In-house Quality Check System Improvement with Kanban System and Analysis Quality Control Circle

(Perbaikan Sistem Pemeriksaan Kualitas In-house dengan Sistem Kanban dan Analisis Gugus Kendali Mutu)

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Abstrak. Perkembangan digitalisasi berdampak positif terhadap gangguan yang berpeluang melahirkan inovasi sebagai bentuk perbaikan yang berkelanjutan. Salah satu perusahaan manufaktur yaitu PT TCH ingin mengimplementasikan inovasi Industri 4.0 dengan mempertimbangkan gagasan integrasi rantai pasokan horizontal dan analitik data. Salah satu penerapannya yaitu melakukan perbaikan pada permasalahan kesalahan labeling dengan nilai persentase 66% dengan rata-rata error 328 buah dengan membuat sistem peringatan sistem Kanban melalui penerapan Quality Control Circle (QCC). Perbaikan dilakukan dengan analisa *Plan*, *Do*, *Check*, and *Action* (PDCA) dengan melakukan perbaikan pembuatan sistem labeling yang dibuat dari *database* PO *in marketing* dan membuat visualisasi *part* untuk membantu verifikasi kesesuaian produk. Perbaikan tersebut menghasilkan pengurangan *cycle time* (CT) dari 265 detik menjadi 215 detik dan penghematan biaya sebesar IDR 70.483.910/tahun. Penelitian ini berkontribusi secara teoritis dalam menunjukkan keberhasilkan penerapan QCC dan secara praktis memberikan peningkatan produktivitas dalam hal penghematan dan pengurangan pemborosan yang terjadi secara aktual pada aktivitas proses di perusahaan.

Kata kunci: QCC, PQCDSM, SMART+C, 4M+1E, PDCA, Kanban.

Abstract. *The development of digitalization has a positive impact to opportunity expand an innovation as a form of continuous improvement. One of the manufacturing companies, PT TCH, wants to implement Industry 4.0 innovation with the thought of integrating data and analytics supply chains. One of its applications is labeling error with a proportion value of 66% with an average error of 328 by creating a warning system for the Kanban system through the application of Quality Control Circle (QCC). The improvements made applying concepts* Plan, Do, Check, and Action (PDCA) *analysis by making improvements to the labeling system created from the PO database in marketing and creating a visualization of parts to help leverage product suitability. The results showed improvement with the decrease in cycle time from 265 seconds to 215 seconds and saving the cost IDR 70.48391 million/year. This research contributes theoretically in demonstrating the success of the application of QCC, and in practical terms, it can provide a continuous increase in productivity and an actual decrease in process activities in the company.*

Keyword: QCC, PQCDSM, SMART+C, 4M+1E, PDCA, Kanban.

1 Introduction

The development of digitalization has an impact on society, one of which is the industry. This research aims to apply digitalization in the industry to be competitive as synchronize automation and connectivity in all fields (Qin et al., 2016). The role of the advancement of Industry 4.0 technology

enables the rapid development of sensor technology, interconnection, and data analysis with the idea of integrating all technologies in various industrial fields (Kagermann et al., 2013). This is what PT TCH uses as a reference for implementing a synchronization and automation system for Kanban work improvements to reduce customer claims and increase company profits.

PT TCH is one of the industries engaged in the field of automotive jigs and dies located in Cikarang. The company requires forms of innovation with the implementation of Industry 4.0 with minimum cost considering the idea of horizontal integration of supply chain and the data analytics for warning system one can be applied to the improvement Kanban system to achieve the target rank customer ratings. These improvements made PT TCH implement improvements to the Kanban system to achieve quality improvements in its products all minimum rank B. Table 1 shows the achievements of the customer assessment.

Table 1 The Achievement of the customer assessment

Company	Rank					
	Jan	*Feb*	*Mar*	*Apr*	*Mei*	*Avg.*
PT SR2	B	A	A	A	A	A
PT SR4	A	A	B	A	A	A
PT YM	C	C	B	C	B	C
PT KT	A	A	A	A	A	A
PT KM	A	B	B	A	A	A
PT SP	A	A	A	C	A	B
PT KP	B	A	B	B	A	B
PT NS	A	A	B	A	A	A
PT SA	B	A	C	A	A	B

Based on the results of the customer assessment, the rating of PT YM received an average rating of C. The cause of the rank of PT YM is getting an average rank of C because the customer based claim data on frequencies based on the results of the Pareto Diagram has a problem of the label with the highest percentage of 66% and an average number of errors of 328 pieces as shown in Figure 1.

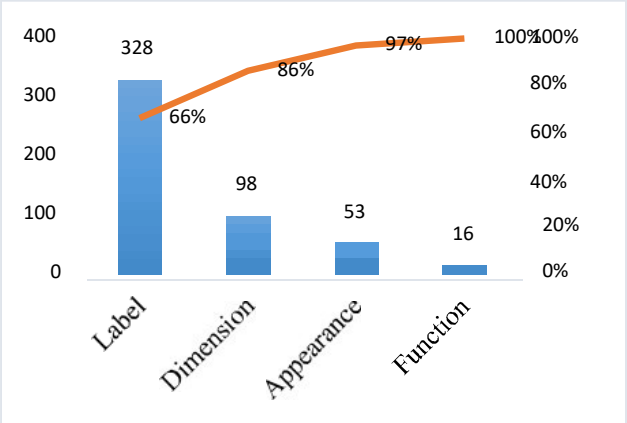


Figure 1 Pareto diagram claim of PT YM based problem categories.

The method that can be used to improve the quality of one of them is a method of Plan - Do – Check – Action (PDCA). The PDCA method is a management system that has been successfully used to discuss quality in industry and services (Isniah et al., 2020). The PDCA method is also useful for making continuous improvement without stopping, such as rotation-oriented, logical, and sensible wheel cycle of all associated elements (Scheneider, 1997).

Based on these, this research try to implement QCC with method approach PDCA to process data and see the factors that cause defective products to further find solutions for each root cause that occurs (Patel et al., 2014).

2 Literature Review

Quality Control Circle (QCC)
In 1960, the Quality Control Circle was introduced by Kaoru Ishikawa in Japan. QCC is a group activity to facilitate, analyze, resolve conflicts, which are used to process data by looking at the factors that cause problems (Nayatani et al., 2010). QCC can be applied to solve problems in the workplace in areas such as quality, productivity, efficiency, cost, communication, absenteeism, staff turnover, and complaints and competition (Salaheldin & Zain, 2007). In general, QCC activity following the Deming cycle (PDCA method) (Wang et al., 2013).

Stages in implementing QCC conducted in eight (8) steps are: 1) Define Themes; 2) Determine the target; 3) Analysis of Condition; 4) Cause and Effect Analysis; 5) Improvement Plan; 6) Implementation of Improvement, 7) Evaluation, and 8) Standardization (Nasution et al., 2018)

Plan, Do, Check, and Action (PDCA)
The PDCA method is a process of continuous improvement. PDCA method used to test and implement changes and improve performance, processes, or a product system an impact on future success. The approach that used to make quality improvements is the PDCA cycle consists of four main components in sequence, namely (Darmawan et al., 2018; Abdel-Hamid, 2019; Alfyanto, 2019):

1) Plan
The "Plan" stage begins with understanding the theoretical basis that will be used in the implementation, followed by a survey after which collected data. The method chosen in planning is the PQCDSM method, with observations made in the Quality Assurance (QA) and Information Technology (IT) Staff at the Final Leader, Out Going Area, and Final Inspection. The data is then processed to determine the condition of productivity in the company and described by analyzing the conditions in the company and setting targets for improvements to be made. Plan conducted in stages:
a. Determine the theme by using the method of brainstorming, process mapping, and assessment:
   - Productivity (P): about labor productivity increased, value-added per person increased, rate of operation increased and breakdown reduced,
   - Quality (Q): about a defect in the process reduced, defects reduced and claimed from clients reduced,
   - Cost (C): about a reduction in manpower, reduction in maintenance cost and energy conserved),
   - Delivery (D): about stock reduced and inventory turnovers increased,
   - Safety (S): about zero accidents and zero pollution
   - Morale (M): about the increase in improvement ideas submitted and small group meeting increase (Sharma et al., 2018).

b. Search the goals and targets should be following the agreement including:
   - Specific (S): the process carried out emphasizes specific, clear targets. In this research, the process was carried out by applying the 5W + 1H questions.
   - Measurable (M): concrete measurements to determine achievement measured by the 1H (How) process (How).
   - Achievable (A): determines the achievements that will be achieved, namely the plan to improve the target customer claims to grade A.
   - Reasonable (R): set goals by considering customer claims with the Pareto Diagram

tools and get the highest claim results on the labeling process.
- Timetable (T): set a deadline for the improvement process, namely the duration of the management agreement in the company, which is 4 (four) months.
- Challenges (C): defines the next process of achievement as challenges improvement (Podgórski, 2015).

c. Analysis of existing conditions with analysis fishbone diagram (cause and effect diagram). This diagram originates from Japan and is used as to approach that allows detailed analysis to be carried out to find the causes of a problem (Hafid & Yusuf, 2018). This fishbone diagram applies by brainstorming the Man, Machine, Method, Material, and Environment (4M + 1E) factors and their impact on PQCDSM sources (Liliana, 2016).

d. Causal analysis with 5Whys method and cause and effect diagram (Card, 2016),

e. Discusses countermeasures with the recovery of What, Why, Where, When, Who, and How (5W1H) (Chung et al., 2009).

2) Do, the process of conducting continuous improvement and gradually implementing, evenly following the capacity of each capability. The stage is implementing the results of the stage of "Plan" with concept 4M+1E cause and effect diagram analysis and clarifying them with the 5W + 1H framework.

3) Check, the process implementation is according to plan and monitoring progress of the plan and resulting in improvements. So that the resulting comparison before and after improvement.

4) Action, actions are taken based on analysis consist of checking components or establishing new standardization- setting new goals for further improvement.

3 Method

This research was conducted at PT TCH is located Cikarang, with a QCC approach in Manufacturing, Quality Department. QCC concept implementation is the establishment of objectives, procedures, and methods used to support the QCC, such as research into using the PDCA method. The steps in the PDCA cycle consist of four phases are Plan, Do, Check, and Act, as shown in Figure 2.

4 Result and Discussion

Define Themes

The selection of the theme in this research creates based on the achievement of the customer assessment. This result shows the biggest ranking problem on "labeling" with a proportion of 66% with an average number of errors of 328 pcs shown in the Pareto diagram (Fig. 1). Based on these results, the focus of the research theme is labeling. Of these issues, used methods PQCDSM to see aspects affected by these problems by performing analysis based on the data based on interviews, observation, and brainstorming that get results comparing standard and also the current situation as it exists in the mapping process PQCDSM has shown in Table 2.

Based on the results of PQCDSM, compared to the existing standardization with the current condition, there are statements of Not Good (NG) and Good (OK). Based on observations, only aspect "Safety (S)" whose current condition is OK, while the other aspects are NG and need to improve.

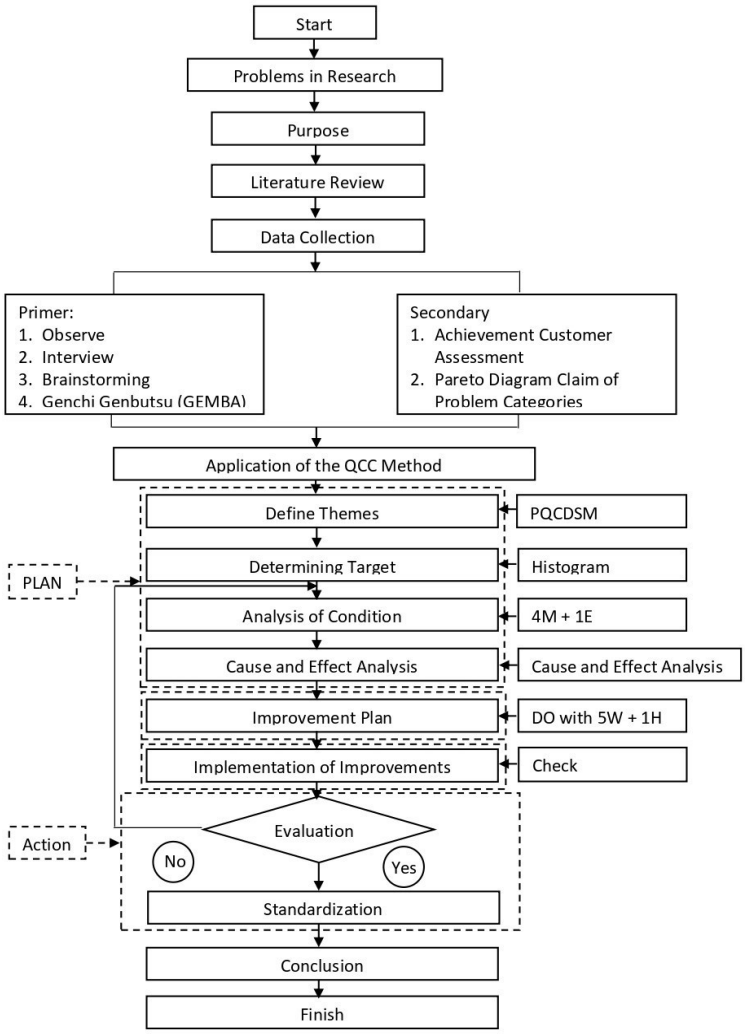


Figure 2 Steps of PDCA.

Determining Target

The target setting process carried out in the QCC process is based on the SMART + C principle:

1) Specific (S), focus on the target to eliminate problems caused by wrong labels,
2) Measurable (M), focus on reducing customer problems caused by wrong labels, as shown in Figure 3 by 328 pcs to 0 pcs,
3) Achievable (A) focus on the target to improvise printed labels and Kanban labels into one label display,
4) Reasonable (R), focus on target KPIs with the increased achievement of the customer assessment,
5) Timetable (T), focus on the target of improvement is 4 (four) months period.
6) Challenge (C) focuses on the target of eliminating customer claims due to label errors.

Analysis of Conditions

The next stage of analysis conditions applied by framework 4M + 1E cause and effect diagram. The process is carried out at final department inspection, scan-in/scan-out, delivery, and declared by the judges as Not Good (NG) and Good (OK) as shown in Table 3 by comparing the standard process and the actual process.

Table 2 Evaluation of PQCDSM

Aspect		Standard	Current Condition	Jdg.
Productivity	Process	Print Labels and Print Kanban.	Cause additional manpower for the repetitive printing process.	NG
	Cycle Time	265 second per lot.	265 second per lot.	NG
Quality	Claim	No claim for labels.	There are claims resulting label.	NG
Cost	Additional	No additional cost.	There are additional costs caused by direct delivery.	NG
Delivery	Just In Time	According to the scheduled delivery.	Delivery is hampered by long process flow and additional activities on the part that confused.	NG
Safety	Zero Accident	Zero Accident.	There is no problem.	OK
Morale	Knowledge	It does not knowing the rule improvement.	Moral manpower decreases because customer image is not good.	NG
Environment	5R	Work area tidy.	5R less neat result many labels are scattered.	NG

Noted: NG (Not Good); Good (OK)

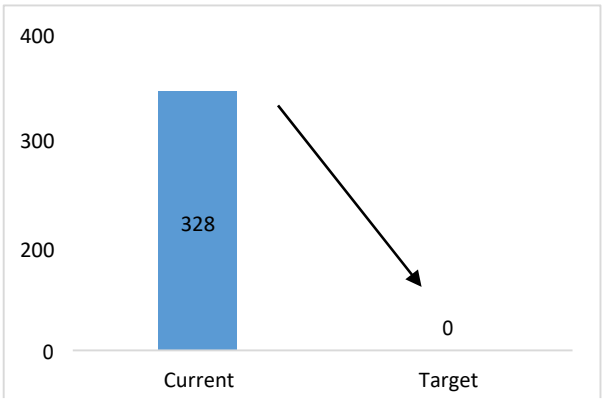


Figure 3 The focus of the industry.

Table 3 Analysis of existing conditions with 4M + 1E

	Line	Standard	Actual	Judges
Man	Final Inspection	There was no error taking the label.	Incorrectly picked label judge.	NG
Method	Final Inspection	The process of making labels based on the purchase order or Item-card cards.	Label-making process based on manual inspection, making any potential incorrectly part numbers.	NG

Table 3 Continue

	Line	Standard	Actual	Judges
	Delivery	The confirmation process by the system about incorrect conditions can be detected.	The confirmation process manually (visually), and there is potential for errors.	NG
Machine	Final Inspection	The database should include the part of local and export.	Database Kanban made general (local and export).	NG
	Scan In/Scan Out	Scan out can confirm the suitability of the label and Kanban.	Scan out could not confirm the suitability of the label and Kanban.	NG
Environment	Final Inspection	No residual scattered label.	There are scattered stock labels judge.	NG
	Scan out	No trash in Kanban.	There was trash in Kanban.	NG

Noted: NG (Not Good); Good (OK)

Cause and Effect Analysis

Cause and effect analysis implementation by applying the 5 Whys concept to get to the root cause of the problem using the 4M + 1E diagram as shown in Table 4. This process is observing the actual condition data that has been previously analyzed.

Table 4 Cause and Effect Analysis

Problem	Why 1	Why 2	Why 3	Root Cause
Man; The operator incorrectly picked a part label.	Operators do not participate in the WI label.	Operators have difficulty participating in the WI label.	Time to find and verify the label and schedule the old process.	Time to find and verify the label and schedule the old Process.
Method; The process of making labels based on the purchase order or Item-card cards.	The process of making the label base on inspection guidelines.	The part number in the inspection guide is only ten digits.	Made based on customer drawing.	Part number on the drawing only ten digits.
Method: When confirming the three papers there is one that is not the same.	Confirmation process manually.	The confirmation process uses three papers (Item-card and label; Kanban and Actual Part).	Sources of identity (label, item-card, Kanban) by different people.	Sources of identity (Label, Item-card, Kanban) by different people.
Machine; The Kanban database is made general.	The database is based on the drawing part.	Part number on the drawing only ten digits.	The drawing part does not specify local and exports part numbers.	The drawing part does not specify local and exports part numbers.
Machine; Scan In and Scan Out could not confirm the suitability of the label and Kanban.	Scan In and Scan Out only confirm Kanban.	The label does not have a QR code to be scanned.	Label creation is still manual.	Label creation is still manual.

Table 4 Continue

Problem	Why 1	Why 2	Why 3	Root Cause
Environment; There was trash in Kanban.	When Scan Out Kanban is taken from the box.	Not all customers have asked for Kanban attached.	Kanban is not needed by the customer.	Kanban functions only as a mutation data warehouse.
Environment; Untidy stock label.	Stock label over.	Making a stock system label.	Label orders are based on minimum order.	The minimum order is three rims.

Improvement Plan

The "Plan" process was implemented by the 4M + 1E concept with the framework 5W + 1H in the final leader table area, exit area, and final inspection area by Quality Assurance (QA) and Information Technology (IT) staff in June. The implementation 5W + 1H were obtained from brainstorming by QA and IT staff, where the results will create a system for making a database of part numbers and visuals on labels to simplify the process and reduce errors in " labeling "as shown in Table 5.

Table 5 Management Plan Framework with Approach 5W + 1H

	What	Why	Where	When	Who	How
Man	Time to find and verify the label and schedule the old process.	The operator incorrectly picked a part label.	Final Leader Table.	In June 2nd week.	QA Staff	Created a system to find and verify labels with a more efficient schedule.
Method	The part number in the inspection guide is only ten digits.	The process of making labels based on PO or Item-card cards.	Final Leader Table	In June 3rd week	QA Staff	Making label database based on PO from marketing.
	Sources of identity (Label, Item-card, Kanban) by different people.	When confirming the 3 papers there is one that is not the same.	Area Out Going	In June 3rd week	IT Staff	Minimize the identity of parts and verification is made by the system.
Machine	The drawing part does not specify local and exports part numbers.	The Kanban database is made general.	Final Inspection	In June 2nd week	QA and IT Staff	Database part updated based on customer PO.
	Making labels is still manual.	Scan In and Scan Out could not confirm the suitability of the label and Kanban.	Final Inspection	In June 3rd week	QA and IT Staff	Made application for making labels that are integrated with Kanban.

Table 5 Continue

	What	Why	Where	When	Who	How
Environment	The function of Kanban just as the mutation data warehouse.	There was trash in Kanban.	Final Inspection	In June 4th week	QA Staff	Modify Kanban into a QC label.
	The minimum order is three rims.	Stock untidy labels.	Final Inspection	In June 4th week	QA Staff	The process of procuring part labels is made in real-time.

Implementation of Improvements

After the implementation of 5W + 1H, the conditions have changed as label verification time is faster, easier, and has been including part number and visualization with Kanban that has been integrated with the system, as shown in Table 6.

Table 6 Implementation of improvements made with QCC

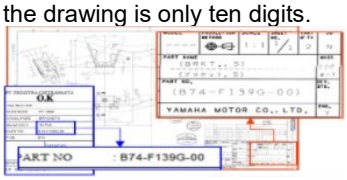
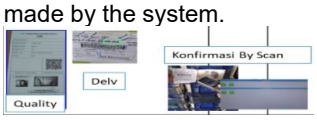
	Before QCC	Improvement	After QCC
Man	Time to find and verify the label and schedule the old process. 	Created a system to find and verify labels with a more efficient schedule. 	Operator time to verify the label shorter so that the operator can follow the existing work instructions.
	The process of comparing potential labels is wrong. 	Compare the process with the visualization part. 	The process of verifying labels is easy.
Method	Making the base on drawing label while the part number on the drawing is only ten digits. 	Creating a label database based on PO in marketing. 	Part number on the label following the part number on Item-card.
	Identity sources (Label, Item-card, Kanban) are made by different people. 	Minimize the identity of parts and verification is made by the system. 	Item-card confirmation process and labels and Actual part process faster because using the system.

Table 6 Continue

	Before QCC	Improvement	After QCC
Machine	Local and export part numbers are specified when printing Item-card. 	Database part updated based on customer PO. 	Part number on the label in accordance with the part number on Item-card.
	Labeling is still manual. 	Created an application for making labels that are integrated with Kanban. 	Item-card confirmation process and Labels and Actual part quicker process for using the system.
Environment	Kanban functions only as a mutation data warehouse. 	Modify Kanban into a QC label. 	Part number on the label in accordance with the part number on Item-card.
	The minimum order is three rims. 	The procurement process is made in real-time label part. 	Item-card confirmation process and Labels and Actual part quicker process for using the system.

Evaluation of Result

The final result of this improvement shows that the problem of "labeling" is significantly reduced from May, June, July, and August to 0 pcs, as shown in Figure 4. The improvement results in the form of modification of part labels and visual part labels into one sheet of a label, resulting in cost savings of paper and minimizing operator work activities resulting in reduced cycle time and the absence of customer claims due to mislabeling again.

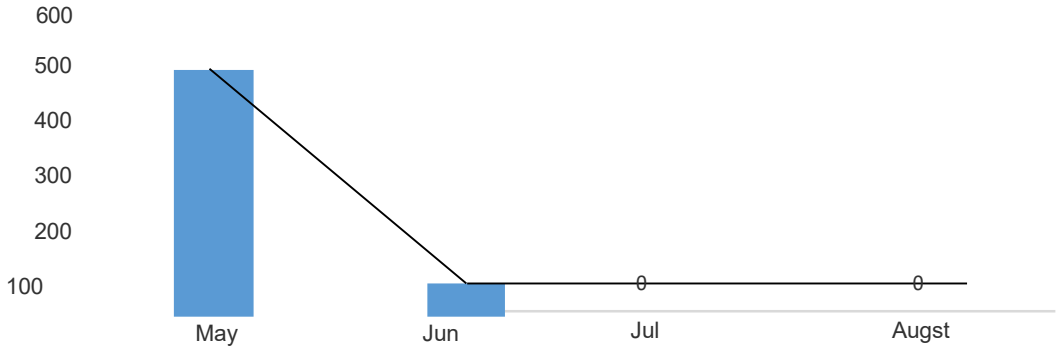


Figure 4 The result after implementation of QCC the labeling process

Details of aspects before and after implementation of QCC with PQCDSM are shown in Table 7. Based on the results of these improvements, there are saving costs = IDR 5.873.649 per month, or IDR 70.483.910 per year, as shown in Table 8.

Table 7 Condition after QCC with PQCDSM

Aspect		Standart	Current Condition	After Improvement
Productivity	Process	Print Labels and Print Kanban.	Cause additional manpower for the repetitive printing process.	Print labels and print Kanban into one process so there is no additional manpower.
	Cycle Time	265 second per lot.	265 second per lot.	215 second per lot.
Quality	Claim	No claim for labels.	There are claims resulting label.	No claim for labels.
Cost	Additional	No additional cost.	There are additional costs caused by direct delivery.	There are no additional costs.
Delivery	Just In Time	According to the scheduled delivery.	Delivery is hampered by long process flow and additional activities on the part that confused.	Delivery according to schedule.
Safety	Zero Accident	Zero Accident.	There is no problem.	No problem.
Morale	Knowledge	Not knowing the rule Improvement.	Moral manpower decreases because customer image is not good.	Moral manpower increases because of the good image of the customer.
Environment	5R	Work area tidy.	5R less neat result many labels are scattered.	5R is tidy due to no stock label.

Standardization

The improvement should be standardized to existing procedures. Standardization of QCC results of this research are:

1) created SOP for the label printing process and print Kanban
2) made SOP process the input database and database Kanban label, and

3) active in socialization activities to provide insight to the manpower.

Table 8 Saving Cost

Aspect	Before	After	Save Cost
CT Procurement label	IDR 2.676.240	-	IDR 2.676.240
CT Labeling	IDR 15.563.079	IDR 12.626.649	IDR 2.936.430
Material	IDR 964.116	IDR 703.036	IDR 261.079
per month	IDR 19.203.435	IDR 13.329.685	IDR 5.873.649
		per year	**IDR 5.873.649 x 12 = IDR 70.483.910**

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5 Conclusion

The results of this study indicate that the implementation of the system integration industry 4.0 with an application of PDCA produces QCC observations:

1 Achievement of the target to fix problems on the labeling become 0%. So from this achievement, customer ratings get better ratings.
2 There was a decrease in CT from 265 seconds to 215 seconds because the process of checking part number labels and visual part labels was carried out simultaneously with only one sheet of the label.
3 There is a cost-saving per year from repairing the labeling problem of IDR 70,483,910 from the savings in paper used
4 Implement standardization by implementing SOPs and socialization to maintain productivity and harmonize the working principle.

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