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Synergizing QCC and PDCA Approaches to Foster Kaizen Practices in Wingbox Production at Karoseri

Fredy Sumasto[1*], Muhamad Eryl Saputra Syaeful[1], Edwin Sahrial Solih[2], Finna Suroso[3], Astriyani Sandya Paramita[4]

[1]Department of Automotive Industrial Engineering, Politeknik STMI Jakarta, Jakarta Pusat 10510, Indonesia
[2]Department of Automotive Engineering Technology, Politeknik STMI Jakarta, Jakarta Pusat 10510, Indonesia
[3]Department of Automotive Industry Information Systems, Politeknik STMI Jakarta, Jakarta Pusat 10510, Indonesia
[4]Department of Automotive Business Administration, Politeknik STMI Jakarta, Jakarta Pusat 10510, Indonesia

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A B S T R A C T

This research applies the Quality Control Circle (QCC) method and the PDCA (Plan-Do-Check-Action) approach to overcome problems in hydraulic cylinder bracket mounts in a manufacturing company. At the "Plan" stage, a defect classification analysis, matrix diagram for problem classification, analysis of existing conditions, setting quality, cost, and morale targets, as well as Why-Why and 5W+1H analysis were conducted. At the "Do" stage, the cylinder bracket mounts was redesigned using UNP 5.4 material as a solution to the existing problems. At the "Check" stage, measurements of the improvement results were made to ensure the achievement of the planned targets, including the reduction of damage frequency and repair costs. The results of overcoming the problem of broken hydraulic cylinder bracket mounts showed a decrease in complaints during the 2-month period after implementation. The application of the QCC method and PDCA approach not only effectively addressed the problem, but also increased customer confidence, company sustainability, and worker morale. The next step is “Action” stage to ensure process continuity by standardizing through the creation of operation standards for the manufacture and installation of hydraulic cylinder bracket mounts. As a result, the material change from SPHC 6.0 to UNP 5.4 successfully resolved the damage problem and eliminated complaints within two months after implementation. After implementation, the company can reduce the cost expense of repair by IDR 1,413,510. This success had a positive impact on customer confidence, cost efficiency, and worker morale.

***Corresponding Author**

Fredy Sumasto
E-mail: f-sumasto@kemenperin.go.id

1. INTRODUCTION

The automotive industry has become one of the main pillars of modern society, providing irreplaceable mobility solutions. To meet customer expectations, the industry is constantly faced with the challenge of producing high-quality and safety-compliant motor vehicles (F Sumasto et al., 2020; Fredy

Sumasto, Nugroho, et al., 2023). However, massive production growth has not always spared the automotive industry from potential product defects or weaknesses (Faiesal et al., 2018). In this context, the wingbox body, a vital component in trucks for transporting heavy and bulky goods, emerged as a focus of attention. Despite maximum efforts being made to ensure quality, customer complaints related to wingbox bodies are still an issue that needs to be addressed effectively (Hernadewita et al., 2019). These complaints not only compromise brand reputation but can also impact customer confidence and business performance. The application of Kaizen (continuous improvement) and Quality Control Circle (QCC) principles is emerging as a promising solution to addressing these challenges. Kaizen, as a Japanese business philosophy focused on continuous improvement, has proven to be an effective method in improving the efficiency and effectiveness of production processes. In this case, the Quality Control Circle (QCC) plays an important role in identifying, analyzing, and correcting problems within an organization, ensuring collective understanding and active participation from employees (Fahturizal, 2020; Faiesal et al., 2018).

This research aims to explore the application of Kaizen and Quality Control Circle concepts in the context of wingbox production at PT Mitra Toyotaka Indonesia. This research will not only identify problems that may arise in the production of wingboxes but will also present the improvement measures taken using the Kaizen approach and the active support of QCC. In this context, documenting the improvements and the process is essential in ensuring the effectiveness and reproducibility of future improvements. The improvement steps taken by the Quality Control Circle (QCC) in the Kaizen approach have the potential to address problems in wingbox production more effectively. This research will outline the implementation of Kaizen and QCC in dealing with the improvement documentation constraints faced by PT Mitra Toyotaka Indonesia. With a strong theoretical foundation and relevant practical applications, this research is expected to contribute to the understanding of the application of Kaizen and Quality Control Circle in the automotive industry. Through an emphasis on documentation of improvements, this research also seeks to present practical strategies to overcome problems that may be faced by similar companies. Thus, this research not only provides new insights but also provides practical guidance for continuous improvement in automotive production.

2. LITERATURE REVIEW

In recent decades, the manufacturing industry has witnessed the adoption of various management models aimed at improving quality and efficiency. While models such as Lean Manufacturing, Six Sigma, and Total Quality Management (TQM) have been implemented individually by many organizations to improve production quality, integrated approaches have started gaining attention. Integrated models such as Lean Six Sigma have empowered organizations to achieve competitive advantage by addressing quality issues in a comprehensive approach (Saad & Khamkham, 2018). This review explores the application of the Quality Control Circle (QCC) as an integrated quality management framework in the context of manufacturing organizations, with a particular focus on kaizen and continuous improvement practices. The application of QCC in the manufacturing industry has a wide scope, covering various types of industries from steel manufacturing to donut production (Ridwan et al., 2022; Riyanto, 2015; Setiawan & Soediantono, 2022; Sulaeman & Gusniar, 2023; Tambunan et al., 2020; Taqwanur & Suryawantiningtyas, 2022). QCC is used to overcome product defects, increase productivity, and reduce production costs. Analysis of factors causing defects is the first step in implementing QCC, often involving Pareto analysis tools, fishbone diagrams, or why-why analysis to identify the root causes of problems (Annai Nashida & Syahrullah, 2021; Sulaeman & Gusniar, 2023; Fredy Sumasto, Maharani, et al., 2023; Tambunan et al., 2020; Taqwanur & Suryawantiningtyas, 2022). Improvement measures are then formulated based on this analysis.

In addition to improving product quality and process efficiency, QCC has also been shown to contribute to quality control and occupational safety (Asiyah et al., 2022; Rusman & Prabowo, 2021). Improvement efforts made by the QCC team can reduce product defect rates and create a safer work environment. The results of QCC implementation are also visible in various aspects of performance, including a decrease in the percentage of product defects, increased efficiency, and positive recognition from QCC team members (Panjaitan et al., 2012; Zhang et al., 2020). However, in adopting the findings from this literature, it is important to consider the unique context of an organization, such as PT Mitra Toyotaka Indonesia. Any QCC implementation must be customized to the production characteristics and specific challenges faced. The results of this content analysis will provide a solid foundation for formulating specific steps in effectively implementing QCC, to sustainably improve kaizen practices and production quality.

3. RESEARCH METHOD

This research aims to apply the Quality Control Circle (QCC) approach with the Plan-Do-Check-Act (PDCA) framework in improving Kaizen practices and production quality at PT Mitra Toyotaka Indonesia as a car bodywork company (Karoseri). This research will use a mixed method approach (quantitative and qualitative) with a focus on the application of QCC with the PDCA framework in the context of PT Mitra Toyotaka Indonesia. The research design (Figure 1.) will involve the stages of literature analysis, problem identification, improvement plan formulation, improvement plan implementation, result evaluation, and follow-up action.

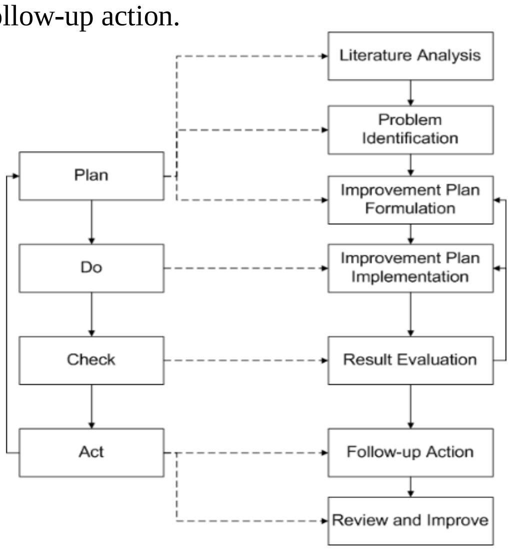


Figure 1. Research design
(Source: Isniah et al., 2020)

The initial stage of this research will involve an in-depth analysis of the literature relevant to the implementation of QCC and PDCA in improving Kaizen practices and production quality. The results of the literature analysis will serve as the foundation for designing a QCC-PDCA implementation strategy at PT Mitra Toyotaka Indonesia. After understanding the concepts of QCC and PDCA from the literature, the next step is to identify the specific problems that need to be solved within PT Mitra Toyotaka Indonesia. This will involve an in-depth analysis of current production practices, identifying areas with improvement potential, and analyzing the root cause of the problem (Fahturizal, 2020; Setiawan & Soediantono, 2022).

After understanding the concepts of QCC and PDCA from the literature, the next step is to identify the specific issues that need to be resolved within PT Mitra Toyotaka Indonesia. This will involve an in-depth analysis of current production practices, identifying areas with improvement potential, and analyzing the root cause of the problem (Fredy Sumasto, Maharani, et al., 2023; Zhang et al., 2020). The formulated improvement plan will be implemented in the PT Mitra Toyotaka Indonesia production environment. This process will involve cooperation between the QCC team and relevant stakeholders, such as production operators and management. After implementation, the results of the improvement plan will be carefully evaluated. Quantitative and qualitative data will be collected to measure the impact of the implemented changes on Kaizen practices and production quality. The evaluation results will help the QCC team and management to take necessary follow-up actions. If the improvement plan has successfully improved Kaizen practices and production quality, the steps can be used as a reference for implementation in other areas or continuous improvement (Saad & Khamkham, 2018).

4. RESULT AND DISCUSSION

Problem solving using QCC with a 7-step Plan-Do-Check-Action (PDCA) cycle approach.

Plan Stage

In this planning stage, there are 4 sub-steps carried out, namely determining the theme, analyzing existing conditions and determining targets, making activity schedules, cause and effect analysis, and countermeasure plans which are divided into 4 (four) sub-plans.

First sub-plan

The first sub-planning is to determine the theme, the implementer collects information about problems or complaints for car body products that occur within a certain period. Data on car body damage reports received by the aftersales department for the period January - February 2023 at PT Mitra Toyotaka Indonesia. The results of the data are obtained in Table 1, it was decided to solve the problem in the classification of damage reports on hydraulics because it has the highest number of damage, namely 9 with a percentage of 41% of the total problems that occur. Then to facilitate problem solving that is more prioritized in the hydraulic classification, a matrix diagram is prepared to see the level of importance of the problem from several factors. Matrix Diagram is made by weighting the level of importance, urgency, trend, and policy based on the results of the QCC team brainstorming (Table 2.). The symbols on the Matrix Diagram have their weight, Δ = low = 1; o = medium = 3; and ● = high = 5.

Table 1. Breakdown classification data

Classification of Breakdown Reports	Total	Percentage (%)
Painting	2	9
Electric	1	5
Construction	8	36
Construction Part	2	9
Hydraulic	9	41
Breakdown total	**22**	**100**

Table 2. Matrix diagram for problem classification

	Factor					
Problem	Importance	Urgency	Trend	Policy	Score	Rank
Broken hydraulic oil tube	●	●	o	o	16	2
The hydraulic motor is not working	●	●	Δ	o	14	3
Broken mounting bracket hydraulic cylinder	●	o	●	●	18	**1**
Rupture of DSS cover spring	o	o	Δ	o	10	5
Leaking hydraulic cylinders	o	o	o	o	12	4
Score	21	19	13	17		
Rank	**1**	2	4	3		

Source: focus group discussion with QCC team

Based on Table 2, the problem chosen to be solved first is the broken mounting bracket hydraulic cylinder because it has the highest point of 55 from several comparison factors. So the theme chosen is "reducing problems for broken mounting bracket hydraulic cylinder".

Second sub-plan

The second sub-planning is to analyze the existing conditions and determine the targets to be achieved. This planning step is carried out by looking for information directly in the field about the conditions that occur and things that can cause the hydraulic cylinder bracket to break on the wingbox car (Table 3.).

After the problem is known and has checked (genba) the actual conditions that exist, the next step is to determine the desired target. The targets to be achieved in solving this problem are as follows: (a) Evaluate the design and use of SPHC material on the hydraulic cylinder bracket mounts so that the same damage complaint does not occur in the future, (b) Make significant improvements to solve the problem because it has occurred several times, because if the hydraulic cylinder bracket breaks, it can cause the wingbox to leak.

Table 3. Analysis of existing conditions

No	Factor	Existing Conditions	Impact	Remark
1	Man	Production operators perform the process in accordance with the existing drawings.	There is no difference between the design drawing and the actual process.	No Impact
2	Method	The production process, especially for roof parts, is in accordance with the standard.	In the production process, there were no direct reasons to support the problem.	No Impact
		The design of the mounting bracket is not perfect in considering when opening and closing the wingbox.	It is necessary to review a better design to withstand the pulling force generated from the hydraulis to find out the reason why the problem occurred.	Impactful
3	Material	Bracket mounts material using Steel Plate Hot Rolled Coiled (SPHC).	SPHC is easy to process but lacks strength as a mount.	Impactful
4	Machine	The machining process (cutting) of SPHC material has been carried out in accordance with the existing drawing reference.	The wingbox production process is appropriate and until the wingbox is completed, no problems have occurred.	No Impact

Source: focus group discussion with QCC team

After knowing the QCC target in general, the next step is to determine the QCDSM (Quality, Cost, Delivery, Safety, Morale) target so that it can be more easily measured when improvements have been made. The targets that the company wants to achieve are contained in Quality, Cost, and Morale, as follows: (a) Quality. Reduce the frequency of complaints about the same problem where in 2 months (January - February 2023) there were 3 similar problems to 0 complaints. The target is to achieve zero complaints in May - June 2023. (b) Cost. Reduce repair costs covered by the warranty period, where repair of the wingbox unit will incur additional costs from the process as well as material replacement if needed. Breakdown cost for repair: (i) Price of hydraulic cylinder bracket mounts with SPHC material 6.0 x 180 mm x 320 mm (2 pcs) = 151,170 IDR. (ii) Hourly work fee is 40,000 IDR. For repairs it takes 8 hours, so the labor cost paid is 320,000 IDR. Based on the breakdown cost for repair, the cost of repairing the hydraulic cylinder bracket mounts = 151,170 IDR + 320,000 IDR = 471,170 IDR. If it happens to 3 units, the total cost that can be eliminated is 1,413,510 IDR. If there are zero complaints, the repair cost can be reduced to 0 IDR. (iii) Morale. When making good wingbox products or not having leaks, it will increase customer confidence, and indirectly it will also encourage workers because their work is accepted and the workplace will last longer.

Third sub-plan

The third sub-planning is to analyze the causes of the problems discussed. Cause analysis uses why-why analysis (Table 4.) to make it easier to find the core root of the problem that occurs.

Fourth sub-plan

The fourth sub-planning is to determine the countermeasure plan to find out the steps to solve the problem. Some of the steps taken will be used as measurement results before and after it is done. The following is a countermeasure plan for the broken mounting bracket hydraulic cylinder problem. Making improvement proposals using 5W + 1H analysis (Table 5.) to overcome these problems.

Table 4. Why-why analysis

Problem: broken mounting bracket hydraulic cylinder			
Why 1	Why 2	Why 3	Why 4
The design of the bracket mounts is still not perfect	The use of SPHC material as a bracket mounts cannot withstand the pulling power of the existing hydraulic system	No strength test comparisons have been made with other material options	-
The design process of the bracket mounts is still focused on the base of the car body (karoseri)	There is no awareness in analyzing design failures	There is no list of critical parts in the wingbox design	The drafter considers the bracket mounting material only as a complement to cover the wingbox

Table 5. 5W+1H analysis

What	Why	Where	Who	When	How
Problem	Reason	Location	PIC	Date to Implement	Action
No strength test comparisons have been made with other material options	The test results of the bracket design using SPHC material have met the standards during the trial. However, in actual terms it is still not strong enough because of the frequent opening and closing of the wing	Drawing and purchasing area	Drafter engineer	30th March 2023	Change the drawing of the hydraulic cylinder bracket mounts design from SPHC 6.0 to UNP 5.4
Drafter considers the bracket mounting material only as a complement to cover the wing box	There is no list of critical parts in the wingbox design	Quality control and drawing area	Quality engineer and drafter engineer	4th April 2023	Create a document identifying critical parts and processes in the wingbox and accommodated in the process.

Do Stage

The Do stage is the second step in the PDCA method. However, in the QCC implementation step, the plan implementation stage is in the same sub-discussion as planning countermeasures, namely the fourth stage. The purpose of this stage is to carry out the countermeasure plan that has been made so that in the next stage it can be measured what changes occur from the results of the improvements made. The improvement made is to make changes to the design of the Hydraulic Cylinder Bracket mounts (Figure 2.) to minimize the occurrence of damage and keep critical parts in good condition.

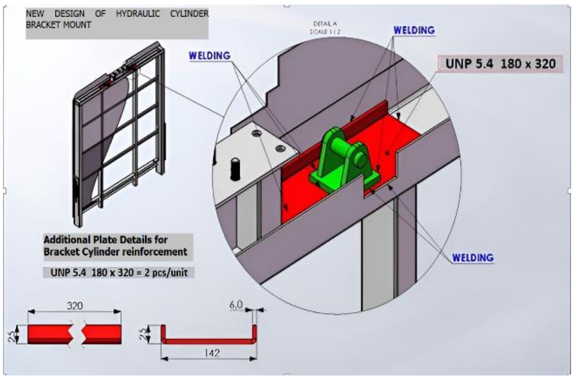


Figure 2. New design of hydraulic cylinder bracket mount uses UNP 5.4 material
(Source: Personal design by author, 2023)

Material selection UNP 5.4. is based on: (1) UNP 5.4 have specific properties that make it more suitable for the intended purpose, such as higher strength, better corrosion resistance, or improved thermal conductivity. (2) UNP 5.4 more cost-effective compared to SPHC 6.0, which could lead to cost savings for the project or application. (3) UNP 5.4 more compatible with other components or materials used in the system, reducing the risk of issues or failures.

Check Stage

The check stage is the third step in the PDCA method. This stage is used to measure the results of overcoming problems. Measurement of the results of this improvement relates to whether the countermeasures carried out are in accordance with the previously planned targets. In general, the QCC targets set have been accomplished and have had a positive impact. The target, namely evaluating the material used for the hydraulic cylinder bracket mounts to prevent the roof from being perforated and leaking, has been achieved due to design changes made. In addition, the measurement of improvement results can also be seen in terms of quality, cost, and morale: **(a) Quality.** Overcoming the problem of broken hydraulic cylinder bracket holder by replacing the material from SPHC 6.0 to UNP 5.4 has succeeded in eliminating complaints for a period of 2 months after implementation (May - June 2023) because there have been no complaints for the problem. The resolution of this problem will also indirectly increase consumer confidence because the company is committed to continuing to make improvements in terms of the quality of its car body products. **(b) Cost.** Based on the decrease in the frequency of damage from 3 units per 2 months to 0 after implementation, the company can reduce the cost burden (expense) of repairs by 3 x 471,170 IDR = 1,413,510 IDR. This not only increases consumer trust, but also makes the company more sustainable. **(c) Morale.** Workers become more enthusiastic because they feel that the results of their work are in demand by customers and sell in the existing market. Welding operators will also not feel disturbed if they have to take care of additional work such as repairs, while having daily work to do.

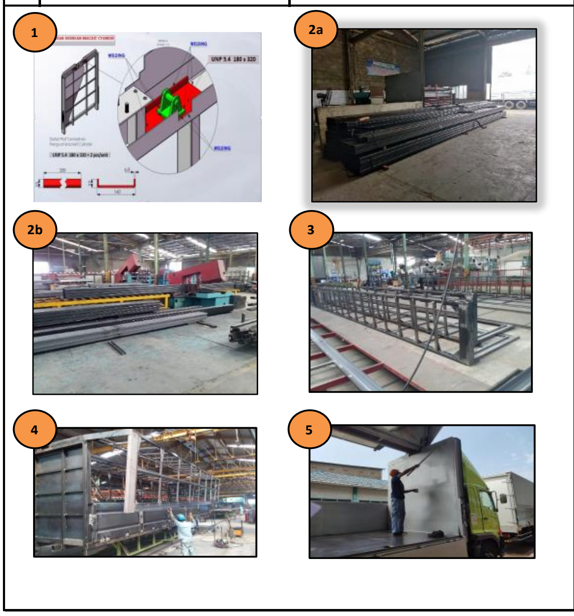
Action Stage

After overcoming the problem of the hydraulic cylinder bracket holder breaking, namely by changing the drawing and changing the SPHC 6.0 material used to UNP 5.4. After the action, the next step is to ensure that the process will continue to be carried out. The thing that can be done to help ensure the change process is to make standardization. Standardization is done by making operation standards for the manufacture and installation of hydraulic cylinder bracket mounts (Figure 3). After the final results of the QCC steps to solve the problem of the broken hydraulic cylinder bracket holder, the repair process will continue to solve the next problem. There are 4 remaining damages from hydraulic damage problems, namely broken hydraulic tubes, dead hydraulic motors, broken DSS spring covers, and leaking hydraulic cylinders. These problems must be resolved at the next plan stage to the standardization stage.

PT.MITRA TOYOTAKA INDONESIA

OPERATION STANDARD				NAME	PEMBUATAN DAN PEMASANGANDUDUKAN BRACKET CYLINDER		CONTROL NO	PAGE
				PROD NO	SEMUA UNIT WINGBOX		MTI-ENG 001	1/1
AREA	PRODUKSI	BAGIAN	PREPARATION, WELDING	PART & MATERIAL	DUDUKAN BRACKET	UNP 5.4	DRAWING PRODUKSI	
				PROCESS	PREPARATION, WELDING	SUB PROCESS	PEMBUATAN PART	

№	URUTAN PROSES	mpat kritikal (Aman ◆Mutu ●Mudah dikerjakan) /alasan tempat kriti



№		Tempat kritikal (Aman ◆Mutu ●Mudah dikerjakan) /alasan tempat kritikal
1	Engineering design membuat drawing produksi mengenai part dudukan bracket cylinder hydraulic	◆ Pastikan bahwa drawing untuk semua unit telah mengganti design dudukan brakcket dengan yang terbaru.
2	a. Drawing part dikirimkan kebagian gudang untuk membantu menyiapkan material untuk dipotong pada area preparation. b. Operator preparation cutting akan memotong material sesuai dengan drawing.	◆ Pastikan bahwa drawing produksi yang dikirim ke produksi sudah menggunakan material UNP 5.4 untuk dudukan bracket cylinder hydraulic.
3	Proses pengelasan (welding) dari material yang telah dipotong sesuai dengan drawing pada bagian assy roof.	◆ Pastikan bahwa pengelasan dudukan bracket cylinder hydraulic tidak terlewati, jika terlewat akan menambah pekerjaan nantinya karena mengulang proses.
4	Melanjutkan proses untuk pengelasan (welding) assy roof dengan bagian assy yang lain seperti frame wall, side door, side roof dan rear side door.	
5	Melakukan pengecekan dari unit yang telah di produksi atau disebut dengan Pre Delivery Inspection (PDI) dan ditambah dengan hal yang dicheck adalah dudukan bracket cylinder hydraulic.	◆ Menambakan bagian wajib yang dicek oleh quality control adalah dudukan bracket cylinder guna memastikan masalah sebelumnya tidak terulang.

REVISION RECORD				VALIDATION				HAL - HAL KHUSUS	
NO	DATE	REMARK	BY	PREPARED MATERIAL CONTROL	APPROVED MATERIAL CONTROL	MENGETAHUI PROD	MENGETAHUI ENG	MASALAH	TINDAKAN
N	17/4/2023	NEW RELEASE	ERIL	Already sign					
01									
02									
03									
04				Eril	DSU	PWD	SGT		

Figure 3. Operation Standard for manufacture and installation of hydraulic cylinder bracket mounts ***(Operation Standard in Bahasa)*** (Source: PT. Mitra Toyotaka Indonesia)

5. CONCLUSION

In this research, the Quality Control Circle (QCC) approach and the PDCA (Plan-Do-Check-Action) cycle have proven successful in overcoming the problem of damaged hydraulic cylinder bracket mounts. At the Plan stage, damage classification analysis, Matrix diagram creation for problem classification, existing condition analysis, and target setting in terms of quality, cost, and morale. The Why-Why Analysis step and the 5W+1H analysis become a strong foundation for identifying the root cause of the problem comprehensively. At the Do stage, corrective action is taken by redesigning the hydraulic cylinder bracket holder using UNP 5.4 material as a counterstep to the existing problems. At the Check stage, the results of the improvement are measured to ensure the achievement is by the planned target. As a result, the material change from SPHC 6.0 to UNP 5.4 successfully resolved the damage problem and eliminated complaints within two months after implementation. Based on the decrease in the frequency of damage from 3 units per 2 months to 0 after implementation, the company can reduce the cost expense of repair by 1,413,510 IDR. This success had a positive impact on customer confidence, cost efficiency, and worker morale. In the Action stage, steps to ensure the continuity of change were taken through process standardization. Creating operation standards for the production and installation of hydraulic cylinder bracket mounts is an important step in maintaining consistency of improvement and dealing with similar problems in the future. Overall, combining the QCC approach with the PDCA cycle proved its effectiveness in addressing problems and achieving continuous improvement. The methodology not only generates concrete solutions to technical problems, but also establishes a culture of improvement that focuses on quality, cost efficiency, and morale. The implications are wide-reaching. This suggests that the approach can be adopted by a wide range of industries to address operational challenges and improve overall performance.

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