ISSN No:-2456-2165

Quality Control Analysis of Cube Fish with Fault Tree Analysis (FTA) Method in ALJB: A Case Study

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Abstract:- ALJB is a producer of various kinds of marine products located in the Lampulo fishing port of Banda Aceh, Indonesia. This factory was founded in 2014, has a land area of 40,000 m2 with the largest cold storage capacity in Aceh, namely 2,000 tons and an ice factory with a production capacity of 4,000 sticks of ice per day. The products produced are frozen and packaged fresh fish. The main concepts of PT Aceh Lampulo Jaya Bahari are "freshness", "hygienic", and "quality". Based on field surveys and observations, despite implementing a quality management system, defects and errors were still found that were unavoidable. This research was conducted to find the biggest problem that resulted in defects in the product and to find the root of the problem so that improvements can be made. Pareto diagrams are used to see what the biggest problem that causes defects is. From the data on the number of productions for 1 year, there are 6530 units of reject products, including 120 units of leaking plastic, 79 units of dehydration, 114 units of discoloration and 56 units of product appearance with a total damage of 368 units, therefore it is very important to improve the quality of tuna cube fish products. both in terms of color, shape and packaging. After that, the largest number of defects was obtained, then the root cause of the defects in tuna fish was searched using Fault Tree Analysis (FTA).

Keywords:- *Quality; pareto diagram; Fault Tree Analysis.*

I. INTRODUCTION

The development of industry and technology in the current era of globalization requires every company to be able to advance in determining the quality of goods and services produced. Quality is not only in the production process but also in the products produced according to or not in accordance with the specified quality. Quality improvement and control can also increase effectiveness and productivity in preventing product failure or defects in order to reduce waste both in terms of raw materials and time. Kotler and Armstrong (2009) quality is the characteristics of a product or service and the overall characteristics that support the ability to satisfy customer needs.

ALJB is one of the companies established in 2014 located in the Lampulo fishing port of Banda Aceh, which is engaged in processing products from marine products in the form of frozen and fresh fish in packaging such as cooked tuna, frozen seafood and so on by prioritizing high quality that meets standards. international. Based on field surveys and observations made by researchers that the problems that occur are the products produced are less than optimal and do not meet the specifications expected by the company and customers. Currently, customer demand for one of the tuna cube fish products has decreased. Therefore the company needs to improve and improve the quality of tuna cube fish products. The number of defective products and not as desired is caused by various factors that can cause a decrease in the quality of the resulting product. Based on the number of productions and the number of defective products from February 2020 to September 2021, there is a total production of 6530 units. Meanwhile, for the type of damage, there are 4 classifications of defective products, such as 120 units of leaking plastic, 79 units of dehydration, 114 units of discoloration, 56 units of product appearance with a total of 369 units. It is necessary to improve the quality of tuna cube fish products both in terms of color, shape and packaging. Therefore, this study aims to 1) identify the biggest factors causing damage to tuna cube fish products, 2) find solutions to repair defects in tuna cube fish products.

One method that can be used to find the cause of the problem is fault tree analysis (FTA), which is to evaluate defective products using the fault tree analysis (FTA) method. The advantage of using the fault tree analysis (FTA) method is that it can identify the cause of the defect (Naik & Singh, 2016). Several studies have used FTA to identify the root of the problem, such as Kartikasari and Romadhon (2019), product defects produced above a tolerance of 2% which have the potential to cause losses to the company if not handled properly, so it is necessary to improve the quality of the tuna canning process by identifying factors -factors causing disability. Previous research has also been carried out such as: Product of pailm oil crude (CPO) (Sofiyanurriyanti, 2020). Production quality in the Veil MSME industry (Sofiyanurriyanti, 2020), Nurwulan and Veronica implemented the failure mode and effect analysis (FMEA) method and fault tree analysis to identify the cause of defective products in one of the paper mills in Indonesia. FTA allows for the identification of failure events based on an assessment of the probability of failure (Dewi, L.T., and Dewa, P.K., 2005).

II. RESEARCH METHOD

Data collection in this study was carried out in 2 stages, namely literature study, namely the method of collecting data by studying the literature, references to support the research results, while the field study was a method of collecting data through surveys, both interviews and observations.

ISSN No:-2456-2165

The data needed in this study include:
- Disability data
- Production process
- Results of interviews with operators

Fault Tree Analysis is a method used to analyze the causes of a risk (Hyun et al, 2015). FTA is an analytical method that determines all possible factors for failure Haimes, Y (2008) and one of the main techniques used to identify and define risk engagements (Anderson, 1976). FTA also aims to determine factors to determine factors that may be the cause of failure, find stages of events that may be the cause of failure, analyze possible sources of risk, and investigate failure (Haasl, 1965).

According to Papadopoulos (2004), Fault Tree Analysis is the identification of the occurrence of damage by describing alternative events in a structured block diagram. The approach taken is top-down, starting with the assumption of failure from the top event because of a top event to the root cause which is described in the form of a fault tree (Pandey, 2005).

This method is carried out by a top-down approach, which begins with assuming failure or loss from the event the top (top event) then detail the causes a top event to a bottom failure (root cause) (Blanchard, 2004).

Fault Tree Analysis (FTA) is an analysis used to determine the root cause of a potential failure that occurs in the system that can be done with efforts to reduce defective products. This method is top-down, which means that it starts as a failure assumption at the top event, detailing to the basic failure. In other words, this method is used to find problems that start from the assumption of events at the top in great detail to get to the root of the basic problem. The following are the steps of the Fault Tree Analysis (FTA) method (Roughton and Crutchfield, 2016):
- Determine the most important event
- Set FTA limits
- Examine the system to understand how the various elements relate to each other and the top event
- Create a fault tree starting from the topmost occurrence and working your way down
- Perform fault tree analysis to identify ways to eliminate events that lead to failure
- Prepare a corrective action plan to prevent failure

According to Soemohadiwidjojo (2017) The benefits of the fault tree analysis (FTA) method are that it can determine the factors that cause failure in the production process, can determine the stages that cause failure in the production process, can analyze possible causes or risks of product failure.

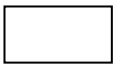
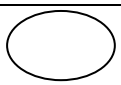
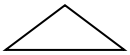
Symbol	Term	Information
	Basic Event	The basic event of an unexpected deviation from a normal state in a component of a system
	Top event	The desired event at the top level that shows so that it will be investigated further
	Logic event AND	Indicates the AND function, the di function is used to indicate the output event that occurs if all inputs occur
	Logic Event OR	Indicates the OR function, this function is used to indicate an output failure that occurs because there are one or more failure events on the input
	Conditioning Event	Special conditions are applied to logic gates when certain conditions are met.
	Undeveloped Event	Events that do not develop do not need to be found because they are not sufficiently related
	External Event	Indicates events that are expected to occur and are not included in the failure event
	Transferred Event	A follow-up description of a different incident that feels on another page

Table 1: Fault Tree Analysis Symbols

ISSN No:-2456-2165

A. Pareto Diagram

Pareto diagram aims to determine the priority of the problem to be solved. Where the Pareto diagram is used to determine the largest type of defect that occurs. The data needed in making Pareto diagrams are types of defects, frequency and cumulative percentage.

- Identify the problem to be studied and the causes of the incident
- Determine the time period required for analysis (monthly, weekly or daily).
- Make a note of the frequency of occurrence on the check sheet.
- Make a list of problems in order of frequency of occurrence (highest to lowest)
- Calculate cumulative frequency and cumulative percentage
- Draw the cumulative frequency of the percentage in the form of a bar graph
- Draw the cumulative percentage in the form of a line graphic.
- Interpret (translate) the Pareto chart

The steps in making a Pareto diagram according to Juran, (2000) are as follows:

- Take action based on the priority of the incident/problem
- Repeat the above steps in implementing improvement actions to compare results.

III. RESULT AND DISCUSSION

This research was conducted at PT. ALJB. This type of research is carried out using a descriptive method which is a method used to describe or analyze a research result by describing the state of the subject or object that is happening at the present time or the actual problem. The first stage of the research is to collect company data for one year from February 2020 to September 2021. It can be seen in Table 1. Data Repair of Defective Products.

PRODUCT REPAIR DATA *REJECT* 2020-2021							
No	**Month**	**Total Production (unit)**	**REPAIR**				
			Plastic leak	**Dehydration**	**Disclosure**	**Product appearance**	**Total (unit)**
1	February	400	10	6	8	4	28
2	March	425	7	4	7	4	22
3	April	300	8	3	5	4	20
4	May	250	5	5	5	2	17
5	June	255	4	5	6	3	18
6	July	350	6	4	4	4	18
7	August	425	7	6	3	2	18
8	September	200	8	3	6	3	20
9	Oktober	165	7	4	7	4	22
10	November	380	5	2	8	2	17
11	December	235	6	1	8	3	18
12	January	400	4	3	5	3	15
13	February	300	3	4	6	1	14
14	March	265	4	5	4	1	14
15	April	425	5	2	4	2	13
16	May	400	5	2	5	4	16
17	June	400	6	6	5	3	20
18	July	350	3	3	3	2	11
19	August	350	7	5	7	3	22
20	September	255	10	6	8	2	26
	Total	**6530**	**120**	**79**	**114**	**56**	**369**
	Persentase Reject		**2%**	**1%**	**2%**	**1%**	**6%**

Table 2: Data Product Reject

ISSN No:-2456-2165

Furthermore, in data processing carried out during this research to find the root of the problem that occurred and provide suggestions for improvements in processing. The following is Table 2. The results of data processing with Pareto diagrams are as follows:

Reject	Frequency	Percentage (%)	Cumulative (%)
Plastic leak	120	32,5 %	32,5 %
Disclosure	114	30,9 %	63,4 %
Dehydration	79	21,4 %	84,8 %
Product appearance	56	15,2 %	100 %

Table 3: Data Jumlah Produk *Reject* Dan Peresentase *Reject*

To identify the dominant errors in the production process of tuna fish processing, it can be seen that the cause of the most rejects in the tuna cube processing process during the period February 2020 to September 2021 is plastic leakage, which is 120 units or 32.5% and the number of rejected products the least is the appearance of the product which only has 15.2%. The following is the process of filling the tuna cube in plastic, weighing the tuna cube can be seen in Figure 1 below:

Fig. 1: The process of filling the tuna cube in plastic

IV. PARETO CHART

To identify the dominant errors in the tuna fish processing production process by PT aceh Lampulo Jaya Bahari, it can be seen that the cause of the most rejects in the tuna cube processing during the period February 2020 - September 2021 is plastic leakage, which is 120 units or 32.5 % of the total causes of product rejects. And the least number of reject products is the appearance of the product which only has 15.2%.

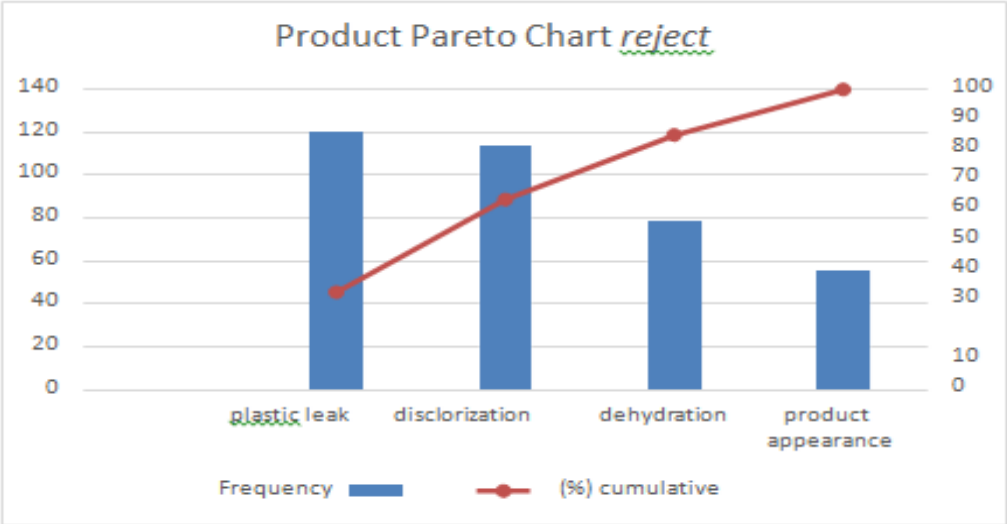


Fig. 2: Pareto Chart

ISSN No:-2456-2165

V. FAULT TREE ANALYSIS

After identifying the total cumulative percentage that will be identified using the FTA method, the next step is to create a fault tree that explains the causes of the defects in the form of a tree diagram using standard logic symbols, which can be seen in Fig. 3.

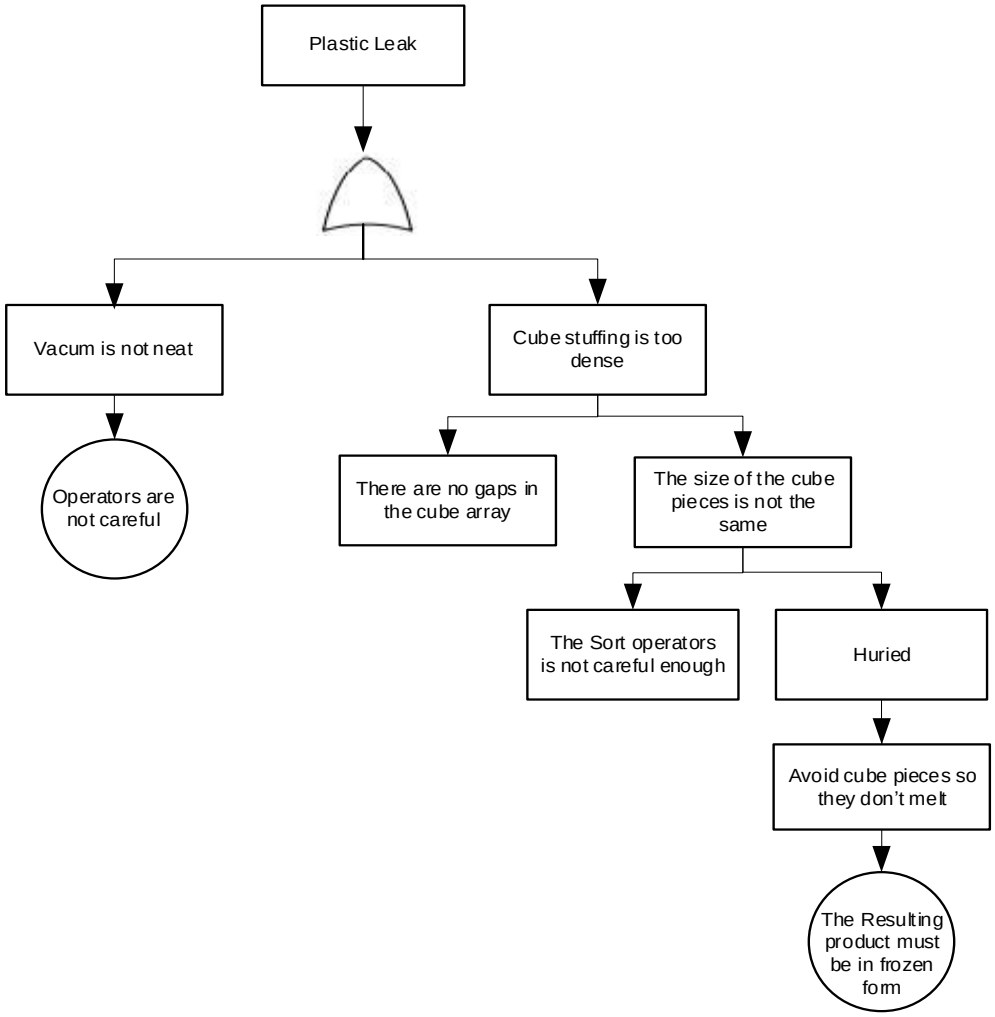


Fig. 3: *Fault Tree Analysis*

A. Identify top events

From the results of the Pareto diagram calculation, plastic leakage reject is the highest percentage, which is 32.5%. Therefore, the percentage of rejects almost reaches half of the types of rejects produced, so this type of defect will be discussed and analyzed using fault tree analysis. Thus, the top level event that will be analyzed is the result of plastic leakage.

B. Fault Tree Diagram or Fault Tree Analysis

FTA is a system analysis method using a top down approach starting from the top level event that has been defined in advance in Figure 4.2 above. The results of the process function fault tree are presented in Figure 4.2.

C. Minimal Cut-Set /Basic Event

In this study, the minimum cut-set is a collection of causes of failure or a combination of them which, if it occurs, can cause process malfunctions to occur. Based on Figure 4.2, the minimum cut set from leaking plastic packaging is that the operator is less careful and the resulting product must remain frozen and must not melt.

VI. REPAIR ANALYSIS

The proposed improvement is based on the root cause of the problem obtained from (minimum cut set) through fault tree analysis, the following is a description of the root cause and suggestions for improvement:

ISSN No:-2456-2165

No	Root of the Problem	Problem Description	Repair Suggestions
1	Operators are not careful	Operators at the plastic vacuum section are not careful to pay attention to the sides of the plastic that has been vacuumed neatly or not so that it causes leakage in the plastic.	Be more focused and careful when working on a plastic vacuum so that the sides of the plastic are vacuumed properly and neatly.
2	The resulting product may not thaw or must remain frozen.	PT ALJB produce products with frozen output, so all kinds of products	All operators in the tuna cube fish processing process must follow all the implement Standard Operational Procedures (SOP)
		The frozen quality must be maintained, it must not thaw, so from the plastic must be really good so that the frozen product inside doesn't melt when exposed to air or contaminated with other objects.	Has been determined so that the texture and quality of the product until the packaging can remain good and safe.

Table 4: Repair Analysis

VII. CONCLUSION

Factors causing damage (reject) on leaky plastic packaging were obtained through fault tree analysis. The root causes of the problem include the operator's lack of care and the resulting product must remain frozen and must not thaw. From the root of the problem obtained, an analysis of what caused this to happen was then given a suggestion for improvement based on the root of the problem and Suggestions in this study based on the results of the discussion and calculations that have been carried out by the author in this study, the author gives advice to the company in order to implement the SOP which has been made and applies a quality control model using the Fault tree analysis (FTA) method so that the root causes of the problem and the most types of product rejections can be found and can find out the reasons why these products dominate the most rejections in production activities.

REFERENCES

[1.] Anderson, R.T. *Reliability Design Handbook. Report No. RDH376.* Rome Air Development Centre, Griffiss Air Force Base,Haasl, D.F., Advanced Concepts in Fault Tree Analysis.Proceedings of the System Safety Symposium, Seattle, In, 1965.

[2.] Blanchard, B.S. (2004). Logistics Engineering And Management, 6th Edition. New Jersey: Pearson Prentice Hall

[3.] Dewi, L.T., dan Dewa , P.K., (2005), Implementation of Fault Tree Analysis in Quality Control System Proceedings of National Seminar II, Industrial Engineering Communication Forum, Yogyakarta

[4.] Hyun, K.C., Min, S., Choi, H., Park, J., & Lee, I.M. Risk analysis using fault-tree analysis (FTA) and analytic hierarchy process (AHP) applicable to shield TBM tunnels. *Tunnelling and Underground Space Technology*, Volume 49, 2015, pp. 121–129.

[5.] Haimes, Y. Risk Modeling Assessment and Management. New Jersey: John Wiley & Sons, 2008.

[6.] Haasl, D.F., Advanced Concepts in Fault Tree Analysis. Proceedings of the System Safety Symposium, Seattle, In, 1965.

[7.] Juran, J. M. (2000). Juran's Quality Handbook. New York: McGraw Hill.

[8.] Kartikasari and Romadhon (2019). Analysis of Quality Control and Improvement of Tuna Canning Process Using Failure Mode And Effect Analysis (FMEA) and Fault Tree Analysis (FTA) Methods Case Study: PT. East Java XXX. Journal Of Industrial View, 01(01),1-10.

[9.] Kotler, P. and Keller, K.L. (2009). Marketing Management: 13th Edition. New Jersey: Upper Saddle River.

[10.] Naik, S., & Singh, A. (2016). Fault Tree Analysis of Single Cylinder Vertical Diesel Engine. International Research Journal of Engineering

[11.] and Technology (IRJET), 3(4),2278-2283. Diakses dari https://www.irjet.net/archives/V3/i4/IRJET-V3I4449.pdf.

[12.] Nurwulan,N.R.&Veronica, W.A.(2020). Implementation of Failure. Mode and Effect Analysis and Fault Tree Analysis in Paper Mill: A Study Case. Jurnal Rekayasa Sistem Industri, Volume 9 (3),171-176.

[13.] Papadopoulos, (2004), faut and event tree analysis "Uncertanty handling *formulation analysis*". Vol. 31, No. (1), 86-107.

[14.] Pandey, M. (2005). Engineering and Sustainable Development: Fault TreeAnalysis. Waterloo: University.

[15.] Roughton, J. & Crutchfield, N. (2016). Job Hazard Analysis A Guide for Voluntary Compliance and Beyond (2nd ed.). United State.

[16.] Soemohadiwidjojo, A. T. (2017). Easy to Arrange SOP (Standard Operating Procedure. Jakarta: Penerbit Plus.

[17.] Sofiyanurriyanti, G.Putra, AR Arifin. (2020). Quality Control of palm West Aceh Regency. In *IOP Conferences Series:Materials Science and Engineering (Vol.* 1072, No. p. 012052*).* IOP Publishing.