Quality Analysis of Black Tea Products Using Fishbone Diagram and Failure Mode and Effect Analysis (FMEA) at PT XYZ

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ARTICLE INFORMATION

ABSTRACT

The purpose of this study was to determine the factors that affect the quality of black tea products. This study shows that PT XYZ as a black tea processing company has problems in achieving product quality. This is shown by not achieving the quality target of black tea products, even though the raw materials are relatively in accordance with standards. The analysis used is a cause and effect analysis using a fishbone diagram to determine the causes of product quality problems, as well as the use of pareto analysis and 5-why as a support. Failure mode and effect analysis (FMEA) is used as a tool to mitigate risks resulting from failure of the production process, the results of which are used for suggested improvements. The results of this study indicate that the factors that influence the quality problems of black tea products include the degree of shoot wilt that does not comply with standards, employees who do not comply with the SOP and the problem of the machine being off during the production process. From these problems, the researcher proposes improvements, namely to tighten the supervisory function in the withering division, improve the supervision system and conduct recruitment or training in the machine maintenance division

Keywords: Quality, Black Tea, Fishbone Diagram, Pareto Diagram, 5-Why's Analysis and FMEA.

INTRODUCTION

The quality of tea is largely determined by the raw materials and processing processes. The raw material is tea shoots that will be processed into black tea. Ideally quality tea shoots will produce quality tea. However, if the shoots of good quality produce low quality black tea, then there is an indication of a problem in the processing process.

PT XYZ as a black tea producer, for export often experiences problems in the form of not achieving production targets. In the observations made it was known that the quality of the tea shoots obtained was relatively in accordance with the standards, but the volume and quality were still below the specified target. This is due to problems in the processing process so that analysis is needed to determine the causes of these problems. The following is a table of targets and realization of black tea in 2018.

Table 1. Target and Realization of PT XYZ Tea Production in 2018

Quality	Target	Realization
Grade I	971.300 Kg	904.218 Kg
Grade II	449.000 kg	447.089 kg
Grade III	345.700 kg	394.991 kg
Total	1.776.000 kg	1.746.298 kg

Source: PT XYZ, 2018

Table 1 shows that the tea production target was not achieved. The targets that have not been met include grade I tea, the production target for production in 2018 is 971,300 kg and the realization is 904,218 kg. The same thing happened to the production of grade II tea. Production results have not reached the specified target. The production target for grade II tea was 499,000 Kg while the realization was 447,809 Kg. The production target was only achieved for grade III tea, which is the lowest quality tea. From these data it can be seen that PT XYZ can only meet the target for the lowest quality black tea.

The production process is an activity to create raw materials into finished or semi-finished materials. The black tea production process at PT XYZ is a process to process the shoots into bulk tea. The processing process is generally divided into several stages including the drying process, rolling or wet sorting, drying process, dry sorting or grading process and packaging process.

LITERATURE REVIEW

Production Process
Production or production process is an activity to create goods or services. The production process makes it possible to create added value by converting inputs into outputs. The production process can also be interpreted as a way or method to add value to goods or services by using existing production factors (Heizer, Render, & Munson, 2017). The production process is a way, method and technique to create or add to the usefulness of an item or service by using existing sources (labor, machinery, materials, funds). The production process is a form of activity that is most important in the implementation of production in a company. This is because the production process is a method, method or technique of how the activity of adding benefits or creating benefits is carried out. The nature of this process is processing, namely processing raw materials and auxiliary materials manually or by using equipment. So as to produce a product whose value is more than the original item.

Quality Management

Management is a process designed to achieve organizational or company goals by using resources effectively and efficiently in a dynamic business environment. Effective means that management aims to achieve the desired results while efficiency refers to the optimal use of raw materials or capital (Ferrel, Hirt, & Ferrel, 2018).

According to Brown (2005), in assessing the quality of a product, tools or tools are needed to evaluate it. Here are seven quality management tools that are useful for assessing product quality and assessing the nets of the production process, including pareto analysis, histogram, fishbone diagram, stratification, check sheets, spread diagrams and control charts.

Fishbone Diagram

Fishbone diagrams can be used as a tool to analyze problems in an organization or company and help analyze the causes or root causes of quality problems (Barraza & Gonzalez, 2019). Diagram Fishbone is a technical schematic to find the source of quality problems. The use of this diagram is generally in the production design process, which is useful for analyzing problems related to product quality. This diagram identifies problems and traces back the root causes of problems that occur in certain phenomena (Brown, 2005).

In addition, fishbone diagrams are very useful for evaluating defects or defects in the lamp production process. The journal also explains that Pareto and fishbone diagrams are useful for improving quality in the production or manufacturing process (Ahmed & Ahmad, 2011).

Pareto Chart Analysis

In the production, we can use the Pareto technique for analysis the performance of product or Process. This analysis can strengthen with the help of fishbone analysis, first identify the root cause through cause-and-effect diagram then cause can further studies through Pareto chart (Raman & Basavaraj, 2019). A Pareto chart and fishbone diagram are used to shown major defects which occurring frequently. The defects can be evaluated and implemented through suggestive action and result was documented. Hence, quality of capacitors is improved using fishbone and Pareto Diagram, resulting high control in defects and improved capacitors manufacturing process.

A Pareto chart enables a quality improvement specialist to make informed decisions and prioritize the appropriate interventions to achieve the desired goal. The main concept behind the Pareto chart is that the weights or effects of the contributing factors that lead to specific outcomes are not equal, so identifying the highly weighted factors and working on them first will shorten the time needed to reach the desired outcome, thus saving effort and unnecessary costs. In 1937, the 80/20 concept was crystallized by Joseph M. Juran, a pioneer in the field of quality improvement, who added the cumulative line at the top of the chart to make it easier to judge the impact that each factor has on the desired outcome. He also came up with the terms ''vital few'' and ''trivial many,'' which are used to categorize the factors based on their weight.

A Pareto diagram is a tool that will enable distributing efforts to resolve emerging issues and identify the main reasons to start acting (Statsenko, Omarov, Shlykov, Nesterenko, & Konieva, 2021). Using these diagrams made it possible to explain the leading causes of defects encountered and develop recommendations for reducing rejects and improving the quality of products.

Why's Analysis
There are several different ways to perform a root cause analysis. One method is the 5 Whys technique. The 5 Whys is attributed to Sakichi Toyoda, the founder of what is today the Toyota Motor Corporation (Francis, 2021). Toyoda developed the technique to uncover errors in the company's manufacturing process. With the causes of these errors identified, Toyoda and his employees could develop solutions to the problem and mitigate the potential of it happening again. 5 Whys is practical methodological techniques that can help diagnose root causes in malfunctioning equipment (Keyser & Pooyan, 2022).

5-why analysis is an analytical method to find the root of a problem in the production process. This method was first introduced by the Toyota company as a Toyota system analysis tool by Sakhici Toyoda. Over time this method has become one way of analyzing problems or root causes in quality management (Adhikari, 2017).

Failure Mode And Effect Analysis (FMEA)
FMEA is a useful method for analyzing the risk of failure. The purpose of FMEA itself is to anticipate the risk of failure. FMEA is useful for identifying potential failures in various aspects including systems, processes, and services (Firdaus & Widianti, 2015). The risk of failure in the FMEA is used as a priority improvement measure. Suggestions for improvement given to the company as a whole is an agar company pay more attention to engine maintenance so that the engine avoid malfunction (Puspitasari & Martanto, 2014). reducing the number of defects that occur, it is necessary to make improvements (Puspitasari, Arianie, & Wicaksono, 2017). Prioritized improvements are based on the RPN score. The results showed that several priority actions were taken, namely for the failure mode in the form of part error (piston type), the presence of foreign objects in the part and the case of the assembly Piston Assy being reversed. Apart from being seen from the RPN score, repairs to the three failures were also carried out by considering realistic actions in terms of time and cost.

Analysis of FMEA in risk analysis is very important. The analysis was carried out on the process of packaging, storing, receiving potatoes, frying and distribution. This study tested the feasibility of the refrigerator. Based on the results obtained from the test analysis with the FMEA method, priority of maintenance or prevention against necessary failure modes Noteworthy in the process of measuring the temperature in the refrigerator test is thermocouple components, RCL meters, walk-in chambers, and power sources because this component has a high RPN value (Widianti & Widianti, 2015). Based on the descriptions of several theories above, the writer determines the conceptual framework as follows.

Figure 1. Conceptual Framework
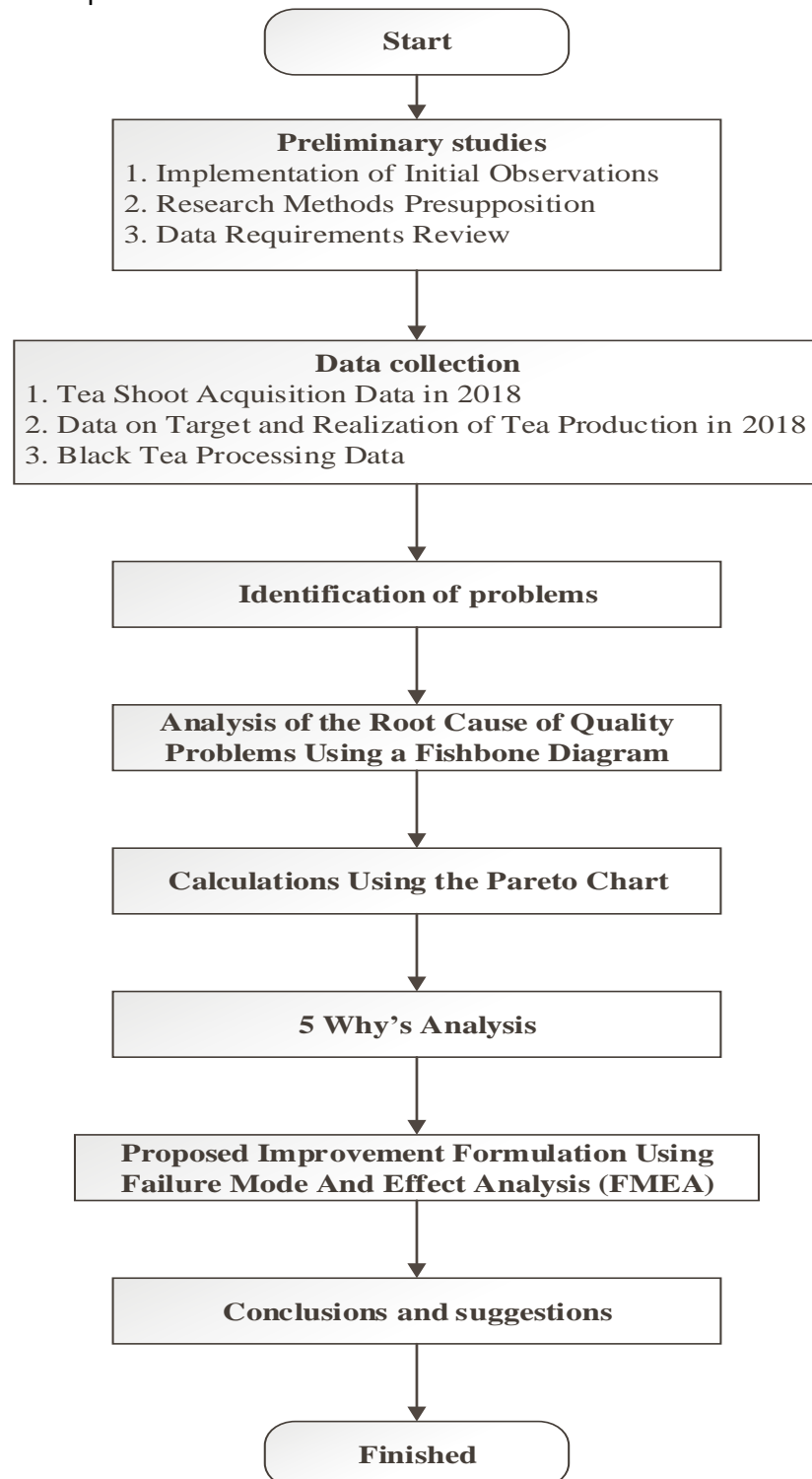
Resources: Processed Data

RESEARCH METHOD

At the data collection stage, several types and sources of data and techniques are required to collect data, namely as follows:

Primary Data
Primary data is data obtained directly in the field from the object of research as the object of writing. Primary data were obtained through interviews, observations and

questionnaires directly related to PT XYZ's production activities from raw materials to finished goods, interview data regarding the causes of not achieving grade I and II teas which were high quality products, as well as FMEA questionnaire results from PT XYZ employees (Cooper & Schindler, 2014).

Secondary Data
Secondary data is data obtained indirectly, such as through documents or literature. These data are obtained from reference books, research journals that are in accordance with the topic of discussion and the methods of the research being carried out. In addition, secondary data is also obtained from reference reports at PT XYZ and documents, such as data on production per month / demand, targets and realization of tea quality and quality of shoots or raw materials (Cooper & Schindler, 2014).

This research was conducted in an outline consisting of three stages, namely identification and formulation of problems, collection and processing of fishbone diagram data and FMEA, conclusions and suggestions.

Problem Identification and Formulation
Identification of problems focused on the problem of achieving PT XYZ production that has not reached the target. The production target in 2018 did not reach the agreed target based on the 2018 RKAP. This research focuses on finding the factors that cause the tea production target not achieved with grade I and II with an analytical approach using fishbone diagrams and FMEA.

Data Collection and Processing Stage
Analysis With Fishbone Diagram
At this stage, the authors look for the root of the problem or the cause of not achieving the black tea production target with grade I and II quality. The analysis uses a fishbone diagram. After getting the factors related to quality problems, weighted with the Pareto diagram so that 80% of the factors that have the most influence is obtained.

5-Why Analysis
5-why Analysis is a method to find the root cause of a problem that occurs in the production process in the manufacturing industry. At this stage, the analysis is used to support the fishbone diagram analysis in order to find the main causes of the quality problems that occur in this case.

FMEA analysis
FMEA analysis is an analyst to find risk factors for not achieving the quality of grade I and II black tea production. FMEA analysis is done by looking for failure modes that affect the quality decline. The failure mode is taken from the results of the analysis with a fishbone diagram and 5 why analysis. After the failure mode is known, several analysis steps are carried out, among others.

Conclusion and Suggestion Stage
The final step in this research is to draw a conclusion based on the results of data collection, processing and analysis so that some suggestions can be made to improve the quality of PT XYZ's black tea products.

RESULTS

The black tea production process starts from the time the tea shoots arrive at the factory to the packaging process. Based on interviews with PT XYZ, it was explained that there are critical points in the production process that greatly affect the quality of the final product, these critical points include picking (raw materials), withering and wet sorting.

Figure 2. Fishbone Diagram Cause of Not Achieved Quality Targets
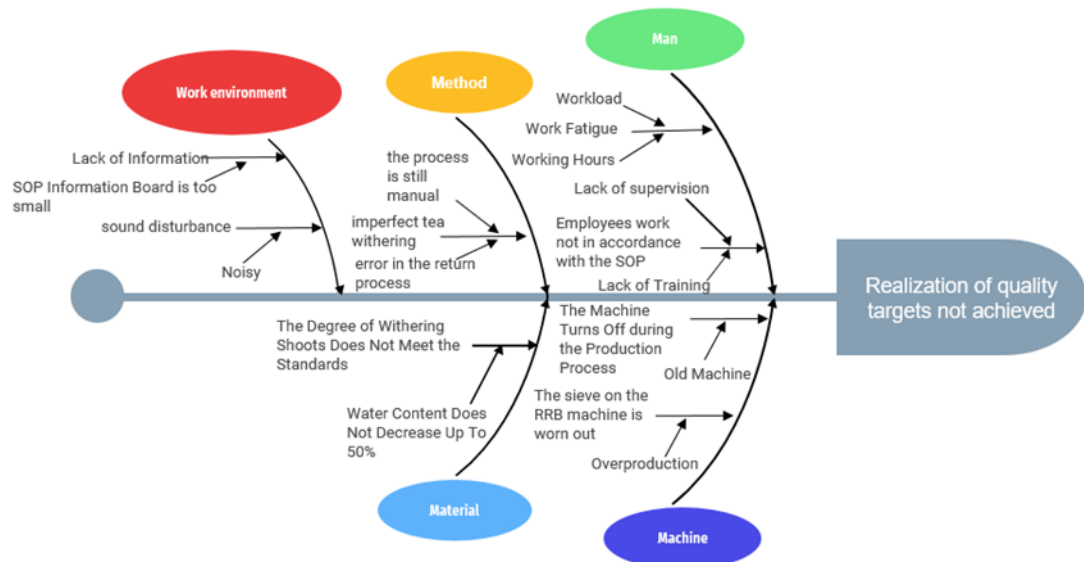
Source: PT XYZ 2019

Figure 4.2 shows the causes and effects which are the source of the problems that lead to not achieving black tea production with grade I and II quality. The analysis of each factor in more detail is as follows:

Machine
The machine is an important aspect of the production process. The condition of the machine will greatly affect the quality of the product produced. Based on observations and interviews with the head of the processing department, it was explained that the condition of the machines, especially the wet rolling and sorting machines, were old machines. Of course, old machines are in a very vulnerable condition and often suffer damage. These machines sometimes experience an overhit so that they die during the production process. When tea production stops, of course, it will affect the water content of the processed tea shoots. Water content that is not up to standard will also affect the quality of the black tea product produced. The condition of the old engine also results in the wear and tear of the RRB engine sieve, so that the output on the sieve is not standard. The sieve cannot filter tea with a certain size, so that the specified size is passed. This greatly affects the quality of the black tea produced.

Material
Material is the key to whether the product quality is good or not. Quality material will determine the quality output as well. Less quality material will cause a decrease in product quality. In this case the material is the result of the withering process. The shoots that are processed that do not meet the standards will have an effect in the next process, namely rolling. The water content standard of withered shoots is reduced by 50% so that it rolls easily during the rolling process.

Work Environment
The work environment greatly affects the work of employees or employees and how production machines work. According to Nitisemito (as cited in Aneta & Turtono, 2019), the work environment define as everything that can be found around the workers that impact themselves. Meanwhile, Bahagia and Afni (2021) state that the work environment is a physical condition and symptoms that affect the implementation of tasks within the company. In this case, the scope of the work environment includes noise level, cleanliness, lighting, and air temperature around the work. Based on the observations that have been made, the working environment is relatively good in all aspects except lighting. The lighting on the wet sorting machine is minimal. Noise-related situations can be overcome by using earplugs, which are standard operating procedures for employees who work in factories or processing departments. Aspects of the work environment other than the scope above that were studied in this study were the lack of information boards in each subsection. Information boards regarding processing procedures and safety are only located at the drying area of the tea shoots. Remembering that information boards are very important for guidelines so that employees or employees always remember to do their work according to procedures.

Humans
Humans determine the success or failure of the production process. Humans in this case employees are the subject of machine control and handling materials from raw materials to finished or intermediate materials. No matter how good the condition of the materials or machines will be meaningless if the performance of humans or employees is not optimal or incompetent. Incompetent operators are usually the result of a lack of training or information from superiors. Apart from that, what causes poor employee performance is poor supervision. At PT XYZ, supervision of the production process is considered good enough, but the supervision process is very lacking in the withering process. Very less automatic supervision, many employees do not work according to the SOP. The productivity of employees or employees is usually measured by their performance. Employee performance can be affected by many things, one of which is work fatigue.

Method
The method is a determining factor for the success of the production process. The method is divided into two aspects, namely humans and machines. The method from the human aspect is how humans, in this case employees, can run the production process or machine properly. While the machine refers to the sequence or stages of the black tea production process. In this study, from the results of interviews and observations, one of the causes of quality problems in black tea is the withering method. The withering method still relies heavily on human performance. The withering process is still manual in terms of turning black tea. Based on the interview with XYZ, it was explained that employees are often late to turn over the withered tea which will automatically affect the moisture content which affects the wilt of the tea. The imperfect withering process will affect the quality of the tea, especially in the rolling process. Less wilted tea will be more difficult to roll by a tea rolling machine called OTR.

The explanation above is the result of the analysis of the causes of not achieving black tea production with grade I and II quality. The analysis in detail has explained the causal factors based on humans, machines, work environment, methods and materials.

Figure 3. Pareto Diagram of Factors Causing Black Tea Quality Problems at PT XYZ
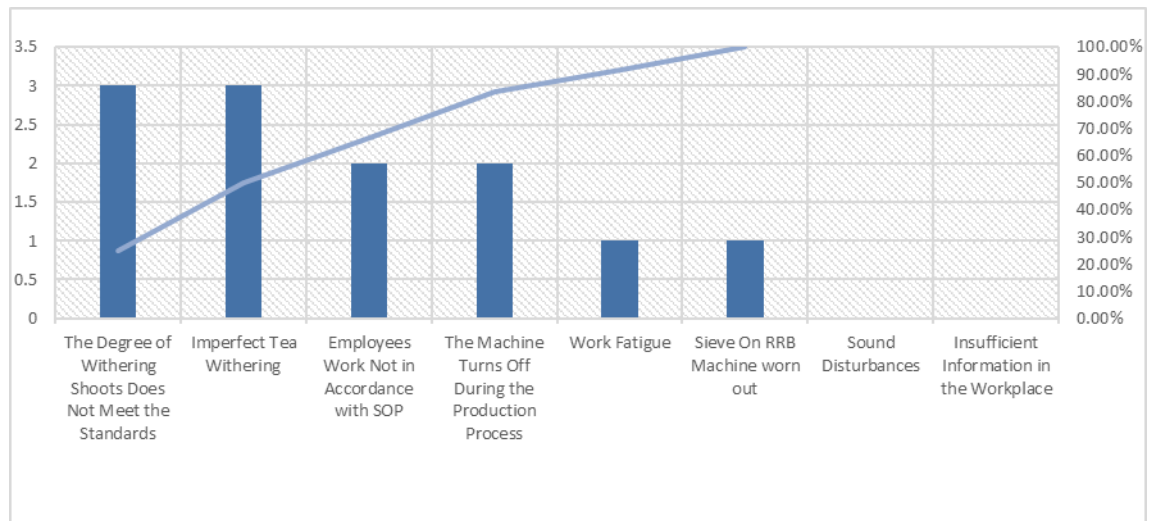
Source: Processed data

The results of the analysis using the Pareto diagram are the factors that most influence the problem of the quality of black tea products at PT XYZ. These factors are obtained by weighting the largest to the smallest percentage. These factors are accumulated to reach 80%, so it can be concluded that these factors are the most influential factors. The most influential factors include:
a. Degree of withering shoots does not meet the standard
b. Imperfect Tea Withering
c. Employees work not in accordance with SOP
d. The machine dies during the production process

Based on the results of interviews with PT XYZ processing parties, the following are the results of the 5-why analysis.

Table 2. 5-why Analysis Results

No	Factor	Why 1	Why 2	Why 3	Why 4	Why 5
1	The degree of shoot wilt did not meet the standard	Water content in shoots is not reduced by 50%	Error in the withering process	Error in reversing process	Employees do not work according to procedures	Lack of supervision
2	The withering of the tea is not perfect	Error in reversing process	Employees do not work according to procedures	Lack of supervision		
3	Employees work not according to SOP	Lack of supervision				

No	Potential Failure Mode		Failure Effects	Potential Causes	Score			RPN
					S	O	D	
1	The degree of shoot wilt did not meet the standard		Downloading Process Interrupted	Lack of Supervision	5.50	5.17	4.83	137.35
2	The withering of the tea is not perfect		Interfere with Wet Sorting Process	Lack of Supervision	5.17	5.25	4.83	131.10
3	Employees work not according to SOP		Error In Reversing Process	Lack of Supervision	4.67	3.75	4.33	75.83
4	The machine dies during the production process		Inhibiting the Production Process	Lack of Training for Mechanical Technicians	4.58	4.17	4.75	90.71
4	The machine dies during the production process	The machine maintenance division is less competent	Lack of Training for Mechanical Technicians					

Source: PT XYZ, 2020

Table 3. FMEA Analysis Results

Source: Processed data

The results of the FMEA results show that each cause of disability has an RPN value. This value is obtained from the multiplication of severity, occurrence and detection values. The determination of these values is obtained by conducting a questionnaire to several PT XYZ employees who are directly related to tea processing. The value of the RPN can be a factor that determines the priority for mass handling in the FMEA table above. The following is an explanation of each risk analyzed by the FMEA method:

The Degree of Withering Shoots Does not Meet the Standard
In the standard withering process, the shoot down wilt is that the water content in the shoots must be degraded by 50%. In this case if the shoots do not meet these requirements it is due to disturbing the rolling process, so that the shoots do not roll according to the standard which will affect the quality of the final product. The failure of this process is the result of the previous process, namely withering.

Imperfect Tea Withering
Incomplete withering of tea occurs when the water content in the shoots does not decrease by 50%. The standard time of shoot withering is 12 hours and there is a subprocess that includes reversal. The reversal is carried out every 3-4 hours. From the results of the interview with PT XYZ, it was stated that the employees were hampered not to comply with the SOP, so there was an error in the withering process. These errors or omissions are the result of less strict employee supervision, so a better supervisory system is needed.

Employees Work not in Accordance with SOP
SOP is an operational procedure determined by the company to be carried out properly. In this case, at the Unit productions of XYZ many employees did not follow the procedure as a result, which resulted in poor performance. This is due to the weak monitoring system at the Company.

The Machine Dies During the Production Process
The black tea production process starts from the withering process to the packaging process. From the results of interviews with PT XYZ, it was stated that the production machines, especially in the wet sorting / rolling process, often had problems, the problem that occurred was that the machine often died during the production process. The shutdown of the machine during the production process causes the shoot quality to decline in quality due to the moisture content that is not in accordance with the process standard. This problem is based on the analysis that has been done, because the machine maintenance employee is considered less competent.

Table 4. Failure Risk Mitigation Table

NO	Risk of Failure	Risk Mitigation
1	Degree of withering shoot does not meet the standard	Improve the function of supervision and supervision in the withering process division.
2	Imperfect Tea Withering	Improve the function of supervision and supervision in the withering process division.
3	Employees not in accordance with SOP	Making improvements to the supervision system
4	The machine dies during the production process	Recruit or conduct training in the machine maintenance division to improve the skills of the division's personnel.

Source: Processed data

DISCUSSION

The result of risk mitigation that has been obtained is an attempt to reduce the risk of failure or failure mode to occur. From these results will be used for improvement proposals that are useful for improving the quality of black tea products. The following are suggestions for improvements to improve the quality of black tea products.

Improve the Supervision and Supervision Functions of the Withering Process Division
In this study, the imperfect withering process so that the withering of the tea shoots was not up to standard is the factor that has the largest RPN, for that it is necessary to carry out more supervision in the withering division. Increased supervision can be done by adding supervisory personnel, installing CCTV to monitor employee performance and imposing strict penalties for employees who work not according to procedures. These three methods can be used to improve the supervisory function which aims to reduce the failure of the production process which impacts on the decline in the quality of the final product.

Conducting Improvement in the Supervision System
Improvement in the supervision system is carried out by supervising each stage of the process so that there are no deviations and the resulting product can meet the expected criteria. The results of quality control at each stage of the process are then recorded on a check sheet. If a disturbance occurs in the production process, it is immediately anticipated. Decision making to anticipate if the process is disrupted will be carried out by the head of quality control so that deviations in the production process can be stopped.

The115ecisionn to stop the production process must first obtain approval from the production manager.

Recruit or Conduct Training at the Machine Maintenance Division
Machines are very influential factors in the production process of a product, especially in manufacturing companies. In this study, problems were found in the wet milling or sorting machine. These problems are the engine dies during the production process and a damaged component, namely the RRB engine sieve. The shutdown of the machine certainly greatly affects the target product quantity, while the wear of the sieve has a very significant effect on the quality of the product based on the particle size for the company, in this case PT XYZ, it is necessary to make efforts to increase the ability of its mechanics in order to overcome and anticipate problems with production machines. This effort can be done by conducting trainings or recruiting more competent employees

CONCLUSION

The factors that influence the quality of black tea products at PT XYZ are raw materials, production processes and employee performance. Raw materials, namely the quality of shoots to be produced into black tea, the production process refers to the quality of the machines used, while the performance of employees is related to how employees work in accordance with established rules so as not to interfere with the black tea production process. The factors that lead to not achieving the quality of black tea at PT XYZ are the degree of withering of the shoots that do not meet the standards so that it interferes with the rolling process, the withering of the tea is not perfect, employees work not according to SOPs and the machine dies during the production process.

In an effort to improve the quality of black tea products at PT XYZ, there are several suggestions for improvement, namely increasing the supervisory and supervision function in the withering division, recruiting or conducting training in the machine maintenance division to improve the skills of the division's personnel and make improvements in the supervision system. The company must improve the supervision system so that all parts of the management comply with the rules or SOPs that have been set, besides that the company must always conduct training for technicians to improve their skills considering that the machines used by the company are relatively old.

DECLARATION OF CONFLICTING INTERESTS
The authors declared no potential conflicts of interest

REFERENCES

Adhikari, D. B. (2017). Informal street food trade: A source of income generation in urban Nepal. *Economic Journal of Development, 23&24*(1–2), 1–17. Doi: 10.3126/ejdi.v23i1-2.19062

Ahmed, M., & Ahmad, N. (2011). An application of pareto analysis and cause-and-effect diagram (CED) for minimizing rejection of raw materials in lamp production

process. *Management Science and Engineering, 5*(3), 87-95. Doi: 10.3968/j.mse.1913035X20110503.320

Aneta, Y., & Turtono, B. (2019). Leadership influence and work environment on employee effectiveness in capital investment and integrated services in One Door City of Gorontalo. *Asia Pasific Journal of Management and Education, 2*(1), 1-10. doi: 10.32535/apjme.v2i1.372

Bahagia, R., & Afni, N. F. (2021). Effect of work environment and communication on emplyoyee satisfaction in PT. Razza Prima Trafo Medan. *Journal of International Conference Proceedings, 4*(2), 455-464. doi: 10.32535/jicp.v4i2.1278

Barraza, M. F. S., & Gonzalez, F. G. R. (2019). Cornerstone root causes through the analysis of The Ishikawa Diagram: Is it possible to find them. *International Journal of Quality and Service Sciences, 11*(2), 302-315. doi: 10.1108/IJQSS-12-2017-0113

Brown, S., Lamming, R., Bessant, J., & Jones P. (2005). *Strategic operations management* (2nd ed.). Oxford: Elsevier Butterworth-Heineman.
Cooper, D. R., & Schindler, P. S. (2014). *Business research methods* (12th ed.). New York: MacGraw-Hill.

Firdaus, H., & Widianti, T. (2015). Failure mode and effect analysis (FMEA) sebagai tindakan pencegahan pada kegagalan pengujian. Retrieved from https://www.researchgate.net/publication/290899548_Failure_Mode_and_Effect_Analysis_FMEA_sebagai_Tindakan_Pencegahan_pada_Kegagalan_Pengujian

Francis, D. M. (2021). Using root cause analysis to help students examine social problems. *Teaching Journalism & Mass Communication, 11*(1), 61-64.

Heizer, J., Render, B., & Munson, C. (2017). *Operation management sustainability and suply chain management*. Stamford: Cenveo.

Keyser, R. S., & Pooyan, P. (2021). Lean at home: Applying 5 whys and lean PFMEA to home projects. *Journal of Applied Research on Industrial Engineering, 1*(1), 1-7. doi: 10.22105/jarie.2022.320848.1410

Ferrel, O. C., Hirt, G. A., & Ferrel, A. (2018). *Business foundation a changing world* (11th ed.). New Yok: McGraw-Hill Education.

Puspitasari, N. B., & Martanto, A. (2014). Penggunaan FMEA dalam mengidentifikasi risiko kegagalan proses produksi sarung ATM (Alat Tenun Mesin) (Studi kasus PT Asaputex Jaya Tegal). *J@TI UNDIP, 9*(2), 93-98. doi: 10.12777/jati.9.2.93-98

Puspitasari N. B., Arianie, G. P., & Wicaksono, P. A. (2017). Analisis identifikasi masalah dengan menggunakan metode failure mode and effect analysis (FMEA) dan risk priority number (RPN) pada Sub Assembly Line. *J@TI UNDIP, 12*(2), 77-84. doi: 10.14710/jati.12.2.77-84

Raman R. S., & Basavaraj, Y (2019). Quality improvement of capacitors through fishbone and pareto techniques. *International Journal of Recent Technology and Engineering (IJRTE), 8*(2), 2248-2252. doi: 10.3940/ijrte.B2444.078219

Statsenko, E., Omarov, R., Shlykov, S., Nesterenko, A., & Konieva, O. (2021). Pareto and Ishikawa diagrams for identifying the causes of defects in poultry meat. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 12*(12), 12A12J, 1-9. doi: 10.14456/ITJEMAST.2021.241