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Quality Control Analysis on Nylon Monofilament Net Production Process Using the Seven Tools Method and FMEA at PT ARIDA

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Abstract
PT. ARIDA is a company engaged in the fishing net production manufacturing industry. This company experienced difficulties in controlling the quality of the nylon monofilament net production process. Quality control is carried out to reduce the occurrence of defects. The author uses the Seven Tools and FMEA methods to analyze the level of defects and look for factors that cause defects that occur. The author uses the Seven Tools and FMEA methods to analyze the level of defects and look for factors that cause defects that occur. The research results show that the defect rate that occurs is 8.97%, this shows that the production process is not under control. Proposed control of potential causes based on RPN values so that companies can prioritize improvements to potential causes that occur.
Keywords: *quality, quality control, seven tools, FMEA*

Abstrak
PT. ARIDA merupakan perusahaan yang bergerak dibidang industri manufaktur produksi jaring perikanan. Perusahaan ini mengalami kesulitan dalam mengendalikan kualitas mutu pada proses produksi *nylon monofilament net*. Pengendalian kualitas dilakukan guna menekan terjadinya kecacatan yang terjadi. Penulis menggunakan metode *Seven Tools* dan FMEA dalam menganalisis tingkat kecacatan serta mencari faktor – faktor penyebab kecacatan yang terjadi. Hasil penelitian menunjukkan bahwa nilai kecacatan yang terjadi sebesar 8,97%, hal tersebut menunjukkan proses produksi belum terkendali. Usulan pengendalian penyebab potensial berdasarkan nilai RPN agar perusahaan dapat memprioritaskan perbaikan pada potensi penyebab yang terjadi.
Kata Kunci: *kualitas, pengendalian kualitas, seven tools, FMEA*

1. Introduction

The era of modern industrial globalization means that companies are required to maintain the quality of their products in order to produce products that are of high quality and that there is no damage to their production.[1] Quality control is the main key in ensuring customer satisfaction. Apart from that, good quality control is also beneficial for the company because it causes less damage to the quality of its products and does not increase the burden of repair costs, raw material costs and labor or have an impact on company profits [2].

PT. ARIDA or Arteria Daya Mulia is a company engaged in the net manufacturing industry since 1982. This company is located on Jalan Dukuh Duwur No. 46, Pegambiran Village, Lemahwungkuk District, Cirebon City. PT. Arteria Daya Mulia is the largest fishing net manufacturer in Southeast Asia, so it is a challenge for the company to create good quality products. This company has a 2% defect tolerance for each type of fishing net it produces. The fishing nets produced by PT. Arteria Daya Mulia is diverse, one of the products that is the focus of this research is the Nylon monofilament net product because it has a large production volume but the percentage of defects that occur reaches 8.91%.

The percentage defect level that exceeds the tolerance limit set by the company, it can be said that the nylon monofilament net production process at PT. Arteria Daya Mulia has not been maximized, so it is necessary to carry out quality control using the Seven Tools and FMEA methods so that the factors that cause defects can be identified and also look for appropriate improvement efforts to reduce the number of defects in the nylon monofilament net production process [3].

2. Material and Methods

The data used in creating a quality control design using the Seven Tools and Failure-Mode-and-Effect-Analysis (FMEA) method is secondary data which is quantitative in nature and primary data which is qualitative in the period January 2023 to September 2023[4]. Secondary data is obtained from historical company data consisting of production data, defective product data, and types of defects, while primary data is obtained from direct observations and interviews with related parties in the form of data on the causes and effects of defects [5]. Data processing in this research uses Statistical Process Control, namely Seven Tools and FMEA [6]. Seven Tools also helps in identifying the causes of existing damage, so that corrective action can be taken with Failure-Mode-and-Effect (FMEA) based on the results of the dominant RPN table [7]. The tools in Seven Tools used are checksheets, control charts, Paretto diagrams and fishbone diagrams [8]. Checksheets are used to record the number of defects and types of defects that occur during checking [9]. The checksheet contains a description of the type of damage that occurred in order to clarify the out of control condition on the control chart.[10]

The control chart forms 3 (three) control lines, namely upper control limit (UCL), control limit (CL), and lower control limit (LCL).[11] These three lines determine whether the data obtained from collecting check sheets exceeds control limits or not, so that it can help to take corrective action on production results. Pareto Diagrams are created by sorting defect type data from highest to lowest from the checksheet results obtained [12]. The Pareto Diagram is closely related to the fishbone diagram in describing cause and effect, where 20% of the types of defects can cause 80% of the types of defects that occur. The results of the Pareto Diagram can make it easier to choose decision-making steps for the type of defect that will be analyzed on the fishbone diagram [13]. Fishbone diagrams are created using qualitative information on the causes and effects of defects in the net. This information was obtained based on direct observations in building H producing Gill Net Monofilament nets at PT. Arteria Daya Mulia and uses information from interviews with related sources so that all causes that have the potential to become defective are fully identified [14]. The results of the fishbone diagram information can be used to create Potential failure and Potential cause based on the rank value criteria of severity, occurrence and detectability.

The rank value severity criterion explains that the higher the ranking value, the higher the level of severity that occurs due to the potential cause. Occurrence explains that the higher the ranking value, the more often the potential cause occurs. Detectability explains that the higher the ranking value, the more difficult it is to detect potential causes [15]. FMEA analysis uses the results of assessment interviews from 10 (ten) respondents who are related to the production process for each potential cause detected. The assessment results for each potential cause are multiplied to find the risk priority number (RPN) value [16]. The RPM values are sorted from the highest value to the lowest RPN value so that PT. Arteria Daya Mulia can determine appropriate corrective action, where the cause of the defect with the highest RPN value becomes the main priority for repair [17].

3. Results and Discussion

Checksheet

The data used is historical data from checking sheets for the period January 2023 to September 2023. This data includes production data, number of damages and details of the types of damage to nylon monofilament nets. The following is a display of the PT Arteria Daya Mulia checksheet form:

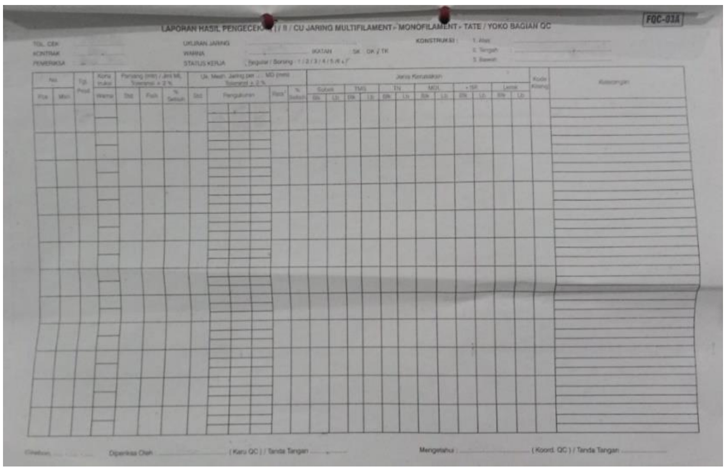

Figure 1. Checkseet form PT. Arteria Daya Mulia
Source: Internal data PT. Arteria Daya Mulia

The net that enters the QC section contains information about production data, so that defects that occur can be identified by the QC section. Disabilities in each category can be written in a column that have been provided and if there are defects that are not in the column, then they can be written in the empty column. The information column is filled with detailed information about repair efforts, such as tearing 179 holes, repairing holes and re-checking. Check sheets for the period January 2023 to September 2023 were collected and then processed, so that the data collected is as follows.

Table 1. Production data nylon monofilament net

Month (2023)	Production (pcs)	Number of defect types								Defect (pcs)	% Defect
		Tear	TMS	DSP	MDL	BR	Lerek	ING	TN		
January	22.402	882	120	39	43	120	664	47	167	2.082	9,29%
February	19.325	764	118	43	52	88	418	40	142	1.665	8,62%
March	24.022	912	134	53	55	173	522	69	126	2.044	8,51%
April	19.635	822	142	41	87	123	428	41	59	1.743	8,88%
May	20.214	828	105	53	39	92	428	57	112	1.714	8,48%
June	20.428	722	115	39	41	102	492	53	194	1.758	8,61%
July	24.422	924	143	58	84	221	668	93	171	2.362	9,67%
August	20.346	744	129	37	32	112	522	31	117	1.724	8,47%
September	26.480	992	212	74	73	221	746	71	221	2.610	9,86%
Total	197.274	7.590	1.218	437	506	1.252	4.888	502	1.309	17.702	8,97%

Source: Internal data PT. Arteria Daya Mulia

Based on **Table 2** above, the defect percentage rate reached 8.97% of the total nylon monofilament net production of 197,274 pcs, while the number of defects was 17,502. There are 8 (eight) types of defects, namly defect *Sobek* as much 7.590, *Tidak Masuk Shuttle* (TMS) as much 1.218, *Double Sparator* (DSP) as much 437, *Mesh Dept Melebar* (MDL) as much 506, *Benang Rusak* (BR) as much 1.252, Lerek as much 4.888, *Ikatan Ngolong* (ING) as much 502, *Tidak Ngait* (TN) as much 1.309.

Control Chart

Control chart analysis uses a P-chart type control chart because it uses the ratio or proportion of product damage. The P – chart is a control chart that looks for the value of the control limit (CL), then followed by the upper control limit (UCL) and lower control limit (LCL) as the maximum limit and minimum limit for damage to a product that can be said to be under control. The following is a table and graphical results of the control chart.

Table 2. Results of *P-chart* data processing

Month (2023)	Production (unit)	Number of defects	Pi	UCL	CL	LCL
January	22.402	2.082	0,093	0,0955	0,0897	0,0840
February	19.325	1.665	0,086	0,0959	0,0897	0,0836
March	24.022	2.044	0,085	0,0953	0,0897	0,0842
April	19.635	1.743	0,089	0,0959	0,0897	0,0836
May	20.214	1.714	0,085	0,0958	0,0897	0,0837
June	20.428	1.758	0,086	0,0957	0,0897	0,0837
July	24.422	2.362	0,097	0,0952	0,0897	0,0842
August	20.346	1.724	0,085	0,0957	0,0897	0,0837
September	26.480	2.610	0,099	0,0950	0,0897	0,0845
total	197.274	17.702				

Source: Internal data PT. Arteria Daya Mulia

Based on **Table 2** above, a control chart image can be prepared using Microsoft Excel software. The following is a control chart image for *nylon monofilament* net production.

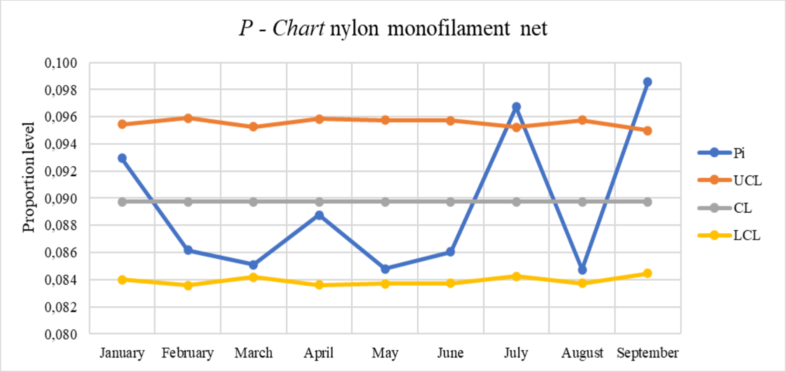

Figure 2. Control chart - p nylon monofilament net
Source: Internal data PT. Arteria Daya Mulia

Based on **Figure 2** above, there is *out of control* data, namely data for July and September which is outside the upper control limit (UCL). The occurrence of *out of control* indicates that the production process is still not under control, so *recalculations* need to be carried out without using data for July and September. The following are the results of recalculation P – Chart without using *out of control* data.

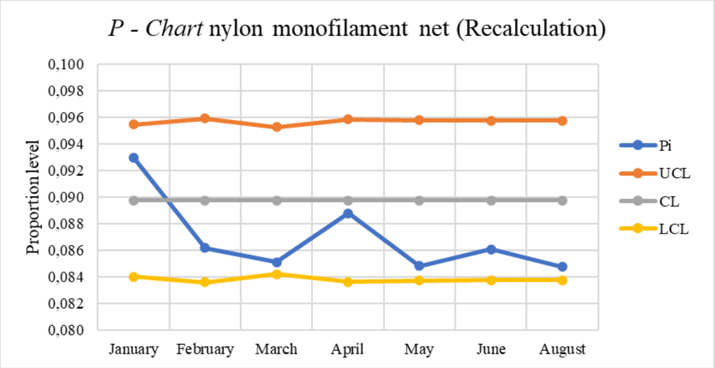

Figure 3. Control chart – p (Recalculation)
Source: Internal data PT. Arteria Daya Mulia

Based on **Figure 3** above, there is no *out of control data*, so it can be said that all data is within the control limits. Control charts can help PT. Arteria Daya Mulia in creating and implementing corrective actions so that production data is controlled.

Pareto Diagram

This diagram helps in prioritizing the types of problems or defects that occur in the production process. Pareto diagram data processing uses data from checksheet processing, the data is sorted from the highest number of defects to the lowest defect, then the percentage and accumulative value of all existing defects is calculated. The following are the results of tables and graphs for preparing the Pareto diagram.

Table 3. Results of data pareto diagram

Defect types	Number of defects	Percentage	Accumulative
Sobek	7.590	42,88%	42,88%
Lerek	4.888	27,61%	70,49%
TN	1.309	7,39%	77,88%
BR	1.252	7,07%	84,96%
TMS	1.218	6,88%	91,84%
MDL	506	2,86%	94,70%
ING	502	2,84%	97,53%
DSP	437	2,47%	100,00%
Total	17.702	100,00%	

Source: Internal data PT. Arteria Daya Mulia

Based on **Table 3** above, then you can arrange a Pareto chart image using Microsoft Excel software. The following is a Pareto diagram of the level of defects in nylon monofilament nets.

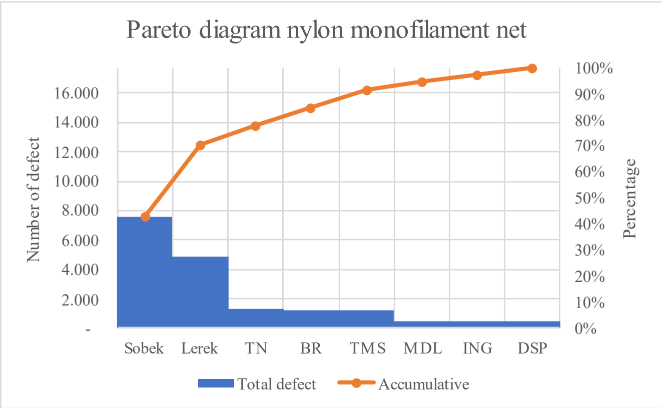

Figure 4. Pareto diagram type defect of nylon monofilament net.
Source: Internal data PT. Arteria Daya Mulia

Based on **Figure 4** above, the highest type of defect is found in defect *Sobek* with a percentage value of 42.88%. The implementation of the Pareto diagram is continued by the fishbone diagram in looking for the factors that cause defects *Sobek* to reduce the number of defects that occur.

Fishbone diagram

The aim of the fishbone diagram is to find the caused and effect factors for the highest defects. The defect analyzed is a type of tear defect because this defect has the highest value compared to other defects. Fishbone diagram analysis in determining cause and effect factors uses primary data from observations and interviews with respondents who are related to the production process. The following are the results of fishbone diagram data processing.

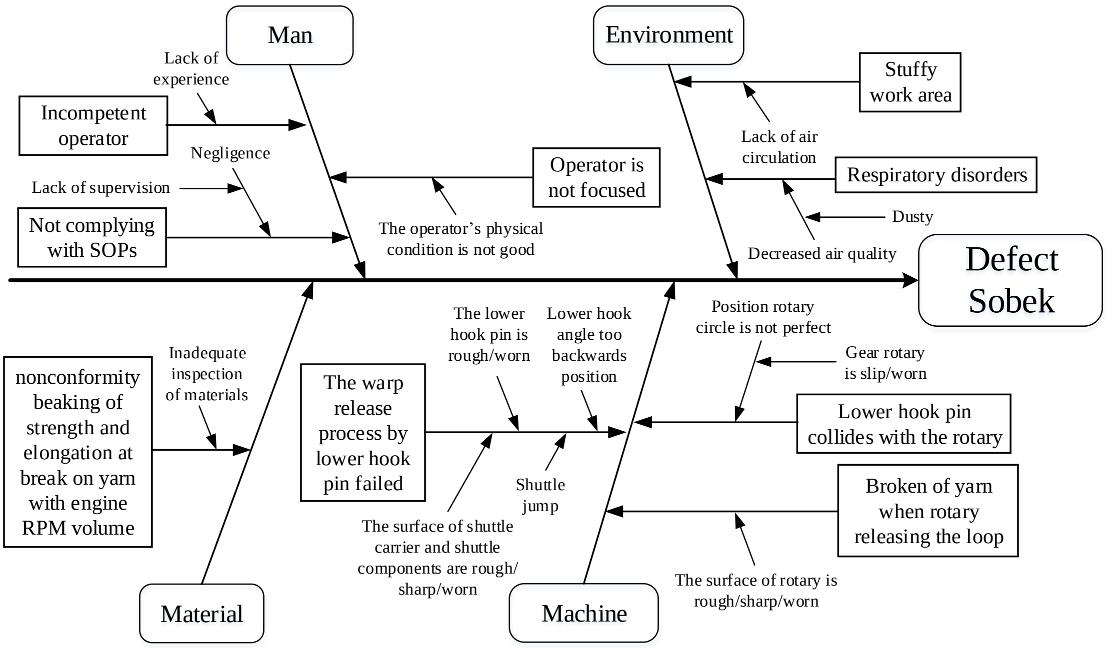

Figure 5. Fishbone diagram defect *Sobek* on nylon monofilament net
Source: interviews and data processing

Based on **Figure 5** above, there are 4 (four) factors that cause tear defects, namely man, environment, material and machine factors. The human factor that is not focused while working due to poor physical conditions disrupts the production process. This condition cannot be avoided, but it is hoped that each operator will be aware in carrying out their duties. There are other causes, such as operators who are less competent due to lack of experience in operating the machine resulting in problem solving that occurs on the machine cannot be resolved and also the cause of operators not complying with SOPs because they are negligent in their work due to lack of supervision resulting in operators being vulnerable to making mistakes that should not occur.

Work environment factors can influence the working conditions of operators and machines. A stuffy work area due to lack of air circulation coming in only through ventilation without an exhaust fan can cause discomfort to the operator and prevent the machine from running normally. Another factor from the environment is the decrease in air quality in the work area caused by production dust, resulting in impaired operator breathing and the surface of machine components becoming rough due to friction with dust.

Material factors cause defects that occur due to inadequate inspection of material resulting in the specifications for thread breaking-of-strength and elongation-at-break not matching the RPM volume of the net production machine. This incident caused the warp threads to tense and break during the net production process. The thread used is thread made by PT. ARIDA itself goes through the extruder process. The thread used for net production passes the specified quality test parameters, the thread quality parameter test is not as a whole, but only per 9 (nine) meters of thread length on one bobbin. Test parameters include yarn denier weight, breaking-strength and elongation-at-break.

The machine factor is the biggest factor that causes the biggest defects in the net production process. The condition of the machine is old and the components have problems, which affects the quality of net production. The company's way of maintaining machines is by carrying out maintenance 2 (two) times a week and if there is a problem with a component during the production process, the problematic component is immediately replaced with a new component. The causal factor that causes defects is the warp release process by lower hook pin failed because the lower hook pin is rough/worn, the lower hook angle is too backwards position, the surface of the shuttle carrier and shuttle components are rough/sharp/worn, and then the shuttle jumps. Another cause is lower hook pin collides with the rotary caused by the position of the rotary circle is not perfect because the rotary gear is slipping/worn. Broken of yarn when rotary releasing the loop caused by the surface of rotary is rough/sharp/worn.

Failure Mode and Effect Analysis

Failure mode and effect analysis (FMEA) on defect *Sobek* types. Potential failure and potential cause use the results of cause and effect analysis from the fishbone diagram. Potential causes that occur are rated by respondents based on the ranking criteria of severity, occurrence, and detectability. The respondents used in the potential cause assessment are respondents who are related to the nylon monofilament net production process. The author used 10 (ten) respondents in this research with the criteria of having worked for the company for 5 (five) years, understanding the entire production flow, and understanding machine components. The results of the respondent's assessment are calculated using the average formula for each potential cause. The following are the results of the potential cause assessment.

Table 4. RPN value analysis of potential causes.

Code	Potential failure	Potential cause	Current Control	Rank value			RPN
				S	O	D	
D1	Incompetent operator.	Lack of experience.	Training programs.	3,4	3,3	1,3	14,59
D2	Not complying with SOPs.	Negligence because lack of supervision.	Supervisory control is carried out on operators and evaluation.	2,5	1,5	5,1	19,13
D3	Operator is not focused.	The operator's physical condition is not good.	Taking endurance medication, drinking water and being given health compensation.	4,3	4,2	1,5	27,09
D4	Stuffy work area.	Lack of air circulation.	Use of blowers in production areas.	3,6	4,2	1,2	18,14
D5	Respiratory disorders.	Decreased air quality because dusty.	Clean the production area thoroughly.	2,4	6,3	1,3	19,66
D6	Nonconformity breaking of strength and elongation at break on yarn with engine RPM volume.	Inadequate inspection of materials.	Carry out testing of yarn parameters using the autograph test, teclock tool denier test per 9000 meters of yarn length.	1,6	4,2	6,5	43,68
D7	The warp release process by lower hook pin failed.	The lower hook pin is rough / worn.	Replace with new ones.	7,6	5,9	4,5	192,81
D8		Lower hook angle too backwards position.	Fix the position lower hook angle.	7,1	2,1	1,3	19,38

Code	Potential failure	Potential cause	Current Control	Rank value			RPN
				S	O	D	
D9		The surface of shuttle carrier and shuttle components are rough / sharp / worn.	Repair by welding / sanding / replacing with a new one.	8,1	1,3	5,9	62,13
D10		Shuttle jump.	Fix the position of shuttle and lock the sekoci plate.	9,7	1,4	1,3	17,65
D11	Lower hook pin collides with the rotary.	Position rotary circle is not perfect because gear rotary is slip / worn.	Fix the position / replace the rotary gear with a new one.	9,8	3,2	3,6	112,90
D12	Broken of yarn when rotary releasing the loop.	The surface of rotary is rough / sharp / worn.	Repaired / replaced with a new one	7,6	5,1	4,3	166,67

Source: Results of interviews and data processing

Above on **Table 4** above, RPN analysis uses analysis of potential causes of defects *Sobek* from the fishbone diagram. The potential cause value is obtained from the average results of the answers of 10 (ten) related respondents. In determining the RPN value, the results of the average severity, occurrence and detectability values from 10 respondents are multiplied by each potential cause. The RPN value results are sorted from highest to lowest value. The following are the results of the FMEA analysis.

Table 5. Analysis FMEA

Number	Code	Potential cause	Improvements proposal	RPN
1.	D7	The lower hook pin is bent / worn.	Create a checksheet form containing the condition of the machine components before the machine starts working, and if periodic defects are found then the operator is obliged to check the condition of the component, if wear occurs then replace it with a new one and write down the number of replacements for the worn component. The goal is to be able to evaluate the use of components so that we can evaluate the use of the machine.	192,81
2.	D12	The surface of rotary is rough / sharp / worn.	Providing stock of new replacement components so they are always available when needed and record the number of worn components, and record the number on the machine component condition checksheet form.	166,67
3.	D11	Position rotary circle is not perfect because gear rotary is slip / worn.	Provides an automatic position adjustment sensor for the rotary gear so that the rotary position is always correct when the lower hook enters the rotary circle. If the rotary gear is worn, it must be replaced and don't forget to note it down so you can evaluate the use of the component.	112,90
4.	D9	The surface of shuttle carrier and shuttle components are rough / sharp / worn.	Provides a protective layer on the surface of the shuttle, so that the friction that occurs is not too significant so that the path for the thread to exit the shuttle is safe.	62,13
5.	D6	Inadequate inspection of materials.	Return to setting the machine, if there are threads that break periodically during the net production process.	43,68
6.	D3	The operator's physical condition is not good.	Providing body immune drinks such as Pocari Sweat to machine operators to focus on work.	27,09

Number	Code	Potential cause	Improvements proposal	RPN
7.	D5	Decreased air quality because dusty.	Installation of exhaust fan in the production area, and provide a blower so it doesn't get hot.	19,66
8.	D8	Lower hook angle too backwards position.	Check the condition of the lower hook angle before the machine is used, measure with a laser sensor measuring tool to ensure the lower hook angle is in the right position.	19,38
9.	D2	Negligence because lack of supervision.	Supervisory control is carried out on operators and evaluation is given in the form of warning sanction if there are defects in the production results.	19,13
10.	D4	Lack of air circulation.	Installation of exhaust fan in the production area, and provide a blower to reduce stuffy rooms.	18,14
11.	D10	Shuttle jump.	Providing an automatic sensor, if there is a shuttle jump, the machine will turn off automatically. The goal is that there are not many defects.	17,65
12.	D1	Lack of experience.	Training programs and competency test for operators on machine use.	14,59

Source: interview results and data processing

Based on **Table 5** above, shows that the main cause that is a priority for repair is the potential cause the lower hook pin is bent/worn with the highest RPN value of 192.81. The surface rotary of rough/sharp/worn as big 166,67. Position rotary circle is not perfect because gear rotary is slip / worn as big 112,90. And so on based on the RPN table. The condition of old machines really requires replacement of components which often wear out. The company only replaces worn components and schedules maintenance regularly. To reduce the number of defects, this can be done by installing sensors so that they can detect defects in the machine and provide protection for components so that the friction that occurs is not too significant. Problems with human resources occur because employees ignore work SOPs which can cause human errors that should not occur, lack of supervision of operator performance. Environmental causes can be prevented by installing an exhaust fan in the production area to increase air circulation, so that the machine can run normally and the operator feels comfortable because the air is not stuffy.

4. Conclusion

Quality control analysis using seven tools and FMEA analysis, especially in the nylon monofilament net production process at PT. Arteria Daya Mulia, it can be said that the production process has not been optimal, this is proven by the check sheet obtained during the period from January 2023 to September 2023, the value of the level of defects that occurred was equal to 8.97%. This value is a value that exceeds the defect tolerance limit set by the company, namely 2%. The implementation of the control chart on the proportion of defects also contains out of control data, namely in July and September. The type of defect that is very significant is defect *Sobek* amounting to 42.88% of the other accumulative defects. The fishbone diagram shows that the causes of defect *Sobek* are caused by 4 (four) main factors, 9 (nine) potential failures and 12 (twelve) potential causes.

FMEA analysis uses potential causes in a fishbone diagram which is calculated using the severity, occurrence and detectability rank value criteria. The results of the potential cause values obtained vary greatly, so the RPN values are sorted based on highest to lowest value. Companies can take action based on the highest RPN value as well as suggestions for improvements provided by the author in controlling quality in the production process.

5. References

[1] R. Rachman, "Pengendalian Kualitas Produk Di Industri Garment Dengan Menggunakan Statistical Procces Control (SPC)," *J. Inform.*, vol. 4, no. 2, pp. 174–182, 2017.

[2] A. Nurholiq, O. Saryono, and I. Setiawan, "Analisis Pengendalian Kualitas (Quality Control) Dalam Meningkatkan Kualitas Produk," *J. Ekonologi*, vol. 6, no. 2, pp. 393–399, 2019, [Online]. Available: https://jurnal.unigal.ac.id/index.php/ekonologi/article/download/2983/2644

[3] F. S. Pratama and S. Suhartini, “Analisis Kecacatan Produk Dengan Metode Seven Tools Dan Fta Dengan Mempertimbangkan Nilai Risiko Dengan Metode Fmea,” *J. SENOPATI Sustain. Ergon. Optim. Appl. Ind. Eng.*, vol. 1, no. 1, pp. 43–51, 2019, doi: 10.31284/j.senopati.2019.v1i1.534.

[4] Gunawan, Harjadi, et al. "Analisis Pengaruh Proses Perencanaan Dan Perancangan Desain Terhadap Kegagalan Komponen Hasil Produksi Di PT “X” Dengan Metode Fault Tree Analysis." *Cylinder: Jurnal Ilmiah Teknik Mesin* 8.2 (2022): 14-22.

[5] R. Arifianti, “Jurnal Dinamika Manajemen Analisis Kualitas Produk Sepatu Tomkins,” *Jdm*, vol. 4, no. 1, pp. 46–58, 2013, [Online]. Available: http://journal.unnes.ac.id/nju/index.php/jdm

[6] M. J. Firmansyah *et al.*, “Analisis Pengendalian Kualitas Produksi Pada PT.XYZ Menggunakan Metode Seven Tools Dan FMEA,” *SITEKIN J. Sains, Teknol. dan Ind.*, vol. 20, no. 1, pp. 231–238, 2022.

[7] T. Hernawati Suryatman, M. Engkos Kosim, and S. Julaeha, “Pengendalian Kualitas Produksi Roma Sandwich Menggunakan Metode Statistik Quality Control (SQC) Dalam Upaya Menurunkan Reject di bagian Packing,” *J. Ind. Manuf.*, vol. 5, no. 1, pp. 1–12, 2020.

[8] Y. Yovita, S. Rahayu, and Veny Megawati, “Pengendalian Kualitas dengan Metode Seven Tools dan FMEA di,” *J. Ilm. Mhs. Univ. Surabaya*, vol. 7, no. 2, pp. 2827–2845, 2019, [Online]. Available: https://journal.ubaya.ac.id/index.php/jimus/article/view/3542

[9] A. Anastasya and F. Yuamita, “Pengendalian Kualitas Pada Produksi Air Minum Dalam Kemasan Botol 330 ml Menggunakan Metode Failure Mode Effect Analysis (FMEA) di PDAM Tirta Sembada,” *J. Teknol. dan Manaj. Ind. Terap.*, vol. 1, no. I, pp. 15–21, 2022, doi: 10.55826/tmit.v1ii.4.

[10] Suharyanto, R. L. Herlina, and A. Mulyana, “Analisis Pengendalian Kualitas Produk Waring Dengan Metode Seven Tools Di CV. Kas Sumedang,” *J. TEDC*, vol. 16, no. 1, pp. 37–49, 2022.

[11] Ishak, Aulia, et al. "Analysis Roofing Quality Control Using Statistical Quality Control (SQC) (Case Study: XYZ Company)." *IOP Conference Series: Materials Science and Engineering*. Vol. 1003. No. 1. IOP Publishing, 2020.

[12] A. W. Pratama and R. Rochmoeljati, “Pengendalian Kualitas Produk Kendang Jimbe dengan Menggunakan Statistical Quality Control (SQC) dan Failure Mode Effect Analysis (FMEA) pada UD. Budi Luhur,” *Juminten*, vol. 3, no. 2, pp. 109–120, 2022, doi: 10.33005/juminten.v3i2.407.

[13] M. B. Anthony, “Analisis Penyebab Kerusakan Hot Rooler Table dengan Menggunakan Metode Failure Mode And Effect Analysis (FMEA),” *J. INTECH Tek. Ind. Univ. Serang Raya*, vol. 4, no. 1, p. 1, 2018, doi: 10.30656/intech.v4i1.851.

[14] S. Andiyanto, A. Sutrisno, and C. Punuhsingon, “Penerapan Metode FMEA (Failure Mode And Effect Analysis) Untuk Kuantifikasi Dan Pencegahan Resiko Akibat Terjadinya Lean Waste,” *J. Online Poros Tek. Mesin*, vol. 6, no. 1, pp. 45–57, 2017,

[15] A. Rachman, H. Adianto, and G. P. Liansari, “Perbaikan Kualitas Produk Ubin Semen Menggunakan Metode Failure Mode and Effect Analysis dan Failure Tree Analysis di Institusi Keramik,” *J. Online Inst. Teknol. Nas.*, vol. 4, no. 2, pp. 24–35, 2016.

[16] A. Suherman and B. J. Cahyana, “Pengendalian Kualitas dengan Metode Failure Mode Effect And Analysis (FMEA) dan Pendekatan Kaizen untuk Mengurangi Jumlah Kecacatan dan Penyebabnya,” *J. UMJ*, vol. 16, pp. 1–9, 2019.

[17] R. V. Zendrato, R. Ryantama, M. A. Nugroho, D. Putri, D. Kuncoro, and S. Parningotan, “Analisis Pengendalian Kualitas Pada Tempe Menggunakan Metode Seven Tools,” *IMTechno J. Ind. Manag. Technol.*, vol. 3, no. 2, pp. 99–109, 2022, doi: 10.31294/imtechno.v3i2.1221.