ever-increasing demands made CPO firms have to work hard to fulfil that demand, meanwhile the constraints always come over to this industry. Nowadays, the world palm oil market conditions for global usage had reached 50 million tons, which has been increasing since 1990 until now. This success can be achieved because palm oil is more profitable than other vegetable oils (WWF Report, 2012). Palm oil prices were lower compared to other vegetable oils, therefore palm oil provides a competitive advantage in user countries like India and China (USDA, 2012). Among the 17 oils and fats in the global market, palm oil is the most consumed oil in 2012, reaching three billion people in 150 countries with a total consumption of 52.1 million tonnes (**Figure 1**). Consuming countries of the world's tallest palm oil are China, India, Indonesia, and the European Union (Sime Darbly 2013).

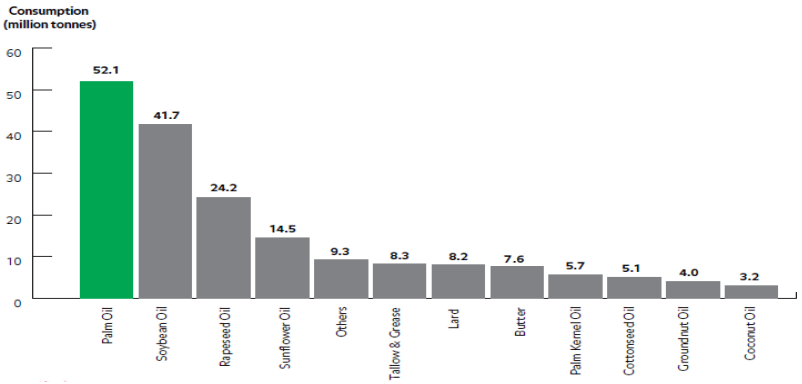

Figure 1: Global Consumption of Oil and Fats 2012 (Total = 183,9 Million Tonnes) Source: Sime Darbly, 2013

Furthermore, according to REA Holding (2016) analysis on their website "the World consumption of oils and fats has grown steadily during the last twenty six years. The Oil World statistics indicate that consumption in the last six years has increased from a level of some 162 million tonnes in 2008 to 195.6 million tonnes in 2014". Therefore, Malaysia must increase the production for fulfilling the market demand.

Moreover, according to Mielke (2011), oil palm along with other vegetable oils will continue to face the increased global demand from the food industry, oleo chemicals and biofuel industries. Mielke (2011) predicts in 2015 the demand for palm oil is around 62.63 million tonnes.

Based on the MPOB report (2013) the production and export of Malaysian crude palm oil in 2013 is increased. But, in 2012 the production decreased 2.3%. Meanwhile the number of stocks from 2010 until 2013 remains high. In 2013 the price decreased quite low, but the total stock remained high (**Table 2**). This can lead to a build-up of inventory in the warehouses and will result in a decrease in the amount of production. To avoid a decrease in the production of crude palm oil, crude palm oil companies should do proper planning so that production can be productive and be able to meet market demand.

Table 1: Total Production of Crude Palm Oil Malaysia.
Source: MPOB 2012 & 2013

Year	Procuction (Tonnes)	Land Area (Ha)
1975	1,257,573	641.791
1980	2,573,173	1,023,306.000
1985	4,134,463	1,482,399
1990	6,094,622	2,029,464
1995	7,810,546	2,540,087
2000	10,842,095	3,376,664
2005	14,961,654	4,051,374
2010	16,993,717	4,853,766
2011	18,911,139	5,000,109
2012	18,785,139	5,037,959
2013	19,216,459	5,230,000

Table 2: Total Stocks, Prices, & Export of Crude Palm Oil Malaysia.
Source: MPOB 2012 & 2013

Year	Stocks (Tonnes)	Prices (RM)	Eksport (Tonnes)
2010	710.541	2.701	23,060,017
2011	1,066,291	3.219	24,271,672
2012	1,575,103	2.764	24,591,025
2013	1,118,531	2.371	25,702,707

To assist decision makers in making decisions in the company, it is necessary to have an effective and efficient model that can help resolve those problems. Fuzzy Inference System Tsukamoto (FIS Tsukamoto) and Analytical Hierarchy Process (AHP) are some of the methods that can be used. Fuzzy Inference System Tsukamoto method first developed by Tsukamoto 1979 is a decision-making method based on fuzzy logic. Fuzzy logic is believed to be capable of handling the vagueness and uncertainty of production. FIS Tsukamoto is one method that is very flexible and has a tolerance to the existing data. FIS Tsukamoto has the advantage, which is it is more intuitive, accepted by many people, more suitable for the input received from a human not a machine (Thamrin, 2012).

Meanwhile, AHP methods are the first method developed by Thomas L. Saaty in 1970s (Grüning & Khün, 2009; Chelst & Canbolat, 2012). This method is a multi-criteria decision making model that can help the human frame which factors logic, experience, knowledge, emotions and sense optimised in a systematic process (Saaty, 1990). AHP method is used to solve complex problems in which aspects or criteria taken quite a lot, this complexity is caused by many things, including the unclear structure of the problem, uncertainty perception of decision making as well as the uncertainty of the availability of accurate statistical data. Sometimes problems arise perceived and observed to be decided as soon as possible, but complicated variations, so that the data cannot be recorded

numerically (quantitatively), but qualitatively, which is based on perception, experience and intuition (Nurbismo, 2010).

Sindora Palm Oil Mill is a Palm Oil Company examined by the researchers. This company is a subsidiary of Kulim Sdn. Bhd. One of the products manufactured are crude palm oil. Therefore, This thesis will be discuss the planning of the production of crude palm oil Sindora Palm Oil Mill by using the FIS Tsukamoto method for analysing the production planning companies, whether it is optimal or not and to plan the production of crude palm oil so that it's optimal. If the results of the calculation of the company is not optimal. It needs to be analysed what factors cause such things can occur. Therefore, in this research will also analyse the factors that influence the amount of production. So, the Analytic Hierarchy Process will be used to determine the priority order of the factors of production and to prevent a decrease in the amount of production.

1.2 Problem Statement

Taking the conventional decision will be difficult by decision makers (Harvard Business School, 2006), especially a production manager. Complex and many problems in production planning cause confusion for decision makers to choose which is the more important issue and should be resolved first (Cuixiao Fu & Xingsan Qian, 2008).

In the book of Harvard Business School (2006) state "Business decisions are difficult when they involve uncertainty presents many alternative, are complex and raise interpersonal issues". This means is in complexity makes decision making is difficult. In manufacture, an uncertainty that arise from factors production in the companies. For example, the uncertainty of data production, inventory, demand, and other factors. Particularly in the crude palm oil industry, which is known in advance that the raw materials derived from fresh fruit bunches. This raw material is perishable, a bit difficult in terms of storage and production. For this matter, it is conceivable complicated and complex production planning in the crude palm oil industry, especially combined with demand for the products is increasing. This certainly make the department of production planning and controlling of the crude palm oil companies are very busy dealing with these issues. Therefore, that uncertainty should be articulated, communicated, analysed, and anticipated (Chelst & Canbolat, 2012).

The decision makers often make bad decisions because the information they need is not enough and because in their future is full of surprises (Harvard Business School, 2006). In order to achieve effective decision making, the decision maker has to rational with high quality information about uncertainty, preference and alternatives (Handbook decision analysis, 2013). A reason to avoid the uncertainty is they may endanger business success (Grote, 2009). Inside the Production Planning of Sindora Palm Oil Mill there are many vagueness and confusion. The vagueness as demand is uncertain and constantly changing, the amount of raw materials that are not certain, the number of machine operators, who often leave and do not come to work, and so forth. While confusion such as crude palm oil product variations (there is high quality and there is a low quality) resulting in a complex production planning (Interview Report, 2015). Therefore, for helping and facilitate decision-maker to make effective decisions in the production planning in the crude palm oil company, this study presented the Fuzzy Inference System Tsukamoto and Analytical Hierarchy Process method.

2.0 Data analysis

2.1 Determine The Output Crisp (*Defuzzification*)

$$Z = \frac{\alpha1 * Z1 + \alpha2 * Z2 + \alpha3 * Z3 + \alpha4 * Z4 + \alpha5 * Z5 + \alpha6 * Z6 + \alpha7 * Z7 + \alpha8 * Z8 + \alpha9 * Z9}{\alpha1 + \alpha2 + \alpha3 + \alpha4 + \alpha5 + \alpha6 + \alpha7 + \alpha8 + \alpha9}$$

$$Z = \frac{\begin{array}{c}(0{,}21 * 4333{,}85) + (0{,}31 * 4222{,}44) + (0{,}31 * 4222{,}44) + (0{,}21 * 4333{,}85) + (0{,}42 * 4016{,}55) + \\ (0{,}62 * 4147{,}85) + (0{,}21 * 3699{,}01) + (0{,}42 * 3929{,}01) + (0{,}69 * 4224{,}44)\end{array}}{(0{,}21 + 0{,}31 + 0{,}31 + 0{,}21 + 0{,}42 + 0{,}62 + 0{,}21 + 0{,}42 + 0{,}69)}$$

$$= \frac{14039{,}87}{3{,}40} = 4129{,}37$$

The resulting Z value is the amount of production which has been optimized. From these results it can be analysed, the month of December 2014 the company produces 4115.78 tonnes, with the total inventory is 492.36 tonnes. The production optimization results using the FIS Tsukamoto are 4129.37 tonnes with total inventory is 918.30 tonnes. Total production and total inventory produced by FIS Tsukamoto in December 2014 is higher than the calculation of the company. This happened because FIS Tsukamoto method optimizes the number of CPO production in order to meet the target of demand as much as 4628.68 tonnes. **Table 3** shows the different results of the calculation between the companies with the FIS Tsukamoto method. Significant differences can be seen more clearly in **Figure 2 and 3**, which presents the plot of data production and inventory in 2014.

Table 3: Production and Inventory Analysis Results 2014.
Source: The Result of Analysis, 2015

MONTH (2014)	DEMAND (Tonnes)	SINDORA PALM OIL MILL PRODUCTION PLANNING		FIS TSUKAMOTO PRODUCTION PLANNING	
		PRODUCTION (Tonnes)	INVENTORY (Tonnes)	PRODUCTION (Z) (Tonnes)	INVENTORY (Tonnes)
January	4311,40	3874,12	1379,50	3886,22	1391,05
February	4684,34	3552,79	247,95	4194,11	900,82
March	3831,10	3974,31	391,16	4071,06	1140,78
April	3543,20	3469,46	317,42	3933,18	1530,76
May	2807,66	3672,17	1181,93	3907,13	2630,23
June	4623,76	3780,08	338,25	4160,63	2167,10
July	3738,81	4043,82	643,26	3981,41	2409,70
August	3630,88	4404,57	1416,95	3837,97	2616,79
September	5450,21	4563,63	530,37	4109,40	1275,98
October	4379,40	4238,45	389,42	4165,05	1061,63
November	3537,22	4153,06	1005,26	3893,20	1417,61
December	4628,68	4115,78	492,36	4129,37	918,30

In **Figure 2** below, shows that the company produces the goods is unstable, sometimes there are high and low. For example, in March the production is quite high as much as 3974.3 tonnes, while in April the production decline was 3469,4 tonnes. As for the total inventory is also the same as the total production, which is unstable, sometimes the amount of residual CPO produced very little, so that if it happens then to the next month, the company had to work hard to produce higher CPO. This happens because the company only has a little reserve to meet the next higher demand. As you know that the raw material of CPO is a perishable. Materials can only survive within 24 hours after being picked from the fields. Raw materials are also imported from the fields far away from the mill, thus becoming a long production lead time. In addition, the amount of raw materials is uncertain, because of factors such as weather, pests and others. Therefore, the company produces CPO to taste according to the number of customer orders.

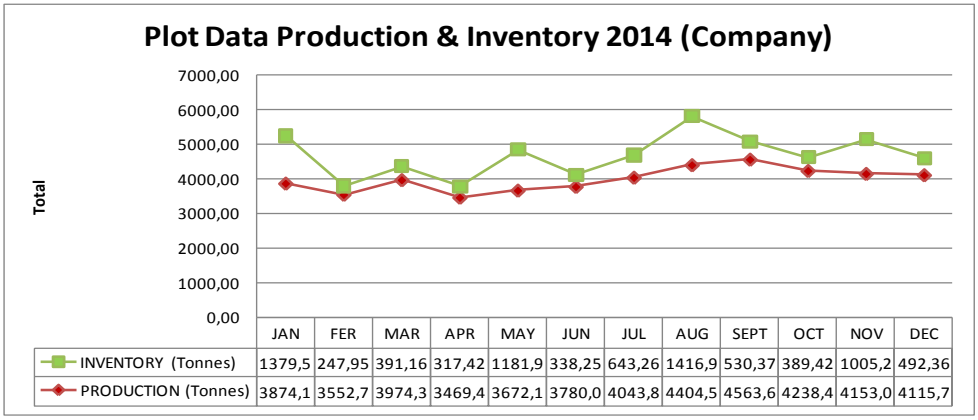

Figure 2: Plot Data for Production & Inventory Crude Palm Oil 2014 (Company).
Source: The result of analysis, 2015

While the results of optimization using FIS Tsukamoto is much different with the results of the calculation of the company. Seen in **Figure 3** the plot shows results fairly stable production data and the amount of inventory that is high enough. The resulting total production is the optimal amount of production, which can be a standard amount of production to meet customer orders. So that later the company remains productive and earn a profit. The amount of inventory that has been optimized by FIS Tsukamoto is a high number. However, it is appropriate for the crude palm oil company, because with such a high number of inventory, the company had reserves of CPO for sale for the next month.

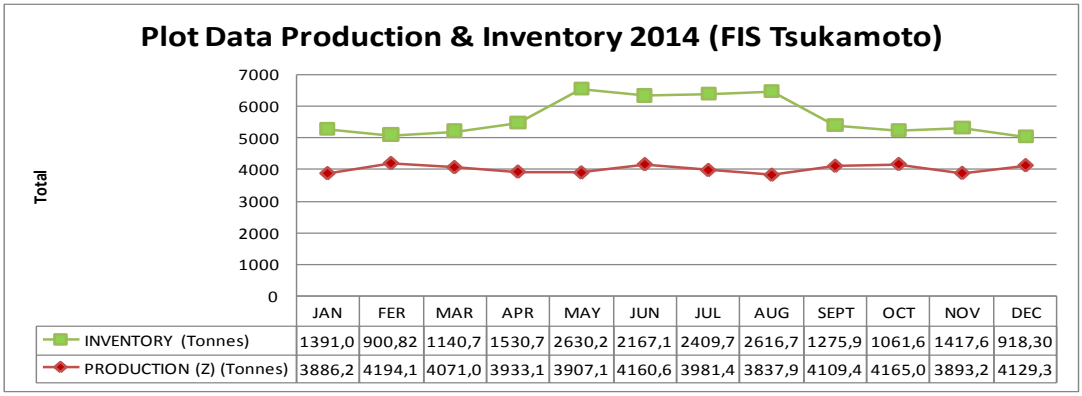

Figure. 3: Plot Data for Production & Inventory Crude Palm Oil 2014
(FIS Tsukamoto)

In detail, the comparison of the products and profits of the company and FIS Tsukamoto calculation, as shown in the table below:

Table 4: Total Product and Profit from the Company 2014.
Source: (Researcher, 2015 & MPOC, 2014)

COMPANY			
MONTH	**PRICES (RM/Tonnes)**	**TOTAL PRODUCT (Tonnes)**	**PROFIT (RM)**
JAN	2.534	5253.62	13,312.67
FER	2.635	3800.74	10,014.95
MAR	2.862	4365.47	12,493.98
APR	2.696	3786.88	10,209.43
MAY	2.605	4854.10	12,644.93
JUN	2.436	4118.33	10,032.25
JUL	2.404	4687.08	11,267.74
AUG	2.174	5821.52	12,655.98
SEPT	2.059	5094.00	10,488.55
OCT	2.179	4627.87	10,084.13
NOV	2.219	5158.32	11,446.31
DEC	2.155	4608.14	9,930.54
TOTAL		56176.07	134,581.46

Table 5: Total Product and Profit from the Results of FIS Tsukamoto 2014.
Source: (Researcher, 2015 & MPOC, 2014)

FUZZY INFERENCE SYSTEM TSUKAMOTO			
MONTH	**PRICES (RM/Tonnes)**	**TOTAL PRODUCT (Tonnes)**	**PROFIT (RM)**
JAN	2.534	5277.27	13,372.60
FER	2.635	5094.93	13,425.14
MAR	2.862	5211.84	14,916.29
APR	2.696	5463.94	14,730.78
MAY	2.605	6537.36	17,029.82
JUN	2.436	6327.73	15,414.35
JUL	2.404	6391.11	15,364.23
AUG	2.174	6454.76	14,032.65
SEPT	2.059	5385.38	11,088.50
OCT	2.179	5226.68	11,388.94
NOV	2.219	5310.81	11,784.69
DEC	2.155	5047.67	10,877.73
TOTAL		67729.48	163,425.71

As seen from **Table 4 and 5**, there is a very significant difference between the results of the calculation of the company and the FIS Tsukamoto. Total company's products for one year is 56176.07 tonnes, with profits when sold for RM 134, 581.46. Meanwhile, FIS Tsukamoto produced a total of 67729.48 tonnes as much product and profit around RM 134, 581.46. There is a difference from the results, because the calculation result FIS Tsukamoto slightly more compared to the results of the calculation of the company. The difference is as much as 11553.41 tonnes and approximately RM 28, 844.25. The result of the calculation shows that the FIS Tsukamoto can be optimized in terms of the amount of production and profits at companies Sindora Palm Oil Mill.

The overall result calculations use the software Expert Choice 11, then the results obtained by internal factor is better with the amount of the percentage of 73,8% (**Figure 4 & 5**). Internal factors that most influence is the capital factor. As for the order of 1 to 3 priority factors that most influence the amount of crude palm oil production at Sindora Palm Oil Mill is good production time, with a value 0,233 or 23.3%. The second factor is the factor delivery time with the value 0.109 or 10.9%. The third factor is the quality factor in workers with 0,103 or 10.3%.
Good production time becomes a major factor for the company Sindora Palm Oil Mill, goods production time is a difficult problem to be solved. Required scheduling technique and a good strategy to solve the problem on this factor. Then the next factor is the delivery time factors (special material). This factor also often causes problems such as delays in raw materials to the factory, and the quality factor of the workers that also gives considerable cause for the decrease in the amount of production.
The third factors are the main factor that directly will give effect on the decrease in production at the Sindora Palm Oil Mill and the production decision makers need to consider and prioritize the production of these factors to be analysed and resolved if a problem occurs. The order of factors can further be seen in **Figure 4 and 5**.

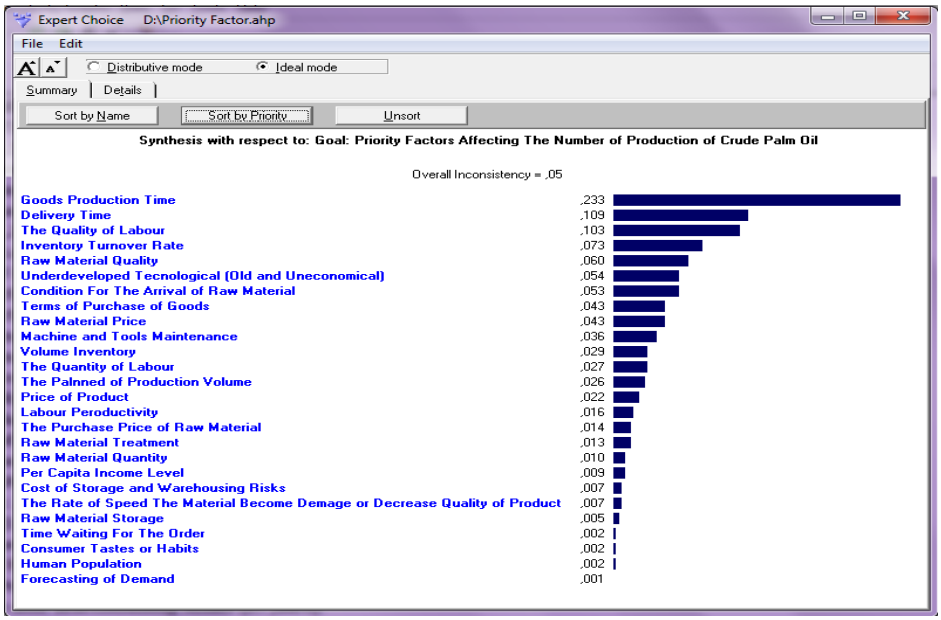

Figure 4: The Overall Order of Priority Factors For Achieving The Goal

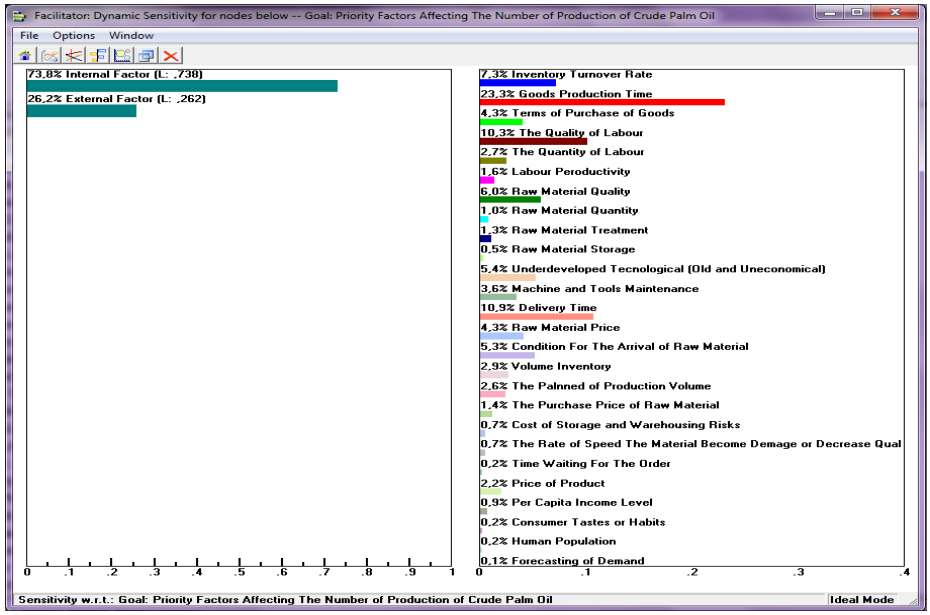

Figure 5: Percentage of Priority Factors

The results of the discussion in this chapter that the AHP method has produced a sequence of factors affecting the production of crude palm oil at Sindora Palm Oil Mill. The main priority factor comes from the internal factor of the company. And globally result calculation using Expert Choice 11, i.e., A sequence of one to three (1-3) are the most influential in the production at Sindora Palm Oil Mill and need to take precedence in advance. The first factor is the goods production time 23.3 %, the second factor is the delivery time factor 10.9% and the third factor is the quality of labour factor 10.3%.

Then, the results of the Fuzzy Inference System Tsukamoto is the amount of production which has been optimized for 2014 and the amount of inventory that is higher than the calculation of the previous company. Comparison of the company's calculation with FIS Tsukamoto calculation is provided in the form of plots of data. Plot the data showed a significant difference between the two. As well as the total number of products on the calculation FIS Tsukamoto more profitable than the previous company's profits. The next chapter will provide the focus and Conclusions of the study.

3.0 Discussion

In the decision-making process of the production company Sindora Palm Oil Mill involves a lot of things to consider to avoid missteps. A decision maker must cleverly and carefully and have a good technique to help quickly and easily in taking decisions. In this study there are three objectives, as in the sub-chapter 1.5.

Objective (i) is to determine the optimal production amount of crude palm oil in the company, using the Fuzzy Inference System Tsukamoto (FIS Tsukamoto). This objective is met after performing calculations using FIS Tsukamoto for production data in 2014. The result is the optimal production quantities. The results have a significant difference with the results of the calculation companies before. The difference can be seen from the plot of the data in **Figure 2 and 3**. The calculation results show that the number of production FIS Tsukamoto is a stable and a high amount of inventory. While the number of productions designed by the company is unstable. So is the amount of inventory which is not stable, it is sometimes very low and very high. Then, the differences are more apparent from the calculation of the total product and profit in 2014 between the company and the FIS Tsukamoto calculation. Total products from the calculation of FIS Tsukamoto was higher compared with the results of the calculation of the company. Thus, it can be said that the results of the calculation of FIS Tsukamoto more profitable.

Objective (ii) is to determine the priority order of production factors which affects the production planning in the company using Analytical Hierarchy Process (AHP). After doing an interview and a questionnaire to 5 (five) of the respondents, who are expert in production. Then, obtained the test results of AHP i.e. The order of factor of production from existing levels in the hierarchical structure. At Level II, the internal factor to be the top priority. And then, At Level III, the capital factor is a top priority, the next factor is the labour factor, raw material factor, and the latter is the technology and machine factor. Then, from level IV obtained the order of one to twenty-six (1-26) factor. Which the main priority is goods production time factor, and the second priority is the delivery time factor, and the third factor is the quality of labour. For the next factor as shown in **Figure 4 and 5**. The order of these factors is the order of the factors that often cause a decrease in the amount of CPO production in Sindora Palm Oil Mill, and became special factors that need to be given more attention in terms of handling. So, the first objective has been fulfilled and can be used as an overview to the decision makers in the companies.

Objective (iii) & (iv) is to apply Analytical Hierarchy Process and Fuzzy Inference System Tsukamoto method in production planning crude palm oil company, in order to help the decision maker to make a decision. From the results of the achievement of objectives (i) and (ii), it can be concluded that the AHP is very suitable when used as a method to assist decision makers to determine the order of priority factors that affect the crude palm oil productions. And FIS Tsukamoto is also very suitable when used to calculate the optimal number of crude palm oil production, so that companies can easily in getting production decisions. Therefore, AHP and FIS Tsukamoto are very suitable if applied to the crude palm oil company's production
Planning, especially companies Sindora Palm Oil Mill.

3.1 Contribution of research

This study discussed the determination to assist decision-makers in planning the production of crude palm oil in Sindora Palm Oil Mill Company and the determination of the order of production factors that affect the amount of production by using the AHP. Without proper planning, decision-making errors can occur. To make decisions that can provide benefits to the company, it is necessary techniques that can facilitate decision-makers. For that, this research was conducted with the aim to reduce the errors.

The contribution of this research provides an understanding of how to determine the amount of production that optimal using FIS Tsukamoto and how to determine the priority factor which affects the amount of crude palm oil production by using AHP, As far as the studied available in the literature review, the determination of the optimal production quantities using FIS Tsukamoto and the determination of the order of the priority factor affecting production using AHP is proposed.

The finding is interesting because both of these methods are easily understood. Both use a simple mathematical logic. AHP with matrix, and FIS Tsukamoto with equation of a straight line. AHP uses a Software Expert Choice 11 to help determine the order of the factors. AHP generates a hierarchical structure that can facilitate decision makers in understanding the source of the problem. While FIS Tsukamoto uses three steps, namely fuzzification, inference and defuzzification to produce an optimal production quantities. The study also gives knowledge to readers of how to apply the method of AHP and FIS Tsukamoto in decision-making, production planning for the company in the future.

In this study, the order of factors that affecting the amount of CPO production has been produced, to resolve the issue of the CPO production. And then, When compared with the results of the company calculation, there is a significant difference. The results of production and inventory of FIS Tsukamoto give more benefit, as well as the planning of production became organised. It shows the number of the production planning using FIS Tsukamoto can help companies Sindora Palm Oil Mill to increase profits and reduce losses.

3.2 Impact to Industry and Academia

In this study, company and researchers will get impacted and benefit. For the company, this research is useful to facilitate production managers in making production decisions. Therefore, production managers can easily identify factors priority to be addressed as soon as possible. In addition, production managers can also easily adjust the amount production and inventory without fear of loss. So that, the company can always reach for a profit. The impact to the researcher is to provide new knowledge on how to apply the method of Analytical Hierarchy Process and Fuzzy Inference System Tsukamoto in production planning. Specifically to the type of product that is special and has the confusion and ambiguity in its production, such as crude palm oil. The researcher obtains an appropriate method to help CPO Company's production planning in order to be optimized.

4.0 Conclusion

The conclusions of this study are, this research can be applied in planning the production of CPO at Sindora Palm Oil Mill to help facilitate decision-making in the company. Tsukamoto Fuzzy Inference System model has produced a number of optimal production for the year 2014. And also the amount of inventory to be high because it is adapted to the uncertain raw material. Because of the amount of production and inventory optimized then the profits generated being optimal. This is evident from the different results of the calculation of the company with the FIS Tsukamoto. FIS provides advantages over Tsukamoto compared with the results of the calculation of the company.

Meanwhile, Analytical Hierarchy Process has produced the order of factors that affect the amount of production. Those factors have rank, from major until the last one. Which means that most contributed to the problem that less influence. The sequence as an overview for decision makers in the company to determine the factors of production which should be prioritized to be resolved. The sequences to help facilitate decision makers (production manager) in resolving the problems that arise. Thus, both of these methods can be applied with properly in the company. And can help a lot the company production planning. Then, providing new knowledge on researchers about a decision-making method that efficiently and effectively.

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Biography

Dr. Abdul Talib Bon is Professor of Technology Management in the Department of Production and Operations Management at the Universiti Tun Hussein Onn Malaysia. He has a PhD in Computer Science, which he obtained from the Universite de La Rochelle, France. His doctoral thesis was on topic Process Quality Improvement on Beltline Moulding Manufacturing. He studied Business Administration in the Universiti Kebangsaan Malaysia for which he was awarded the MBA. He's bachelor degree and diploma in Mechanical Engineering which his obtained from the Universiti Teknologi Malaysia. He received his postgraduate certificate in Mechatronics and Robotics from Carlisle, United Kingdom. He had published more 150 International Proceedings and International Journals and 8 books. His research interests include manufacturing, forecasting, simulation, optimization, TQM and Green Supply Chain. He is a member of IEOM, IIE, IIF, TAM, MIM and council member's of MSORSM.