

Quality Control of Kinasih Bread Products Using Statistical Quality Control and Failure Mode and Effect Analysis Methods

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Abstract. Roti Kinasih UMKM is a business that focuses on the culinary sector by producing various types of bread. The business process carried out at this UMKM is a Make to Order system where products are made after receiving orders from customers. One problem that often arises is the inability to control product quality. Having defective products has a big impact on MSMEs because the costs incurred increase. Based on the existing problems, the Statistical Quality Control and Failure Mode And Effect Analysis methods were chosen to determine the factors causing product defects in UMKM Roti Kinasih. The aim of this research is to determine the level of defects in Kinasih bread products and carry out quality control measures using statistical methods. After processing and analyzing the data, it was found that the burnt bread defect and the sinking bread defect were said to be in an uncontrolled condition and needed recommendations for improvement. The highest RPN value for the burnt bread defect was 245 with the overtime baking failure mode, while the RPN value for the sinking bread defect was 175 with the too cold room temperature failure mode.

Keywords: defect; product quality; failure mode and effect analysis, statistical quality control

I. INTRODUCTION

Competition in industry the more strict along with Keep going emerging progress technology in the digital era. Many companies and business entities are competing promote the product through various targeted strategies for get confession widespread among public. At the moment environment business is very complex and ongoing changed (Krisnawati, 2018). Change technology, regulation, and market policy can in a way significant influence dynamics competition industry. Globalization has open door for more competition intensive between company from various countries (Ferdian, 2021). Something company must compete on a global level for maintain their market share. Preference consumer can just change with Hurry, people now more

knowledgeable and possessive more access spacious and easy to every information. This matter push company or perpetrator business for more responsive to desire consumer.

As it goes time, progress and development of the times have change method customer looking something in choose product or desired item. When choosing A product, quality is the most important thing besides factor price competitive products (Zainuddin, 2018). Something Business is very dependent on consumers and the products it produces. Ofcourse just consumer expect the product he purchased can fulfil his needs and desires, so product the must in optimal conditions and quality guaranteed. Therefore it, become must for companies and business entities for guarantee and maintain quality the product so that consumer can participate active in Market (Suhartini et al, 2020).

Control quality in the company Good from company service or company manufacturing very required. Along with quality service or the goods produced, of course just company want to interesting consumer with satisfying needs and desires. Enhancement quality and systematic process improvement need done If something company want to produce good and quality product in time short, then must increase quality and process throughout system production

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(Wardah et al, 2022). Something company can considered quality If own system functioning production with good and controlled process. Through application steps control quality, company can increase effectiveness control and prevention happen product flawed, which in the end reduce waste materials and energy work so that can increase productivity (Suryatman et al, 2020).

UMKM Roti Kinasih is businesses operating in the field culinary, UMKM Roti Kinasih produce various types of bread such as torn bread, krumpul bread, polish bread, donuts, as well as various type snacks like pie, wingko tripe, floss roll, mini roll, and lapis legit. The business processes carried out by the UMKM that is with system Make to Order which product made after accept order from customer. With system these are the UMKM tend more focus on satisfaction customer. Production process making bread at UMKM Roti Kinasih that is started with weighing future materials will made dough, then the mixer process is carried out, after the mixer process finished will enter to machine breadline for form, fill, and cut dough in a way automatic and precise, next done stage proofing and finally namely the oven process. With exists a number of stages the an UMKM of course must own good control to quality the product. If not, then the UMKM will experience constraint in develop his business. One of frequent problem appear is inability in control quality product. UMKM Roti Kinasih has carry out the production process in accordance with plan company, however still just Still find nonconformity the products produced like lots found product defects at the end of the production process like charred and collapsed. With exists product disabled it is very influential for UMKM because cost incurred the more big. Companies need something method for create good quality in the products produced and maintained consistency to match with market needs viz with apply something system control to process activities carried out.

According to Mulyono and Apriyani (2021), control quality is activities carried out for guard and direct quality product something company to remain awake in accordance plan. Control quality

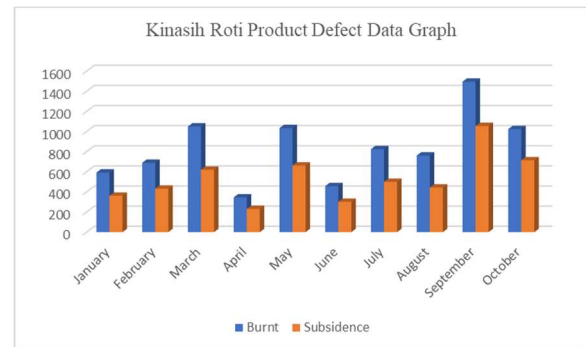


Figure 1. Kinasih Roti Product Defect Data Graph

that is activities carried out for ensure that policy about quality or standard reflected in results end. In other words, control quality this aim for ensure that product made own appropriate quality with specification products determined by the leadership company (Siregar and Setiawannie, 2021). Every business own limit tolerance used for organize and monitor quality the product. If something product Already is outside limit control or existing tolerance set so company must implement control processes quality so that it doesn't experience loss. There are many types available tools for control quality like check sheet, histogram, flow chart, diagram Pareto, control charts, scatter diagrams, and cause diagrams consequence (Suherman and Cahyana, 2019, Djunaidi and Ryantaffy, 2018).

One of possible methods used for control quality that is Statistical Quality Control which is collect and analyze data using method statistics for know and monitor quality from results production to be uniform (Andespa, 2020). There are some method in ensure quality that is with taking sample product, testing, as well do enhancement or repair. Statistical Quality Control apply theory probability in testing as well as inspection sample for did it control quality product (Audina et al, 2020). Apart from the SQC method, there are also method control mentioned quality Failure Mode and Effect Analysis (FMEA). that method used for identify, define, and minimize disability in the production process good from known and unknown issues is known or possible potential arise. Steps for do analysis using the FMEA method is with

determine the failure mode product, determine mark level frequent failures occur (occurrence), establish mark (severity), and detect appearance failure (detection) (Ardiansyah and Wahyuni, 2018).

Therefore that 's important maintain quality products at Roti Kinasih UMKM so researcher lift topic that is control quality Kinasih Bread products use method Statistical Quality Control and Failure Mode and Effect Analysis. Based on explanation already be delivered on study this aim for know big level defects product, analyze reason happen product defect, as well minimize many defects products found at Roti Kinasih UMKM with give recommendation repair. On research This own limitation namely the data used is amount production and defects in torn bread and krumpul bread, which are both own the same production process flow.

II. RESEARCH METHOD

This study will need some data as supporter for analyzing and interesting conclusion as results from study. On research this done with use two types of data, namely primary data and secondary data. Primary data is data taken by researchers in a way direct plunge to location for do observation with objective obtain data. Secondary data namely existing data There is previously used for support data and information needs related existing problems. Data required for research this namely quantity data production and defect data period January to by October 2023.

Method used in study this that is Statistical Quality Control and Failure Mode and Effect Analysis. The data processing process carried out will through a number of steps, including:

A. Statistical Quality Control Method

1. Make sheet inspection or check the sheet presented in form table contains quantity data production and quantity existing defects. the data used as base for stage analysis problem quality.
2. Create a histogram, the data used is the defect data on the results production. The purpose of making a histogram is to see the

distribution of data on the number of defects in bread production.

3. Count map control, for know whether the data obtained is at in limit control or no. If there is data there outside limit control so then done analysis for know reason why the data is outside limit control. Following is formula in map control:

$$UCL = \bar{P} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad \dots(1)$$

$$CL = \bar{P} = \frac{\text{Total defective product}}{\text{Total products inspected}} \quad \dots(2)$$

$$LCL = \bar{P} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad \dots(3)$$

4. Create a Pareto diagram for know frequent failures appears, the failure is major and frequent appear later will solved for remove defects and repairs operation.
 5. Definition the real problem using cause diagrams consequence or fishbone diagram.
- B. Failure Method Mode and Effect Analysis.

1. Identify failure modes in the production process.
2. Identify potency effect failure production.
3. Identify reason from production process failure.
4. Identify system detection each failure mode in the production process.
5. Determine the rating for Severity, Occurrence, Detection. After getting it mark Severity, Occurrence, Detection so will obtained mark Risk Priority Number.

For know mark Risk Priority Number (RPN), namely with formula:

$$RPN = \text{Saverity} \times \text{Currency} \times \text{Detection} \quad \dots(4)$$

6. Recommendation repair. After getting it RPN value, activities production that has highest RPN value own role important in activity production where recommendations repair need applied for reduce level defects product. Recommendation improvements provided based on literature reviews.

Saverity or level severity is how much big level seriousness from something failure product, occurrence or level incident is possibility happen frequent failures appear from something reason during the period of use something product, detection is detection appearance failure

occurred. Severity, occurrence, and detection rating values can seen in Tables 1, 2 and 3.

III. RESULT AND DISCUSSION

Kinasih bread production data obtained of total production data daily on every the month from January arrives with October 2023. UMKM Roti Kinasih producing bread based on order customer. There is defects products available at Roti Kinasih UMKM that is charred and collapsed, Figure 2 shows example burnt bread defects and Figure 3 shows example subsidence bread defect.

Table 1 shows recapitulation amount production and defects Kinasih bread products January – October 2023. I is known that amount Kinasih bread production from January to _ by October 2023 that is as many as 562,703 pcs with a total of 8,272 pcs defects. Amount production

and defects the most namely in September it was 105105pcs with amount defects namely 1495pcs. Whereas amount production and defects smallest namely in March it was 24431 pcs with amount defects namely 345 pcs.

Based on Table 2, each value is obtained proportion disabled burnt, the CL value is 0.0147, the UCL is 0.0152, and the LCL is 0.142 for each the month. Proportion value disabled burnt biggest occurred in August namely 0.0162. Control chart P attribute for disabled burnt can seen in Figure 4.

Based on Figure 4. it is known that there is a number of point that is outside LCL and UCL limits are in January, April, June and August. Control chart P attribute for disabled burnt can said in condition No controlled and necessary exists recommendation repair.



Figure 2. Burnt Bread Defect



Figure 3. Subsidence Bread Defect

Table 1. Production Data and Defect Data as of January – October 2023

No	Month	Amount Production	Type of Defective Product				Amount Defective Products	% product defects
			Burnt	% burnt defect	Subsidence	% subsidence defects		
1	January	37716	592	1.6%	362	1.0%	954	2.5%
2	February	48124	689	1.4%	432	0.9%	1121	2.3%
3	March	69890	1050	1.5%	620	0.9%	1670	2.4%
4	April	24431	345	1.4%	231	0.9%	576	2.4%
5	May	71842	1034	1.4%	662	0.9%	1696	2.4%
6	June	32696	457	1.4%	301	0.9%	758	2.3%
7	July	54616	825	1.5%	499	0.9%	1324	2.4%
8	August	47041	761	1.6%	443	0.9%	1204	2.6%
9	September	105105	1495	1.4%	1055	1.0%	2550	2.4%
10	October	71242	1024	1.4%	714	1.0%	1738	2.4%
TOTAL		562703	8272	14.7%	5319	9.4%	13591	24.1%

Table 2. Control Map Calculations P Attribute Burn Defect

No	Burnt (pcs)	Burnt Defects			
		Proportion of Burnt Defects	CL	UCL	LCL
1	592	0.0157	0.0147	0.0152	0.0142
2	689	0.0143	0.0147	0.0152	0.0142
3	1050	0.0150	0.0147	0.0152	0.0142
4	345	0.0141	0.0147	0.0152	0.0142
5	1034	0.0144	0.0147	0.0152	0.0142
6	457	0.0140	0.0147	0.0152	0.0142
7	825	0.0151	0.0147	0.0152	0.0142
8	761	0.0162	0.0147	0.0152	0.0142
9	1495	0.0142	0.0147	0.0152	0.0142
10	1024	0.0144	0.0147	0.0152	0.0142

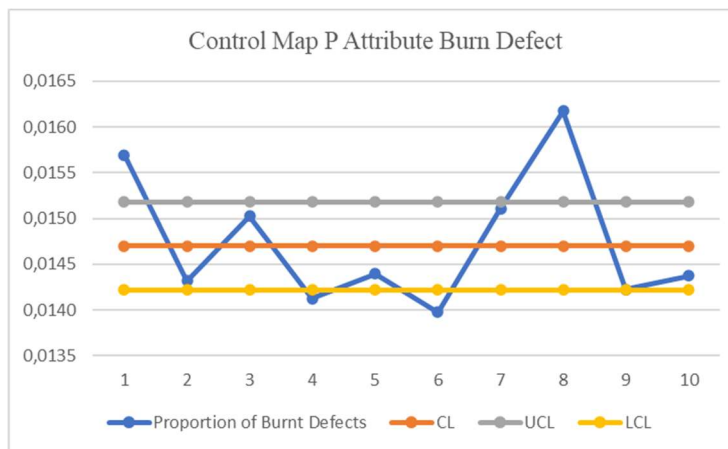


Figure 4. Control Map P Attribute Burn Defect

Table 3. Control Map Calculation P Attribute Subsidence Defect

No	Subsidence (pcs)	Subsidence Defects			
		Proportion of Defects Subsidence	CL	UCL	LCL
1	362	0.0096	0.0095	0.0098	0.0091
2	432	0.0090	0.0095	0.0098	0.0091
3	620	0.0089	0.0095	0.0098	0.0091
4	231	0.0095	0.0095	0.0098	0.0091
5	662	0.0092	0.0095	0.0098	0.0091
6	301	0.0092	0.0095	0.0098	0.0091
7	499	0.0091	0.0095	0.0098	0.0091
8	443	0.0094	0.0095	0.0098	0.0091
9	1055	0.0100	0.0095	0.0098	0.0091
10	714	0.0100	0.0095	0.0098	0.0091

Based on Table 3, each value is obtained proportion subsidence defects , CL of 0.0095, UCL of 0.0098, and LCL of 0.0091 for each the month . Proportion value largest subsidence defect occurs in September and October of 0.0100. Control chart P attribute for subsidence defects can occur seen in Picture 5.

Based on Figure 5. you can is known that there is a number of point that is outside _ UCL and LCL limits are in months February, March, September and October. Control chart P attribute for subsidence defects can occur said in condition no controlled and necessary exists recommendation repair.

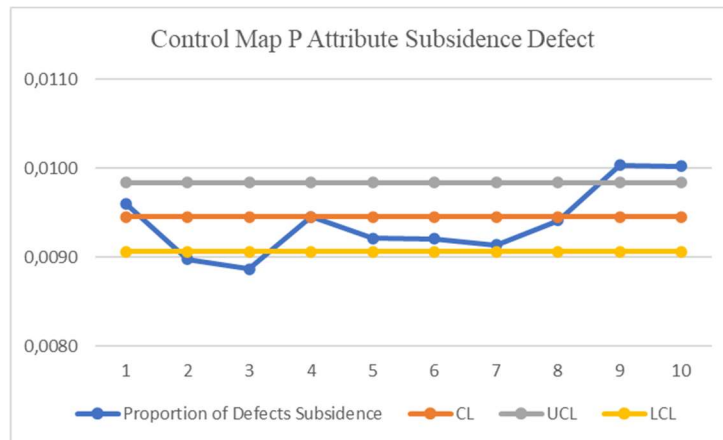


Figure 5. Control Map P Attribute Subsidence Defect

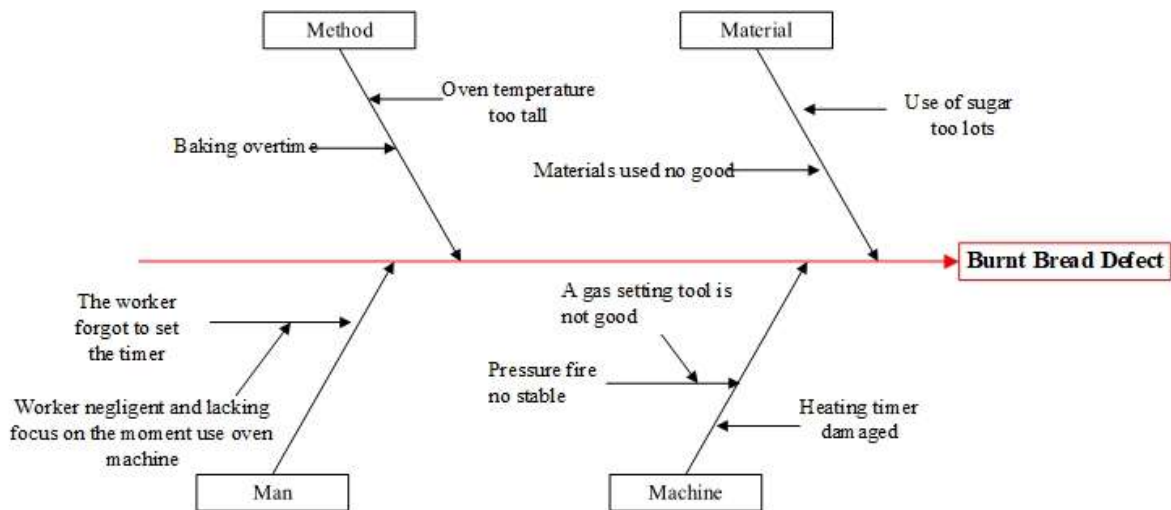


Figure 6. Fishbone Diagram of Burnt Bread Defect

Based on calculations on the map control attribute P, obtained results that burnt bread defects and still sinking bread defects there is point that exceeds the UCL and LCL so that can said kinasih bread defect in condition No controlled and necessary exists recommendation repair For minimize exists existing defects, so need seek and know factors What that's the only thing that influences it quality product and give rise to exists defects with use fishbone diagram. Figure 6 is image of a fishbone diagram of burnt bread defects and Figure 7 is fishbone diagram of bread collapse defects.

Fishbone diagram or cause diagram consequence is schema that includes causes and

sub- causes related with problems that occur. Once it's known problem the most dominant main in damage or disability product using a histogram, then done analysis factor reason disability product with use cause diagrams consequence. Additionally, fishbone diagrams are used for show exists connection systematic between something symptom or the consequences and causes (Milah, 2022). As for this fishbone diagram made based on results interview to UMKM owners and leaders in the section production.

Based on fishbone diagram in Picture 7. can is known that there is four (4) categories are possible analyzed as cause happen burnt bread

Table 4. Reasons Consequence Burnt Bread Defect

Factor	Because	Consequence
Man	Worker negligent and lacking focus on the moment use oven machine, so: Worker forgot to set the timer on the oven machine	Not enough workers focus on the moment use machine can cause decline productivity in a way whole. This matter can result products that don't fulfil standard quality, like no ripe or no equally the roasting.
Machine	A gas setting tool is not good, so causes: Pressure fire no stable Heating timer damaged	No gas regulator good can cause distribution hot that is not evenly in the oven. Inhibits the production process and reduces productivity processes because worker must use up time longer for ensure proper temperature and gas settings.
Method	a. Oven temperature too tall b. Baking overtime	a. The oven temperature is too high tall cause part outside product become burnt or too brown, temporary part inside No ripe with Good. b. Bread becomes dry and hard, so texture skin become fragile.
Material	a. Materials used no good b. Use of sugar too lots	a. Use flour, less milk Good can influence the texture of the bread, making it become hard or not enough crunchy. b. Shortens shelf life bread. c. If the amount of sugar is too high Lots can affect the baking and making process the surface of the bread becomes dark.

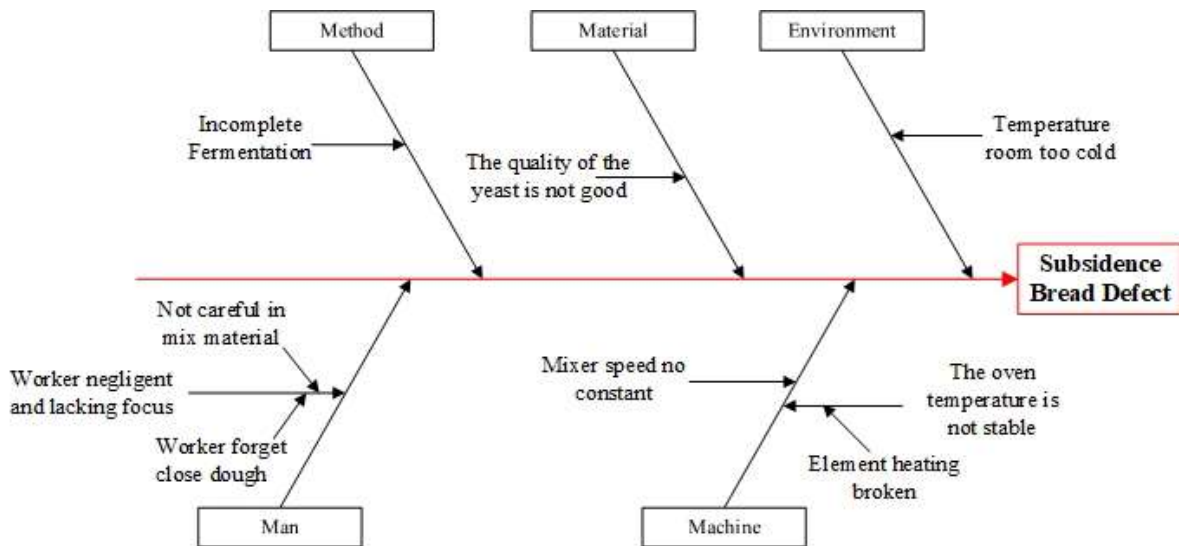


Figure 7. Fishbone Diagram of the Subsidence Bread Defect

defect in the UMKM Roti Kinasih. Category the including from factor humans, machines, methods and materials. Following This is table because consequence burnt bread defects that can be seen in Table 4.

Based on fishbone diagram in Figure 7 is known that there are five (5) categories that can

be done analyzed as cause happen Bread defects collapsed at UMKM Roti Kinasih. Category the including from factor humans, machines, material methods and also the environment. This consequence a sinking bread defect that can occur seen in Table 5.

Table 5. Reasons Consequence Subsidence Bread Defect

Factor	Because	Consequence
Man	Worker negligent and lacking focus so that: Worker forget close dough Not careful in mix material	open dough can take too long cause lost moisture and inhibit yeast growth, so can affect the volume of bread. lack of accuracy mixing material in dough result decline quality product and influence time fermentation so that dough no expand with perfect.
Machine	a. Element heating broken, so cause: 1) The oven temperature is not stable b. Mixer speed no constant	a. Element heating damage and temperature no stable result roasting no consistent with a number of part product no expand with perfect b. Consistency mixer speed is important for optimal gluten formation, if no stable can influence elasticity of bread and making the quality of the bread becomes low.
Method	a. Incomplete Fermentation	a. Fermentation is not perfect can hinder yeast growth so resulting in bread having less volume and some the bread part doesn't ripe with perfect.
Material	a. The quality of the yeast is not good	a. Less yeast quality can produce the dough does n't elastic so the bread has less volume or no expand perfect b. Shelf life become more short because lack of reliability in the fermentation and endurance processes to contamination.
Environment	a. Temperature room too cold	a. Temperature too room cold can slow down yeast activity, and slow fermentation resulting in less bread volume maximum. b. Temperature the room didn't consistent can result non-uniformity in quality product and have different characteristics.

Table 6. FMEA Method Calculation Results

Failure	Failure Mode	Severity	Ocurrence	Detection	RPN	Rank
Burnt Bread	Worker Not yet too understand use equipment	6	5	6	180	5
	Worker forgot to set the timer on the oven	7	5	5	175	6
	A gas setting tool is not good	8	6	4	192	4
	Pressure fire no stable	6	6	4	144	7
	Heating timer on the oven is broken	7	5	6	210	3
	Baking overtime	7	7	5	245	1
	Oven temperature too tall	7	8	4	224	2
	Materials used no good	3	2	6	36	9
Bread Subsidence	Use of sugar too lots	6	3	7	126	8
	Worker negligent and lacking focus	2	2	10	40	9
	Dough no closed	4	4	8	128	5
	Not careful mix material	4	2	7	56	8
	Mixer speed no constant	6	3	4	72	7
	The oven temperature is not stable	7	5	4	140	4
	Element heating damaged	7	6	3	126	6
	Incomplete Fermentation	6	4	6	144	3
	Poor yeast quality good	6	5	5	150	2
	Temperature room too cold	7	5	5	175	1

After identifying cause handicap, step furthermore is determine reason most influential failure use FMEA method, method this used for evaluate associated risks with potency disability.

FMEA creation stage, namely determine mark severity rating which is mark severity from effects caused by the failure mode to whole system. Second step that is determine mark ratings

Table 7. Percentage Cumulative Failure Mode Burnt Bread Defect

Failure Mode	RPN	%	Cumulative%
Baking overtime	245	16%	16%
Oven temperature too tall	224	15%	31%
heating timer on the oven is broken	210	14%	44%
A gas setting tool is not good	192	13%	57%
Worker not yet too understand use equipment	180	12%	69%
Worker forgot to set the timer on the oven	175	11%	80%
Pressure fire no stable	144	9%	89%
Use of sugar too lots	126	8%	98%
Materials used no good	36	2%	100%

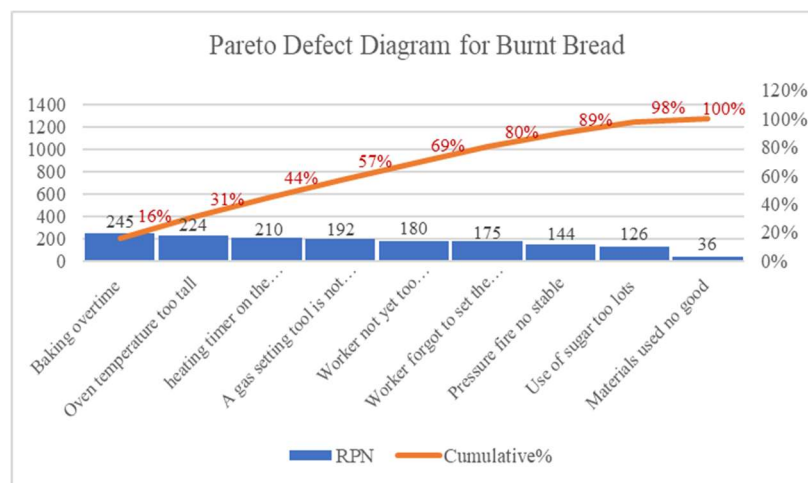


Figure 8. Pareto Defect Diagram for Burnt Bread

Occurance which is probability or opportunity happen damage to the product. Third step that is determine mark ratings Detection which is evaluation from possibility tool the can detect reason potential happen form failure. Furthermore count RPN value with multiply mark ratings from severity, occurrence, detection. The last step that is determine ranking based on existing RPN value. FMEA calculation results can be obtained seen in Table 6.

Based on results FMEA calculation obtained from results interview, shows that ranking 1 cause happen burnt bread defect namely overtime baking with RPN value of 245, failure mode it is very influential to happen burnt bread defect. Meanwhile, the bread subsidence shows defects that rank 1 cause happen defects that is temperature room too cold with RPN value of

175, failure mode it is very influential to happen the bread defect collapsed.

In Table 7. shows percentage and value cumulative for each failure mode in the burnt bread defect and Figure 6 is a Pareto diagram of the burnt bread defect.

Based on failure mode RPN value burnt bread defect can determined scale priority of existing failure modes _ using the Pareto diagram. In the Pareto diagram applies the 80/20 rule means that that 80% of defects occur caused by 20% of causes failure something production, so can chosen types failure with cumulative reaches 80% with assumption that 80% can represent all over defects that occur (Saputra and Santosa, 2021). Pareto defect diagram of burnt bread can seen in Figure 8.

Based on Pareto 80/20 diagram rule, obtained results that failure mode is necessary

Table 8. Percentage Cumulative Failure Mode Subsidence Bread Defect

Failure Mode	RPN	%	Cumulative%
Temperature room too cold	175	17%	17%
Poor yeast quality Good	150	15%	32%
Fermentation No perfect	144	14%	45%
The oven temperature is not stable	140	14%	59%
Dough No closed	128	12%	71%
Element heating damaged	126	12%	84%
Mixer speed no constant	72	7%	91%
Not careful mix material	56	5%	96%
Worker negligent and lacking focus	40	4%	100%

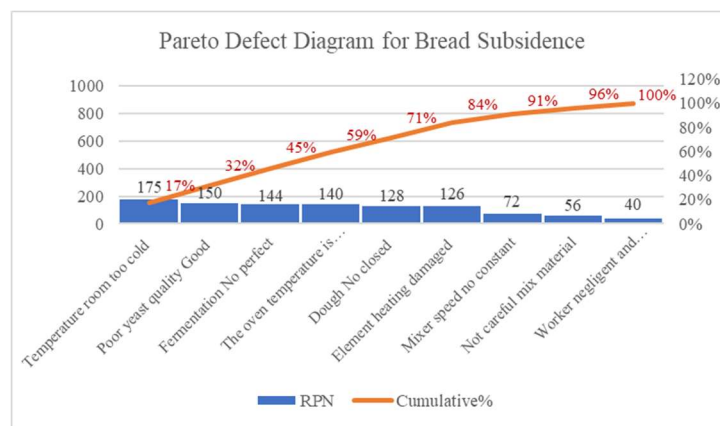


Figure 9. Pareto Defect Diagram for Bread Subsidence

prioritized i.e. failure mode with 6 rankings top that is overtime roasting , oven temperature too high , the timer on the oven is broken, A gas setting tool is not good, worker not yet too understand use equipment , and workers forget setting the timer on the oven.

In Table 8 shows percentage and value cumulative for each failure mode in sinkhole bread defects and Figure 9 is a Pareto diagram of sinkhole bread defects.

Based on failure mode RPN value bread defects can collapse determined scale priority of existing failure modes using the Pareto diagram. In the Pareto diagram applies the 80/20 rule means that that 80% of defects occur caused by 20% of causes failure something production, so can chosen types failure with cumulative reaches 80% with assumption that 80 % can represent all over defects that occur (Saputra and Santosa, 2021). Pareto defect diagram of bread collapse can be seen in Picture 10.

Based on Pareto 80/20 diagram rule, obtained results that failure mode is necessary prioritized namely 6 ranks top that is temperature room too cold, the quality of the yeast is not good, Incomplete fermentation, the oven temperature is not stable, doughy no closed and elements heating damaged.

Proposed Improvements

Once done data processing uses method Statistical Quality Control and Failure Mode and Effect Analysis and obtained a number of factor reason happen defects kinasih bread products, step furthermore will give proposal repair based on level priority on failure modes. Proposal repair can see in Table 9.

IV. CONCLUSION

Based on results related data processing control quality in UMKM Roti Kinasih, then obtained a number of conclusion:

1. Defects in UMKM Roti Kinasih that is charred and submerged, based on calculation map control attribute P is defective burnt obtained CL value of 0.0147; UCL value of 0.0152; and the LCL value is 0.0142 with results that burnt bread defect said in condition No under control Because there is point that is outside UCL and LCL limits are in months January, April, June and August. Meanwhile, a sinkhole bread defect was obtained CL value of 0.0095; UCL value of 0.0098; and the LCL value is 0.091 with results that bread defects can collapse said in condition no under control because there is point that is outside UCL and LCL limits are in months February, March, September and October. Based on results calculation the so need exists recommendation improvements to the kinasih bread production process for reduce defects existing products.
2. On a fishbone diagram for burnt bread defect there is four factor reason exists defects that is factor humans, machines, materials, and also methods. Meanwhile, there are five factors in sinking bread defects reason exists defects that is factor humans, machines, materials, methods and also the environment work.
3. Based on results calculation use method Failure Mode and Effect Analysis is obtained mark Risk Priority Number (RPN) and ranking for each failure mode for each defect. Then done analysis use the pareto diagram for know scale priority of existing failure modes. Based on Pareto's 80/20 diagram rule is obtained results that in failure mode necessary burnt bread defects prioritized that is overtime roasting, oven temperature too high, the timer on the oven is broken, the appliance gas setting not good, worker not yet too understand use equipment, and workers forget setting the timer on the oven. Meanwhile, in the sinking bread defect, the failure mode is necessary prioritized that is

temperature room too cold, the quality of the yeast is poor OK, fermentation No perfect, the oven temperature is not stable, doughy no closed, and element heating damaged.

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