The Structure Problem Solving Approach to Solve Product Quality Issue

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Abstract-This paper explores the contribution that can be made by Eight-step problem solving to deal with the problem of product quality degradation that causes customers to complain. Specifically analyzing the application of Eight-step problem solving in the woodworking industry which located in Central Java Indonesia. The research method used is through field observation, following Eight-step problem solving analysis (Toyota Model), preparing recommended actions and monitoring communication progress and results. The available literature lacks papers that explore preparation before implementing Eight-step problem solving, where Initial planning especially related to the selection and formation of team members of problem solving is needed to support this Eight-step problem solving approach. It is important to build the team which consisting of cross functional member. Empirical evidence adds to the existing literature on this problem by showing a structured Eight-step problem solving approach that significantly influences organizational performance in terms of improving product quality as customer need.

Index Terms- Problem solving, Product quality, Customer complaint, Problem, Quality.

I. Introduction

The Eight-step problem solving are problem solving process tools which developed to solve problems. Focusing on the process stage, clarify the problem, find the root cause of the problem and set a standard to prevent recurring problems.

In this paper, we present a case of Eight-step problem solving application at woodworking industry which located in Central Java-Indonesia through the illustration of an overall Eight-step problem solving implementation to furnish an insight into the potential impact of Eight-step problem solving in the woodworking industry about improving product quality to avoid recurrence of customer complaints in the future.

II. LITERATURE REVIEW

The implementation of the problem solving process varies between companies and or organizations. Some companies have adopted PPSP over the past decade, but they have failed to achieve success as achieved by Toyota (Liker, 2004).

The eight-step is effective because, it links methods to results by running trials to determine countermeasures (Marksberry et al, 2010). The main reason is that the 8 steps process should be applied as a systematic way of thinking instead of a template or a document that needs to be completed (Marksberry et al, 2010).

Toyota Manufacturing introduces a practical problem solving process (PPSP) as part of its TPS tool; PPSP is a systematic process for achieving a robust solution for differences and problems (Marksberry et al, 2010).

The team leader, supervisor, manager, operation manager, coordinator, and engineer responsible for the zone or area where the problem occurred will take the lead in the problem solving process. This concept is based on the reasoning that this individual or team is the primary concerned party and the expert in the area or work zone for resolving the problem (Liker, 2004).

The Kaizen approach through 8 PDCA cycles involves all components in the company both management and employees to get optimal results (Darmawan, Hasibuan, Hardi Purba, August -2018).

Toyota Business Practices (TBP). It is an action to practice The Toyota Way then to realize continuous achievements efficiently for all positions or functions and to enhance quality in order to make company growth in the mid to long term. TBP consists of eight steps of concrete actions and processes (Abdulmouti, 2018).

The Toyota PPSP is based on the PDCA continuous improvement process and it follows a structured sequence of 8-steps that a problem solver must conduct in order to identify and eventually eliminate a problem (zhang & Liang, 2010).

The problem solving model is seen as very important in solving problems and maintaining performance improvements. It begins with the leaders' commitment to genchi genbutsu when problems are discovered (Shang & Sui, 2013).

Toyota overcomes the problem by using eight step based on the PDCA, which enforces scientific and methodical procedures by carefully identifying successful processes and the exact root of any problem, the 8 Toyota problem-solving Steps (Schweitzer & Capstone, 2012).

A proven and correct way to identify and solve problems is eight steps towards solving practical problems developed by Toyota. This system is structured, but simple and practical enough to handle the smallest problems, to the most complex problems (Holland, 2013).

In many organizations, the problem solving process is often rushed, focusing on finding the quickest and easiest solution rather than the one that adds the most value. Toyota, on the other hand, uses a systematic problem solving process by carefully describing the problem, finding the real root of the problem and using experiments to test preventive actions to ensure the problem is corrected once and for all (Lean Enterprise Academy, 2014).

As a standard problem solving process, it is excellent and widely applicable (Miller, 2009)
One of the main reasons is thought to be management's focus on the hard side of Lean (tools like 8-step problem solving, kaizen, kanban systems, etc.), making a recognizable mistake by ignoring the soft side of culture, respect for people (Vadnais, 2015).

The period of time spent depends on the complexity of the problem and all those involved in completing the 8 PPS steps (P. Arunagiria and A. Gnanavelbabu, 2014).

The performed literature overview on the selected topic showed that mostly the research in principles shows that Eight-step problem solving give benefits in solving complex problems that occur in the product or processes which can prevent bad effect on customers. The available literature lacks papers that explore preparation before implementing eight-step problem solving, where Initial planning especially related to the selection and formation of team members of problem-solving is needed to support this Eight-step problem-solving approach.

This paper is to add the basis for preparation before starting the Eight-step problem solving as stated on the term of reference team evaluation plan.

III. IDENTIFY, RESEARCH AND COLLECT IDEA

The Eight-Step problem solving is a process step for problem solving which follow Plan, Do, Check, Act (PDCA) cycle. Plan for step 1 to 5, Do for step 6, Check for step 7, Act for step 8.
The type of research used is descriptive qualitative research where the Eight-Step problem solving approach used as the basis in this study. The step of Eight-Step problem solving is as follow:

1.Step1 (Clarify the problem).
Key Points for Problem Statements. A problem statement i.e.: not containing a cause, not containing the solution, factual, within scope, short, focused on the current situation and the gap, measurable, descriptive of the desired situation, clear and understandable.

2.Step2 (Break Down the Problem).
Break the big vague problem down to its smaller specific problems i.e.: go see the actual problem process or situation, look at various inputs and outputs in order to select the problem to solve, narrowing the scope and prioritizing helps root cause analysis (step 4) significantly.

3.Step3 (Set a Target).
Clear define with these: "What we will do" with the target, "How we will do it" with the target, the "Ideal situation" with the target to be achieved.

4.Step4 (Analyze the Root Cause).

Consist of: Step1 (assumptions): Brainstorm all possible, Step2 (Prioritize): Categorize and display possible, Step3 (Analyze): Gather data to determine the root cause

5.Step5 (Develop Countermeasures).
Follow the process i.e.: a proper root causes analysis will point to the action needed: remove the root cause, make a plan that includes who, what, when, pursue multiple countermeasures – not just one, explore as many countermeasures as possible at once, build consensus rather than promote/defend solutions, prevents decisions from being made too quickly, fosters dialog and responsibility for understanding the problem more deeply.

6.Step6 (see countermeasures through).
Narrow Down Countermeasures i.e.: which factors have the greatest impact (Pareto analysis) then prioritization matrix and create Gantt chart.

7.Step7 (Evaluate Both Results and Process).
Follow up, i.e.: check the results, check the process, ask, “Was it an effective countermeasure or just luck?”, what worked and what didn’t? (which factors contributed?), which actions in “Do” phase gave us results? (what does the data tell us?), where did we deviate from the plan? (What did we learn?).

8.Step8 (Standardize Success, learn from Failures).
Consist of: successes: Look for similar problems and share learning, failures: Identify unresolved issues, set next targets, there is never a perfect resolution.

IV. STUDIES AND FINDINGS

Before implementation of the Eight-step problem solving, the selection and formation of team members is carried out which is adjusted to the complexity of the problem and then the planning of activities was created. It is important to build the team which consisting off cross functional member.

Terms of Reference: Quality Improvement (Daily)			
Aim of the Review	To review quality performance and improvement effectiveness to improve product quality level		
Hari	Monday to Friday	**Participants**	
Duration	30 mins	1. FM	5.Prod. Plan.
Frequency	Daily	2. Prod. Mgr	6.Purc.
Day/ Time	09.00 - 09.30 PM	3. HR. Mgr	7.Ka Shift
Location	Learning & Development room	4. Mech. Mgr	
Objectives :		**Inputs**	**Outputs**
- To evaluate quality issues, problem solving steps & quality improvement		- Updated communications board	- Update board performance
- To identify areas of concern for improvement		- Top 1 issues from Ka Shift	- Update Roll Out Actions
- Ensuring areas of concern for repairs and regular monitoring			
Agenda	**KPI's**	**Ground Rules**	
- Review product grading & complain	- Performance Product quality level	- Start & finish on time	
- Review production performance	- Performance production	- All participants (according to the list are present and ready to update the information)	
- Delivery Concern		- Fair and open discussion, all participants have the right to issue ideas	
- Review Open Actions		- Silence means AGREE	
		- Participants are responsible for the agreed action. The person responsible for the action must be the person present at the meeting	
		- Commit to achieving results on target	

Table 1. Team evaluation plan of TOR

1.Step1 (Clarify the problem).

The decrease in product quality (bare core board) as indicated by complaint from customers. Voice of customer: “Our factory feedback again about the quality for A grade, compared with before, there are more burls and pith. I also advise your factory to reduce use of putty, it's better not to use putty”.

Figure 1. Picture of product defect

2.Step2 (Break Down the Problem).

Detail issue as shown on below table.

No	Falcata Barecore	Defect related with customer complain
1	Knot (live, dead)	Dead knot has relation with putty
2	Center Pith (hard, soft)	Soft center pith has relation with putty
3	Gap on butt joint	No issue
4	Gap (wane) on back face, front face	Gap (wane) has relation with putty
5	Not to arrange	No issue
6	Defect within 10 cm from end	No issue
7	Split, peeled	No issue
8	Water stain	No issue
9	Pinhole	No issue
10	Slight hairy/ unflat	No issue
11	Decay	No issue
12	Lamina pitch	No issue
13	Packing	No issue
14	Both side must use FJ on face	No issue

Table 2. Defect related complain

3.Step3 (Set a Target).

The target as shown on below table.

No	Falcata Barecore	Grade A	Grade B
1	Knot (live, dead)	Accept max Ø 30mm, no loose knots, to apply wood dust glued on gap (+/-10%)	Accept putty, loose knots on back face
2	Center Pith (hard, soft)	If hard accept (+/-5%)	If soft accept need putty or to be place on back face
3	Gap (wane) on Front face	< 3x150 mm (rp 500 coin) accept (need putty)	<6 mm x 200 mm accept (need putty)
		< 5x20 mmn accept (need putty)	< 10 mm x 50 mm accept (need putty)
	Gap (wane) on Back face	< 3x150 mm (rp 500 coin) accept (need putty)	< 15mm x 300 mm accept
		< 5x20 mm accept (need putty)	< 6 mm depth/thickness accept
Putty on A grade to be limited (+/-5%)			

Table 3. Defect requirement

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4.Step4 (Analyze the Root Cause).

- Correlation raw materials and grading finish product

Correlations: Grade A (m3); Grade B (m3); Input KOTAK; Input SEMI; ...

	Grade A (m3)	Grade B (m3)	Input KOTAK	Input SEMI
Grade B (m3)	0,495 0,000			
Input KOTAK	0,270 0,013	-0,037 0,738		
Input SEMI	0,365 0,001	-0,013 0,905	0,665 0,000	
Input DS3	0,461 0,000	0,030 0,786	0,263 0,016	0,355 0,001
Input DS -	0,159 0,151	-0,058 0,604	-0,191 0,084	-0,249 0,023
Input BC	0,104 0,351	0,503 0,000	-0,495 0,000	-0,447 0,000
Input C	0,001 0,992	0,081 0,467	-0,219 0,046	-0,250 0,023

	Input DS3	Input DS -	Input BC
Input DS -	-0,156 0,160		
Input BC	-0,479 0,000	-0,001 0,991	
Input C	-0,149 0,179	0,450 0,000	0,132 0,234

Cell Contents: Pearson correlation
P-Value

Figure 2. Correlation analysis raw material & grading finish product

Explanation from Figure 2:

1) The input of raw material “Box Shape” has a positive significant effect to grade A
2) The input of raw material “Semi-Box Shape” has a positive significant effect to grade A
3) The input of raw material “DS3” has a positive significant effect to grade A
4) The input of raw material “BC” has a positive significant effect to grade B

- Correlation raw materials and WIP (Pelos – carrier for grade B)

Correlations: Tambah Pelos; Input KOTAK; Input SEMI; Input DS3; Input DS -; ...

	Tambah Pelos	Input KOTAK	Input SEMI	Input DS3
Input KOTAK	-0,217 0,048			
Input SEMI	-0,093 0,406	0,665 0,000		
Input DS3	0,192 0,081	0,263 0,016	0,355 0,001	
Input DS -	0,284 0,009	-0,191 0,084	-0,249 0,023	-0,156 0,160
Input BC	0,419 0,000	-0,495 0,000	-0,447 0,000	-0,479 0,000
Input C	0,176 0,111	-0,219 0,046	-0,250 0,023	-0,149 0,179

	Input DS -	Input BC
Input BC	-0,001 0,991	
Input C	0,450 0,000	0,132 0,234

Cell Contents: Pearson correlation
P-Value

Figure 3. Correlation analysis raw material & WIP (Pelos – carrier for grade B)

Explanation from Figure 3:

1) The input of raw material “Box Shape” has a negative significant effect on increasing “Pelos”.
2) The input of raw material “DS-” has a positive significant effect on increasing “Pelos”.
3) The input of raw material “BC” has a positive significant effect on increasing “Pelos”.

- Correlation raw materials and WIP (sorting activity on conveyor)

Correlations: Tambah siap ; Input KOTAK; Input SEMI; Input DS3; Input DS -; ...

	Tambah siap	Input KOTAK	Input SEMI	Input DS3
Input KOTAK	0,048 0,668			
Input SEMI	0,110 0,322	0,665 0,000		
Input DS3	0,241 0,028	0,263 0,016	0,355 0,001	
Input DS -	0,137 0,217	-0,191 0,084	-0,249 0,023	-0,156 0,160
Input BC	0,436 0,000	-0,495 0,000	-0,447 0,000	-0,479 0,000
Input C	0,107 0,338	-0,219 0,046	-0,250 0,023	-0,149 0,179

	Input DS -	Input BC
Input BC	-0,001 0,991	
Input C	0,450 0,000	0,132 0,234

Cell Contents: Pearson correlation
P-Value

Figure 4. Correlation analysis raw material & WIP (sorting activity on conveyor)

Explanation from Figure 4:
The input of raw material "BC" has a positive significant effect on increasing "sorting activity".

5.Step5 (Develop Countermeasures).
Use cause & effect matrix to identify the correlation between input & output, the importance of output and level of control.

Cause & Effect Matrix

	Type Rating of Importance to Customer in this Row	10	10	8	6			
		1	2	3	4			
	Type Outputs in this row	Finish product Grade A	Finish Product Grade B	Work In Process	Putty			
	Type Inputs to be prioritized in the Column below	Relate the Inputs to the Outputs and enter your numerical rankings in the				Listed below are the Prioritized List of Inputs	Level of control	Control of priotity
1	Raw material "Box Shape"	9	5	5	1	186	3	56
2	Raw material "Semi-Box Shape"	9	5	5	3	198	3	59
3	Raw material "DS3"	5	5	5	3	158	3	47
4	Raw material "BC"	3	9	9	5	222	3	67
5	Raw material "DS-"	5	9	5	3	198	3	59
6	Skill of sorter	9	5	9	9	266	3	80
7	Machine performance	5	3	5	5	150	3	45
8	Raw material storage	5	5	9	5	202	3	61

Table 4. Cause & Effect Matrix of Barecore Board process

Explanation from Table 4.:
1) Cause & Effect Matrix used for identifying the importance of input to output (score 1 to 10), the highest score is more important.
2) Cause & Effect Matrix used for identifying the correlation of input to output (score 1,3,5,9), the highest score is having a stronger correlation.
3) Rating of controlling the input (score 1,3,9), the highest score is more difficult to control.

6.Step6 (see countermeasures through).
To prioritize attention in the problem and follow up with an action plan as follow:

Rank	Input	Severity	Control of Priority
1	Skill of sorter	266	100
2	Raw material "BC"	222	83
3	Raw material storage	202	76
4	Raw material "Semi-Box Shape"	198	74
5	Raw material "DS-"	198	74
6	Raw material "Box Shape"	186	70
7	Raw material "DS3"	158	59
8	Machine performance	150	56

Table 5. Prioritization Matrix

Action taken:
1) Set up strategic of new employee's recruitment & training plan, pic: HR Mgr.
2) Do refreshment training especially 'falcata barecore' knowledge to sorter, pic: HR Mgr.
3) Optimizing production group composition, pic: Prod. Mgr.

4) Optimizing layout, the raw material storage area, pic: Prod. Planner
5) Coverage raw material storage area from water rainy, pic: Facility Leader
6) Arrange % composition of raw material to be input in production, pic: Prod. Mgr.
7) Improve machine capability, focus on Double Planner & Multi rip, pic: Mech. Mgr.

7.Step7 (Evaluate Both Results and Process).
After some action is taken, the result shown on the below figure.

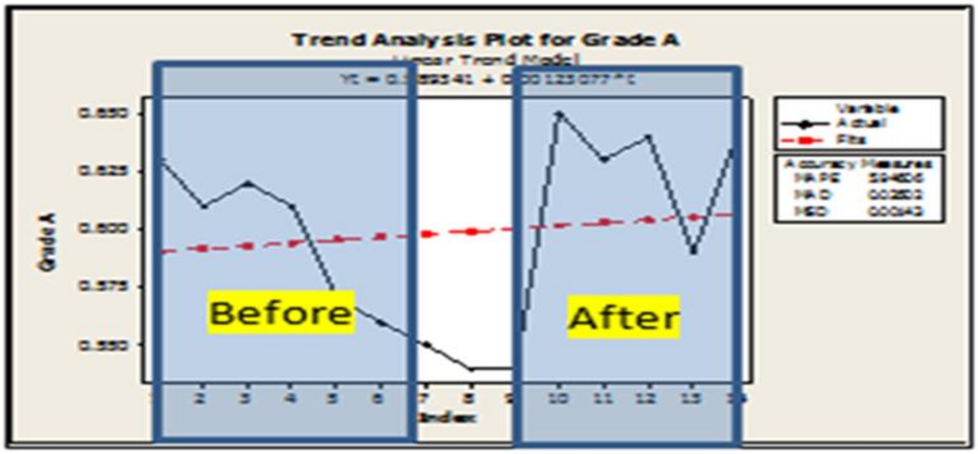

Figure 5. % Finish product grade A achievement

Explanation from Figure 5:
From the above figure shown that the corrective action has taken give significant improvement in product quality. Comparing trend before and after, in the area of 'after' improvement the trend of grade A is increased and more stable.

8.Step8 (Standardize Success, learn from Failures).
To sustain the performance increasing grade A of finish product barecore board have to be followed by standardization of the action especially treatment to new employee, arrange % composition of raw material to be input in production & machine maintenance.

V. CONCLUSION

In this paper shows the Eight-step problem-solving in solving deterioration product quality, by following the eight stages, the problem of deterioration product quality of barecore board in woodworking company can finally be reduced and the customer's interests can be saved.

Benefit of The Eight-Step problem solving implementation:
1) Customers are more trusting because improving quality product
2) Improve knowledge of structured problem solving technique
3) The lowest level in the organization have better ownership in keeping quality of product
4) Increased sustainable results through behavior changes in processes and people.

The key factors of successful the Eight-Step problem solving mainly are:
1) The Eight-Step Problem Solving is one of the key elements to solve a complex problem. The aim is to clarify, explore and solve problems, and is useful in improving products and processes. Introducing this structured approach will provide clear direction to the representative's employee on solving problems that arise.
2) The team's goals and membership roles been clarified which will the team require to function effectively. In the case of complex problems and give an impact on the customer's interests, the selection of the right team members makes the key in solving problems effectively.
3) In the review meeting there is a chance to discuss related problem solutions and very good for the learning process in the whole organization.

The Eight-step problem solving is a method used to approach and to resolve problems. Initial planning especially related to the selection and formation of team members of problem solving is needed to support this Eight-step problem solving approach. It is important to build the team which consisting off cross functional member.

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