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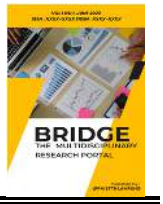

Quality Control of TH Lever Assy Products Using the Six Sigma Method at PT. IMC Tekno Indonesia

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ABSTRACT

This Study discuss about product defects in the TH Lever Assy manufacturing process. Objective from study This is For identify cause and reduce disabled products in the TH Lever Assy production process. Object study This is companies operating in the field producer component plastic resulting precision from Injection *molding* , meanwhile focus research on the TH Lever Assy production process. Study This analyzed use six sigma method with stages *Define, Measure, Analyze, Improve, Control* (DMAIC), the six sigma method is stages enhancement quality For reach the expected sigma level company . Research result This namely 6 causes happen disabled product that is *short mold* , *burry* / *flashes* , *scratch , child part* No installed , *frash* , metal material in *plastic* . Before sigma level improvement reached 4.32 with DPMO value of 2,445 and after repair reaching the sigma level of 4.31 with DPMO value is 2,428.

Keywords: *Quality , Six Sigma Method , DMAIC*

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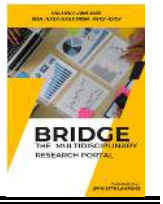

INTRODUCTION

Every industry in general will try maintain the product produced capable fulfil desire and satisfaction customer . This matter push company For more increase quality the product produced in accordance with existing standards and specifications set .

PT. IMC Tekno Indonesia is one of them moving company in field producer component plastic resulting precision from Injection *molding* . Plastic injection *moulding* is something plastic precision produced by the machine injection plastic , which one The process is plastic material melted by heat and flow to suitable mould with the shape that has been designed with specifications and tolerances from *drawing* / image product plastic injection the .

TH Lever Assy is something product plastic injection *molding* produced by PT. IMC Tekno Indonesia, request at each the month For product This Enough tall . So that donate sufficient profit big for company . However condition moment This product the often problem on *line* production as well as exists *customer complaints* . This is a big no recommended happens in the world of manufacturing , because can make *stop line* at *the customer* and get it give rise to quite a loss big . As well as products This happens internally too often problematic related quality .

For minimize percentage product disabled every controlled process stages start from entry material standard until product So . Element reason happen disabled made possible by material, human and equipment / machinery factors in the production process Still there is obstacles , p This need exists repair in a way Keep going continuous (*continuous improvement*) so that the product become more Good . Type deviation or defects that occur including *short molds* , *burry* / *flashes* , scratches *, child parts* No installed , *frash ,* metal material in *plastic* . As well as factors method control quality that is whole will culminates in control quality .

As for goals from study This is For know system control quality to product defects in TH Lever Assy products implemented at PT. IMC Tekno Indonesia, and for know effort repair system control quality at PT. IMC Tekno Indonesia with use Six Sigma method .

LITERATURE REVIEW

According to Assauri (2011:75), production process is ways , methods and techniques For create or add utility something goods or service with use resources (energy work , machines , materials , funds) available . Production process is something form most important activity in implementation production in a company .

Quality is one of the strategies used For win competition between Lots product the kind on the market . Consumer No Again use price as benchmark For buy goods , will but more to durability item , type material standard , design goods , *content* goods , suitability function with needs and others (Wayuni et al , 2015)

According to Pande et al, control quality done Agara can produce product form goods or appropriate services with desired and planned standards , as well repair quality product yet in accordance with standards that have been determined and appropriate Possible maintain quality that has in accordance . Control quality is a planned technique and action that is carried out For achieve , maintain and improve quality something product to match with standards that have been determined and can be fulfil satisfaction consumers (Aprianto , 2017).

Control quality have a number of tool statistics used as tool help control quality , among others is a cause diagram consequences (*fishbone*), Pareto diagrams and control diagrams .

1. Cause Diagram Consequences (*fishbone*)
2. Pareto Chart
3. *Control Chart*

Six Sigma method according to Gazpersz is something method control and improvement quality implemented by Motorala since 1986. Six *sigma* is something form enhancement quality towards the target of 3.4 *Defer Per Million Opportunities* (DPMO) for every product Good goods or service in effort reduce amount disabled (Aprianto , 2017).

Whereas according to Evans, *six sigma* can also be done defined as method purposeful business process improvement For find and subtract factors reason defect , reduce time cycles and costs production , increase productivity , fulfilling need customers , reach utility optimal engine as well get more results Good from facet production nor service (Franciscus , 2014).

Six sigma originates from the word *six* which means six and sigma which is unit from standard deviation which is also denoted with symbol σ. *Six sigma* is also common symbolized with 6σ. The higher the sigma , the more the quality is good too . In other words, more and more tall sigma the more low level too disability or his failure . Can seen from table 2.1 (Nurullah A et al , 2014).

Table 1. Sigma Value Conversion

Long term yield (basically the percentage of successful output) %	*Defects Per Million Opportunities (DPMO)*	*Sigma Processes*
99.99966	3.4	6
99.98	233	5
99.94	6,210	4
99.73	66,807	3
69.1	308,538	2
30.9	691,462	1

Source : Nurullah et al , 2014

According to LJ Bain and Engelhardt, stages implementation enhancement quality with *six sigma* consists of five steps viz with DMAIC concept (*Define, Measure, Analyze, Improve, Control*) (Aprianto , 2017).

- *Define* is phase determine problem . In phase This used For identify problems that occur and determine priority problem The Define stage is stage First of the DMAIC process, stage This aim For unite opinion from teams and sponsors regarding project that will done , fine That room scope , objectives , costs and targets of projects carried out .
- Measure is step operation second in the improvement program Six Sigma quality for measure level performance moment This . before measure level performance usually moreover formerly do analysis to system measurements used .
- Analyze is verify causes that influence key inputs and key outputs
- Improve is find the right solution For overcome problem.

  Controls is For complete all Work project and deliver results of the improvement process to up management and ensure that everyone works has trained For do procedure new improvements .

METHODS

In implementation study Currently , data collection is carried out at PT. IMC Tekno Indonesia which is located in the Bukit Indah *City area* Purwakarta . Research time implemented in the month January 2023 to April 2023.

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Study This use 2 kinds variable study that is control quality as variable first and sub variables measurement researched quality that is measurement in a way attributes used determine level discrepancies that occur to products produced by the company .

Method data collection carried out in study This is with do observation directly at the company that became object study . Data collection techniques used is as following:

1. Interview
2. Observation
3. Documentation

The method used For solve problem is with using DMAIC six sigma consisting from (Define, Measure, Analyze, Improve, Control). DMAIC is a structured and formal process for do improvement activities with concrete steps and results.

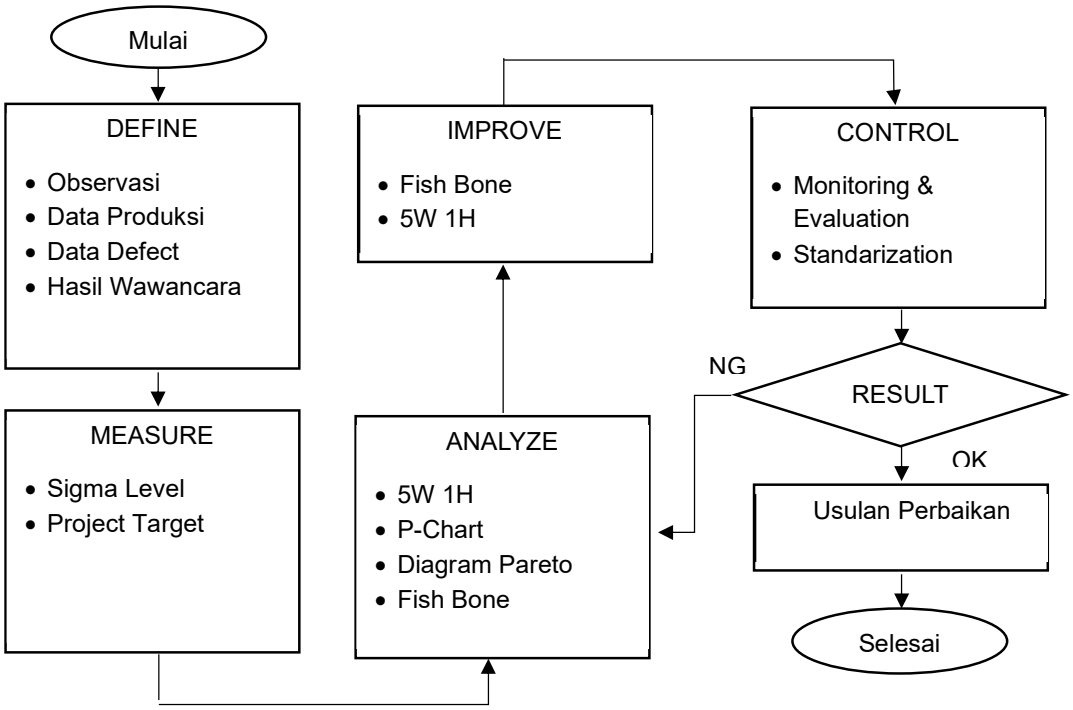


Figure 1. Flow of the Solving Process Problem

Define

At stage This found proportion *defects* that become most significant cause to exists damage which constitutes source failure production . Defects taken is :

1. Identify problem standard quality in produce products that have been determined company.
2. Identify plan necessary action done based on results observation and analysis study.

3. Set goals and objectives enhancement Six Sigma based quality results observation.

Measure

At stage second There are 3 tools used , namely determine CTQ, Pareto Diagram, Sigma Level.

1. CTQ

   Identify that problem will be explained a number of *Critical to Quality* (CTQ).

2. Determining the Pareto *Chart*

   Determine priority mistakes that must be concentrated on so that they are mistakes No happen again, this diagram give order importance problem or reason happen problem, so can focus the most important problem For do more improvements formerly.

3. Sigma Level

   Determine company the in which sigma level and see the six sigma program experienced enhancement in reduce level disability .

Analyze

At stage Third , there are 4 tools used that is : make *Fishbone* Diagram, *Control Chart* , FMEA

1. *Fishbone* Diagrams

   Create a cause diagram consequence For know what to be reason main from existing problems . This diagram is very helpful For identify root reason happen problem as well as can be searched solution from problem the .

2. P *Control* Diagram

   P control chart is used For attribute namely on traits based goods on proportion amount something incident like accepted or rejected as a result of the production process . This diagram can arranged with step as following :

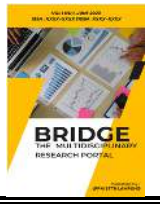
   a. Taking population and sample population taken For P *Chart* analysis is amount the product produced in activity TH Lever Assy production at PT. IMC Techno Indonesia.

   b. Inspection characteristics with count mean value . Formula find the mean:

      $$\bar{p} = \frac{\sum np}{\sum n}$$

      np = Amount whole rejected production

      n = Number whole inspected production during period study



c. Determine control limits to supervision carried out with set UCL value (*Control Limit Upper* / specification limit upper) and LCL (*Lower Control Limit* / specification limit lower).

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

$$UCL = P - 3\frac{\sqrt{P(1-P)}}{n}$$

UCL: Upper Control Limit p: average proportion disability

LCL: Lower Control Limit n: amount sample

3. FMEA

   FMEA (*Failure Mode Effect Analysis*) is For see consequences failure something product and help identify , analyze , as well reduce need in develop production processes.

Improve

Objective Improve stage is find the right solution For overcome problem with use 5W1H and *Action Planning* tools

1. Stage 5W1H

   Stage 5W1H in question are (*Who, What, Where, When, Why , How*).

2. Stage *Action Planning*

   Stage *Action Planning* is a given set of tasks to individual or team containing a list of targets for every assignment , right time , full not quite enough answer .

Controls

Objective Control stage is For complete all Work project and deliver results of the improvement process to up management, and ensure that everyone works has trained For do procedure new improvements there is 1 tool that is used is *Control Chart.*

RESULTS AND DISCUSSION

Study This carried out at PT. IMC Techno Indonesia. Data collected based on primary data obtained from observation and research in a way directly in the field with method observe in a way direct the object to be discussed in study This is secondary data which is data source or documents obtained from party related companies with control quality . After the data is collected collected , then writer do data processing uses

six sigma method with follow DMAIC stages which include *define, measure, analyze, improve, control* .

In study This focused on control quality TH Lever Assy products with approach six sigma method . In fact when still carrying out the TH Lever Assy production process just there is experienced products failure and writer get quantity data disabled production of TH Lever Assy parts experienced failure . Table 4.1 below This showing amount type TH Lever Assy defect period January 2023 to April 2023.

Table 2. Type Data Disabled TH lever assembly products

Period	Amount Production (pcs)	Amount Disabled (pcs)	Type Disabled Product					
			Short Mold (pcs)	Burries/Flashes (pcs)	Scratch (pcs)	Child part no installed (pcs)	Frash (pcs)	Metal material in plastic (pcs)
1st Jan	17,280	678	64	55	175	42	117	225
2nd Jan	17,120	710	49	75	197	53	78	258
3rd Jan	17.020	643	56	65	187	49	59	227
4th Jan	15,124	545	32	41	149	35	43	245
1st Feb	16,754	710	48	55	190	38	115	244
2nd Feb	17,120	675	50	65	187	64	75	234
3rd Feb	17,116	765	70	64	173	68	100	290
4th Feb	15,100	725	55	62	211	48	102	247
1st March	17,130	721	60	64	207	53	88	249

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Period	Amount Production (pcs)	Amount Disabled (pcs)	Type Disabled Product					
			Short Mold (pcs)	Burries/Flashes (pcs)	Scratch (pcs)	Child part no installed (pcs)	Frash (pcs)	Metal material in plastic (pcs)
2nd March	17,210	671	59	58	192	55	45	262
March 3rd	17,220	677	55	62	180	54	67	259
March 4th	15,130	536	31	42	102	37	43	281
1st Apr	17,110	689	58	63	185	67	95	221
2nd Apr	17,130	654	61	58	168	65	77	225
3rd Apr	17,230	719	48	64	192	55	91	249
4th Apr	14,970	617	64	55	173	64	78	183
Total	265,764	10,735	880	948	2,868	867	1,273	3,899
Percentage			8.2 %	8.8 %	26.7 %	8.1 %	11.9 %	36.3 %

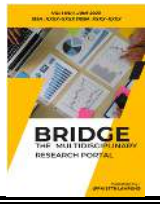
Source : Data Processing Results

Based on data obtained at the company , then done Data processing follows DMAIC stages (*Define, Measure, Analyze, Improve, Control*). With thereby writer will elaborate reason happen failure , that is as following :

Define

Define is stage identification problem quality in product end type TH Lever Assy, at stage this is what makes it product experience disabled defined the cause .

1. Identify problems standard quality



Identify causes of defects that occur most potential problem in produce TH Lever Assy products . Most potential cause in produce TH Lever Assy products identified as following :

a. *Short Mold*

   Short mold is lack of material on *the part* , so *parts* become No intact / loss of part of the material on the part. reason from *defects* This is the setting of engine parameters that are not optimal.

b. *Burries/Flashes*

   Burries/flashes is the opposite from *short mold* , ie excess material on *part, burry* occurs in the line part area . Reason from *burry* There are 2 , namely , existing molding No precision or *parameter settings* that are not optimal.

c. *Scratch*

   Scratch is exists scratches on parts, scratches This caused because of the cutter during the part finishing process by the operator.

d. *Child Part* No installed

   Child part No installed caused by machine operator negligence No Install the child part on the mold.

e. *Frash / silver mark*

   Frash / silver mark i.e. part no shiny / diarrhea striped part surface putuh , p This caused because the material is lacking hot during the injection process.

f. Metal material in *plastic*

   Metal material in *plastic* caused by a chipped child *part* during the injection process so stuck to the *plastic area* .

2. Identify plan necessary action done based on results observation and analysis study that is :

   a. Do repair machine that is less than optimal in production and setup machine according to SOP.

   b. Increase in power Work in do work .

3. Set goals and objectives enhancement six sigma quality

   Based results observation , for reduce or push product disabled from 4.03% to 0% proven with total product disabled highest of 4.80% and the lowest of 3.54% based on percentage Lowest Actually can push product disabled up to 0%. Based

on problem exists product defects caused by Short Mold, Burry / Flashes, Scrath , Child Part not installed , Frash , Metal material in plastic that can be cause loss for company so company do something strategic planning in its operations with push product disabled to 0% with appropriate action .

Measure

1. Determine *Critical To Quality* (CTQ)

In determine type of defect part TH Lever assembly (short mold, Burry / flashes, Scrath , Child Part no installed , Frash , Metal Material in plastic) which will became the focus of research This determined based on table 4.2 about order *critical to quality* (CTQ). From table data the showing amount the largest percentage of TH Lever Assy part defects occurs in types Metal material defects in plastic are as much as 36% so give contribution biggest to happen defect in the TH lever assembly part and the defect become priority main For quick done improvement and meaning other cases not yet become attention special such as short mold as much as 8%, Burry / Flashes as much as 9%, Scrath 27% and Frash 12%. with thereby six type defective TH lever assembly part that's the most disabled is a metal material in plastic that will become the main focus discussion to process improve, will but type other defects later day must done repairs so that defects become 0 %.

Table 3. *Critical To Quality* (CTQ) types TH lever assembly defect

No	Type Disabled	Amount Disabled	Cumulative	% disabled	Cumulative %
1	Metal material in plastic	3,899	3,899	36%	36%
2	Scratch	2,868	6,767	27%	63%
3	Frash	1,273	8,040	12%	75%
4	Burries/Flashes	948	8,988	9%	84%
5	short mold	880	9,868	8%	92%
6	Child part no installed	867	10,735	8%	100%
Amount		10,735	10,735		

Source : Data Processing Results

2. Pareto diagram

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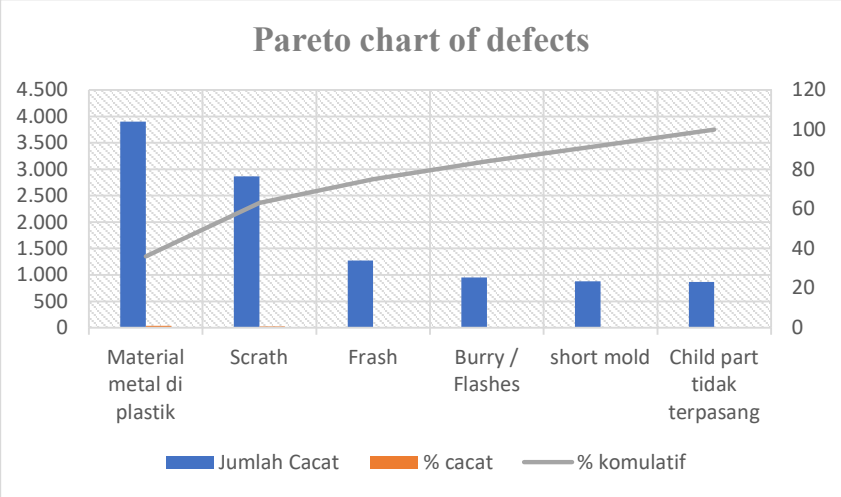

Figure 2. *Pareto Chart of* Disabled

Pareto diagram created For determine importance or priority from category the reasons that will analyzed so that can is known level defective part TH Lever assy in form chart noted product . From the results of the Pareto diagram above , it is known that defects that occur in the TH lever assembly part , namely metal material in plastic with level disabled of 36% of course result This made priority repair first thing to do done company , then *Scarth* 27%, *Frash* by 12%, *Burries / Flashes* by 9%, *short mold* of 8% and *child part* No installed 8%.

3. Defects per million of opportunities (DPMO)

Table 4. *Defects per Million of Opportunities* (DPMO)

No	Period	Amount production	Amount disabled	P	Lots CTQ	Level Opportunities Disabled	DPMO	Mark Sigma
1	1st Jan	17280	225	0.013021	6	0.002170	2170.1	4.36
2	2nd Jan	17120	258	0.015070	6	0.002512	2511.7	4.31
3	3rd Jan	17020	227	0.013337	6	0.002223	2222.9	4.35
4	4th Jan	15124	245	0.016199	6	0.002700	2699.9	4.29

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No	Period	Amount production	Amount disabled	P	Lots CTQ	Level Opportunities Disabled	DPMO	Mark Sigma
5	1st Feb	16754	244	0.014564	6	0.002427	2427.3	4.32
6	2nd Feb	17120	234	0.013668	6	0.002278	2278.0	4.34
7	3rd Feb	17116	290	0.016943	6	0.002824	2823.9	4.27
8	4th Feb	15100	247	0.016358	6	0.002726	2726.3	4.28
9	1st March	17130	249	0.014536	6	0.002423	2422.7	4.32
10	2nd March	17210	262	0.015224	6	0.002537	2537.3	4.31
11	March 3rd	17220	259	0.015041	6	0.002507	2506.8	4.31
12	March 4th	15130	281	0.018572	6	0.003095	3095.4	4.15
13	1st Apr	17110	221	0.012916	6	0.002153	2152.7	4.36
14	2nd Apr	17130	225	0.013135	6	0.002189	2189.1	4.35
15	3rd Apr	17230	249	0.014452	6	0.002409	2408.6	4.32
16	4th Apr	14970	183	0.012224	6	0.002037	2037.4	4.38
Amount		265,764	3899	0.235260	6	0.002445	2445.2	4.32

Source : Data Processing Results

Table 4 shows sigma value for metal materials in plastic 4.32 with The Defect Per Million Opportunity (DPMO) value is 2445.2

Count DPMO value :

DPMO = (D / (U x O)) x 1,000,000

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Information :

D = Amount *defects*

U = Number of Units

O = Amount the opportunity will be result disability (*Opportunity*)

DPMO = (D / (U x O)) x 1,000,000

= 3,899/ (265,764 x 6) x 1,000,000

= 0.002445 x 1,000,000

= 2445.2

Sigma value = 4.32

Analyze

At the researcher's analysis stage use *tools fishbone* diagram, *control chart* and *failure mode and effect analysis* (FMEA).

1. *Fishbone Diagrams*

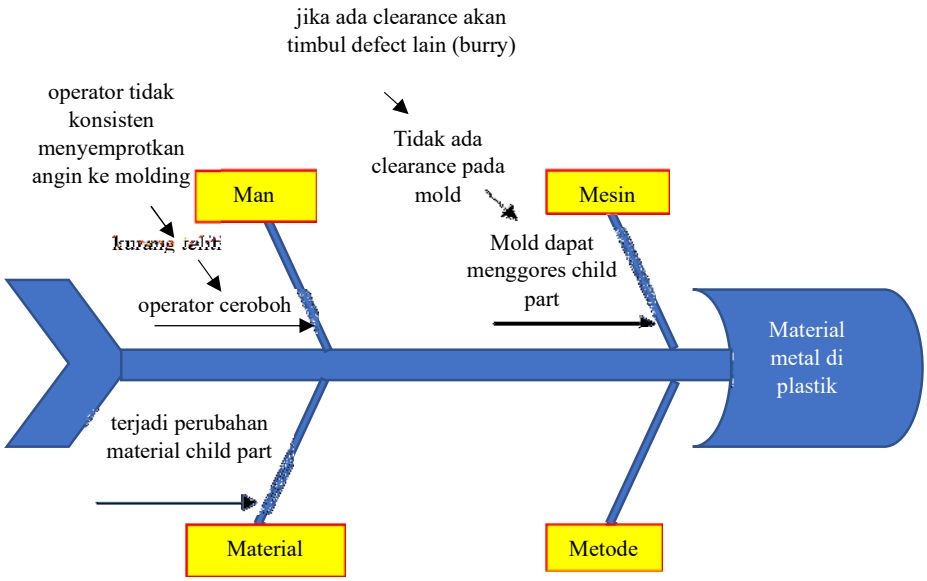

Figure 3. *Fishbone* Diagram of Defects

Fishbone diagram above there is reason main the occurrence of plasticized metal materials and will analyzed with 3 *whys* , namely as following :

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Table 5. *Why*

	Why 1	*Why 2*	*Why 3*
Machine	Mold can scratching the child part	exists friction between the child part and the mold.	No exists clearance in mold
Man	Operators don't squirt wind to molding	Operators don't follow applicable SOPs	Operators don't squirt wind to molding
Material	Material *child part* more soft compared to with molds	There is change in child part material	In accordance with *customer* requirements

2. Control chart analysis (*P – Chart*)

Table 6. Control P-Chart Data TH Lever Assy

No	Period	Amount Production	Amount Disabled	P (proportion disabled)	UCL	CL	LCL
1	1st Jan	17280	678	0.0392	0.0449	0.0404	0.0359
2	2nd Jan	17120	710	0.0415	0.0449	0.0404	0.0359
3	3rd Jan	17020	643	0.0378	0.0449	0.0404	0.0359
4	4th Jan	15124	545	0.0360	0.0452	0.0404	0.0356
5	1st Feb	16754	710	0.0424	0.0450	0.0404	0.0358
6	2nd Feb	17120	675	0.0394	0.0449	0.0404	0.0359
7	3rd Feb	17116	765	0.0447	0.0449	0.0404	0.0359
8	4th Feb	15100	725	0.0480	0.0452	0.0404	0.0356
9	1st March	17130	721	0.0421	0.0449	0.0404	0.0359
10	2nd March	17210	671	0.0390	0.0449	0.0404	0.0359
11	March 3rd	17220	677	0.0393	0.0449	0.0404	0.0359
12	March 4th	15130	536	0.0354	0.0452	0.0404	0.0356
13	1st Apr	17110	689	0.0403	0.0449	0.0404	0.0359
14	2nd Apr	17130	654	0.0382	0.0449	0.0404	0.0359
15	3rd Apr	17230	719	0.0417	0.0449	0.0404	0.0359
16	4th Apr	14970	617	0.0412	0.0452	0.0404	0.0356
Amount		265764	10735	0.0404			

Source : Data Processing Results

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a. Count Proportion Disabled

P = $\frac{X}{N}$

Where: P = Proportion error in every sample

x = Number product disabled in every sample

n = Number samples taken in inspection

January 1st = P = $\frac{x}{n}$ = $\frac{678}{17.820}$ = 0.0392

Feb 1st = P = $\frac{x}{n}$= $\frac{710}{16.754}$ = 0.0424

March to – 1 = P = $\frac{x}{n}$= $\frac{721}{17.130}$ = 0.0421

Apr to – 1 = P = $\frac{x}{n}$ = $\frac{689}{17.110}$ = 0.0403

b. Calculating the center line or *Center Line* (CL)

CL = $\bar{P}$ = $\frac{\text{Total banyaknya produk cacat dalam setiap sampel}}{\text{Total banyaknya sampel yang diambil dalam inspeksi}}$

= $\frac{10.735}{265.764}$ = 0.0404

c. Calculating the Upper Control Limit (UCL) or control limit on January 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 + 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.280}}$ = 0.0449

Feb 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 + 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{16.754}}$ = 0.0450

March 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 + 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.130}}$ = 0.0421

April 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 + 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.110}}$ = 0.0449

d. Calculating the Lower Control Limit (LCL) or control limit lower January 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 − 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.280}}$ = 0.0359

Feb 1st :

UCL = $\bar{P}$ + 3$\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0404 − 3$\sqrt{\frac{0{,}0404(1-0{,}0404)}{16.754}}$ = 0.0358

March 1st :

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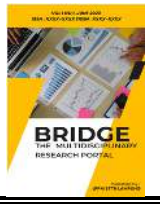

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.0404 - 3\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.130}} = 0.0359$$

April 1st :

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.0404 - 3\sqrt{\frac{0{,}0404(1-0{,}0404)}{17.110}} = 0.0359$$

From the results calculation Table 6 Data *Control P-Chart TH Lever Assy* above, then furthermore made map control P can seen in the picture following This :

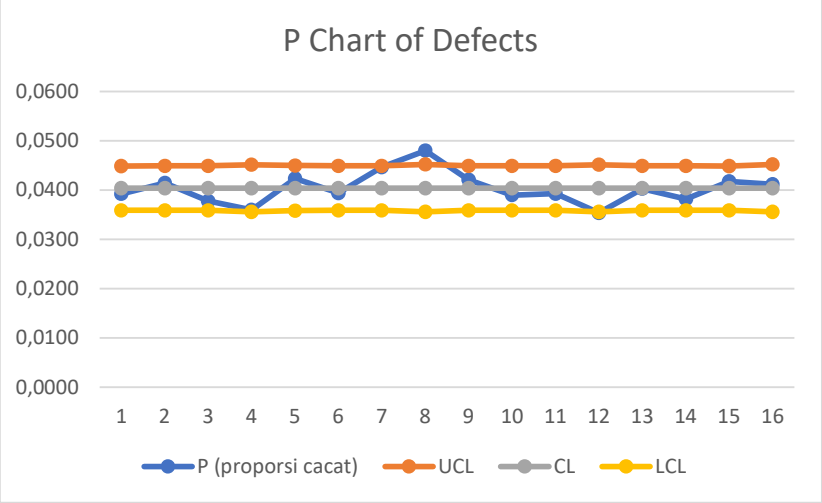

Figure 4. P *Chart of* Disabled

Based on Figure 4 P *Chart of* Disabled showing that process does is at in under control Because There is some measurement data is located beyond the limits of control. As for the extreme data that will be removed is data number 8 (1st February) 2023.

3. Stage Revision
   a. Revision *Defects Per Million Opportunities*

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Table 7. Revised DPMO Data and Sigma TH Lever Assy Values

No	Period	n	Np	P	Lots CTQ	Level Opportunities Disabled	DPMO	Mark Sigma
1	1st Jan	17280	225	0.013021	6	0.002170	2170.1	4.36
2	2nd Jan	17120	258	0.015070	6	0.002512	2511.7	4.31
3	3rd Jan	17020	227	0.013337	6	0.002223	2222.9	4.35
4	4th Jan	15124	245	0.016199	6	0.002700	2699.9	4.29
5	1st Feb	16754	244	0.014564	6	0.002427	2427.3	4.32
6	2nd Feb	17120	234	0.013668	6	0.002278	2278.0	4.34
7	3rd Feb	17116	290	0.016943	6	0.002824	2823.9	4.27
8	4th Feb	15100	247	0.016358	6	0.002726	2726.3	4.28
9	1st March	17130	249	0.014536	6	0.002423	2422.7	4.32
10	2nd March	17210	262	0.015224	6	0.002537	2537.3	4.31
11	March 3rd	17220	259	0.015041	6	0.002507	2506.8	4.31
12	1st Apr	17110	221	0.012916	6	0.002153	2152.7	4.36
13	2nd Apr	17130	225	0.013135	6	0.002189	2189.1	4.35
14	3rd Apr	17230	249	0.014452	6	0.002409	2408.6	4.32
15	4th Apr	14970	183	0.012224	6	0.002037	2037.4	4.38
Amount		250,634	3618	0.216688	6	0.002396	2396.0	4.33

Source of Data Processing Results

After done revision with remove table in months March Sunday to 4, then obtained DPMO value is 2396.0 and occurs enhancement The sigma value which was originally 4.32 became 4.33

Count DPMO value :

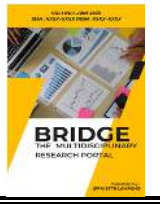
DPMO = (D / (U x O)) x 1,000,000

Information :

D = Amount *Defect*

U = Number of Units

O = Amount the opportunity will be result disability (Opportunity)



DPMO = (D / (U x O)) x 1,000,000
= (3,618/ (250,664 x 6)) x 1,000,000
= 0.002396 x 1,000,000
= 2396.0

Sigma value = 4.33

b. Stage Revision 1 map P control

Table 8. Data Revision 1

No	Period	Amount Production	Amount Disabled	P (proportion disabled)	UCL	CL	LCL
1	1st Jan	17280	678	0.0392	0.0444	0.0399	0.0355
2	2nd Jan	17120	710	0.0415	0.0444	0.0399	0.0354
3	3rd Jan	17020	643	0.0378	0.0444	0.0399	0.0354
4	4th Jan	15124	545	0.0360	0.0447	0.0399	0.0352
5	1st Feb	16754	710	0.0424	0.0445	0.0399	0.0354
6	2nd Feb	17120	675	0.0394	0.0444	0.0399	0.0354
7	3rd Feb	17116	765	0.0447	0.0444	0.0399	0.0354
8	1st March	17130	721	0.0421	0.0444	0.0399	0.0354
9	2nd March	17210	671	0.0390	0.0444	0.0399	0.0355
10	March 3rd	17220	677	0.0393	0.0444	0.0399	0.0355
11	March 4th	15130	536	0.0354	0.0447	0.0399	0.0352
12	1st Apr	17110	689	0.0403	0.0444	0.0399	0.0354
13	2nd Apr	17130	654	0.0382	0.0444	0.0399	0.0354
14	3rd Apr	17230	719	0.0417	0.0444	0.0399	0.0355
15	4th Apr	14970	617	0.0412	0.0447	0.0399	0.0351
Amount		250664	10010	0.0399			

Source : Data Processing Results

c. Count Proportion Disabled

$P = \frac{X}{n}$

Where: P = Proportion error in every sample

x = Number product disabled in every sample

n = Number samples taken in inspection

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January 1st = P = $\frac{x}{n} = \frac{678}{17.280}$ = 0.0392

Feb 2nd = P = $\frac{x}{n} = \frac{675}{17.120}$ = 0.0394

March to – 1 = P = $\frac{x}{n} = \frac{721}{17.130}$ = 0.0421

Apr – 2nd = P = $\frac{x}{n} = \frac{654}{17130}$ = 0.0382

d. Calculating the center line or *Center Line* (CL)

CL = $\bar{P} = \frac{\text{Total banyaknya produk cacat dalam setiap sampel}}{\text{Total banyaknya sampel yang diambil dalam inspeksi}}$

$= \frac{10.010}{250.664}$ = 0.0399

e. Calculating the Upper Control Limit (UCL) or control limit on January 1st :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 + $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.280}}$ = 0.0444

February 2nd :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 + $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.120}}$ = 0.0444

March 1st :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 + $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.130}}$ = 0.0444

April 2nd :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 + $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.130}}$ = 0.0444

f. Calculating the Lower Control Limit (LCL) or control limit lower January 1st :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 − $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.280}}$ = 0.0355

February 2nd :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 − $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.120}}$ = 0.0354

March 1st :

UCL = $\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$ = 0.0399 − $3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.130}}$ = 0.0354

April 2nd :

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$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.0399 - 3\sqrt{\frac{0{,}0399(1-0{,}0399)}{17.130}} = 0.0354$$

After eliminate the measurement data that causes it No control of the process, again done repair values proportion into the map *control chart* . As for the results can shown in figure 4

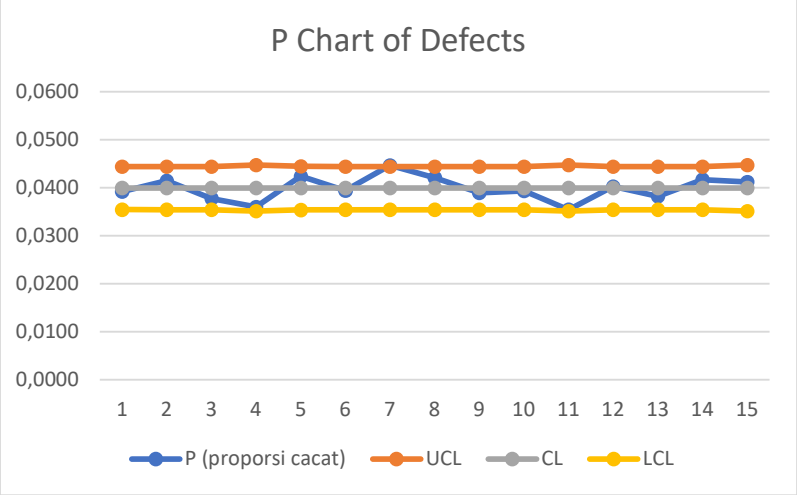


Figure 5. Graph Revision 1 Control Chart P

Based on map *The Control Chart* in Figure 5 shows that the process is complete in circumstances stable Because all processes are in place within control limits .

4. Use *Failure Mode and Effect Analysis* (FMEA)

In FMEA there are columns characteristics *mode of failure, cause of failure, effect of failure, frequency of occurrence, degree of severity, chance of detection* the resulting values in column range between 1-10 is appropriate tables and figures this is multiplied so that obtained Risk Priority Number (RPN) and will become scale priority problem that must be resolved moreover formerly .

Table 9. Failure Mode and Effect Analysis (FMEA) TH Lever Assy Defects

Failure Mode	Failure Cause	Effect	Cause	SEV (S)	OCC (O)	DET (D)	RPN (SxOxD)	Rank
Metal Material in Plastic	Mold scratches child part	Reject	No there is clearanc	5	5	8	200	2

			e in the mold					
	The remaining grams are left in the molding	Reject	Operators don't squirt wind to the mold	7	7	8	392	1
	More child part material soft compared to molds	Reject	There is change in child part material	2	5	8	80	3

Improve

Stages This is stages For perfect existing process performance moment this, with do repair continuously (*continuous improvement*). At stage This done with 5W1H and *Action Planning* methods.

1. Making Table 5W1H

Table 10. 5W1H

Root causes	*What?*	*Where?*	*Why?*	*Who?*	*When?*	*How?*
Mold scratches child part	Child part is chipped ,	In the child section	Mold no There is clearence	Molding	Every mold is used	Do *improve* in molding
Remaining grams / metal flakes are left behind in the modling	Child part is peeling off so that arise grammar	In the molding section	Operators don't consistent spray remaining grams	Operator section production	During the production process	Make attention sheet and re-operator training

Root causes	*What?*	*Where?*	*Why?*	*Who?*	*When?*	*How?*
More child part material soft compared to mold	Child parts are easy peeled off	In the child section	There is change in child part material	Child part	Every child part is used	Do reviewer towards child parts

2. Making Table *Action Planning* Based on *Risk Priority Number* (RPN)

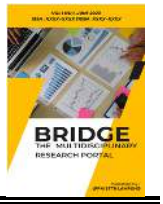
Determination solution problem with table *action planning for failure mode* based on order priority , determination solution problems found in Failure Mode *Effect Analyze.*

Table 11. Risk Priority Number (RPN)

RPN	Failure Mode	Actionable Cause	Design Action Potential Solution	Design Validation
392	The remaining grams are left behind in molding	Operators don't consistent squirt wind to molding	Give briefing to the operator	Make attention sheet and operator training
200	Mold scratches child part	Place Rough child part seat	Repair place child part holder	Check in a way periodically the child part holder
80	More child part material soft compared to molding	There is change the child part accordingly with customer requirements	Do review towards child parts	do reporting towards customers

Controls

At stage This researcher try provide top suggestions control and supervision of the results process where is the implementation and improvement stage ? on solution problem applied will be controlled . At stage This *six sigma* tools used can form *Control Chart* , so can be known how much big amount disabled TH Lever Assy products after solution problem applied . *Control Chart* consists from the lower limit target and the upper



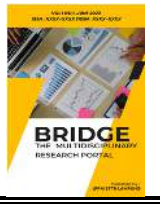
limit target . If there are mark is at beyond control limits so must taken action corrective, so expected performance become more good and not decrease return.

At stage This can also be applied *poka yoke* Where existing conditions created For prevent or avoid happen accident , p This can made with given signs warning , slogans, alarm if happen something wrong or at the moment machine will operate , slogans about safety Work.

CONCLUSION

Based on research that has been carried out at PT. IMC Tekno Indonesia and after the data obtained collected and done processed in discussion, then can obtained appropriate conclusion with desired goal achieved, as following :

1. Start application *six sigma* with DMAIC method of control quality company , then from every stage that has been done can withdrawn various conclusion . At stage *define* obtained conclusion that problems that must be resolved is reduce happen Metal material defects in *plastic* with percentage amounting to 36.3%. At stage *measure* obtained conclusion that sigma value before repair For Defects Metal material in *plastic* 4.32 with mark *defects per million opportunities* DPMO 2,445. At stage *analyze* obtained some flawed data that must be done revision or repair repeat because of this data outside the control limits , namely monthly data March 4th 2023. After done revision delete that data so sigma value increases to 4.33 with DPMO value 2,396.
2. Through research that has been done, can given proposal improvements to the production process based on discussions quality with the six sigma method has been done. Proposal improvements suggested by the author For Metal material defects in plastic, including :
    a. Carry out retraining to operators to ensure consistency squirt wind into the mold before the injection process.
    b. Selection of child part / metal part material must be in accordance with standard, so that during the injection process there is no peeled off
    c. For Making a new mold / renewing the TH Lever Assy mold must be designed in *a mold* so that it doesn't scratching the child part.



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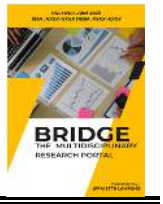

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