ISSN No:-2456-2165

The Affecting Factors of Reject Bottles in Bottle Washing Machine

Denny Tjatur Indarto Magister Management Program Mercubuana University Jakarta, Indonesia
Niken Sulistyowati Magister Management Program Mercubuana University Jakarta, Indonesia

Abstract:- Technological developments and business today are in a very fierce competition, many companies are trying to become the fronliner of the market leaders of their products, therefore many companies are trying to find innovation and diversification to be different from the others. The quality parameter is one of the most important things for the development of the company's business, without maintaining quality it is impossible for the business to develop, and to run smoothly and generate optimum profit. This study aims to determine and analyze the effect of dirty bottle conditions, caustic concentration, contact time and temperature on reject bottles in bottle washing machines in relation to increasing the efficiency and effectiveness of production machines in a beverage company. This type of research is a causal associative explanation to determine the cause and effect relationship of several parameters and this study uses the measurement from several different parameters. This study uses SPSS version 23 software application to describe, analyze correlation and multiple regression of the effect of reject bottles. Based on the research results, it was found that a significant influence between the independent variables (bottle condition, caustic concentration, contact time and temperature) had an effect on the percentage of reject bottles, but of the four parameters the most significant parameter for reject bottles was the bottle condition factor. It is necessary to sort the condition of the bottles, the caustic concentration must be maintained, the caustic solution is deposited to remove impurities so as to improve its performance, longer contact times and high temperatures can increase the cleaning process so as to reduce bottle rejects.

Keywords:- *Reject Bottles, Contact Time, Temperature.*

I. INTRODUCTION

Technological developments and business competition today are very tight, therefore the parameters of quality and productivity are indeed one of the factors that must be maintained and improved so that companies can continue to grow and can generate optimal profits. One of the factors that is an advantage in competing is quality. the resulting goods meet the wishes of customers or consumers, if the quality does not comply with the standards that have been set then the product will be rejected or rejected so that it will cause losses to the company and to be able to understand more clearly about quality and productivity, here are some definitions according to experts:

Product quality is a condition of an item based on an assessment of its conformity with a predetermined measurement standard. The more according to the standards set, the more quality the product will be assessed (Handoko, 2013). According to the ISO 8402 International Standard which has been adopted into SNI 19-8402-1996 Quality Management and Quality Assurance, Vocabulary, Quality is defined as: "the overall description and characteristics of a product or service relating to the ability to meet or satisfy stated needs. directly or expressly or indirectly or implied "

Productivity is the relationship between inputs and outputs of a production system (Handoko, 2010), while according to (Stevenson, 2013) productivity is an index that measures output (products and services) connected to inputs (labor, raw materials, energy, and other resources) used to produce these products and services.

	2018	YTD 2019	JAN	FEB	MAR	APR	MAY	JUN	YTD JUNE
TOTAL PRODUCTION	58,525,940	43,048,336	5,811,816	3,862,248	4,286,216	3,575,052	3,763,680	3,442,944	24,741,956
TOTAL INFEED	66,170,057	45,856,533	6,627,893	4,504,190	4,769,091	3,993,674	3,418,747	3,900,117	27,213,712
TOTAL REJECT	7,041,273	4,518,495	757,404	587,828	444,524	430,753	367,887	429,733	3,018,129
Total Reject (%)	**10.43%**	**9.85%**	**11.43%**	**13.05%**	**9.32%**	**10.79%**	**10.76%**	**11.02%**	**11.09%**

Table 1:- *Bottle Reject* January-June 2019
Source: Monthly Report of Reject Bottle in Packaging 2019 PTD

Based on the data above, which is taken from the monthly Bottle Reject report from the bottling section, the researchers are interested in conducting research on the reject bottles. The reject bottles were the biggest contributor to the delay and can be seen in the total reject bottles in the reject bottle table from January to June, the reject bottles were 11.09%. The productivity and quality of the washed bottles are not up to the desired standard. This can also increase operational costs.

The purpose of this paper is to determine and analyze the things that affect the parameters of dirty bottles, caustic concentration, contact time and temperature of the reject bottles.

ISSN No:-2456-2165

II. THEORITICAL REVIEW

❖ *Factors Affecting the Performance of a Bottle Washing Machine*

The results of the bottle washing machine work, there are many factors that affect the results and some of these factors can be controlled and carried out so that the work results can match the desired quality (Ecolab Chemical Aspects in the Bottle Washing Process, 2017), namely:

➢ *Mechanical condition of the bottle washer*

The mechanical condition of the bottle washer is an important factor that determines the efficiency and cost of production and usually the lack of cleaning power is always compensated for by increasing the concentration of chemicals. Regular and planned maintenance is very important as well as daily inspection of bottle washing machines such as: operating conditions T, P, C (temperature, water pressure, chemical concentration), control sensor level sensors, sensor temperature, sensor conductivity to ensure the percentage of caustic concentration, The dosing system for additive auxiliary injection as well as the accuracy of the sprayer nozzle and the cleanliness of the filter are also quite important factors and must be controlled.

➢ *The condition of the return bottle or used bottle*

Cultural and climatic conditions have a big effect on the degree and type of dirt contained in the bottles, normal conditions are only leftover beer, dirty bottles have sand, mold and rust impurities, bottles that are stored for too long have insect egg droppings, larvae and damaged labels, bottles that cannot be cleaned have paint, oil and cement in them.

➢ *Labels, printing inks and adhesives*

For labels, it can be easily removed if the label is intact and is not damaged or torn because the removal of the label is a combination of the functions of contact time, caustic concentration, surface tension and mechanical action, namely the rinsing water pressure. This printing ink will have a little effect on the label removal process, the label adhesive material can also have a significant effect on the label removal process and usually when using glue with the casein base type it is very easy to come off in the washing machine but not so strong or fast when it comes off. label soaked in cold water.

➢ *Water quality and movement in the rinse side.*

Water with a high hardness level is not good and a high content of insoluble salt can cause: white coating on the surface of the bottle, movement of the heating element / pipe and movement of the engine, pipe filters and nozzles.

The movement of the rinse section, the rinse section is a series of gradual dissolution, fresh water continues to flow from the final rinse section to the pre-rinse section however water can cause scaling faster at higher temperatures and pH. It is necessary to do descaling regularly by means of acid chemical circulation.

➢ *Temperature / heating*

The temperature required for the bottles to be clean and sanitary and the chemical activation of the caustics is doubled with each heating up to 10 ° C, for example, the cleaning power of caustic at 80 ° C is 32 times greater than at 30 ° C.

➢ *Pressure and nozzle size*

The nozzle should conform to the recommended, very alignment of the nozzle. It is important and clogged nozzle should also be avoided, the caustic solution must reach the bottom of the bottle to remove soft dirt, the flow of the washing solution in and out of the bottle must be balanced for proper and correct hydraulic action.

➢ *Bottled chemicals*

Caustic is a chemical that is aggressive. The functions of caustic are: it can destroy microorganisms, dissolve organic impurities, dissolve glue on paper labels, dissolve aluminum. The function of caustic as described above, but caustic also has several weaknesses, namely: dirt can be removed but can be repel back on the same surface, shoes do not have dirt dispersing properties, caustic can react with the hardness of water to form insoluble deposits, caustic cannot dissolve Inorganic dirt, therefore, usually the caustic solution is added with an additive which functions to reduce the surface tension so that the washing solution can easily enter under the label.

➢ *Time of contact of bottles and washing solution*

The longer the time, the better the cleaning power, but this will be taken into account with the efficiency over time as well.

III. METODOLOGY

This study uses secondary data from reject data on the EBI (Empty Bottle Rejecter) machine and there are 4 independent variables to be examined, namely X1 = Bottle Condition, X2 = Caustic Concentration, X3 = Contact Time, X4 = Temperature and 1 dependent variable, namely Y = reject bottle. Researchers analyzed the data using Statistical Product and Service Solution (SPSS) version 23, the authors used multiple regression analysis, which is an analysis tool that can predict the value of the effect between two or more independent variables (X) on one dependent variable (Y) in order to prove there is not. the functional relationship between two or more independent variables (X) to one dependent variable (Y).

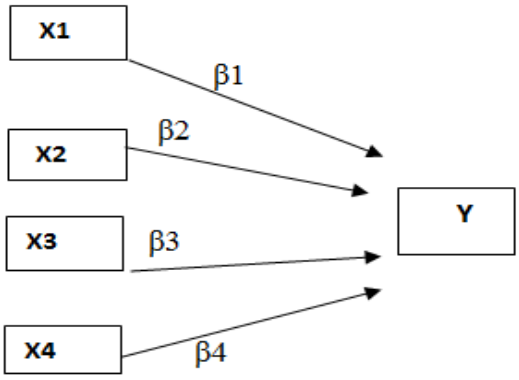

Fig 1:- Multiple Linear Regression

Figure 1 multiple linear regression can be depicted or illustrated like the picture.

Multiple linear analysis is used to determine the relationship between the independent variable and the dependent variable, namely between the condition of the bottle (X1), caustic concentration (X2), contact time (X3), temperature (X4) and the reject bottle (Y), so that the multiple liner equation used are:

$Y = a + \beta1X1-\beta2X2-\beta3X3-\beta4X4 + €$

Where the values of X1> 1 and X2, X3, X4 <1

Information:

Y = Reject bottle variable

a = Constant

β1, β2, β3, β4 = multiple regression coefficient

X1 = The condition of the bottle

X2 = Caustic concentration

X3 = Contact time

X4 = Temperature

€ = error

IV. RESEARCH RESULT

➢ *Descriptive Statistical Analysis*

Descriptive statistical analysis of research data was used to determine the characteristics of each variable of the condition of dirty bottles, caustic concentration, contact time, high temperature and reject bottles in the form of the average data value, minimum value, maximum value and standard deviation presented in table 2.

Descriptive Statistics					
	N	Min	Max	Mean	Std. Deviation
Kondisi Botol	87	1	3	1.53	.713
Kosentrasi Kaustik	87	1.61	2.50	2.1445	.17263
Waktu Kontak	87	9.90	18.00	11.3310	2.16173
Temperatur	87	80.00	86.10	85.0656	1.44789
Botol *Reject*	87	2.03	18.88	5.7402	3.52084
Valid N (listwise)	87				

Table 2:- Descriptive Statistics of Research Data
Sumber: Hasil Perhitungan SPSS

➢ *Data Normality Test*

From the test results with the Kolmogorov Smirnov method in table 2. It can be seen that the value of each variable in Asym.Sig. (2-tailed) is greater than 0.05, this means that all the data tested are normally distributed and fit for use in further research.

➢ *Multicollinearity Test*

Multicollinearity test is a condition in which X (free) variables are correlated with one another. If a multiple regression equation occurs multicollinearity between the independent variables, the variables that have collinearity do not provide any information on the variable. Therefore, a good multiple regression equation is one that is free from the multicollinearity between the independent variables. Symptoms of multicollinearity can be detected using Pearson Correlation and Tolerance value and Variant Inflation Factor (VIF). The tolerance value limit is 0.10 and the VIF limit is 10. If the tolerance value is below 0.10 or the VIF value is above 10, it can be ascertained that multicollinearity has occurred (Ghozali, 2013: 232). The multicollinearity test uses the VIF (Variance Inflation Factor) amount as in table 3.

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Kondisi Botol	.289	3.464
	Kosentrasi Kaustik	.864	1.158
	Waktu Kontak	.465	2.150
	Temperatur	.466	2.147
a. Dependent Variabel: Reject Bottle			

Table 3:- Multicollinearity Test with VIF

Based on table 3, it can be seen whether or not there is a multicollinearity problem in the variables studied. The basis for decision making used is the amount of VIF (Variance Inflation Factor) and Tolerance where the guidelines for a regression model that is free from multicollinearity must have a VIF value below 10 and have a Tolerance number above 0.10.

Based on the table above in the coefficient column, it can be seen that the variable condition of the dirty bottle, caustic concentration, contact time and temperature, the VIF number is below 10 (dirty bottle condition = 3,464, caustic concentration = 1.158, contact time = 2,150, and temperature = 2.147) . Likewise, the Tolerance value is above 0.10 (dirty bottle condition = 0.289, caustic concentration = 0.864, contact time = 0.665, and temperature = 0.466). Thus it can be concluded that the regression model does not have multicollinearity problems based on the VIF and Tolerance quantities.

➢ *Linearity Testing*

Linearity testing is intended to show that the average obtained from the sample data group lies in straight lines. The linearity test of the research variables is presented in table 4. From the table above, it can be seen whether or not linearity occurs in the variables studied. The basis for making decisions about linearity is to use the Durbin Watson magnitude which in general can be taken benchmarks, namely:

Model Summary[b]	
Model	Durbin-Watson
1	1.356[a]
a. Predictors: (Constant), Temperatur, Kosentrasi Kaustik, Waktu Kontak, Kondisi Botol	
b. Dependent Variable: Botol Reject	

Table 4:- Linearity Test
Source: SPSS Calculation Results

a. A D-W number below -2 means no linearity.
b. The D-W numbers are between -2 to +2, meaning there is linearity.
c. A D-W number above +2 means that there is negative linearity.

Based on table 4 above, it can be seen in the Model Summary section, it can be seen that the D-W number is 1.356 which is between -2 to +2, this means that the regression model above has linearity.

➢ *Correlation Analysis and Multiple Regression*

In the following, we will analyze all the data obtained from PT Delta using the SPSS (Statistical Product and Service Solution) application program version 21 with multiple regression and correlation analysis, where the variables are dirty bottle condition (X1), caustic concentration (X2), time high temperature contact (X3) (X4) and reject bottle (Y).

This research data analysis is used to answer the objectives of the study which include:

- To find out and analyze things that affect the parameters of the dirty bottles against the reject bottles.
- To find out and analyze the things that affect the caustic concentration of the reject bottles.
- To determine and analyze the things that affect the contact time of the reject bottles.
- To know and analyze the things that affect the temperature of the reject bottles.

Furthermore, based on data processing output, the following will be discussed about:

A. Multiple Regression Equation Analysis

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	60.818	16.657		3.651	.000
Kondisi Botol	3.862	.496	.782	7.791	.000
Kosentrasi Kaustik	-2.871	1.183	-.141	-2.427	.017
Waktu Kontak	-.415	.129	-.255	-3.220	.002
Temperatur	-.589	.192	-.242	-3.068	.003
a. Dependent Variabel: Botol *Reject*					

Table 5:- Multiple Regression Equation Output
Source: SPSS Calculation Results

Multiple regression equation formula:

Y = 60,818 + 3,862 X1 - 2,871 X2 - 0,415 X3 - 0,589 X4 + €

This equation means

- If there is no change in the X1, X2, X3 and X4 variables or the respective values are 0 (constant), the reject bottles (Y) at PT Delta will increase by 60,818 bottles
- If there is an increase in the level of the bottle condition variable (X1) by one unit, the reject bottle variable (Y) will increase by 3,862 from the type of bottle being fed and or vice versa assuming X2, X3 and X4 are fixed.
- If there is an increase in the caustic concentration variable (X2) by one unit, the reject bottle variable (Y) will decrease by 2.871 and or vice versa with the assumption that X1, X3 and X4 are fixed.
- If there is an increase in the contact time variable (X3) by one unit, then the reject bottle variable (Y) will experience a decrease of 0.415% and or vice versa with the assumption that X1, X2 and X4 are fixed.
- If there is an increase in the temperature variable (X4) by one unit, then the reject bottle variable (Y) will decrease by 0.589% or vice versa assuming X1, X2 and X3 are fixed.

B. Analysis of the Coefficient of Determination (R2)

The coefficient of determination describes the closeness of the relationship between the X and Y variables or in this case the closeness of the relationship between the bottle condition variables, caustic concentration, contact time and temperature with the reject bottle variables.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.873[a]	.762	.750	1.76028
a. Predictors: (Constant), Temperature, Caustic Concentration, Contact Time, Bottle Condition				
b. Dependent Variable: *Reject Bottle*				

Table 6:- Results of the Output Coefficient of Determination (R2)

Based on the results of data processing output, it can be seen that the Mutipple R square point is 0.762, so the coefficient of determination between the variables of bottle condition, caustic concentration, contact time and temperature of the reject bottle is 0.762. The correlation of 0.762 proves that the variable condition of the bottle, caustic concentration, contact time and temperature of the reject bottles at PT Delta has a strong and significant relationship or R is close to +1.

➢ *Partial Effect Test (t test)*

The regression coefficient testing aims to test the significance of the relationship between the X and Y variables, either partially or simultaneously (together). (Santoso, 2010)

- *Hypothesis*

The hypotheses for the t-test case are:
HO: ρx1234y = 0, there is no influence between variable X and variable Y.
H1: ρx1234y ± 0, there is an influence between variable X and variable Y.

- *Determine t tabel and t count*

The level of significance is 5% (α = 0.05)
Degree of freedom (df) = (n-p-1)
Where: n = amount of data, p = number of variable X then (df) = 87-4-1 = 82 and for t (0.05: 82) on t table get ± 1.989. The results of t-table calculations used the Excell 2010 program with the T.INV.2T formula (0.05: 82)

By comparing ttable and tcount:
If tcount> ttable, then Ho rejects
If tcount <ttable, then Ho is accepted

From table 4. It can be seen that the bottle condition variable (7,791) is greater than t table (1.989), the bottle condition has a significant positive effect on the reject bottle, the caustic concentration variable (-2,427) is greater than t table (± 1.989) then the caustic concentration has a significant negative effect for reject bottles, the variable contact time (-3,220) is greater than t table (± 1.989) then the contact time has a significant negative effect on the reject bottles. While the temperature variable (-3.068) is greater than t table (± 1.989), the temperature has a negative and significant effect on the reject bottles.

➢ *Simultaneous Effect Test (Test F)*

Testing of two independent variables X simultaneously (together) on the dependent variable Y is carried out by using the F test, namely through the following procedures: (Santoso, 2010)

- *Make a hypothesis:*

The hypothesis for the F-test submission case is:
Ho: ρx1234y = 0, there is no influence between variable X and variable Y.
H1: ρx1234y □ 0, there is an influence between variable X and variable Y.

- *Determine F table and F count*

The level of significance is 5% (α = 0.05) degree of freedom: from the SPSS output in the ANOVA section and the df column: obtained numerator = 4 and denumerator = 82, then F (0.05: 4: 82) is obtained ± 2,483. The results of the Ftable calculation used the Excell 2010 program with the F.INV.RT formula (0.05: 4: 82)

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	812.001	4	203.000	65.514	.000[a]
	Residual	254.083	82	3.099		
	Total	1066.084	86			
a. Predictors: (Constant), Temperature, Caustic Concentration, Contact Time, Bottle Condition						
b. Dependent Variabel: Reject Bottle						

Table 7:- Simultaneous Effect Test Output (Test F)

- *By comparing F table and F count*

If F count> F table, then Ho rejects
If F count <F table, then Ho is accepted

Based on the table above, it is obtained that Fcount (65.514) is greater than Ftable (2.483), then Ho is rejected or H1 is accepted, meaning that the variables of dirty bottle condition, caustic concentration, contact time and temperature together have a significant effect on the reject bottle variable.

➢ *Hypothesis Testing*

Based on the results of the following analysis, hypothesis testing will be discussed as follows:

- *Hypothesis 1 (H1)*

Based on the results of the "t" test, it was found that t count = 7,791> t table = ± 1.989 then Ho was rejected and Ha was accepted, which means that there was a significant influence between the X1 variable (bottle condition) on the Y variable (reject bottle).

ISSN No:-2456-2165

Based on the research results, hypothesis 1 which states that the condition of the dirty bottle has a positive effect on the reject bottle can be accepted.

- *Hypothesis 2 (H2)*

Based on the results of the "t" test, it was found that tcount = -2.427> ttb = ± 1.989, so Ho was rejected and Ha was accepted, which means that there was a significant influence between the X2 variable (caustic concentration) on the Y variable (reject bottle).

Based on the results of these studies, hypothesis 2 which states that caustic concentration has a negative effect on reject bottles is acceptable.

- *Hypothesis 3 (H3)*

Based on the results of the "t" test, it was found that tcount = -2.137> ttb = ± 1.989, so Ho was rejected and Ha was accepted, which means that there was a significant negative effect between variable X3 (contact time) on variable Y (reject bottle).

Based on these results, hypothesis 3 which states that contact time has a negative effect on reject bottles can be accepted.

- *Hypothesis 4 (H4)*

Based on the results of the "t" test, it was found that tcount = -3.068> ttb = ± 1.989, so Ho was rejected and Ha was accepted, which means that there was a significant influence between the X4 variable (temperature) on the Y variable (reject bottle).

Based on the results of this study, hypothesis 4 which states that the condition of dirty bottles, caustic concentration, contact time and high temperature simultaneously affects the reject bottles can be accepted.

Based on the results of multiple regression tests, the coefficient of determination (R2) is 76.2%. This means that the independent variables (condition of dirty bottles, caustic concentration, contact time and temperature) contributed 76.2% to the dependent variable (reject bottles) while the remaining 23.8% was influenced by other factors which were not examined.

V. CONCLUSION AND SUGGESTIONS

A. Conclusion

Based on the results of research and discussion in previous chapters, several research conclusions can be stated as follows:

- The condition of the dirty bottle has a positive effect on the reject bottle.
- Caustic concentration negatively affects the reject bottles.
- Contact time negatively affects the reject bottles.
- Temperature negatively affects the reject bottles.

The results of this study were the variable condition of the dirty bottles that had the most influence on the size of the reject bottles.

B. Suggestions

Based on the conclusions of the research results, several suggestions that might be useful for the company and other researchers are as follows:

- The dirty bottle condition variable has a significant effect on the reject bottle variable. For this reason, the company should strive for the condition of the bottles not to be too dirty or by sorting them first so that there are no bottles to be fed to the bottle washing machine or a few bottles that are in the Very Dirty Bottle category so that it can reduce the occurrence of reject bottles (Sanmiguel School of Brewing, Fundamental of Engineering and Packaging Course Book, 2017).
- Caustic concentration has a significant negative effect on the reject bottle variable. For this reason, the company should pay attention to the percentage of caustic concentration of 2.4% - 2.5% and preferably the caustic solution that is in the tub of washing the bottle at least once a week is deposited in the settling tank so that dirt and sludge deposits in the caustic solution can be reduced so that its effectiveness caustic solution is better and can reduce the occurrence of reject bottles (Sanmiguel School of Brewing, Fundamental of Engineering and Packaging Course Book, 2017).
- The contact time variable has a negative effect on the reject bottle variable. For this reason, the company should also pay attention to the optimal contact time of bottles to washing solutions so that they can suppress the occurrence of reject bottles (Manual Book Bottle Washer Lavatec KD-2-663, German, 1996)
- The high temperature variable has a significant negative effect on the reject bottle variable. For this reason, the company must be able to pay attention to the optimal high temperature of bottle washing when washing bottles between 85oC to 86oC so that it can reduce the occurrence of reject bottles, but if the temperature of the caustic solution is too high it will cause significant broken bottles (Sanmiguel School of Brewing, Fundamental of Engineering and Packaging Course Book, 2017).

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