Analysis of Defective Causes in Coffee Product Using Decision Tree Approach

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Abstract. The development of Indonesian coffee through exploration of regional wealth needs to be done to add coffee products when expanding the domestic and overseas coffee market. But there are still many defective products found in domestic coffee, where defective products are products produced in the production process, where the product resulted is not in accordance with the applied quality standards, but it can still be improved by spending certain costs. The method used to identify defects in the product is assessed of space, workers and machinery aspects, and then a decision tree is made to determine the critical point. The results of the research conducted found that most defects are in coffee that does not has epidermis about 21% of the total sample of 23,000 grams. With fishbone diagrams and the decision tree approach the cause of the defect is known.

1. Introduction
Coffee is a potential commodity that is widely cultivated by smallholders and large plantation. Reviewing from its economic activities, coffee is seen as a commodity that has a high economic value and strategic for equitable income distribution so that it gives a high contribution to improve the welfare of farmers in secluded areas, providing employment opportunities, and providing foreign exchange income. Thus, coffee can be valued as a plantation commodity provides a multiplier effect for several other economic sectors [1].

Market globalization and the competitiveness growth in the manufacturing industry demand that product quality be a key of success factor [2]. Quality control of the production process is an activity of planning and control the production process starting from raw materials until the materials are turned into finished products in accordance with company standards. If the product produced by the company does not meet the established standards, then the product categorized into the defective product group. The defective product is analyzed for the defect causes so that the company make a improvements to the production process and the processed raw materials. The goal is that the company does not make the same mistakes in the future and get a quality product [3].

The quality of coffee is affected by many factors, depending on the quantity of time coffee is stored in the warehouse [4]. Good condition, proper appearance, size and coffee beans are also criteria for assessing the coffee quality [5]. Much research has been done to assess the coffee quality. Some of these studies see the effect of coffee bean composition on the coffee quality [6,7,8]. Other studies have also examined the quality of coffee beans [9,10].

This study examines the defects that often occur in coffee bean processing. Then describe the defect causes found in the processed coffee beans. In one of the coffee bean processing industries in Indonesia,
Defects are often found due to errors during the production process and raw materials used. Defects in coffee beans produced include spindles beans, beans which are still have epidermis in the dry process, grade 1 of hole coffee beans, grade 2 of hole coffee beans, broken beans, speckled beans, and black beans.

2. Methodology
Defect analysis is done by collecting information about existing defects. Then brainstorming was carried out with the whole team to find ideas, opinions about coffee product defects. Brainstorming is a technique used to obtain a large quantity of ideas from a team using its collective power [11]. The opinions obtained are be set out in the Cause and Effect Diagram or often called the Fishbone Diagram or Ishikawa diagram which was introduced by Prof. Kaoru Ishikawa [12]. Cause and Effect Diagrams are tools used to systematically place the root cause of a problem [13].

Data analyzed by cause and effect diagrams usually come from brainstorming sessions. This diagram is also used to identify and analyze a process and to find possible causes of a problem. Cause and effect diagram (fishbone) for the biggest defect problem is the coffee beans that still have epidermis. To find out the specific cause at each defect, decision tree tools are used so that the root cause of the problem is obtained from each work station [14]. The results of the product analysis, space, equipment, and workers then made a decision tree to describe the specific causes of defect at each work station. Furthermore, suggestions are given to prevent and reduce defects in coffee beans produced in the future.

3. Result and Discussion
In the initial stage, a product analysis that have the most defects are do not have epidermis, the defective results at each product can be seen in Table 1.

| No. | Types of Coffee Bean Defects | Quantity of Defective Products (gram) | Total Sample (gram) |
|-----|-------------------------------|--------------------------------------|---------------------|
| 1   | Broken                        | 1.050                                |                     |
| 2   | Hole of Grade 1               | 410                                  |                     |
| 3   | Hole of Grade 2               | 20                                   |                     |
| 4   | Spotting beans                | 10                                   | 23.000              |
| 5   | Black beans                   | 5                                    |                     |
| 6   | Have epidermis                | 4.830                                |                     |
| 7   | Spindle                       | 450                                  |                     |

There are 7 types of defects that most often occur in coffee beans, namely broken bean, hole of grade 1, hole of grade 2, spotting beans, black beans, have epidermis, and spindle beans. Of the 23,000 grams of sample taken, coffee beans have epidermal defects that occur most frequently at 4,830 grams (21%). Broken bean defects were found as much as 1,050 grams (4.57%), spindles were found as many as 450 grams (1.96%), and hole of grade 1 was found as much as 410 grams (1.78%). Furthermore, a fishbone diagram was made to find out the cause of defects in coffee beans are still have epidermis as shown in Figure 1:
Coffee beans have epidermis
Lack of understanding using huller machine
There is no training to operators
Operator do not notice the blade distance
Lack of leader line control production to observe operators
Processed coffee beans are still green
The lack of checking coffee beans before do the production process
Method of blade usage is incorrect
The machine used is old
Blade machine is not sharp
The lack of SOP understanding
Low quality of human resources

Figure 1. Fishbone Diagram of Epidermis Coffee Beans Defect Causes

To find out the specific causes of each defect, decision tree tools are used so that the root causes of the problems are obtained from each work station.

Figure 2. Decision Tree at Siphon Tub Station

From the decision tree above, it can be seen that the causes of defect is sourced from workers who are not careful in observing the water level in the siphon tub which is sometimes exceeds 40 cm so that the superior and inferior coffee beans join.
Figure 3. Decision Tree at Raung Pulper Station

From the decision tree above, it can be seen that the causes of defect are sourced from the worker and also the machine used. Inaccuracy in workers in regulating water debit will cause the coffee fruit to be squashed completely which if further processed will cause black coffee beans and also coffee beans that do not experience skin removal causing coffee beans spindle.

Figure 4. Decision Tree at Masson Station

From the decision tree above, it can be determined that the cause of the defect is sourced from the space, where at the Masson Station the finished coffee beans will be accommodated with burlap and the rest will be poured directly into the production floor, so that with the open space, it will cause contaminated coffee beans with dust. The workers are also a cause in checking the water content of coffee beans because the incompatibility will cause the coffee to break.
From the decision tree above, it can be seen that the causes of defect are sourced from workers in setting the blade. Worker errors in adjusting the blade cause the epidermis do not to peel completely, which causes many epidermis on the coffee beans and also cause the coffee beans to break.

From the decision tree above, it can be concluded that the causes of defect is sourced from open spaces and also workers in the sorting process. Worker error in the coffee inspection of coffee beans done manually is the inaccuracy of workers in differentiating coffee beans quality 1, quality 4, and local. The mistakes made will reduce the quality of the next process which is roasting. Unclean workers hands will also cause coffee to become dirty.
From the decision tree above, it can be seen that the causes of the defect are the worker sourced in the machine temperature regulation. Worker errors in regulating the machine temperature cause coffee taste too bitter or the tasteless of coffee produced.

4. Conclusion
Based on the decision tree analysis above, the improvement obtained at siphon tub Station is that workers are more careful in observing the water level in the siphon tub so it does not exceed 40 cm. At the Pulper Station, workers must be more careful in regulating the water flow so as not to find the crushed coffee fruit and skin removal in the coffee fruit. At the Masson station, improvements are made to an open space so that the coffee is not contaminated with dust in the area and workers must be more careful in checking the water content of the coffee beans. At huller station, workers must be more careful in blade managing. Inaccuracy in the blade setting causes there are so many epidermis on the coffee beans and also cause coffee beans to burst. At the sorting station, workers must be more careful in the inspection activity of coffee beans which are carried out manually. Inaccuracy of workers occurs in categorizing coffee beans of quality 1, quality 2, and local. At the roasting Station, workers must be more careful in regulating the machine temperature which is cause coffee tastes are too bitter or tasteless. To improve the workers accuracy and carry out their activities according to Standard Operational Procedures (SOP) it is necessary to conduct related training, observing, and controlling from management.

Acknowledgement
Authors would like to thank to Universitas Sumatera Utara for its financial support so that this paper can be published. Authors also thanks one of the coffee industries in Indonesia for allowing this research to be carried out.

References
[1] M Malahayati 2018 Open Agriculture 3, pp 171-179
[2] M Colledani and T Tolio 2006 CIRP Annals 55 1, pp 453–456
[3] M Sharabi 2010 International Journal of Quality and Service Sciences 2 2, pp 189-205
[4] A Illy and R Viani 2005 Second Edition Espresso Coffee The Science of Quality Elsevier Academic Press: United Kingdom
[5] J Rodríguez, C Durán, and A Reyes 2010 Sensors Journal 10, pp 36-46
[6] P Mazzafera P, K V Gonçalves and M M Shimizu 2002 Scien. Agric 59, pp 695-700.
[7] P Montavon, E Duruz, G Rumo and G Pratz 2003 J Agric. Food Chem 51, pp 2328-2334.
[8] M K V Carr 2001 Expl Agric 37, pp 1-36.
[9] F M Borem et al 2013 Journal of Stored Products Research 52, pp 1-6
[10] L S Oliveira 2006 LWT-Food Science and Technology 39 3, 235-239
[11] H S Gitlow and D M Levine 2009 Six sigma for green belts and champions. 7th Edition FT Press
[12] K Ishikawa 1985 What is total quality control New Jersey: Prentice Hall.
[13] R E Devor, T Chang and J W Sutherland 2007 Statistical quality design and control: Contemporary concepts and methods. 2nd Edition Pearson Prentice Hall.
[14] J K Kim et al 2007 Expert System 22 4, pp 193-205