Application of Six Sigma Techniques with a Focus on Statistical Process Control in Wiring Harness Production

Final Project Proposal

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Batam, 6 June 2024

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Validity Sheet

The Final Assignment is prepared to fulfill one of the requirements for obtaining a degree Associate Expert in Engineering (AMd.T.)
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Application of Six Sigma Techniques with a Focus on Control Process Statistics in Wiring Harness Production

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***Abstract*— The wiring harness plays a vital role in a wide range of electronic devices, with a particular emphasis on its importance in the automotive sector. The objective of this study is to apply the Six Sigma method to enhance wire manufacturing quality in industrial settings.**

The process begins review the key steps of the Six Sigma process, which include Define, Measure, Evaluate, Improve, and Control (DMAIC).. Next, gather information on different phases of wiring harness production to evaluate the current quality of the product. The measurements results are utilized for analyzing the underlying reasons for issues and pinpointing areas requiring enhancement. This will result in tangible benefits by boosting customer satisfaction and enhancing the overall production process. .

The research results show that the application of the Six Sigma process has succeeded in improving the quality of wiring harness production at this company. This will bring real benefits by increasing customer satisfaction and improving the overall production process.

Keyword: Quality control system, DMAIC, Six Sigma

I. INTRODUCTION

A. Background

The manufacturing industry, particularly in the automotive and electronics sectors, has faced increasing challenges in meeting the quality and reliability standards of their products. One of the key components in various electronic devices is the wiring harness, which has an important role in connecting various electronic components. The quality of the wiring harness is a determining factor in the safety and performance of the final product. Therefore, it is important for manufacturers to ensure that wiring harness production is under strict control, with minimal defect rates.

Six Sigma techniques have been known as one of the most effective approaches in controlling quality and minimizing defects in the production process. One important aspect of implementing Six Sigma is the focus on control process statistics. Statistical process control is a powerful tool for monitoring, analyzing and continuously improving production quality. This final project takes an important role in exploring the application of Six Sigma techniques with a focus on control process statistics in the context of wiring harness production. This research will explore how this approach can be used to identify and overcome problems related to the quality of wiring harness production. We will also test the effectiveness of statistical process control tools in monitoring and improving these production processes.

PT. Sumitomo is a company that operates in the manufacturing sector that produces wiring harness. The process of making this wiring harness is a complex process continuous process (continuous process) that produces more than one type wiring harness. In every production process, defective products or products are always found disabled. The Spacia Roof line is one of the production lines at PT Sumitomo. There are still many defects that occur in the production process on this line. in the period August - October 2023, the amount of production produced in this period amounted to 14,275 sets of wiring harnesses. Of this number, the number of wiring harness defects is 240 sets. The most common defect in this line is the absence of soft tape. Soft tape is also called a protective tube, and is a tube type covering material that is used to fill gaps and holes that are not possible with masking tape. It has soft material with various thicknesses and shapes, and can be used according to the required length. where defect no softape amounted to 58 cases out of 240 cases found on the line in the period August to October 2023. . This is a highlight for improvement for the company. Repair and Quality improvement must be carried out continuously by the company in order to be able prevent customer claims in the future due to the discovery of defective products which can cause losses for the company.

TABLE I
DATA DEFECT IN SPACIA ROOF LINE AUG-OCT 2023

Type Of Defect	Quantity	Percentage
No softape	58	26
part breakage	35	16
dimension	26	12
Terminal Bend	25	11
No taping	22	10
Part attachment defect	17	8

other	37	17
Accuumlation defect	220	100

table shows the tabulation of all the defects that occurred in the Line Spacia Roof process from July to October of the year 2023. A total of 28 DPMO in this line was computed. These data were used in making a Pareto Chart in order to determine the defect that needs to be prioritized

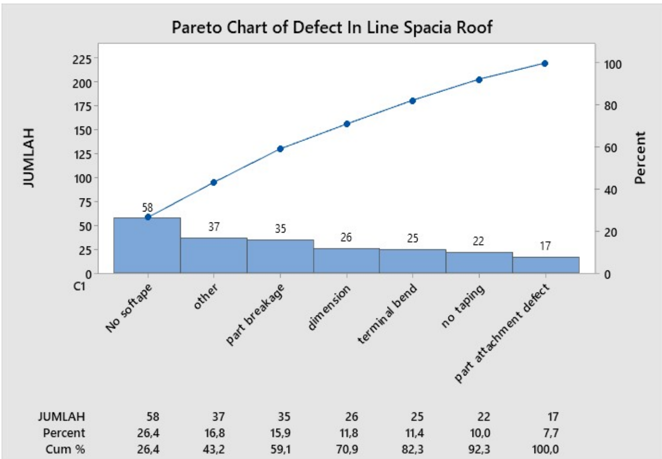

Fig. 1. Pareto chart defect at line spacia roof line aug-oct

The researchers determine the main problem of the assembly process.

Based on the pareto chart, No Softape defect has the highest percentage from all the defects which is equivalent to 26% making it the priority of the study.

Trough this research, it aims to provide in-depth insight into how Six Sigma techniques with an emphasis on statistical process control can help manufacturing companies improve quality, reduce defects, and increase efficiency in wiring harness production. We will explore key aspects of the Six Sigma methodology, such as Define, Measure, Analyze, Improve, and Control (DMAIC), and how it can be used to address specific challenges in wiring harness production.

This research becomes relevant in the context of an everchanging industry, where customers are increasingly demanding high-quality products, while keeping production costs efficient. Hence, gaining insight into how Six Sigma techniques can be applied to statistically control wiring harness production processes could greatly benefit both manufacturers and customers.

B. Problem Formulation

How the application of six sigma can provide recommendations for improving the wiring harness production process?

C. Purpose

The purpose of this final project is to investigate the application of Six Sigma with a focus on process control statistics in wiring harness production and to give recommendations for improving the wiring harness production process

D. Benefit

The benefit that can be taken from this research is to obtain a solution to improve production quality in the wiring harness industry by applying Six Sigma techniques. Applying Six Sigma techniques with a focus on statistical process control in wiring harness production to improve the quality of the products produced.

E. Scope

This research will focus on the application of Six Sigma techniques with an emphasis on statistical process control in wiring harness production. We will limit the scope of research to the following aspects:

1. In-depth explanation of the Six Sigma methodology and its steps.
2. Evaluation of the effectiveness of various statistical process control tools in controlling the quality of wiring harness production.

II. LITERATURE REVIEW

A. Quality Control

Quality control is a system consisting of inspection, measurement and testing, analysis and actions that must be carried out using all existing equipment and techniques, so that the products produced comply with established standards. With technological developments, manufacturers are trying to maintain their reputation. Efforts to maintain reputation (good name) can be done through the quality of the goods produced.

According to experts, there are several main experts who define integrated quality management, Total Quality Management (TQM), who share their opinions. Below is the definition of quality according to four TQM experts, namely:

G. Garvin, "Quality is a dynamic condition related to products, people or labor, processes and tasks, and the environment that meets or exceeds customer or consumer expectations," 2004.

A. Feigenbaum, "Quality is full customer satisfaction. A product can be said to be of quality if it can provide complete satisfaction to consumers, namely in accordance with what consumers expect of a product made by a company and the product has good quality," 2002.

W. E. Deming, "Quality is conformity with market needs. If Juran defines quality as fitness for use and Crosby as conformance to requirements, then Deming defines quality as conformity to market or consumer needs. Companies must really be able to understand what consumers need for the product they will produce," 2005.

P. B. Crosby, "Quality is conformance to requirements, namely in accordance with what is required or standardized. A product has quality if it complies with predetermined quality standards. Quality standards include raw materials, production processes and finished products," 2006

B. Quality Dimention

There are 8 quality dimensions developed by Garvin and can be used as a framework for strategic planning and analysis, especially for manufactured products, namely:

- Performance: characteristics of the core product
- Additional characteristics or features: secondary or complementary characteristics,
- Reliability: small chance of damage or failure to use,
- Conformity to specifications: the extent to which design and operating characteristics meet previously established standards,
- Durability: relates to how long the product can be used,
- Service Ability: includes speed, competence, comfort, easy repair, satisfactory complaint handling,
- Aesthetics: the product's appeal to the five senses, Perceived quality: the product's image and reputation and the company's responsibility towards it.

The concept of quality must be comprehensive, both product and process. Product quality includes the quality of raw materials and finished goods, while process quality includes the quality of everything related to the manufacturing company's production process and the process of providing services or services to service companies. Quality must be built from the start, from receiving input until the company produces output for its customers. Every stage in the production process or service provision process must also be oriented towards this quality. This is because every stage of the process has customers. This means that the customer of a process is the next process.

C. Six Sigma

Six Sigma is a process improvement methodology that aims to minimize waste and improve efficiency in manufacturing. It was created in the 1980s by Motorola engineer Bill Smith and derives its name from standard deviation. The goal of Six Sigma initiatives is to reduce variation to the point that defects are counted in the parts per million. Six Sigma in manufacturing is often closely associated with lean manufacturing, which also seeks to improve quality and efficiency by eliminating manufacturing defects and waste. However, the approach taken in Six Sigma manufacturing differs from that taken in lean manufacturing. Lean manufacturing uses a five-step process to create continuous improvement, while Six Sigma initiatives involve the following seven steps:

1. Define the problem
2. Measure the current process
3. Analyze the process to determine the root cause of defects
4. Improve the process by eliminating defects
5. Control the process to ensure that defects do not recur
6. Verify the results
7. Standardize the process

Six Sigma in manufacturing focuses on eliminating variation, which results in reduced costs and greater customer satisfaction. The starting point with Six Sigma is the customer's experience, and the methodology is data-driven. A manufacturing operations management system (MOM) incorporates Six Sigma software and/or the Six Sigma methodology. Six Sigma software may employ the steps outlined above or what has become known as the DMAIC method: define, measure, analyze, improve, control.

Six Sigma is a methodology that uses statistical analysis and project management to improve business functionality and quality control by identifying and correcting mistakes or defects in existing processes. In manufacturing, Six Sigma aims to reduce variation and defects in the production process, resulting in improved efficiency, reduced costs, and greater customer satisfaction.

D. Statistics Process Control

Statistical process control (SPC) is a methodology that uses statistical methods to monitor and control a process. It is a scientific visual method to monitor, control, and improve the process by eliminating special cause variations in a process. SPC is appropriate to support any repetitive process and has been implemented in many settings where quality management systems are used, including financial auditing and accounting, IT operations, health care processes, and clerical processes such as loan arrangement and administration, customer billing, etc. SPC tools and procedures can help control a process or production method, and many SPC techniques have been adopted by organizations throughout the globe in recent years, especially as a component of quality improvement initiatives like Six Sigma. The widespread use of control charting procedures has been greatly assisted by statistical software packages and sophisticated data collection systems. The following are some of the key features of SPC:

- Data collection: Data is collected from the process being monitored. This data is used to create a control chart that shows the process performance over time.
- Control limits: Control limits are calculated based on the data collected. These limits represent the range of acceptable variation in the process.
- Monitoring: The process is monitored over time to ensure that it stays within the control limits. If the process goes outside the control limits, it is considered out of control and corrective action is taken.
- Corrective action: When the process goes out of control, corrective action is taken to bring it back within the control limits. This may involve adjusting the process or making other changes to ensure that it stays within the acceptable range of variation.
- Continuous improvement: SPC is a continuous improvement process. The data collected is used to identify areas for improvement, and corrective action is taken to improve the process.

The benefits of SPC include:

- Improved quality: SPC helps to identify and correct issues in the process, resulting in improved quality of the product.
- Cost savings: By identifying and correcting issues in the process, SPC can help to reduce waste and improve efficiency, resulting in cost savings.

- Increased customer satisfaction: By improving the quality of the product, SPC can help to increase customer satisfaction.

SPC is a powerful tool for improving the quality of products and services. It is a data-driven approach that helps organizations to identify and correct issues in their processes. By monitoring the process over time, SPC helps to ensure that the process stays within the acceptable range of variation. This results in improved quality, cost savings, and increased customer satisfaction. The following are some of the typical process control techniques used in:

1. Control charts: A control chart is one of the primary statistical process control techniques (SPC). The control chart is a graphical display of quality characteristics that are measured or computed from a sample versus the sample number or time. Furthermore, the control chart contains a center line that represents the average value of the quality characteristics and two other horizontal lines known as the upper control limit (UCL) and lower control limit (LCL). The UCL and LCL are calculated based on the data collected and represent the range of acceptable variation in the process.
2. Pareto charts: A Pareto chart is a graphical representation of the relative frequency or size of problems. It is used to identify the most significant problems in a process.
3. Cause-and-effect diagrams: A cause-and-effect diagram is a graphical representation of the relationship between a problem and its possible causes. It is used to identify the root cause of a problem.
4. Statistical process control software: Statistical process control software is used to automate the process of collecting and analyzing data. It can be used to create control charts, histograms, Pareto charts, scatter diagrams, and cause-and-effect diagrams. The following are some of the typical steps involved in implementing SPC:

1. Define the process: The first step in implementing SPC is to define the process that will be monitored. This involves identifying the inputs, outputs, and the steps involved in the process.
2. Collect data: Data is collected from the process being monitored. This data is used to create a control chart that shows the process performance over time.
3. Calculate control limits: Control limits are calculated based on the data collected. These limits represent the range of acceptable variation in the process.
4. Monitor the process: The process is monitored over time to ensure that it stays within the control limits. If the process goes outside the control limits, it is considered out of control and corrective action is taken.
5. Take corrective action: When the process goes out of control, corrective action is taken to bring it back within the control limits. This may involve adjusting the process or making other changes to ensure that it stays within the acceptable range of variation.
6. Continuous improvement: SPC is a continuous improvement process. The data collected is used to identify areas for improvement, and corrective action is taken to improve the process.

The following are some of the typical benefits of implementing SPC:

1. Improved quality: SPC helps to identify and correct issues in the process, resulting in improved quality of the product.
2. Cost savings: By identifying and correcting issues in the process, SPC can help to reduce waste and improve efficiency, resulting in cost savings.
3. Increased customer satisfaction: By improving the quality of the product, SPC can help to increase customer satisfaction.
4. Improved productivity: By reducing waste and improving efficiency, SPC can help to improve productivity.
5. Improved employee morale: By improving the quality of the product and reducing waste, SPC can help to improve employee morale.

In summary, SPC is a methodology that uses statistical analysis and project management to improve business functionality and quality control by identifying and correcting mistakes or defects in existing processes. SPC is appropriate for any repetitive process and has been implemented in many settings where quality management systems are used. SPC tools and procedures can help control a process or production method, and many SPC techniques have been adopted by organizations throughout the globe in recent years, especially as a component of quality improvement initiatives like Six Sigma.

E. Wiring Harness Process

A wiring harness is a bundled processed wires with a protective covering to guard against wear and tear due to environmental conditions and other potential damaging factors. They may have a protective sheath around the wires that is typically made of thermoset or thermoplastic material, which provides additional protection against damage to the individual wires. These harnesses are important because they organize wires for easy implementation into equipment and systems. Wire harnesses are used in various applications, including automobiles, flat panel displays, flight simulators, ruggedized computers, heavy equipment, and more. Wire harnesses are different from cable assemblies in that cable assemblies bind multiple covered wires tightly with a covering to provide robust protection suitable for more demanding environments. Despite the product names, both cables and wires may be found within wire harnesses and cable assemblies.

There are different types of wire harness manufacturing processes, and the process can be simple or complex, depending on the design and work requirements. The following are some of the typical wire harness manufacturing processes:

- Wire Harness Design: The manufacturing process begins with the design aspect. The wire harness needs to be custom designed for each product. This involves identifying the inputs, outputs, and the steps involved in the process. The designs would vary across these applications. So, creating a custom design is one of the challenging aspects of the wire harness manufacturing process.

- Wire Cuting and Terminal Crimping : To produce a wiring harness, the wires are first cut to the desired length, the ends of the wires are stripped to expose the metal (or core) of the wires, which are fitted with the required terminal.
- Subassembly : In this step, all manual and semiautomatic operations are performed like crimping of more than one wire in the same terminal, twisting, soldering, shrinking, thermal tube cutting, double crimping, splicing and so on.
- Assembly Process : In this step, the cables are assembled and clamped together on a special workbench, pin board (assembly board) or a conveyor, according to the design specification, to form the cable harness.
- Circuit Test : The electrical functionality of a cable harness is tested with the aid of a test board in which the circuit diagram data are preprogrammed into the test board.
- Final Inspection : After passing electrical testing, wiring harnesses are subjected to final inspection for dimensions,vpassed harnesses fitted in protective sleeves, conduit, or extruded yarn to be ready for shipment.

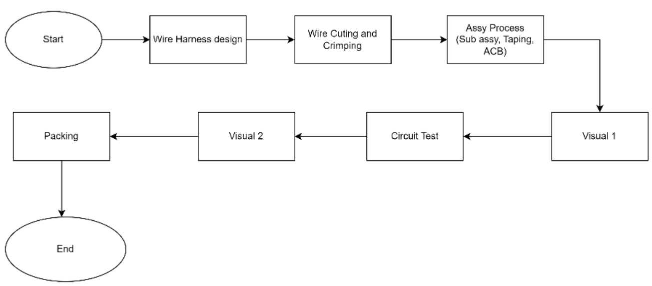

Fig. 2. Flowchart manufacturing process wiring harness

Wire harness manufacturing is a complex process that requires a great deal of skill and expertise. The process can be simple or complex, depending on the design and work requirements. Wire harnesses are important because they organize wires for easy implementation into equipment and systems. They are used in various applications, including automobiles, flat panel displays, flight simulators, ruggedized computers, heavy equipment, and more. The wire harness manufacturing process is largely manual, unlike other electronic manufacturing processes. These assemblies often work as components for large parts. It is because wire harnesses require a high level of customization. Manual assembly helps resolve electric and geometric issues associated with the manufacturing process.

III. IMPLEMENTATION METHODE

A. Research Steps

In this research, several stages were carried out in solving the problem. Following
flow chart in this research

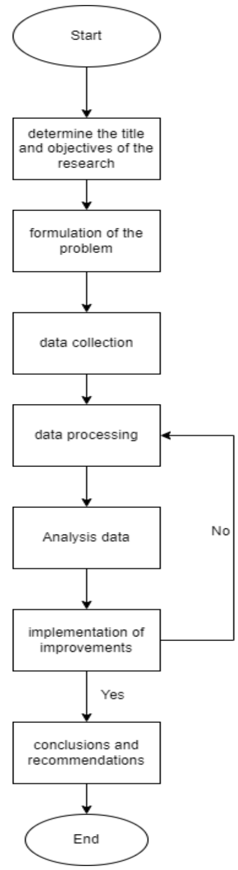

Fig. 3. Research method flowchart

B. Methode Research

This research was designed using a qualitative approach where researchers attempt to understand and interpret conditions or events that occur in the company in depth to obtain information and reveal new knowledge that can contribute to the company in the form of suggestions and improvements in quality improvement activities. After considering the suitability between the phenomena studied, the method used is a descriptive exploratory method which aims to describe the state of a phenomenon, and in this research it is not intended to test a particular hypothesis but only to describe what a variable, symptom or situation is (Arikunto, 2002). The object studied in this research is the quality control system in the development of new products in the wiring harness production line, while the research subject in this research is representative management in the relevant business unit that produces wiring harness products.

Determining the subjects studied in this research was using a purposive sampling method. Purposive sampling is a technique for sampling data sources with certain considerations (Sugiyono, 2017). The use of the purposive sampling method was carried out because the researcher determined certain considerations or criteria that must be met by the samples in this research.

C. Data Collections Technique

Based on its nature, this research data collection technique uses quantitative techniques. Quantitative data is obtained by collecting data such as data on the number of wiring harness models, production number data, and data on the number of defects. Data analysis techniques in research in qualitative research are carried out while data collection is taking place. Activities in data analysis include data collection, data reduction and data presentation.

in data collection, for comparative analysis. data is taken based on the amount of production that occurs in the following period. The samples taken for this research were wiring harness products produced on the Spacia Roof line which were found to be defective in the quality control section during January 2024 or 22 days of production.

D. Processing Method and Analysis Data

Define

The define stage is setting targets for six sigma quality improvement activities, stage this aims to bring together the opinions of the team and sponsors regarding the upcoming project done. The tools that will be used in the Define stage are:

a. Pareto Chart was used in stratifying the internal defects in order to determine the defect to be prioritized. The focus was on low insulation defect.
b. Process Mapping was used to illustrate the flow of the process in order to understand it clearly and to identify opportunities for improvement.

Measure

The measure stage is the stage of measuring the level of defects and the current level of performance in the production process using the DPMO formulation. In this method, researcher use SPC tools, namely P chart to measure the value of DPMO. P chart is a control chart used to control the proportion of defects in a process.

Process capability was used to analyze how capable a process is in meeting its customer requirements.

Analyze

Aims to get to the root of the problem so that an improvement plan can be made according to the problem that occurs. The tools used are:

a. Why Analysis helped the team in determining the root cause of its occurrence.
b. Fishbone diagram: Finding the root cause of problems that occur in the production process using a fishbone diagram.

IV. RESULT AND DISCUSSION

Based on the research method, the first step is taken to analyze production quality control statistically is make a check sheet, then make a control chart with help Minitab application and create a Pareto diagram based on primary data has been processed and finally creates a cause and effect diagram based on the results.

A. Checksheet

In carrying out statistical quality control, steps The first thing you will do is create a check sheet. Check sheet useful for simplifying the process of data collection and data analysis. Apart from that, it is also useful to find out problem areas based on type damage and make a decision whether to carry out repairs or not.

The check sheet compiles a table with a date column, total defect points per day, total production, and type of damage. Then record each one day for day.

The results of data collection through the check sheet that has been carried out, it can be seen in the following table:

TABLE II
RECAP RESULT PRODUCTION AND REJECT JANUARY 2024

Date	Production	Reject				Reject Accumulation	Production Accumulation
		No Component	Wrong Dimention	Breakage Part	Incorrect Part		
2	1344	2	0	2	0	4	1348
3	1286	3	1	4	0	8	1294
4	1335	0	0	3	1	4	1339
5	1352	1	0	0	1	2	1354
8	1312	0	0	1	0	1	1313
9	1300	1	0	1	0	2	1302
10	1320	1	1	6	0	8	1328
11	1290	2	4	0	0	6	1296
12	1290	0	0	0	1	1	1291
15	1287	0	0	1	0	1	1288
16	1267	2	0	0	0	2	1269
17	1269	1	0	0	0	1	1270
18	1302	2	0	0	1	3	1305
19	1310	4	1	0	0	5	1315
22	1302	1	3	0	1	5	1307
23	1306	0	0	2	0	2	1308
24	1316	0	0	1	0	1	1317
25	1290	0	1	10	1	12	1302
26	1312	7	1	0	0	8	1320
29	1330	3	2	0	0	5	1335
30	1320	3	0	0	0	3	1323
31	1252	0	1	0	3	4	1256
Total	28692	33	15	31	9	88	28780

B. Identidy Defect

From the results of the check sheet data, you can find out what types of damage occurred during the production process. To identify the type of damage, a Pareto diagram is used. A Pareto diagram is a diagram used to identify, sort and work. By using the Pareto chart, we can find out and identify the types of defects that most often occur from production results on the Spacia Roof Line in January 2024.

The following is data on the types of defects that occurred in January 2024 at Line Spacia Roof.

TABLE III
DEFECT IN JANUARY 2024

No	DEFECT	AMOUNT	PERCENTAGE (%)	ACCUMULATION (%)
1	No Component	33	37,50	37,50
2	breakage part	31	35,23	89,77
3	Wrong Dimention	15	17,05	54,55
4	incorrect part	9	10,23	100,00
GRAND TOTAL		88	100,00	

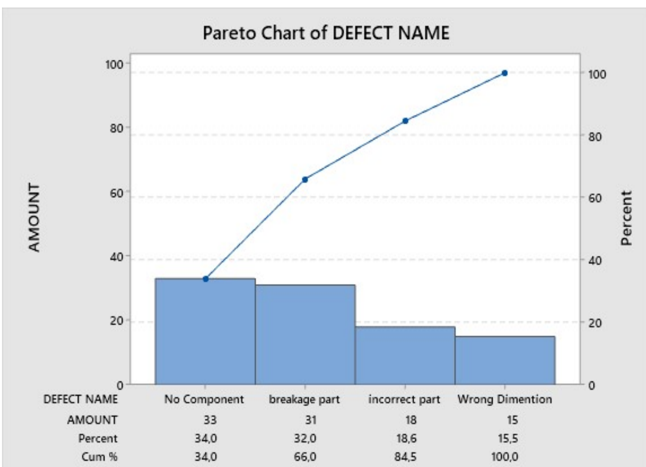

Fig. 4. Pareto chart of defect in spacia roof line on January 2024

Based on the results of the Pareto diagram above, it can be seen that defects in the Spacia Roof production line in January 2024 dominated by the type of defect Missing part or no component amounted to 37.5% and breakage part defects amounted to 35.2%. then followed by wrong dimension defects at 17% and the remaining incorrect parts at 10% of the total defects that occurred.

So repair of production damage can be focused on no component defects and breakage parts defects, this is because 75% of all defects consist of these 2 types of defects so repairs need to be made during the production process to avoid further damage.

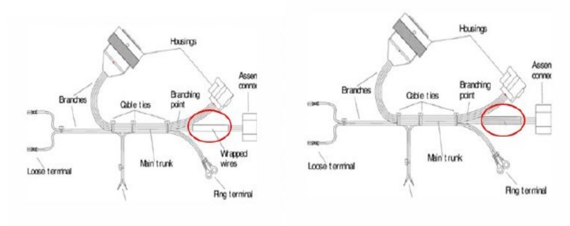

Fig. 5. Wire harness diagram OK and NG defect no component

C. Control Chart

The second step is to create a control chart. The control chart is a tool that is graphically used to monitor and evaluate whether an activity or process is under quality control statistics or not so that it can solve the resulting problems quality improvement. The control chart shows changes in data from time to time. the formula for the control chart is :

a. calculate the percentage of damage :

$$P = \frac{nnnn}{nn}$$

b. Calculating the Center Line

The center line is the average product damage

$$CL = \frac{\sum nnnn}{\sum nn}$$

$$CL = \frac{33}{28780} = 0{,}0011466$$

c. Calculating the Upper Control Limit

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

$$UCL = 0{,}0011466 + 3\sqrt{\frac{0{,}0011(1-0.0011)}{28780}} = 0{,}00401$$

d. Calculating the Lower Control Limit

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

$$LCL = 0{,}0011466 - 3\sqrt{\frac{0{,}0011(1-0.0011)}{28780}} = -0{,}0001$$

The following is results of data processing on control charts :

TABLE IV
CONTROL CHART DEFECT NO COMPONENT

	Production	qty defect	P	LC	UCL	LCL
1	1348	2	0,0014837	0,0011466	0,00401	0
2	1294	3	0,0023184	0,0011466	0,00401	0
3	1339	0	0,0000000	0,0011466	0,00401	0
4	1354	1	0,0007386	0,0011466	0,00401	0
5	1313	0	0,0000000	0,0011466	0,00401	0
6	1302	1	0,0007680	0,0011466	0,00401	0
7	1328	1	0,0007530	0,0011466	0,00401	0
8	1296	2	0,0015432	0,0011466	0,00401	0
9	1291	0	0,0000000	0,0011466	0,00401	0
10	1288	0	0,0000000	0,0011466	0,00401	0
11	1269	2	0,0015760	0,0011466	0,00401	0
12	1270	1	0,0007874	0,0011466	0,00401	0
13	1305	2	0,0015326	0,0011466	0,00401	0
14	1315	4	0,0030418	0,0011466	0,00401	0
15	1307	1	0,0007651	0,0011466	0,00401	0
16	1308	0	0,0000000	0,0011466	0,00401	0
17	1317	0	0,0000000	0,0011466	0,00401	0
18	1302	0	0,0000000	0,0011466	0,00401	0
19	1320	7	0,0053030	0,0011466	0,00401	0
20	1335	3	0,0022472	0,0011466	0,00401	0
21	1323	3	0,0022676	0,0011466	0,00401	0
22	1256	0	0,0000000	0,0011466	0,00401	0

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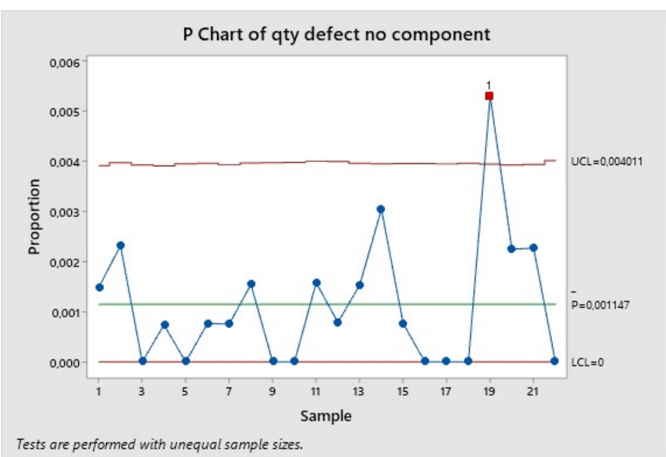

Fig. 6. Wire harness diagram OK and NG defect no component

Based on the calculation results and control chart graph above, it can be said that the quality of wire harness production on the Spacia Roof Line in January 2024 is still not under control and there are still large defect deviations in the production process.

It is said to be uncontrolled seen from the presence of points that exceed the upper control limit and lower control limit and do not meet the specified tolerance limits. On the control chart there is 1 point that exceeds the predetermined statistical control limits. namely on the 18th day of the experiment which reached a proportion value of 0.00922 with an upper limit value of 0.004011 and a lower limit value of 0

Based on the explanation and graphs that have been displayed, it can be concluded that control the quality of the Spacia Roof line is beyond control. Production quality control still requires further improvement to overcome deviations that occur and prevent further deviations.

D. Cause And Effect Diagram

Fishbone diagram is a line diagram describes factors in the occurrence of product defects identified from various aspects, including: humans, machines, methods and materials. Fishbone diagrams show the relationship between the problems faced and the possible causes and factors that influence them.

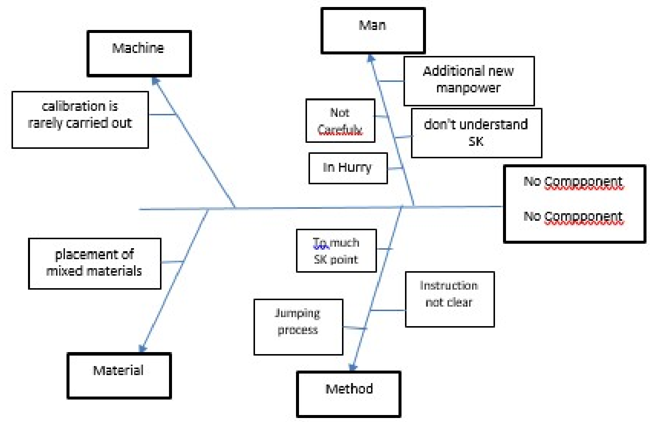

Fig. 7. Fishbone diagram

Validation of "Not Understanding SK" as the Main Root Cause

Human Factor

1. Additional New Manpower

- Analysis : New employees often are not familiar with the company's systems and procedures, including SK.

- Validation: As they are new, they need time and training to understand SK. This issue is more significant than problems with machines or materials because humans are the primary executors of SK procedures.

2. Not Careful

- Analysis : Lack of carefulness is usually a behavioral issue that can be improved with better understanding of SK.

- Validation: If workers better understand SK, they will be more careful in performing their tasks. Carefulness can be enhanced through a solid understanding of established procedures and SOPs.

3. In a Hurry

- Analysis : Rushing is often caused by pressure to meet targets.

- Validation : If workers understand SK well, they can work more efficiently and reduce errors even under pressure.

With good understanding, they can identify the correct task priorities.

Machine Factor

1. Calibration is Rarely Carried Out

- Analysis : Uncalibrated machines can lead to inaccuracies and operational failures.

- Validation : However, this problem can be more easily identified and addressed through regular maintenance. This is more of a technical issue than a human understanding issue of procedures.

Material Factor

1. Placement of Mixed Materials

- Analysis : Mixed materials can cause confusion in the production process.

- Validation : However, this can be managed with a good material management system and is not as crucial as workers' understanding of SK. Understanding SK helps workers follow procedures despite chaos in material placement.

Method Factor

1. Too Many SK Points

- Analysis : Too many SK points can overwhelm workers.

- Validation : This indeed shows that workers may not understand SK well because it is too complex. Simplification and training can help, linking this back to understanding SK.

2. Jumping Process

- Analysis : Skipping steps in the process indicates a lack of understanding of the importance of each step in SK.

- Validation : If workers understand SK well, they are more likely to follow each step correctly.

3. Instructions Not Clear

- Analysis : Unclear instructions cause confusion and errors.

- Validation : This shows that understanding SK is very important. If instructions are clarified and SK understanding is improved, errors can be minimized.

Component Factor

1. No Component

- Analysis : Lack of components can disrupt the production process.

- Validation : However, this is a logistics issue that can be resolved with a good inventory system. This is not as crucial as workers' understanding of SK, as those who understand SK can find alternative solutions or report problems appropriately.

TABLE V
FIVE WHY ANALYSIS

Defect	1st	2nd	3rd	4th	5th
No Component	too many work instruction done by the one operator	The operator doing jump process	The operator don't understand work standard correctly	The operators less trained	The operator just placed in that line

From the table five why analyze above, it can be concluded that the root of the problem resulting from defects in no component is that there are new operators placed on the resulting in a lack of training and not understandings work standard properly. This causes the operators to jump the process so that a process is missed wich results in component not being installed in the main wire harness.

The root cause "not understanding SK" is chosen because a good understanding of SK is fundamental to operational success. Human factors are crucial in executing the procedures and processes established. With a good understanding of SK, many other issues like lack of carefulness, rushing, skipping steps, and unclear instructions can be minimized or eliminated.

Understanding SK also serves as a basis for training, development, and overall performance improvement. Therefore, ensuring that all workers have a good understanding of SK is a critical step in enhancing efficiency and quality in the production process.

V. Conclusion and Suggestions

A. Conclusion

This study highlights the effective application of Six Sigma methodologies, specifically the DMAIC (Define, Measure, Analyze, Improve, Control) approach, in improving the quality of wiring harness production at PT. Sumitomo. Through detailed analysis of defect data from the Spacia Roof line during the period January 2024, it was identified that the most common defect was the No component, accounting for 37,23 % of total defects.

The root cause analysis revealed that defects were primarily due to process inefficiencies and lack of stringent quality control measures.

The autor give provides suggestions for improvement to provide training by conducting trials in accordance with the real process in line will be placement and there are work instruction in the work area to minimize the oprators forgetting the process in that section.

B. Suggestions

From the research that has been carried out, the author can provide some suggestions that are expected to be useful for the company are:

1. Calculation and application of the Statistical Process Control (SPC) method it is hoped that this can continue to be carried out in order to obtain accurate information in improving the quality of products produced and knowing what factors cause damage.
2. Routine checks and supervision should be carried out properly as one way to avoid machine errors, so the process production runs smoothly and the system processes materials into a finished product that can operate optimally and with awareness operators regarding maintenance of machines and equipment

needs to be improved to be able to maintain machine performance and the quality of the products produced

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LAMPIRAN

FORMULIR LOOGBOOK BIMBINGAN DAN PENGAJUAN SIDANG TUGAS AKHIR

Nama : Martua Yeremia Simanjuntak
NIM : 3222101045
Pembimbing I : Aditya Gautama Darmoyono, S.T.,M.T.
Judul : Application of Six Sigma Techniques with a Focus on Control Process Statistics in Wiring Harness Productions

No	Hari/Tgl	Rincian Kegiatan	TTD Pembimbing
1	Jumat 15-03-2024	Membahas grafik /chart yang dipakai.	
2	Selasa 19-03-2024	Perbaikan data / grafik P chart yang dibuat	
3	Senin 22-04-2024	Perbaikan urutan grafik yang ditampilkan di bab 4.	
4	Kamis 25-04-2024	Cause & effect diagram. Serta bahan conclusion.	
5	Rabu 29-05-2024	~~Penambahan~~ ~~suggestions~~ Perbaikan dibagian analisis.	
6	Kamis 30-05-2024	~~[illegible]~~ Suggestions and conclution	
7	Jumat 31-05-2024	PPT Revision	
8			
9			
10			

Berdasarkan hasil bimbingan yang telah dilaksanakan selama 6 bulan dan telah disetujui oleh dosen pembimbing, maka dengan ini saya mengajukan diri sebagai peserta Sidang Tugas Akhir.

Batam, 31-5-2024
Peserta

Martua Yeremia Simanjuntak.
NIM: 3222101045