Carton Sheet Quality Control In Pt. Xyz Using Six Sigma Approach Method With Dmaic Tools

CARTON SHEET QUALITY CONTROL IN PT. XYZ USING SIX SIGMA APPROACH METHOD WITH DMAIC TOOLS

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Abstract. Every industry ensures the existing system in the company runs well and continues to strive so that the products produced are able to meet customer satisfaction. PT. XYZ is a manufacturing company in Purwakarta which is engaged in cardboard boxes. This research was conducted by applying the six sigma method as a quality control product in PT. XYZ in order to reduce disability with DMAIC tools. By controlling the quality of the product that is controlling from the beginning to the distribution of products to consumers. It is known that the average value of waste at PT. XYZ reaches 5.36% which means it needs improvement. In the DPMO calculation it is proven that the company's sigma value is 3.6 where if you want to raise it to 4 sigma there is a GAP of 0.4 with the largest type of crepe defect. After knowing the average waste and the existing sigma value, a standard improvement was made for the approval of the implementation for the company.
Keywords: Quality, Six Sigma, DMAIC

1.Preliminary

Every industry ensures the existing system in the company runs well and continues to strive so that the products produced are able to meet customer satisfaction. This encourages companies to further improve the quality of products produced in accordance with predetermined standards and specifications. The industrial world continues to head towards effectiveness and efficiency. Companies are required to be able to produce quickly, but still with a good quality and affordable prices. In addition to meeting these demands, effectiveness and efficiency will greatly affect the profits to be received by the company. Production quality is the most important part for manufacturing companies. tatistical quality control with the Six Sigma method is often applied by companies in controlling product quality. Quality control is a control system that goes from an early stage of a process to a finished product, even to the distribution of product to customer. Six Sigma is a firm and sustainable approach of reducing variation from all critical processes to obtain sustainable breakthroughs that benefit the upper and lower ranks of companies and organizations and increase customer satisfaction.[1] "*Quality is conformance to requirements or specification*" which means that quality is a suitability (the criteria of desire requested) to meet the requirements or specifications given.[2] In the case of the manufacturing industry this shows that product quality is an important requirement or specification in meeting customer needs and desires.

Quality Control is the activity of maintaining and improving products and services offered to the company, Quality Control is not only the responsibility of the Quality Control section, but all employees or parties become a unity to solve problems.[3] In this sense it means that product quality is a shared responsibility in maintaining and improving its quality.

Corrugated Carton Box is a packaging made from paper with the highest recycled material content among other types of packaging. About 75% of cardboard boxes produced worldwide use raw materials with a recycled content of between 70-100%. Recession economic in Europe and in the United State is causing societies to plummet on both continents so that the circulation of economic products using carton boxes is also reduced quantitatively. This resulted in a significant reduction in recycled raw materials for producing paperboard.

Corrugated Carton Box or better known as cardboard in the middle of the community is really needed. One of its main functions is certainly to pack or package goods / materials before being shipped or marketed. In addition, boxes like this can be used to store some used goods that are not used anymore. You can also use it when you want to pack goods before moving to a new home.

The raw material for making Corrugated Carton Boxes is paper roll. There are 3 types of carton boxes, namely singlewall, doublewall and triplewall which distinguishes these three types is the number of flutes and layers of paper. Each carton box that is loaded is based on customer orders, then the substance used is also not the same. The raw material for making Corrugated Carton Boxes is roll paper, which can be broadly grouped into 3 types namely: Kraft Liner paper (brown kraft), Medium paper (fluting medium), White Kraft paper (white top). In the beginning there were only 3 types of paper for the KKG manufacturing as mentioned above, but in its development to meet the demands of customers from different segments, new variants were made with lower grades. So there is a Kraft Economic Grade in the market or commonly called B Kraft.

PT. XYZ manufactures packaging from cartons, consisting of carton sheets, carton sheets of various sizes. Based on available data, there are 3 types of product defects that occur in January to June on the corrugator carton sheet. The following are some of the factors that affect defects in carton sheet products, namely crepe, tear / dents, and dirty. Based on the calculation of disability from January to June there is still an average disability of up to 5.361%. With the average disability is still relatively large, then it is good to do an analysis to find out the biggest cause and make improvements on a regular and periodic basis.

In making improvements, certainly one of the influences is the consumer. The consumer is the process that a person goes through in finding, buying, using, evaluating, and acting after consumption of products, services and ideas that are expected to meet their needs.[4]

Meanwhile, each consumer has their own behavior to get and fulfill their satisfaction. Consumer behavior is an action that will be directly involved in getting, consuming, and will also spend products and services, which include the decision process that precedes and will takeover this action.[5]

2. Research methods

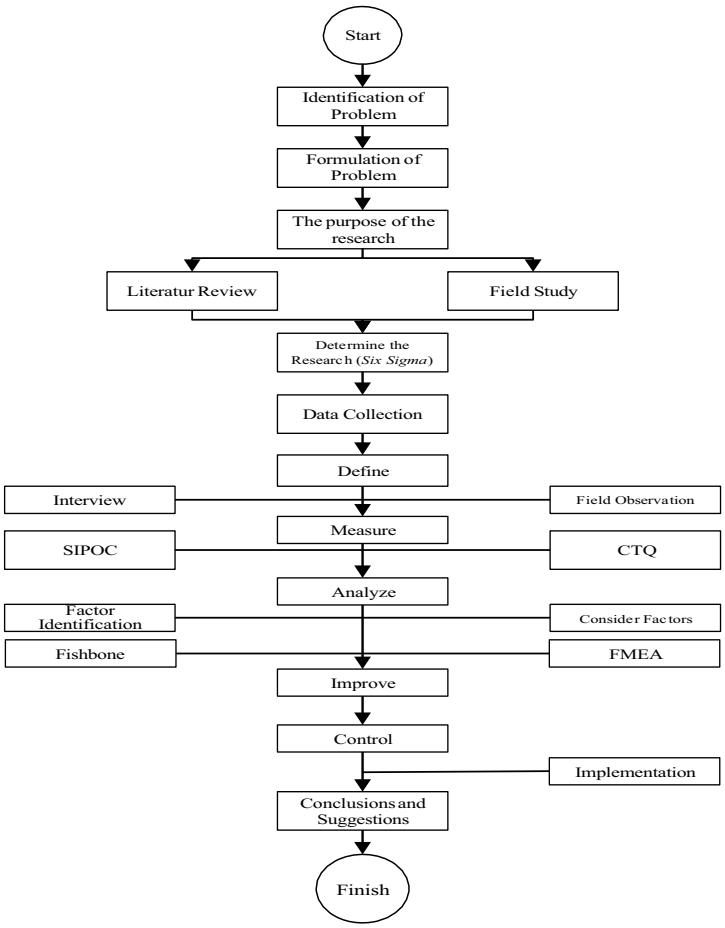

Figure 1. Flowchart of research methodology

In conducting this research there are several stages. The first stage is the identification of problems by making observations to find out the situation and can identify the problem. After formulating the problem, the next step is to formulate the problem and make the goal of the problem from the results that have been obtained when identifying the problem. Then do a literature study and field study to ensure the existing conditions and the research can go both ways.

The second stage is designing validation of measurements to assess the measuring instrument used whether it is appropriate and appropriate. Furthermore also do variations in the measurement system in order to get the right data. In this study the measuring instruments used are define, measure, analyze, improve, control (DMAIC) with the six sigma method as its application.

The third stage is identifying the causes of disability that occur in production. In identifying factors, a fishbone and FMEA diagram is used. FMEA is used to identify factors as well as analyze and provide actions to overcome the factors that cause problems. Fishbone diagrams will identify various potential causes of an effect or problem, and analyze the problem through a brainstorming session.[6]

Then furthermore, in this study is to control production after identification of the causes that arise and the implementation of the analysis carried out separately to overcome the problem factors that cause disability.

3. Results and discussion

A carton box defect that occurred at PT. XYZ is divided into three types, namely crepe, ripped / dented, and dirty. The following is disability data from carton sheet production from January to June 2019.

Table 1. Product defect data

Month	Production (pcs)	Number of Defect			Amount
		Krepek	Torn / Dented	Dirty	
Januari	8.639.766	229.125	137.933	87.888	454.946
February	6.380.263	197.668	98.430	59.497	355.595
March	7.443.724	224.829	92.641	67.449	384.919
April	14.170.335	376.053	278.035	124.508	778.596
May	13.256.265	345.096	216.373	146.783	708.252
June	7.222.671	192.465	128.778	62.901	384.144
Amount	57.113.024	1.565.236	952.190	549.026	3.066.452
Average	9518837,33	260.873	158698,33	91.504	511.075

In the next stage, the relevant elements that are usually carried out before the process improvement project are identified using the SIPOC diagram by setting quality standards in each flow. The following is a table of quality standards for SIPOC diagrams and SIPOC diagrams from carton boxes.

Table 2. Quality Standards

Quality Standard				
Supplier	**Input**	**Process**	**Output**	**Customer**
Delivery on Request	Paper Roll doesn't cause Tapioka flour passed the	Pass the physical carton sheet	Carton sheet has gone through	Carton sheet doesn't krepek, tear / dented and

Created to support the SIPOC diagram that occurred at PT. XYZ

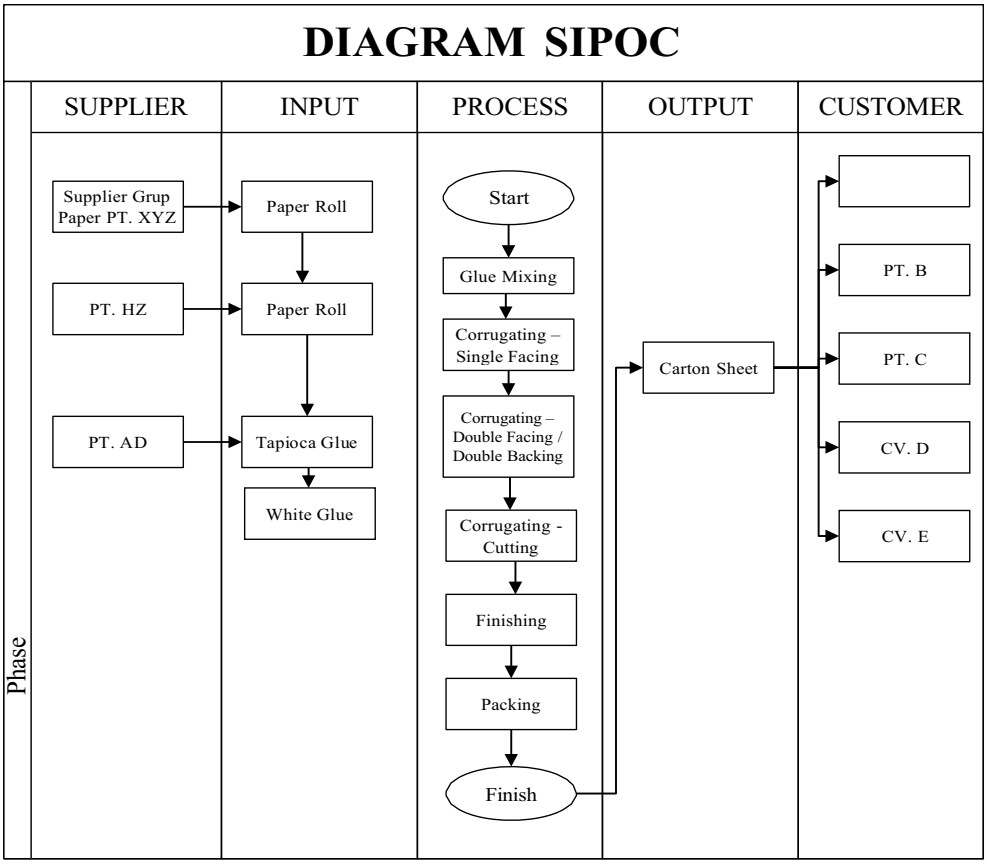

Figure 2. SIPOC Diagram

Before doing the six sigma level calculation at PT. XYZ, researchers must determine the specific needs that the customer wants through the stage of determining CTQ. The CTQ table can be seen below.

Table 3. Determining CTQ

Description	**CTQ**
Dimention	360X240X220 (±2mm)
Paper Type	K150/M150/K150 (± 4%)
Bursting	7.5 (± 0,5)
Box Weight	305.78 (± 4%)
Moisture	6 – 9
The Design	According to the design of PT. A

Furthermore, to find out how much data is still controlled within the control limits or not, then the calculation of the proportion of defects and the percentage of defects is made. The following is presented in the form of a table calculating the proportion of defects and the percentage of defects produced in January to June. The table can be seen in the table below.

Table 4. Proportion of Defects

Month	Production (pcs)	Number of Defect			Dirty	Proportion of Defect	Precentage of Defect
		Krepek	Torn / Dented	Dirty			
Januari	8.639.766	229.125	137.933	87.888	454.946	0,053	5,266
February	6.380.263	197.668	98.430	59.497	355.595	0,056	5,573
March	7.443.724	224.829	92.641	67.449	384.919	0,052	5,171
April	14.170.335	376.053	278.035	124.508	778.596	0,055	5,495
May	13.256.265	345.096	216.373	146.783	708.252	0,053	5,343
June	7.222.671	192.465	128.778	62.901	384.144	0,053	5,319

In the next stage is to do the calculation of CL, UCL, LCL to control the proportion of items that do not meet the requirements of the specified specifications which are categorized as defective for operational definitions precisely about what is meant nonconformity.[7] The CL, UCL and LCL calculation tables can be seen in the table below.

Table 5. CL, UCL and LCL

Month	Production (pcs)	Number of Defect	Proportion of Defect	Precentage of Defect	CL	UCL	LCL
Januari	8.639.766	454.949	0,053	5,27	0,054	0,05423	0,05377
February	6.380.263	355.595	0,056	5,57	0,054	0,05427	0,05373
March	7.443.724	384.919	0,052	5,17	0,054	0,05425	0,05375
April	14.170.335	778.596	0,055	5,49	0,054	0,05418	0,05382
May	13.256.265	708.252	0,053	5,34	0,054	0,05419	0,05381
June	7.222.671	384.144	0,053	5,32	0,054	0,05425	0,05375

Based on the number of defects and the number of existing production, we can get the value of CL, UCL, and LCL and make a p-chart diagram. The following is a p-chart diagram using the Minitab application:

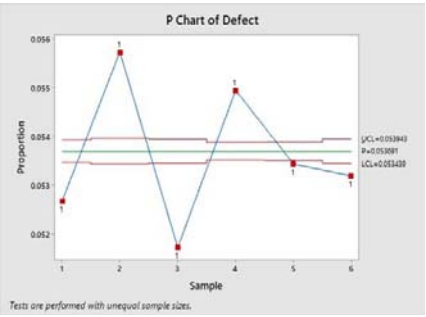

Figure 3. P-Chart Diagram

Then to determine the capability level of the process used and to find out the production process is in accordance with existing procedures or have not been calculated Cp and Cpk. The results obtained will be included in the range of existing criteria. The percentage of disability is obtained from the number of defects divided by the number of production times 100%, so that the percentage of disabilities will be obtained every month, as in table 2 the proportion of defects.

The average percentage of disability obtained from the total percentage of disability divided by the number of months of observation six months, which is 5.36. Then it is found to calculate Cp based on the average calculation percentage above:

$$a = 1 - \frac{presentase\ proporsi\ cacat}{100\ x\ opportunities\ cacat} = 1 - \frac{5,36}{100\ x\ 3} = 0,9821$$

The a value obtained is 0.9868 and then look for the normal distribution table and obtained:
Z value = 2.10, then the value of Cp is obtained $\frac{Z}{3} = \frac{2,10}{3} = 0,70.$ (Cp <1, the capability of the process is low so that performance needs to be improved through process improvement). So from the results of Cp that have been obtained above, it states that the capability of the process carried out is low, after that calculate the value of Cpk to find out whether the process is in accordance with existing specifications using the formula:

$$a = 1 - \frac{Rata-Rata\ Persentase\ Proporsi\ Cacat}{100} = 1 - \frac{5,36}{100} = 0,9464$$

Where in Table Z the value of 0.9464 is 1.61

So we get the value of Cpk = $\frac{a\ (Tabel\ Z)}{3} = \frac{1,61}{3} = 0,537 \approx 0,54.$

(Cpk <1, the process of producing products that do not meet the specifications desired by the customer). From the results obtained, it means that the process that occurs is not in accordance with existing product specifications, so it needs further analysis of what causes this to happen which aims to improve the existing system at the company.

The next stage is to determine the six-sigma level, which is to do a DPMO calculation that is done every month from January to June 2019.

Table 6. Calculation of DPMO

Month	U	OP	D	DPU	TOP	DPO	DPMO	Nilai
Januari	8.639.766	3	454.94	0,0527	25.919.29	0,0176	17.552,5	3,61
Februar	6.380.263	3	355.59	0,0557	19.140.78	0,0186	18.577,8	3,58
March	7.443.724	3	384.91	0,0517	22.331.17	0,0172	17.236,8	3,61
April	14.170.33	3	778.59	0,0549	42.511.00	0,0183	18.315,1	3,59
May	13.256.26	3	708.25	0,0534	39.768.79	0,0178	17.809,2	3,60
June	7.222.671	3	384.14	0,0532	21.668.01	0,0177	17.728,6	3,60
Averag	9518837,	3	511075,8	0,0536	2855651	0,0179	17870,04	3,6

The following is a production defect data in the form of pareto diagrams to see the types of defects that occur most in the carton sheet and identify the causes that occur in the carton sheet at PT. XYZ.

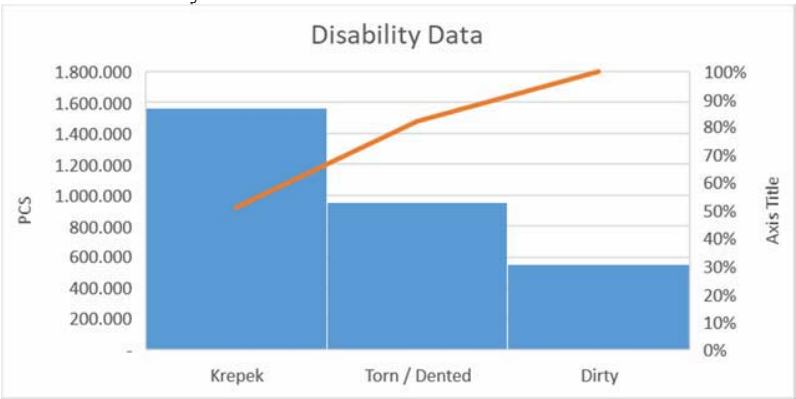

Figure 4. Pareto Disability Data Diagram

Based on the data of disability above, it can be seen that the most defects that occur in the production of carton boxes are crepe. Then the analysis of the causes of crepe in the carton box will then be made so that an analysis can then be made to improve the causes of the crepe.

In identifying the causes of defects in carton sheet production, the tool used is a fishbone diagram to find out the root of the problem that occurs in the production of carton sheet defects. Here is a fishbone diagram of disability crepe, tear / dent, and dirty.

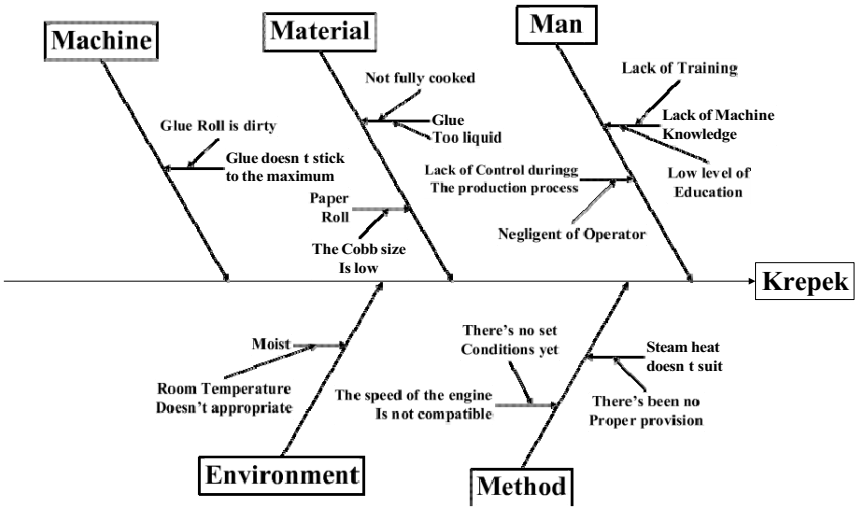

Figure 5. Diagram Fishbone of Krepek's Defect

Then do the Failure Mode and Effect Analysis (FMEA) to defect crepe which is the most common problem and identify improvements that can be done with the highest Risk Priority Number (RPN) value. The following is a fishbone diagram and FMEA table for carton sheet production.

Table 7. FMEA and RPN

No	Efek Kegagalan Potensial	Penyebab Potensial	*Severity*	*Occurance*	*Detection*	RPN	Tindakan Saat Ini	Tindakan Rekomendasi
1	Lack of Machine Knowladge	Lack of Training	5	5	7	175	Procurement Training	Imporving Productivity
2		Low level of Education	4	4	5	80	-	Standard for Human Recruitment
3	Lack of Control during the production process	Negligent of Operator	7	8	2	112	Conduction another Briefing	Field Observations
4	Glue	Not fully cooked	7	6	5	210	Cook thoroughly	Make another glue observation before using the glue
5		Too Liquid	7	7	5	245	Cook thoroughly	Make another glue observation before using the glue
6	Paper Roll	The Cobb Size is Low	5	7	2	70	Replace it with another Paper roll	Do some test before using
7	Glue doesn't Stick to the Maximum	Glue Roll is Dirty	3	4	1	12	Clean the Glue Roll	Make a SOP of Cleaning Schedule
8	Steam heat doesn't suit	There's been no proper provision	5	7	3	105	The Machine is Stopped for Resetting	Standardize each condition
9	The Speed of the Engine isn't compatible	There's no set Condition yet	4	6	3	72	The Machine is Stopped for Resetting	Standardize each condition
10	Moist	Room temperature doesn't appropriate	2	3	9	54	-	Set up the Exhaust Fan at the Corner of the Production Floor

Based on the results of identification on the crepe defect using FMEA and the calculation of RPN that has been done above to determine the value to determine the priority of the most critical and urgent issues to be addressed, it is known that the glue obtained is too liquid to be the highest RPN value of 245 with a high level of severity as well namely 7 then the second is imperfect glue with a RPN value of 210 and a high severity value as well as 7 and the third highest RPN value is the lack of training with a value of RPN 175 and severity value of 5.

Glue is a material that functions as an intermediate object to glue ingredients to one another. The way glue works is liquid solidification by melting macromolecules above the melting point. After a cold they have a high adhesive strength.[8] Then the adhesive strength of the glue occurs when the glue has cooked and after cooking the glue has cooled. In this case it refers to the two most critical focus priorities on the carton sheet crepe defect. For the case of defective crepe because the glue is too liquid

can be caused by raw materials, cooking methods (fire or stirring). According to a research the use of tapioca flour in the manufacture of glue concluded that tapioca flour has an insignificant influence on the quality of the glue, as well as the adhesion and viscosity value. It was explained that the addition of tapioca flour with four experiments with different flour compositions but with the same composition of other ingredients in the manufacture of dry mixing glue caused a decrease in adhesive and viscosity values. The results of the close to the glue obtained in the treatment of tapioca flour 12g with a value of the adhesive strength of 4.17 kg / in and a viscosity value of 51.33Cp.[9] Meanwhile, for undercooked glue, identify the factors that cause it, namely the quality of the glue is not good and when the cooking process is not done according to the procedure and lack of control when cooking and glue maturity tests are not done. For the proposed next action on the cause of the glue is too runny and not ripe is to do the cooking of the glue again with due regard to the composition and operation of the work properly so that the remanufactured glue can be as per the standard and can be used in a corrugator machine. As a proposal for a long-term action on the cause of the glue is too runny and not mature enough to make observations before cooking glue. Where this observation is included in checking the raw material and controlling the glue cooking procedure to prevent crepe defects.

The third highest RPN value is the lack of training on the effects of potential failures due to lack of machine knowledge. Operators who operate machines are still a problem due to lack of knowledge of the machine here, known to occur due to lack of training of machine operators, so that the steps of the work procedures that are carried out are less precise. So for the proposed next action to overcome this is to conduct regular training for operators and make an assessment of the results of training and performance expected machine operators, in the future able to improve operating performance. It is considered lack of training because during the production process there are still operating machines that are wrong and not according to procedure. Control production on a regular basis with the operator.

4. Conclusion

After performing the existing DMAIC stage, the researcher concludes as follows:

1. There are three types of defects in PT. XYZ namely crepe carton sheet, tear / dented carton sheet, and dirty carton sheet with 51%, 31%, and 18% of the total defect, respectively. Among the three types of defects that exist, crepe is the most common defect that occurs in the production process on the corrugator machine.

2. In the results of the calculation of process capability (Cp) and kane process capability index (Cpk) that is obtained 0.70% for the Cp value and 0.54% for the Cpk value. From the results of the calculation of Cp and Cpk, it can be seen that the results of the capability of the process that occurs are still low so that it is necessary to improve and improve the quality of the production process so that future production will be better.
3. According to the calculation of the average level of sigma PT. XYZ based on data and circumstances that there is a sigma level value that is 3.6 sigma then to be able to reach the level 4 sigma value occurs GAP of 0.4. This situation was shown to improve the carton sheet production process.
4. In the discussion of the analysis for the proposed improvement in reducing the defect carton sheet in accordance with the largest RPN value glue that is too liquid becomes the highest RPN value that is 245 with a high severity level that is 7 then the second is imperfect glue with a RPN value of 210 and a high severity value that is 7 and the third highest RPN value is the lack of training with a value RPN 175 and severity value 5.

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