Production quality control with new seven tools for defect minimization on PT. Dirgantara Indonesia

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Abstract. PT. Dirgantara Indonesia has a high production complexity by producing components for aircraft and aerospace products. The company report from 2016 until 2018 noted that the higher the number of defective products is delayed delivery to the main contractor, this is very detrimental to the company because in addition to getting fined also has to pay shipping costs. To analyze the problem, Seven New Tools are used. Affinity diagrams classify the problems causing defective products can be grouped into six groups. Interrelationship Diagram find out that 'Not strictly monitored' is the main factor. Tree diagrams designate three objectives to be achieved items, namely facing the reward and penalty system, conducting monitoring, and emphasizing on the process and results according to quality standards. The Priority Box determines several needs, namely giving a penalty for the operator, using the checklist in the production, and making a monitoring schedule. The Matrix Diagrams choosing the most important is Training Time and creating a monitoring schedule. Chart of Decision Making Process Programs provides solutions for problems that occur in the field, which are simultaneously monitoring, giving a good understanding of the process, and leadership function. The arrow diagrams provide a critical path for making a monitoring schedule.

1. Introduction
PT. Dirgantara Indonesia has a high production complexity because it produces hundreds of components for Aircraft and Aerostructure products. In the Aerostructure field, the company moves as a sub-contractor for wing components of the Airbus A-320, 330, 350, 380 aircraft. The quality standards used are determined by Airbus from material to product dimensions.

The Airbus wing component production process is handled by the Spirit AeroSystems rooms division ensures the continuity of the process in accordance with the standard with the SAP (System Application and Products) system. The product defect report is reported every three months, the report contains statistics on the number of data defects and causes of defects in the product.

Determination of product defects Obtained from the results of measurement of quality control stations. There are three types of quality control stations items, namely, Prismatic QC stations for small-sized components, QC CMM (Coordinate Measuring Machine) stations for components with dimensions that are difficult to measure manually, and Manual QC stations, for medium-sized and big components. Products that are declared defect will not continue with the production process and product defects stored in the warehouse.
The report from 2016 - 2018 notes the high defect product numbers resulted in delays in delivery to the main contractor. This is very detrimental to the company because in addition to getting a fine the company also has to pay shipping costs that are the responsibility of the main contractor.

Table 1. Number of Defect Product 2016-2018

| Year | Number of Defect |
|------|------------------|
| 2016 | 60               |
| 2017 | 26               |
| 2018 | 10               |

From Table 1, it was found that there was a 43% reduction in disability from 2016 to 2017 and 38% from 2017 to 2018. The decline in the number of disability will be increased by applying the new seven tools. By implementing seven new tools, this paper aims to find the cause of late delivery and provide alternative improvements to reduce the number of late deliveries.

2. Literature Review

2.1. Quality Control

Increasingly tight competition in the business world today encourages companies to develop ideas to obtain effective and efficient ways to achieve their intended goals and objectives [1].

Many factors influence the success of achieving company goals. One of the most important forces that support the success of achieving company goals and increasing the growth rate of companies in the market is quality or quality factors. The role of quality greatly supports the smooth production of a product within the company. The quality control system provides a significant contribution to achieving optimal quality. Basically, a quality control activity has a broad scope, because it must pay attention to all the factors that can affect the results of reviews these qualities [2].

Quality control is a system that consists of testing, analysis, and actions that must be taken using a combination of all equipment and techniques that are useful for controlling the quality of a product with minimal costs, in accordance with the wishes of consumers [3]. Whereas to know the meaning of quality control, we need to know first the meaning of "control" and "quality" [4].

Quality control can be defined as the overall way we use to determine and achieve quality standards. In other words, quality control is to plan and implement the most economical way to be able to make a product that will benefit and satisfy the demands of consumers to the fullest [5].

This quality control is a tool for management to improve product quality if needed, to maintain high quality, reduce the number of damaged products. Quality control procedures for a product, process or service are systematically arranged so that the implementation of this quality control function is carried out effectively. General steps in realizing this quality control function are carried out effectively [6].

The Engineering Department Determining is responsible for quality standards, evaluating the final product in accordance with the desired quality and designing a test of significant-quality deviations. Manufacturing Department regulates the activity of manufacturing to create jobs - jobs that meet the specified requirements.

Quality Engineering Department does the best coordination of activities related to quality control activities.

Inspection Department in principle, make an effort to prevent excessive or inaccurate checks, this section keeps the optimal procedure for inspection [7].

Quality engineering develops quality plans in detail. Process control engineering (including inspection and tests), monitors the implementation of quality control in the production process and
carries out quality improvements or the way the inspection is carried out. Quality Equipment Engineering designs and develops inspection and testing facilities in order to obtain measurement, control and flow of quality information as specified\[8\].

So it can be concluded that quality control is an activity that is closely related to the production process, where quality control is carried out by examination or testing, on the quality of the product to assess the ability of the production process that is associated with product specification standards. Then the analysis will get the causes of irregularities because it is the basis for taking corrective or preventive actions.

2.2. Basic and New Seven Tools

The following will explain seven quality control tools (The 7 QC Tools) items, namely: Check Sheet (Check Sheet). This tool is a form of recording the data easily, so as to avoid mistakes that may occur, in the collection of the data. Generally, this Check Sheet contains questions that are made in such a way, so that the note taker simply gives a column that has been available, and provides information as needed\[9\].

A histogram is a bar chart that serves to describe the form of distribution of a set of the data which is usually in the form of quality characteristics. This histogram can be made by first forming the frequency table, then followed by statistical calculations, then the plotting of the data into a histogram. The results of the data plots will make it easier to analyze trends in a group of data\[10\]. Pareto diagram, a diagram or graph that explains the hierarchy of problems that arise so that it serves to determine the priority of problem-solving. The sequence of priority improvements to overcome problems can be done by starting on the dominant problem needed and obtained from this Pareto diagram. After the improvement is made a new Pareto diagram can be made to compare with the previous conditions \[11\].

Stratification of Problems, is an attempt to classify the business (data damage, phenomena, cause, and effect) into groups that have the same characteristics. The base of the grouping stratification depends on the purpose of the grouping so that the base of the grouping can vary depending on the problem.

Stock diagram, a diagram that illustrates the relationship between two factors by plotting the data from Reviews. These two factors from a graph. With this diagram, we can determine the correlation between a cause and its consequences. Correlation calculations can be done using regression or by using the middle-value method.

The graph is a way of presenting data that consists of lines that connect two specific amount. The control chart is a chart with a list of the maximum and minimum limit which is the limit of the control area. Objectives describe the control chart is to establish whether any point on the graph is normal or not normal, and be aware of changes in the process from which the data are collected so that each point on the graph must indicate quickly from the process where the data is taken. This map shows the change from time to time but did not indicate the cause of the deviation, although the deviation will be visible on the control chart.

Fish Bone Diagram, this diagram is a diagram used to find the cause of the suspected elements can cause the problem. This diagram is often referred to as a fishbone diagram because it resembles the shape of a fishbone structure. The right part of the diagram usually describes the result of the problems while the fishbone branches describe the cause\[12\].

New Seven Tools developed as a result of research efforts of a committee of the Japanese Society for Quality Assurance Techniques Development. Goal / QPC (quality consulting firm) recommends the use of the new seven tools as a cycle of activity where one tool providing input for other tools. New Seven Tools consisting of: Affinity diagram helps a group to find a composition of themes and ideas that can be used next. Affinity Diagram create a hierarchy of ideas on a large surface. Interrelationship diagram shows the relationship between the different issues. After completing the affinity diagram, it would be useful to determine the causal relationship between the different issues on the surface. A tree diagram is useful to identify the steps needed to solve the existing problems.
Prioritization Grid used to make decisions based on multiple criteria. For example, in selecting a technology, we can just have a variety of options. Besides the decision criteria also varied as how to select the desired result. When several alternatives and criteria are available, a priority matrix is a useful method to tell the giver decisions without resorting to complex analysis.

Matrix diagram has the same concept as quality function deployment on how to use them to symbols, layout, and application. Diagram matrix is a brainstorming tool that can be used to indicate a relationship between the different ideas[13].

Process Decision Program Chart is a tool to help possibilities for brainstorming or problem-related with the implementation of some programs or development.

Arrow diagram used to find the critical path (the longest time from the starting point to the endpoint) is used to control the project[14].

New Seven Tools itself has been widely applied to solve a wide range of good quality control problems in manufacturing or services [15][16][17][18].

3. Methodology

The study was conducted by interviewing the production manager and operator, and then conducted field observations and mutilation of data to be processed systematically by the method of the New Seven Tools

4. Results and Discussion

Affinity Diagram is used to identify the problem through the brainstorming process and conducted grouping similar problems.

![Figure 1. Affinity Diagram](image)

Based on the above diagram concluded that problems cause product defect can be grouped into 6 groups, namely the human, material, process, equipment, systems, and work environment. This grouping aims to facilitate the identification of the cause of the problem. Interrelationship Diagram for the delivery delay problem can be seen in Figure 2
From Figure 2 obtained that factor 'Not to be monitored closely' to be a factor in the direction of the arrow out most to be a major factor.

A tree diagram is used to identify the steps needed to resolve the issue. The problems to find the solution obtained from the Interrelationship Diagram.

Based on the tree diagram is three objectives, namely:
1. Reward and penalty system is done on the operator.
2. Be monitored regularly and carefully.
3. The emphasis of the process and results in line with quality standards.

Prioritization Grid is used to look at the relationship between the strategies that have been formulated in a tree diagram with the objectives to be achieved. This chart uses three types of symbols that represents the degree of correlation is strong, medium and weak.
| Solution                                      | Resource Needed | Capital Investment | Training Time | Certification Assessment |
|-----------------------------------------------|-----------------|--------------------|---------------|--------------------------|
| information system implementation for operators | ○               |                   | ●             | ○                        |
| Reward for over perform operator              | ○               | ●                  | Δ             | Δ                        |
| Penalty for under perform operator            | Δ               | Δ                  | Δ             | Δ                        |
| Integrated information system implementation | ●               | ●                  | ○             |                          |
| Checklist on Processing                       | Δ               | Δ                  | Δ             |                          |
| Monitoring schedule                           | Δ               | Δ                  | Δ             |                          |
| Scrum system implementation                   | ●               | ●                  | ●             |                          |

Figure 3. Prioritization Grid
From Prioritization Grid can be concluded that the chosen solution is the lowest is in need of resources:

1. Give a penalty if the operator does not reach the target,
2. Using the checklist on the production process, and
3. Creating a monitoring schedule.

Diagram matrix is used for the quantitative analysis of several options against several criteria. Options are analyzed here is the solution that requires the lowest resource derived from a matrix diagram.

| Option                  | Capital Investment | Training Time | Certification Assessment | Importance Score Sum | Option Ranking |
|-------------------------|--------------------|---------------|--------------------------|----------------------|----------------|
| Penalty for under perform operator | Percentage Weight 0.2 | 0.5 | 0.3 | | |
|                         | Rank 1 | 2 | 3 | 2.1 | 2 |
|                         | Importance Score 0.2 | 1 | | 0.9 | |
| Checklist on Processing | Percentage Weight 0.4 | 0.4 | 0.2 | | |
|                         | Rank 3 | 1 | | 1.8 | 1 |
|                         | Importance Score 1.2 | 0.4 | | 0.2 | |
| Monitoring schedule     | Percentage Weight 0.2 | 0.6 | 0.2 | | |
|                         | Rank 1 | 3 | 1 | 2.2 | 3 |
|                         | Importance Score 0.2 | 1.8 | 0.2 | | |

**Figure 4. Diagram Matrix**

The figures given for each option is derived from interviews with the production manager. Where vertically is the most important selection criteria training Time and horizontally the selected option is to build the monitoring schedule.

PDPC used to determine the obstacles that may occur on the application of field solutions and actions to those constraints

From the PDPC obtained solution to a few choices if there are problems in the field include:

1. To monitor simultaneously,
2. Provide good understanding process, and
3. Give the dual function of each department leaders.

Arrow diagram is used to determine the schedule and order of implementation of the solution that has been selected. Making the monitoring schedule is used based on the National Occupational Standards guidelines for the Plan, schedule and monitor production.

Based on the Arrow diagram obtained processes that must elapse before carrying out an activity. So that it can continue to make a diagram of arrows.
Obtained results for each tool used, including:

1. Affinity Diagram classify problems cause product defect can be grouped into 6 groups, namely the human, material, process, equipment, systems, and work environment. This grouping aims to facilitate the identification of the cause of the problem.

2. Interrelationship Diagram look for the factors most associated with other problems. 'Not to be monitored closely' to be a factor in the direction of arrow out most to be a major factor.

3. Tree diagram shows the three objectives, namely:
   a. Reward and penalty system is done on the operator.
   b. Be monitored regularly and carefully.
   c. The emphasis of the process and results in line with quality standards.

4. Matrix diagrams concluded that the chosen solution is the lowest is in need of resources:
   a. Give a penalty if the operator does not reach the target,
   b. Using the checklist on the production process, and
   c. Creating a monitoring schedule.

5. Matrix Data Analysis vertically choose the most important selection criteria are horizontally Training Time and the selected option is to build your monitoring schedule.

6. Process Decision Program Chart provides a solution to several options if there are problems in the field include:
   a. Monitoring simultaneously,
   b. Give a good understanding of process, and
   c. Giving the dual function of each department leaders.

7. Arrow Diagram provides a critical path scheduling is sequentially 1-2-3-4-11-12-13 monitoring.

5. Conclusion
Based on the result, it can be concluded that by using Seven Tools, it can be identified as the cause of the failure problem. In addition to that, Seven Tools can be used to formulate alternative improvements. By applying Affinity Diagrams and Interrelationship Diagrams, we can classify problems that cause product defects and identify the causes of problems. By applying Tree Diagram, Matrix Diagram and Matrix Data Analysis, we can classify critical needs are needed to solve existing problems. By applying Process Decision Program Chart and Arrow Diagram, we can provide a solution to several problems. The result ultimately shows us that the New Seven Tools can be applied to solve a wide range of good quality control problems in manufacturing or services.
6. Reference

[1] Fonsesca L, V Lima, M Silva 2015 Utilization of Quality Tools (International Journal for Quality Research Vol 9) 1-5

[2] MMA Omar Abdullah KA 2016 The Use of the Probability Tree Diagram to Test the integrated Model in Building the Management Information System (Global Journal of Management and Business Research Vol 16) 80-81

[3] S Muhammad in 2015 Quality Improvement of Fan Manufacturing Industry by Using Basic Seven tools of Quality (Int. Journal of Engineering Research and Application Vol 5) 30-35

[4] R Ramphal 2016 A quality Tool Box for the Hospitality Industry (African Journal of Hospitality, Tourism, and Leisure) 1-5

[5] FH Lerman, MF Morais, C Matos, R Roder, Roder 2016 C Data Envelopment Analysis (Independent Journal of Management & Production) 833-852

[6] V Jayakumar, FMA Sheriff, A Muniappan, G. Bharathiraja 2017 Implementation of Seven Tools of Quality in Educational Arena (Int. Journal of Mechanical and Technology) 882-890

[7] MR Suryoputro, M Sugarinda, H Erfaisalsyah 2017 Quality Control System using Simple Implementation of Seven Tools for Batik Textile Manufacturing (IOP Conf. Series: MOIME) 1-5

[8] I Goicoechea, M Fenollera 2012 Quality Management in the Automotive Industry (DAAAM International Scientific Book Ch. 51) 619-632

[9] Andersson K, M Lintinen, T Lehtonen, PH Andersson. 2014. Differences and Similarities between Quality Improvement Methods Originating from the USA and Japan (Australia: NordDesign) 845-853

[10] ST Foster 2009 Managing Quality: Integrative Approach (New Jersey: Prentice Hall)

[11] Yutao M, L Shumao 2009 Enhancing the Application of Quality Engineering Technique to Improve Quality Assurance Ability (IEEE) 1348-1351

[12] CB Fotopoulos, EL Psomas. 2009 The Impact of "soft" and "hard" TQM Elements on Quality Management Results (Int. Journal of Quality & Reliability Management Vol. 26) 150-163

[13] FS Handika, AB Barnadi 2017 Electricity Consumption Analysis on Drainage Pump Unit by Using New Quality Tools (Journal of Systems and Industrial Management Vol 1) 91-98

[14] S Fauzi, K Siregar 2011 Quality Improvement Method Using New Seven Tools and Fault Tree Analysis (Proceedings SNTI and SATELLITE) 110-117

[15] P Wisnubroto, A Rukmana 2015 Product Quality Control by Pendeketan Six Sigma and Kaizen Analysis And New Seven Tools For Business Disability Reduction Products (Technology Journal Vol 8) 65-74

[16] YFE Sugijopranoto 2014 Improvement Plastic Bags with Seven Steps Method of Using Old and New Seven Tools PT Asia Chakra Cheers Plastic Surakarta (Yogyakarta: UAJY) 1-6

[17] A Chandradevi, NB Puspitasesari 2016 Analysis Production Quality Control X 500 ml bottles at. Berlina, TBK by Using New Seven Tools (Semarang: E-Journal Undip) 1-8

[18] MA Silviadara, W Budiawan 2016 Lack of Customer Visitation Analysis Using New Seven QC Tools (Case Study in Acasta Restaurant) 1-9