Elements in Estate and Palm Oil Mill that Affecting the Oil Extraction Rate (OER) and Kernel Extraction Rate (KER): A Case Study in Larut Matang Selama District in Perak

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Abstract
OER and KER is a challenging substance to produce. This research is being conducted to identify the which factors are giving an affect towards OER (Oil Extract Rate) and KER (Kernel Extract Rate). This study had been conducted at Larut Matang Selama District of Perak. The data that being collected are OER, KER, rainfall record, oil losses, Free Fatty acid (FFA), loose fruit and Fresh Fruit Bunches (FFB) for 36 months. For Oil Extraction Rate (OER), the most dominant factor is FFA which affecting the oil quality with Beta value is -0.410. Meaning that, if the FFA increases by 1 percent, OER degrease by 0.41 percent. Meanwhile, overripe bunches have become the only elements that influencing the Kernel Extraction Rates (KER) with beta value is 0.439. Thorough of all the process between estate management and mill management, the problem to achieved high quality of OER and KER are come from the estate. The estate management must improvise harvesting ripeness standard by following the MPOB grading guideline. This is because of, some of ripeness category are not even giving any increment towards OER and KER performance. Despite the above limitations, we believe that this study provides a contribution to the literature. In addition, the results of the study will provide a better understanding on the importance of controlling and monitoring the qualities of the FFB especially at the field. Nevertheless, the mill also shall play a huge role by making a more stringent action for those sending a low quality of fruit in their mill.
Keywords: Oil Extraction Rate (OER), Kernel Extraction Rate (KER), Rainfall, Oil losses, Free Fatty Acid (FFA), Loose Fruit and Fresh Fruit Bunches (FFB) Grading.

Introduction
From 2013 until the end of 2021, over nine years have passed with OER and KER performance remaining below the national target. The mill and the estate are beginning to point fingers at one another. It has also been influenced in some way by the macroenvironment or external

causes. For instance, it is rain, soil type, or even natural disaster. Between 2010 and 2016, the total regional OER increased from 16.993 million tonnes to 19.961 million tonnes. However, using Malaysian Palm Oil Board (MPOB) data, it began to show a fall to 17.319 million tonnes in 2017. As a result, it is critical to ascertain whether the issue stems from the estate management or the Palm Oil Mill. As the subject to be clarified, estate performance is entirely dependent on the estate management. Whether goods are delivered quickly or slowly from the estate to the industry is entirely dependent on the estate management. Because the industry is solely concerned with the manner of processing. Which are responsible for the transformation of raw materials into finished products.

The first factor that frequently occurs in estate management stems from the processing of the root materials. Which is the variety of planting supplies. For instance, Yangambi, AVROS, Calix, or GH5000. The second factor is the application of fertiliser. Additionally, the management will have supplied rules and dates for when to fertilise and spray pesticides and herbicides on the trees. The rules and dates supplied are intended to maximise OER production in the future. Any current activity will be reacted to in the future. The third is the rainfall factor. Rainfall is another likelihood factor that could impact OER performance or FFB growth. In this situation, we aim to identify whether natural or synthetic compounds may occasionally impair the performance of Free Fatty Acids (FFA) and OER. Finally, the fresh bunches' state. The classification of ripeness bunches may result in an increased or decreased proportion of OER, FFA, and also Kernel Extract Rate (KER). According to Slew and Mohamad (1992), oils harvested at the proper age and without risk of harm exhibit negligible degradation when processed within a few days. In other fields, which are viewed through the lens of industry, there were not as many factors or independent variables. Neither element is likely to result in changes in the percentage of OER or KER. Significant factor that could be identified are by examining the statistics on oil losses caused by mills that are unable to operate. To comprehend the methodology or formula used to calculate oil losses, (OER + Oil Losses = Total Oil) and (OER = Total Oil − Oil Losses). This equation eliminates uncertainty across the OER and binds all participants to their respective obligations. This guarantees that all oil entering the mill is transported by the estates and that the mill compensates for the oil effectively which it would forfeit upon acquiring the FFB.

The purpose of this study is:
1. To evaluate the factors that influence the OER and KER performance in estate and oil mill.
2. To identify the most powerful elements in affecting OER & KER performance.

Methodology
Conceptual Framework
Based on prior studies the following conceptual model has been developed to illustrate the impact of rainfall, loose fruit, FFA and FFB grading on palm oil qualities (Figure 1)
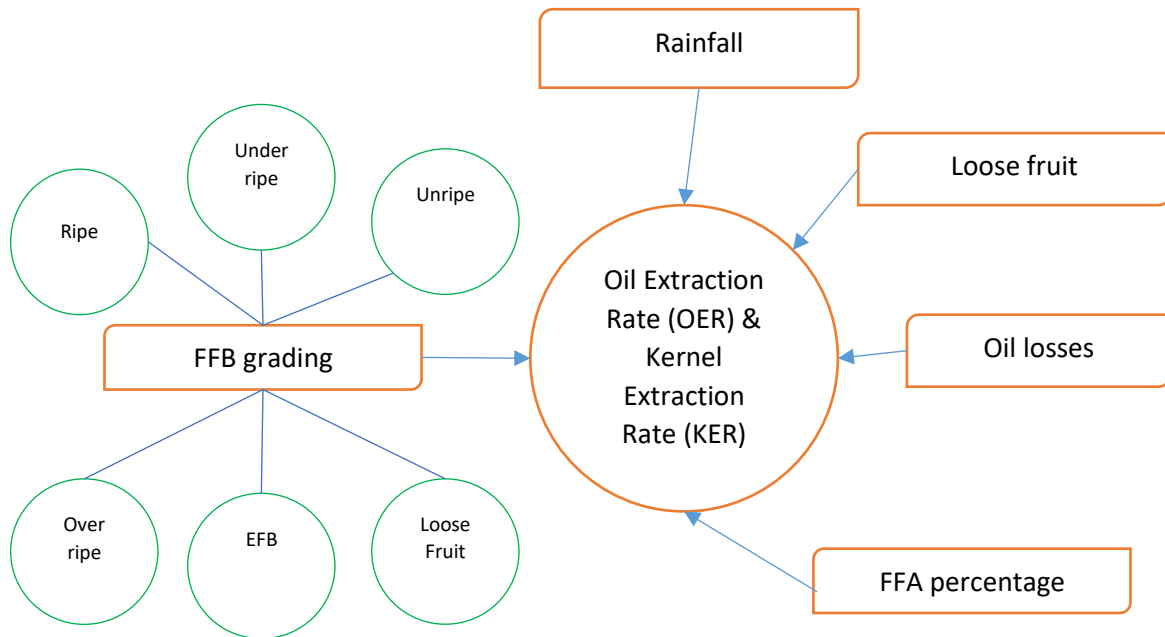
Figure 1: Conceptual framework of elements that influencing OER and KER

Data Collection
Data that obtained throughout this study are to observe and identified the relationship between dependent variables (OER and KER) and independent variables (FFB grading, FFA percentage, oil losses, loose fruit and rainfall. The type of data collection in this study are secondary resources. The multivariate secondary data. The qualitative data may be gathered by papers, dailies, interviews, documents, etc., while a census, financial statements and reports are used to collect the quantitative data. The data that collected are the factual between mill and estate performance in yearly and monthly. In this study, there was some various ways in data collection that has been done before.

First of everything, data collection done by collection all the factual data that related in performance and maintenance under estate management. This is including factual data of rainfall by monthly and loose fruit percentage in daily. For data that collected from mill management, mostly data are in percentage and factual according to the real time performance. Then both data from both managements must be tally in month, so that outcome result can be identified purely.

Location
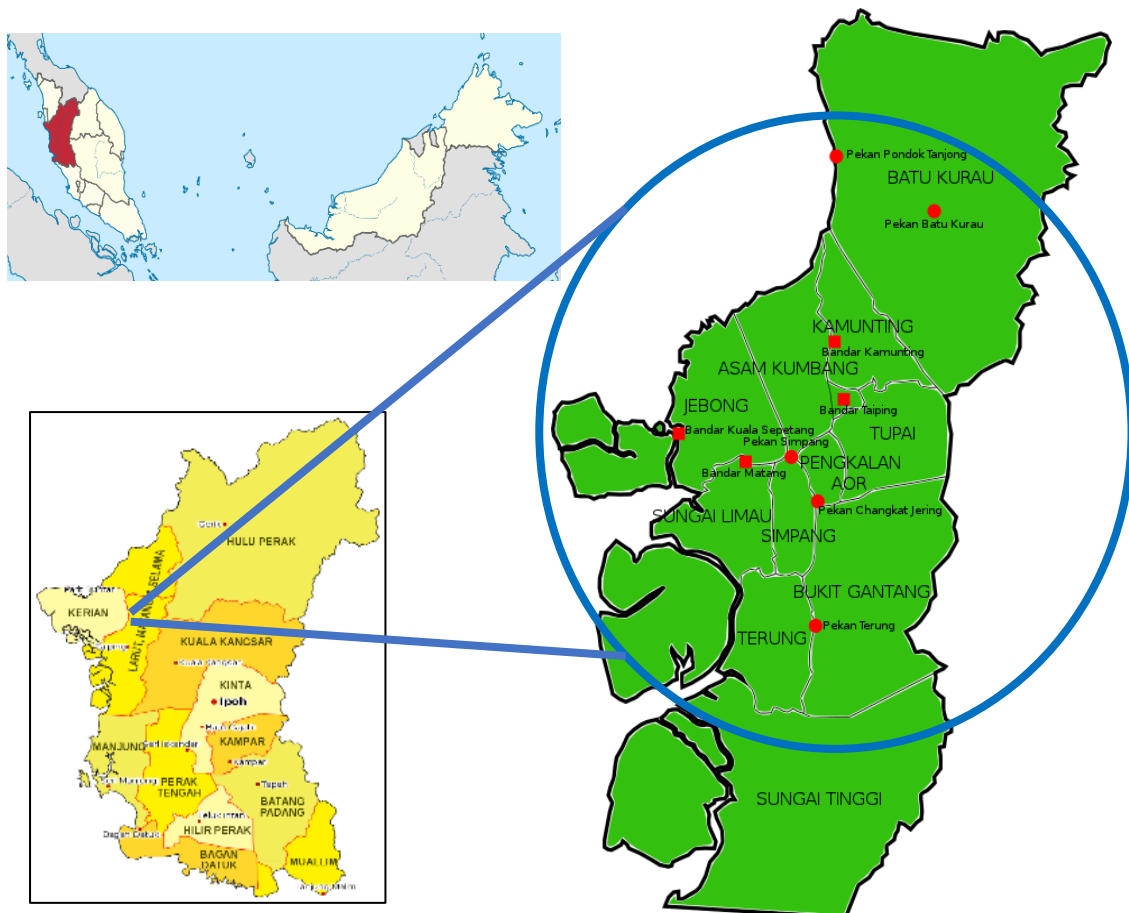
Figure 2: Location of study

This survey was done out at Oil Palm estate and Palm oil Mill in Perak's Larut Matang Selama District. These areas been selected due to the record of profit performance is likewise maintained in a positive light. In addition, all the necessary data has demonstrated a positive outcome and flawless recording.

Statistical Analysis
All the secondary data that gathered would be interpreted in Social Science Statistical Package (SPSS) 22nd edition. The data is analyzed the proportion and calculated the data of KER, OER, FFA, L/F percentage and FFB grading.

Results and Discussion
Correlation
Relationship between elements affecting the OER and KER
Pearson Correlation Analysis was used to identify the relationship between the independent variables (salary, safety, amenities and technical training) that affect the dependent variable (employee performance). Theoretically, the higher value of the correlation between two variables, the more related these variables are to each other (these values show the strength of relationships among variables). From table 5, the significant number between group or in 3 years are mostly less than P – value = 0.05 and more than r – value = 0.05 to be significant. And in table below, the prediction is to be determined which year have the best performance

of OER. From table 1 below, as we can have interpreted are this table indicated the relationship between independent variables and dependent variables. The direction of relationships among variables is another issue that should be considered in analysing the correlations between variables. A positive correlation indicates that the direction of the relationship is positive (if one increases, the other one increases). Bivariate Correlations are used to know the nature, direction, and significance of the bivariate relationship of the variables of this study. Therefore, the Bivariate Correlations procedures have used to compute Pearson's correlation coefficient. A rule of thumb is that multicollinearity may be a problem if a correlation is >. 90, in the correlation matrix formed by all the independent variables (Coakes S. J. and L. G. Steed, 2000). The correlation value is as presented in Table 2 below: -

Table 1: OER correlation matrix.

		OER	FFA	RAIN	RIPE	UNRIPE	UNDERIPE	OVERRIPE	EFB	LF	TOL
FFA	Pearson Correlation	**-.410***									
	Sig. (2-tailed)	.013									
	N	36									
Rainfall	Pearson Correlation	**-.362***	.229								
	Sig. (2-tailed)	.030	.178								
	N	36	36								
Ripe	Pearson Correlation	-.080	-.006	.052							
	Sig. (2-tailed)	.642	.971	.765							
	N	36	36	36							
Unripe	Pearson Correlation	.234	**-.465****	.015	-.289						
	Sig. (2-tailed)	.170	.004	.930	.088						
	N	36	36	36	36						
Underripe	Pearson Correlation	**.377***	-.292	-.054	.244	.168					
	Sig. (2-tailed)	.023	.084	.753	.151	.326					
	N	36	36	36	36	36					

		1	2	3	4	5	6	7	8	9	10
Over ripe	Pearson Correlation	-.140	.229	-.029	-.843**	-.006	-.701**				
	Sig. (2-tailed)	.417	.180	.867	.000	.974	.000				
	N	36	36	36	36	36	36				
Empty fruit Bunch (EFB)	Pearson Correlation	-.052	-.176	-.097	-.041	.107	.092	-.052			
	Sig. (2-tailed)	.763	.306	.574	.811	.534	.594	.762			
	N	36	36	36	36	36	36	36			
Loose Fruit (LF)	Pearson Correlation	.018	.448**	.168	.071	-.622**	-.012	.020	-.246		
	Sig. (2-tailed)	.917	.006	.328	.681	.000	.945	.909	.148		
	N	36	36	36	36	36	36	36	36		
Total Oil Losses (TOL)	Pearson Correlation	.173	-.487**	.031	-.556**	.399*	-.379*	.558**	.110	-.365*	
	Sig. (2-tailed)	.313	.003	.856	.000	.016	.023	.000	.524	.028	
	N	36	36	36	36	36	36	36	36	36	
Total kernel Losses (TKL)	Pearson Correlation	.094	-.394*	.057	-.507**	.297	-.439**	.566**	.096	-.306	.974**
	Sig. (2-tailed)	.584	.018	.741	.002	.078	.007	.000	.578	.070	.000
	N	36	36	36	36	36	36	36	36	36	36

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation value Interpreted according to Cohen 1988

Correlation Value	Effect Size value
0.7	Very large
0.5	Large
0.3	Medium
0.1	Small

Table 3: Correlation between the OER and the elements (rainfall, FFB grading, TOL and TKL).

Oil extraction Rate (OER)

Factors	Significant (p)	Correlation value (r)	Effect size		Ranking
FFA	**.013**	**-.410***	**Medium (significant)**		**1**
Rainfall	**.030**	**-.362***	**Medium (significant)**		**3**
Ripe	.642	-.080	No effect size		NA
Unripe	.170	.234	Small	(not	4
			significant)		
Under ripe	**0.023**	**.377***	**Medium (Significant)**		**2**
Over ripe	0.147	-.140	Small	(not	6
			significant)		
EFB	.763	-.052	No effect size		NA
LF	.917	.018	No effect size		NA
TOL	.313	.173	Small	(not	5
			significant)		
TKL	.584	.094	No effect size		NA

The results of correlation analysis in table 3 reveals three elements that have a significant relationship with the OER. The highest ranking is FFA (r=-0.410) and rainfall (r=.0362) at the third place have a negative correlation with a medium effect size. Its mean that, when the FFA and rainfall increase, the OER quality will be decrease and depleted. Underripe (r=0.377), on the other hand, demonstrated a medium positive association with OER, indicating that the higher the estate sent underripe bunches, the higher the OER produced by the oil palm mill. A bunch that has less than 10 loose fruits detached from the bunch's socket is considered underripe. Unfortunately for the other elements such as Ripe Unripe, Underripe, Overripe, EFB, LF, TOL and TKL the output are all not significant with a small size effect.

Table 4: KER correlation matrix.

		FFA	RAIN	RIPE	UNRIPE	UNDERIPE	OVERRIPE	EFB	LF	TOL	TKL
RAIN	Pearson Correlation	.229									
	Sig. (2-tailed)	.178									
RIPE	Pearson Correlation	-.006	.052								
	Sig. (2-tailed)	.971	.765								
UNRIPE	Pearson Correlation	-.465**	.015	-.289							
	Sig. (2-tailed)	.004	.930	.088							
UNDERIPE	Pearson Correlation	-.292	-.054	.244	.168						
	Sig. (2-tailed)	.084	.753	.151	.326						
OVERRIPE	Pearson Correlation	.229	-.029	.843**	-.006	-.701**					
	Sig. (2-tailed)	.180	.867	.000	.974	.000					
EFB	Pearson Correlation	-.176	-.097	-.041	.107	.092	-.052				
	Sig. (2-tailed)	.306	.574	.811	.534	.594	.762				
LF	Pearson Correlation	.448**	.168	.071	-.622**	-.012	.020	-.246			
	Sig. (2-tailed)	.006	.328	.681	.000	.945	.909	.148			
TOL	Pearson Correlation	-.487**	.031	.556**	.399*	-.379*	.558**	.110	-.365*		
	Sig. (2-tailed)	.003	.856	.000	.016	.023	.000	.524	.028		
TKL	Pearson Correlation	-.394*	.057	.507**	.297	-.439**	.566**	.096	-.306	.974**	
	Sig. (2-tailed)	.018	.741	.002	.078	.007	.000	.578	.070	.000	
KER	Pearson Correlation	.079	.020	-.321	-.258	-.308	.439**	-.242	.245	.228	.282
	Sig. (2-tailed)	.646	.907	.056	.129	.068	.007	.155	.150	.180	.095

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5: Correlation between the KER and the elements (rainfall, FFB grading, TOL and TKL).

Kernel Extraction Rate (KER)

Factors	Significant (p)	Correlation value (r)	Effect size	Ranking
FFA	0.646	0.079	No effect size	
Rainfall	0.907	.020	No effect size	
Ripe	0.056	-0.321	Medium (Not significant)	2
Unripe	0.129	-0.258	Small (Not significant)	5
Under ripe	0.068	-0.308	Medium (Not significant)	3
Over ripe	**0.007**	**0.439****	**Medium**	**1**
EFB	0.155	-0.242	Small (Not significant)	7
LF	0.150	0.245	Small (Not significant)	6
TOL	0.180	0.228	Small (Not significant)	8
TKL	0.095	0.282	Small (Not significant)	4

It is appearing that in table 5, only overripe (r=0.439) bunches have a significant relationship with a medium size effect on KER. Meaning that, the more overripe bunches been sent to the mill, the higher KER will be produce. While the other elements, are sadly to be said, have no significant with a small and medium effect size.

Regression
Coefficient of determination for OER and KER

Table 6: Model of summary for OER

Model	R	R^2	Effect size
1	0.740	0.548	Large effect (Cohen,1988)

Table 7: Model of summary for KER

Model	R	R^2	Effect size
1	0.620	0.385	Large effect (Cohen, 1988)

R^2 value is said to be strong when in explaining the variation of the independent variables on the dependent variable the value is between 0 (zero) and 1 (one). According to Table 6, the Coefficient of determination (R^2) was 0.548; meaning that all the 5 variables can explain its effect on employee performance in Oil Palm Estate and palm oil mill equal to 55%. Its mean that the variables have a large effect on OER. The remaining 45% was influenced by other factors that are not been investigated, or out of this research framework. But for KER, it showed only 39% (R^2=0.385) clarified from those elements. But still have a large effect on the KER performance. These findings are consistent with the predicted relationships and provide support to our conceptual framework.

Multiple Linear Regressions analysis OER and KER

Table 8: Results of multiple regression analysis for OER

Unstandardized coefficients			Standardized coefficients			Collinearity Statistics	
Model	B	Standard error	β	*t*	significant	Tolerance	VIF
FFA	-0.625	0.238	-0.410	-2.621	0.013	1.0	1.0

Table 9: Results of multiple regression analysis for KER

Unstandardized coefficients			Standardized coefficients			Collinearity Statistics	
Model	B	Standard error	β	*t*	significant	Tolerance	VIF
Over ripe	0.032	0.011	0.439	2.847	0.007	1.0	1.0

Next, multiple regression analysis was applied to see which the dominant factor is influencing OER and KER qualities. Regression analysis aids to measure the relative strength of independent variable on dependent variable. Due to three predictors are correlated, multicollinearity must be diagnosed using tolerance and Variance inflation factors (VIF). Values of VIF that exceed 10 and tolerance below 0.25 are regarded as multicollinearity. It is discovered the regression model is fit. It can be concluded in table 8, the FFA (β =-0.410) is the dominant factor in influencing the OER qualities. Meaning that, if FFA increases by 1 percent, OER will be degrease by 0.41 percent. Therefore, it is crucial for the estate to send their FFB as soon as possible by setting the benchmark not more than 24 hours after harvesting. Meanwhile in table 9, overripe bunches (β=0.439) have become the only elements that affecting the KER. This value indicates, if the overripe bunches increase by 1 percent, the KER will increase by 0.439 percent.

Conclusion
The study conclude that all the variables have been evaluated successful. It is found that, rainfall, FFA, under ripe, unripe, over ripe and TOL are influencing the OER quality. The dominant factor is FFA that have a large adverse effect on OER. It is also found that all FFB grading criteria (unripe, under ripe, ripe, over ripe and EFB), TOL, TKL and LF have a relationship with the KER, only rainfall and FFA doesn't affecting KER. Then. the powerful element in influencing KER quality is over ripe. This finding will give an information for the estate and mill to control their OER and KER quality. For the estate, it is important for them to follow the MPOB FFB grading criteria to achieve a higher OER. The estate also needs to send the FFB within 24 hours after harvesting because the FFA start rising and increase for every hours after been harvest that will degrade the OER percentage. The eatate also need to collect all loose fruit because it also affecting the uo and down of OER. Meanwhile for the mill, they also should assign a grader to screen all the fruit at the ramp to make sure the estate follows the grading standard. In addition, the mill shall reject fruit that is not fresh meaning that the fruit already backlog in the field almost 2 night more than that. However, in the processing side, the mill shall monitor the oil losses for step in mill processing. Hence the oil palm company can attain a good OER and KER.

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