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Product Quality Control Using Six Sigma Methods and Seven Tools in the PDL Shoes Industry

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ABSTRACT.

CV Yunanda is one of the companies whose manufacturing process is in the form of shoes and sandals, CV Yunanda has one of PDL's main products in the field of leather footwear. The problem with this company is a production defect. Based on these problems, the purpose of this study is to determine the extent of the defects, determine the underlying causes of defective products, and make recommendations for improvement to reduce the number of defective products. This study uses seven tools and six sigma methods to identify the key factors that cause defective products and identify corrective actions to be taken based on the underlying factors. The results showed that there were 4 types of product defects, namely 13% overlapping skin defects and 11% flexed skin, 10% wrinkled skin, 7% scratched skin. The proposed solution is to control, inspect and perform maintenance on machines or equipment used in the production process, establish SOPs for each machine area, improve human resources through training and improvement of the work environment.

Keywords Defect , Quality, Six Sigma, Seven Tools, Shoes.

INTRODUCTION

Competition that occurs brings every actor industry to increase value the quality of the product that produced In addition company must make products that match with consumer desires so that can increase competition between industries manufacturing i other . Age is getting progressing and continues to grow every year as well as a company must be able to grow and can face tough competition . Every company must able to highlight the quality of products and can compete with competition which tight [1]. Consumer always hope with product that received quality which corresponds with what want and expected. Competition which is strictly this is which later will differentiate product one with other, is seen from aspect of quality product itself [2] . The number of products which equals and variance price and

packaging product that is that will attract consumer. Therefore company must anticipate competition market by favoring quality product which is guaranteed and according to i expectations consumers because quality is key company in get trust consumer [3] .

CV.Yunanda is a company that is engaged inindustry manufacturing which produces leather shoes and sandals which is located CV. Yunanda implementation of production which use system make to order with activities produce as many goods as 2000-8000 pairs of shoes on every month.In order for achieve target of the company ,most important part of CV. Yunanda is Production department Department of production is a part which charge of for manage course process production. Quality product which contained in CV. Yunanda it is known that there is variety type defect which less good so that affects quality in company as target company defect produced by production includes among others, is item has damage to product shoe leather such as product scratched, overlap, product bent and shoe product wrinkled [4] Product defects contained in the production department required efforts to improve product quality in order to meet product quality in the hands of consumers to consumer satisfaction and in order to fulfill existing production targets [5] .

In activity production required determination of strategy in order reduce level defects product produced [6] , there are several that cause defects from kinds of as terms of cost, method and machine [7] . In order to the of product defects it is necessary to have analysis regarding deviation that occurs in process production and search for cause defect product that [8] . In addition to that, is also needed strategy improvement as efforts to minimize defects product so that defects product not repeat be well received by consumers [9]To improve quality control production which is currently running research conducted by using method Six sigma Seven tools [10] The reason from selection method is as improvement which measure value quality performance with having continuous improvement which is able to reduce pass defect on product and able to improve quality of

production [11] Method implementation Six sigma in the identification step to the formulation of the problem i and solving existing problems i using the "DMAIC" approach (Define , measure , analyze, Improve , Control) (Gazperz, 2002).

The use of the seven . method tools , functions as statistical process control that has the advantage of being able to know the analysis of deviations that occur during production activities and can analyze the level of quality of products that have been completed and are ready to be marketed into the hands of consumers or product finish good [12] . Product quality measurement using Seven tools and Six sigma methods it is expected that has results which can become means improvement quality and able to reduce product defects especially in process production because process production which pay attention to quality will yields product which is free from damage [13] . The result of repair has various forms such as reduces occurrence of defect product before will be processed so can sort material which is good quality and does not have abnormal , so that firm able to provide quality

which conforms to with standard and has advantage for compete , has value which more than manufacturer other shoes and has confidence is more than p ara customers and able to avoid from wasting so that costs production unit afford pressed and price product can become competitive .

METHOD

Output results production total whole product PDL shoes on CV Yunanda from September 2021 to December 2021 with a maximum standard of defect on CV Yunanda of 3% so that you can see the defect status of the product that is lacking or inappropriate for the quality that has been standardized according to company regulations. Therefore, it is necessary to increase the optimization of the results of the work carried out in order to minimize the defect value of DPL's shoe products .

No	Month	Target Global	results /day	Note.
1	September	5000	192	Not Achieved
2	October	7000	196	Not Achieved
3	November	4000	201	Not achieved
4	December	5000	226	Not achieved

Table 1. Monthly Outcome Product Achievement

Significantly the assessment of the achievement indicators of shoe products described in table 2. is as follows:

Month	Order	Week	Reject
September	5000 Install	1	39 install
		2	55 install
		3	47 install
		4	51 install
October	7000 Install	1	49 install
		2	44 install
		3	59 install
		4	44 install
November	4000 Install	1	43 install
		2	39 install
		3	61 install
		4	58 install

December	5000 Install	1	41 install
		2	64 install
		3	59 install
		4	62 install

Table 2. Description of Shoe Performance Indicators

RESULTS

Six Sigma Method
A. Define stage

In analyzing the six sigma method, an initial stage is needed to define the value of product defects, so the first step is to collect analytical data related to the percentage of defects product as in the table. 3 as follows:

Period d e / Sunday	Amount Product	Amount Product Disabled				Total Disabled	Percentage
		Skin Overlap	Skin flexed	Skin Wrinkled	Skin Scratched		
September							
I	1450	10	9	12	8	39	2.69%
II	1285	11	18	22	4	55	4.28%
III	1380	18	7	13	9	47	3.40 %
IV	885	13	17	15	6	51	5.76%
TOTAL	5000	52	51	62	27	192	3.84%
October							
I	1830	13	14	10	12	49	2.68%
II	1745	16	15	8	5	44	2.52%
III	1695	28	13	11	7	59	3.48%
IV	1730	15	12	9	8	44	2.54%
TOTAL	7000	72	54	38	32	196	2.80%
November							
I	1254	18	14	17	12	61	4.86%
II	484	5	15	8	5	33	6.81%
III	9 01	28	13	11	7	59	6.54%
IV	1361	15	12	13	8	48	3.52%
TOTAL	4000	66	54	49	32	201	5.03%
December							
I	1 349	16	14	16	12	58	4.30%
II	677	16	18	13 15		2	9.15 %
III	1 558	16	13	11	7	47	3.01%
IV	14 16	21	12	15	11	59	4.16%
TOTAL	5000	69	57	55	45	226	4.52%

Table 3. Percentage of PDL Shoe Defects for September – December 2021

In Table.3 the most dangerous level of defects occurs in November as big as 5.03% as well as level product lowest occurred in month October by 2.80%. height product of 5.03% should be overcome and minimized, as evidenced by the level of product disabled Lowest as big as 2.80% with this thing i company in implementation should capablecarry out the process production with defect level 2.80%.

During production activities, CV Greece implement the minimum level of existing defects with set policy limit maximum standard damage amount 3%.

The results of the analysis related to table.3 regarding

reason product disabled among others :

a. Material on warehouse no arranged neatly.
b. Not existence process Inspection on pile material which not enough noticed before production activities as well as the handling process on sewing machines that are lacking thorough.
c. Determination of measurement activities that are not adapted to the pattern on process cutting often occur mismatch with measurement whichcaused on shoe pattern.
d. Error installation on accessories on shoe type in division Assembling .
e. In the sewing process, it occurs in the upper part (finished goods) because of an error which occurs in process weebing and inner.
f. Strouble machines are often constrained causing problems on when merging on upper activities and inner .

Inspection on the level of product quality is carried out by classifying between defective products and OK products , so it is hoped that product defects can reach consumers . Examiner product good and disabled conducted with withdrawal the number of samples , as well as the placement of the actual limit of each product in the quality assessment .

B. Stage Measure

Activity This measure is carried out to determine the DPMO score and sigma value which is useful for measuring and determining the value of sigma capabilities in the company. Assessment is carried out according to output result defects in units of Defects Per Million Opportunity (DPMO). The duration of data collection activities for level level inspection defects calculation started from step first define control chart (P - Chart). Calculations directly performed could viewed on one period first the following :

1. Defect Proportion $= \dfrac{\text{Jumlah defect}}{\text{jumlah total pesanan}}$

$= \dfrac{39}{1450}$

$= 0.027$

2. CL/ Average $= \dfrac{\text{Total Defect}}{\text{Jumlah Total Pesanan}}$

Defect $= \dfrac{815}{21000} = 0,039$

3. UCL $= p + 3\sqrt{\dfrac{p(1+n)}{n}}$

$= 0.039 + 3\sqrt{\dfrac{0,039\,(1+0,039)}{21000/16}}$

$= 0.039 + 3\sqrt{\dfrac{0,039\,(1,039)}{1312,5}}$

$= 0.039 + 3\sqrt{\dfrac{0,040521}{1312,5}}$

$= 0.039 + 3\sqrt{0,00003087}$

$= 0.039 + 3 \cdot 0.005556077753$

$= 0.039 + 0.01668233259$

$= 0.5566$

The next step is to determine the Critical to Quality that has been determined with 3 assessments of customer needs, delivery quality and service quality assessment and continue to calculate Defect Per Opportunity (DPO), Defect Per Million Opportunity (DPMO), yield (%), and sigma capabilities are as follows.

4. DPO $= \dfrac{\text{Total defect} \div \text{Total Produksi}}{\text{Critical To Quality (CTQ)}}$

$= \dfrac{39 \div 1450}{3}$

$= 0.008966$

5. DPMO $= \text{DPO} \times 1.000.000$

$= 0.008966 \times 1.000.000$

$= 8966$

6. Yield (%) $= 100 - \dfrac{39 \times 100}{1450 \times 3}$

$= 100 - \dfrac{3900}{4350}$

$= 100 - 0.897$

$= 99.103$

7. Sigma $= \text{NORMSINV}\ (1-\ \text{DPMO}/1{,}000{,}000) +\ 1.5$

$= \text{NORMSINV}\ (1-8966/1{,}000{,}000) +\ 1.5$

$= \text{NORMSINV}(0.008965) + 1.5$

$= 3.87$

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Table 4. Sigma . Capability Output Values

No	Production quantity	Number of defective products	Proportion	CL	UCL	DPO	DPMO	Percentage Yield	Sigma
September I	1450	39	0.027	0.039	0.055	0.0090	8966	99.10	3.87
September II	1285	55	0.043	0.039	0.055	0.0143	14267	98.57	3.69
September III	1380	47	0.034	0.039	0.055	0.0114	11353	98.86	3.78
September IV	885	51	0.058	0.039	0.055	0.0192	1909	98.08	3.57
October I	1830	49	0.027	0.039	0.055	0.0089	8925	99.11	3.87
October II	1745	44	0.025	0.039	0.055	0.0084	8405	99.16	3.89
October III	1695	59	0.035	0.039	0.055	0.0116	11603	98.84	3.77
October IV	1730	44	0.025	0.039	0.055	0.0085	8478	99.15	3.89
November I	1254	61	0.048	0.039	0.055	0.0162	16215	98.38	3.64
November II	484	33	0.068	0.039	0.055	0.0227	22727	97.73	3.50
November III	901	59	0.065	0.039	0.055	0.0218	21828	97.82	3.52
November IV	1361	48	0.035	0.039	0.055	0.0118	11756	98.82	3.77
December I	1349	58	0.043	0.039	0.055	0.0143	14332	98.57	3.69
December II	677	62	0.091	0.039	0.055	0.0305	30527	96.95	3.37
December III	1558	47	0.030	0.039	0.055	0.0101	10056	98.99	3.82
December IV	1416	59	0.041	0.039	0.055	0.0139	13889	98.61	3.70
Amount	21000	815	Average	0.039	0.055	0.0150	14533	98.55	3.71

Based on results from processing data above value from I (DPMO) of 8966 where can be interpreted that every one million orders package goods have defect of 8966 defect product. For each values i of capability sigma company average value is 3,87 sigma where can means that company is needed there is increase quality _ in process produce and product is produced .

C. Analyze Stage

Advanced stages in improvement quality deep step control level defect product is looking for cause For can find out the cause occurrence of the defect porosity, carried out analysis cause effect using 5 factor :

1. F Human actor

Saturated, is factor which is caused by work which is repeated Fatigue and lack concentration, actually factor this is caused by factor work physical which is caused by because there is factor pressure in work so in does work worker will quickly feel tired and as a result of this fatigue also will cause every worker to become less concentrated in doing work. Less skilled, workers only know about ways that can operate tools only, but they are not given training about ways maintenance tools Less skilled,worker only know about how operate tools only, but them not given training about way maintenance tools the tool.

2. Raw Material Factor (Material)

Raw material is not good, because in selection raw material skin or in sorting raw material less done with good, and also in hadling less right.

3. Method Factor

The method that used is not accurate, only performs inspection at the end of process production by separating product both and defective without there is repair directly

4. Environmental factor

The air temperature high, due to lack of roof cover sun rays at every station factory

5. Engine Factor

The press machine for combining the upper and the inner does not operate optimally because the machine is old and wears out.

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After causes to occur defects i are found in i process operation manufacture shoes type PDL, then stage next is determine cause is dominant from the five main factors As for the step that did , namely with analysis of cause effect on workforce involved in process production of shoes type PDL

D. Improve stage

This stage is the stage in making plan for improvement. Plan repair. will do through implementation of kaizen with matrix 5W+ 1H. This plan will compiled according to with questions which is in matrix with giving answers, that makes it easier for factory in carry out and to carry improvement quality and can help minimize defects to product shoes type PDL.

Table6. Repair Plan Matrix (5W + 1H)

No.	Dominant Cause	Who	What	Where	when	Why	How
1.	Inspection no regular	Man	Conduct regular inspections of the production division	The process of processing raw materials until the finished goods are good	When the activity operation takes place	For minimize product disabled	- Mapping of quantities, and production activities and rescheduling - Direct inspection of activities that are considered prone to defects)
2 .	Sew not enough neat	Man	Out collar stitch broken-down	Departme ntsewing	When sewing Upper	The sewing process is too sideways	
3 . Upper disabled	Upper Material disabled DepartmentAssembling				When operator holdneedle noton purpose about Product	Operator not careful and stuck needle	-Improve accuracy skills for employees - The use of needles should be more observant for employees

E. Stage Control

final stage of approach DMAIC is control. This stage has not been carried out or is implemented in an scope of company, so that is given in this stage to party company is advice to always review projects repair which am currently doing In this stage need there is an record or history repair data so can do an comparison whether process can is better than with process repair before. Some of the tools that can use to do do this these are check sheet, performance

baseline,quality report, map control,and documentation

Seven Tools Method

1 . Check sheet

Check sheet in this research is used to classify type defects and number defects . Check Sheet in the form of sheet which designed simple contains list things need for purpose recording data so that users can collect data easily .

No	Month	Total Products	Total Defect	Percentage
1	September	5000	192	3.84%
2	October	7000	196	2.80%
3	November	4000	201	5.03%
4	December	5000	226	4.52%
	Total	21000	815	16.19%

1. Pareto chart

The pareto diagram one of the tools quality assurance used to find out sequence problem biggest based frequency which got from sheet Basically diagram _ Pareto is bar graph where shows problems based on sequence number number of events

Here is data which shows total product defect and percentage cumulative product defect in product shoes PDL brand at CV Yunanda .

No	Defect Type	Total (PCS)	Percentage	Cumulative Percentage	Priority
1	Overlap Skin	259	31.78%	31.78%	1
2	Bent Skin	216	26.5%	58.28%	2
3	Wrinkled Skin	204	25.03%	83.31%	3
4	Scratched Skin	136	16.69%	100%	4
	Total	815	100%		

Table 8. Number of Defects in DPL Brand Shoe Products

Assessment of problems in the Pareto diagram can be seen from the level of product defects , the greater the percentage value of product defects , it can be ascertained that the larger the problems that must be solved, therefore a priority scale is needed from value 1 to so on which can be seen in overlapping skin defects as priority. first with a percentage value of 31.78%, followed by flexed skin defects with a percentage value of 26.5%, wrinkled skin as the third priority with a percentage value of 25.03%, and scratched skin as the lowest priority with a percentage value of 16.69%.
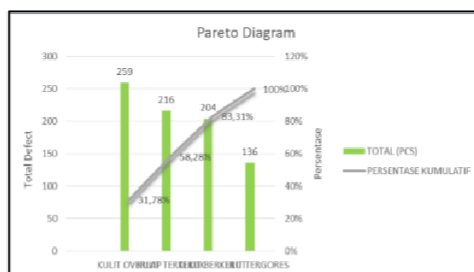
Figure 1. Pareto Diagram

3. Histogram

Histogram is a tool like a bar chart that aims to show the frequency distribution of defective products. The following is the amount of data obtained from the types of overlapping defects, flexed skin, wrinkled skin and scratched skin. In the results of the research that is implemented into the histogram , it can be seen that the overlapping skin has the highest distribution frequency value which indicates that the overlap defect is the highest type of defect at the defect level among other types of defects as shown in Figure 2.
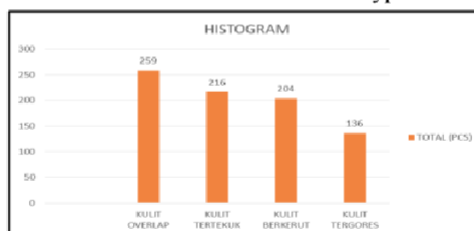

Figure 2. Histogram

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4. Fishbone Diagram

The effect diagram or fishbone diagram is part of seven tools which uses to analyze causes of problem main that occur. Problems - existing problems then analyzed further for obtained suggestions improvements _ to the cause of a problem or condition and is commonly referred to as a cause-and-effect diagram.
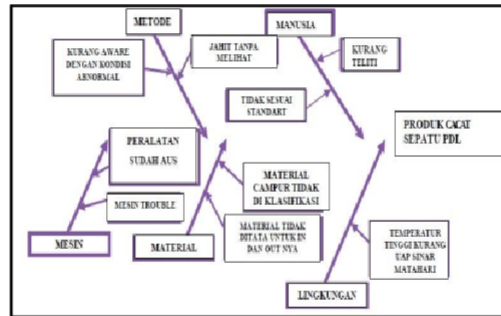

Figure 3. Fishbone Diagram

5. Control Chart

By knowing the condition of the production process from the amount of product deviation data, it can be calculated the proportion of PDL shoe product defects . This control chart is also used for to find out whether is defective product producedis stillwithin the required limit If passesm of limit then need to do repair .
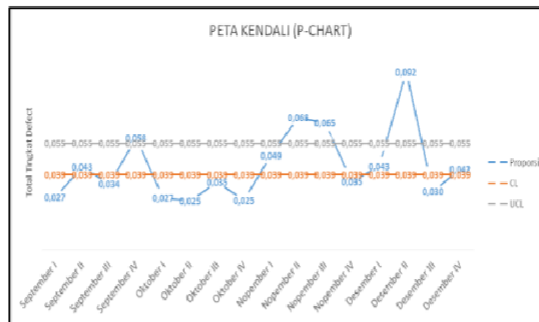
Figure 4. P-Chart

Based on Figure 4. there is no proportion that exceeds the limit, so there is no need for improvement .

6. Scatter Diagrams

Scatter Diagram in this research is used to determine correlation between variables . Variable on axis X shows the number of defects in period September to with December 2021 and variable on axis Y total production as which shows on figure 5. Below:
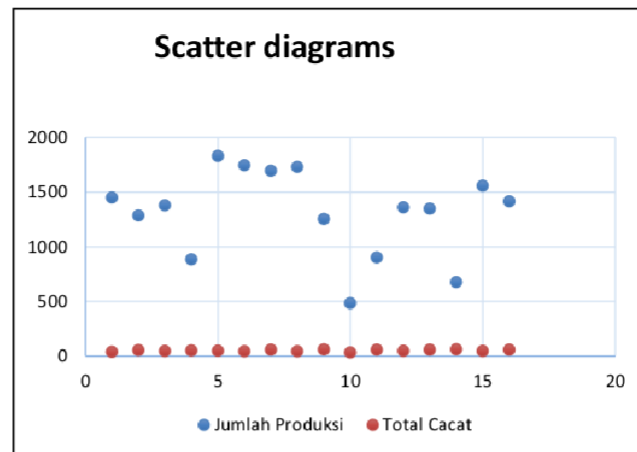
Figure 5. Scatter Diagram

7. Stratification

The data grouping or stratification was carried out based on the types of overlapping skin defects, flexed leather, wrinkled skin and scratched skin on DPL brand shoes at CV. YUNANDA.

No	Defect Type	Total (Pcs)
1.	Overlap Skin	259
2.	Bent Skin	216
3.	Wrinkled Skin	204
4.	Scratched Skin	136
	Total	815

Table 9. Stratification

In the results of the analysis, it is necessary to analyze the proposed improvements which are expected to be able to provide alternative solutions in solving the problems being faced.

No.	Factor	Reason Problem	Analysis Problem
1.	Man	-Owner not enough monitor performanceemployee Fatigue which causeemployee lack of concentration -Not enough skilled -does not carry out Worker Operational Standards	- Do inspection / inspection control produced -Break a moment - providing cheek sheets to facilitate employee performance - Implementation training for employee -Doing employee supervision
2.	Machine	-The tool does not operate properly maximum because machine long and old	- Rejuvenated or _ if permanent experience troublechange engine new - Performing preventive maintenance on machines - Periodic machine checks
3.	Method	-Checking only very so that abnormality still escape	- Double implementation check -Adding tools and implementing new ideas

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| 4. | Material | -Skin is ingredient raw production shoe PDL which not enough handling his and not enough neat Storage in warehouse | -Necessity 5R (Concise Neatdress Care Diligent) |
| 5. | Environment | -Temperature factory the height cause employee feel hot and tired quickly so want To do profession by in a hurry | -More blower machines on production |

Table 10. Proposed Improvements

CONCLUSION

Based on the research that has been done, the following conclusions are obtained:

1. Defects Defects that occur during process production shoes PDL amounted to 815 pcs from total production amounted 21000 pcs result value with percentage defects product 4.0475%, where there are 4 types of defects, namely overlap defects of 259 pcs, skin defects bent by 216 pcs, wrinkled skin defects 204 pcs and scratched skin defects by 136 pcs.

2. Obstacles which faced for CV. Yunanda from the human factor, namely operator working not according to standard, less skilled and not running SOP (Worker rationale standard).

3. For minimize type disabled product on PDL Shoes especially on defects which keeps happening over and over again and in the same area, it is necessary to have a checker or double check in order not to do escape defects again.

4. Proposed improvements obtained from this research are use of checksheet cycle work, i perform supervision to employees, implement to preventive maintenance machine which. I hope that can improve the performance of I on the maintenance of the engine, I add the blower.

Suggestion

As for the suggestions i that i got i given i from this research are :

1. It is necessary to carry out supervision routinely on process production for to give directions i and input to operator if work does not according to SOP.
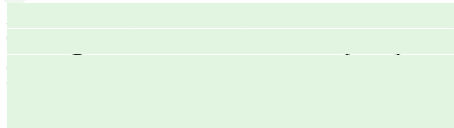
2. This research examines level defect and factor causes defect in process production shoes, is expected results of this research can be applied to job at time next.

3. For the next research, which will discuss is defect which is dominant, only that is more detailed.

4. The proposed improvement which was given from the results of this research later can be applied in the next research to find out whether the recommendation improvement given has a good impact on companies.

5. Next research can apply plan control that has made and compare state company time before and after made repair. So that when research conducted, was more effective, for was used in in the long term in the future.

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