Optimization of Cost by Using 7 QC Tools

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Abstract

Quality plays very important role in today’s highly competitive industrial environment. Quality leads to an improvement in productivity. By improving quality, the method of optimization reduces process operational costs and variation in product. Quality, productivity & cost of operation relatively depended to each other. The main goals of quality management are customer satisfaction by delivery of defect free products at quality cost. Controlled processes are the most important ways to reach this goal. The primary objective of quality control in any organization is to reduce the costs of its operation. If control efforts do not lead to any saving in costs or cost reduction then, in principle there is no need for quality control. However, in most control activities, cost saving are real and they remain a principle objective of quality control for most organizations.

Keywords: Quality, quality control, cost optimization, inspection.

Introduction to quality control

Many companies in the world are gradually promoting quality as the central customer value and regard it as a key concept of company strategy in order to achieve the competitive edge. Quality improvement decisions are viewed as the catalyst for substantial technological developments being made in the manufacturing sector. Quality Costs are a measure of the costs specifically associated with the achievement or non-achievement of product or service quality –including all product or service requirements established by the company and its contract with customers and society. Measuring and reporting the quality cost is the first step in a quality management program. Quality costs allow us to identify the soft targets to which improvement efforts can be applied.
Three types of cost are generally associated with quality control:
1. Assignment costs.
2. Prevention costs.
3. Non-conformance costs.

Assignment costs are the cost which an organization incurs in measuring quality characteristics to ensure that they conform to quality standards. This cost typically includes costs of inspection including labour, materials, and cost of approval or certification when organizations meet quality standards and so on. Prevention costs involve cost when organizations undertake measures to prevent poor quality of products or performance. Example of prevention cost would include the costs associated with quality planning, design and development of quality measurement instruments, quality training and so on. Finally non conformance costs also called failure costs occur when an organization fails to meet quality standards. This may be due to poor quality of labour, materials and overhead, i.e. expenses accumulated.

Seven Quality Control Tools
The various tools are used to check the quality of the product to define weather the product is a quality one or not and to take the further necessary actions to bring the process under control.

- Check sheet
- Pareto chart
- Flow chart
- Cause and effect diagram
- Histogram
- Scatter diagram
- Control chart

Check sheet
The function of a check sheet is to present information in an efficient, graphical format. This may be accomplished with a simple listing of items. However, the utility of the check sheet may be significantly enhanced in some instances by incorporating a depiction of the system under analysis into the form.

Pareto Chart
Pareto charts are extremely useful because they can be used to identify those factors that have the greatest cumulative effect on the system and thus screen out the less significant factors in an analysis.

Ideally, this allows the user to focus attention on a few important factors in a process.
Flowchart
Flowcharts are pictorial representations of a process. By breaking the process down into its constituent steps, flowcharts can be useful in identifying where errors are likely to be found in the system. In quality improvement work, flowcharts are particularly useful for displaying how a process currently functions or could ideally function.

![Flowchart Diagram](image)

**Figure 2:** Flowchart.
Cause and Effect Diagram
This diagram, also called an Ishikawa diagram (or fish bone diagram) is used to associate multiple possible causes with a single effect. Thus, given a particular effect, the diagram is constructed to identify and organize possible causes for it.

Figure 3: Cause and effect Diagram.

Causes in a cause & effect diagram are frequently arranged into four major categories. While these categories can be anything, given below:
- Manpower, methods, materials, and machinery (recommended for manufacturing)
- Equipment, policies, procedures, and people (recommended for administration and service).

Histogram
A histogram is a specialized type of bar chart. Individual data points are grouped together in classes, so that you can get an idea of how frequently data in each class occur in the data set. Histograms provide a simple, graphical view of accumulated data.
Scatter Diagram
Scatter diagrams are graphical tools that attempt to depict the influence that one variable has on another. A common diagram of this type usually displays points representing the observed value of one variable corresponding to the value of another variable.

Control Chart
The control chart is the fundamental tool of statistical process control as it indicates the range of variability that is built into a system (known as common cause variation). Thus, it helps determine whether or not a process is operating...
consistently or if a special cause has occurred to change the process mean or variance.

Problem: Optimization of cost by using 7 quality control tools.

Step 1: - Introduction to the problem
In operation 67 of control valve cylinder head (as shown in Figure 6) of the diameter 15.840/15.862 mm was getting oversize.

![Control Valve Cylinder Head](image)

**Figure 6:** Control Valve Cylinder Head.

**Background of problem selection:**
This problem was selected because in-house rejection was alarming and also product returned from the line at vendor *(automotive industry in central India)* was repeated time to time (refer figure 7 & 8). Total rejections in house are 10 units and product returned is 16 units.

![Line Rejection Trend Op67 Dia 15.840/15.862mm in CVCH](image)

**Figure 7:** Line rejection.
Optimization of Cost by Using 7 QC Tools

Problem Selected:- Elimination of rejection due to diameter 15.840/15.862 mm which was getting oversize.

Target: - Zero defects in diameter 15.840/15.862 mm of Operation 67.

Step 2:- Observation
Information regarding process and operation are observed.
(1) Operation done on vertical milling machine.
(2) All the tools are operated like 14.68 mm drill hole, mill to correct the axis & then reamer.
(3) Rigid clamping fixture.
(4) This is operated after the operation 50 done. In solid stage without putting on any machine.
(5) Tool change frequency decided for every operation as discussed.
(6) Coolant used for reaming is kerosene or solvent 2445.
(7) Variable type gauging i.e. Air plug Gauge is used for in-process inspection of this reamed bore with 1 in 5 inspection frequency.

Step 3:- Identification of Probable Causes:- Probable causes are identified and represented in the form of cause and effect diagram as shown in figure 9.

Figure 8: In House rejections.
Step 4: Brainstorming
The most probable causes (Identified by cause and effect diagram and Brainstorming)
  Cause1: Insufficient knowledge of operator.
  Cause2: Hardness inconsistency in raw material.
  Cause3: Intermittent supply of coolant.
  Cause4: Tool run out not checked before putting on the machine & after the part detected oversize.

Analysis done to test the validity of probable causes
Cause1: Test 1: Insufficient Knowledge of operator.
Observation:- After interviewing the machine operator it was confirmed that they are having adequate operating and inspection knowledge.
  Also, there was standard operating procedure available near the machine which were regularly followed
Result: In valid cause for the problem.

Cause 2: Test 1: hardness less in rejected components
Specification 179 to 229 BHN.
  Actual observation: 189,198,182,192,194.
  Also, hardness of 5 ok components were checked and it was observed that hardness was with in specification.
  Actual observation: 190,195,192,185,198.
Result: In valid cause for the problem.

Cause 3: Test 1: Intermittent supply of coolant
Observation: To get the proper finish kerosene or solvent 2445 is applied continuously to the reamer to avoid the chip rubbing & proper cutting.
Result: Invalid caused for the problem  
Since all most probable causes were found invalid, focus was shifted to other causes.

Cause 4: Tool run out not checked before putting the tool on the machine.  
Observation: to know the reason for rejection, the tool was checked for the run out but found with in 10 microns.  
Result: Invalid cause for the problem.

Why the rejected parts were oversize in between?  
For this we have checked the run out of the tool when the part was rejected. After analyzing the problem after deep studies that the raw material is grey cast iron. For machining of cast iron does not need any coolant, it may be cut in dry condition. As in our case also, the operation for drilling and hole milling kept as in dry cutting condition. As the property of the cast iron is to produce dust with small flakes of chip, such dust get fly off along with current air by the fans put in the shop floor & get accumulated every where. In due course of time this dust get accumulated on the BT 40 taper of the tool holder & causes to have run out in the tool. As the tool run out increase the bore to become oversize.  
Result: Valid cause for the problem.

Step 5:- counter measure:  
Short term:  
• Instruction was given to all the operators & the officials about the valid cause of the size for getting over size.  
• Part checking frequency was changed from 1in 5 to 100% in process inspection.  
Long term:  
• All the taper of the tools & the spindle to be clean after every 12 hours.  
• Air connection was given through the spindle to blow off the dust in the spindle taper for accumulating it.

Step 6:- Implementation of countermeasure:  
All the action are implemented at once.

Step 7:- Standardization:  
Standard operating procedure for operation 67 update. Standard operating procedure for operation 67 was revised by putting these important points.

Step 8:- Direct benefit:  
Cost saving as no internal rejection for the same reason.

Result: After implementation no Problem was observed from the last 3 months.
Cost analysis

Raw Material i.e. casting is given by automotive industry from Approved Vendor M/S CASPRO LTD, Kolhapur.

Costs-
- Raw material Cost  : Rs.248/piece.
- Machining Cost  : Rs.200/piece.
- Total costs  : Rs.448 /Piece.

Various consumables costs for Operation 67-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Tools</th>
<th>Materials</th>
<th>Cots in Rs</th>
<th>Life in parts</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Combination drill</td>
<td>HSS</td>
<td>1200</td>
<td>4000</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td>Milling cutter</td>
<td>Carbide</td>
<td>1750</td>
<td>6000</td>
<td>0.29</td>
</tr>
<tr>
<td>3</td>
<td>Drill dia 14.5 mm</td>
<td>Solid carbide</td>
<td>8500</td>
<td>30,000</td>
<td>0.28</td>
</tr>
<tr>
<td>4</td>
<td>Hole mill</td>
<td>Solid carbide</td>
<td>8500</td>
<td>30,000</td>
<td>0.28</td>
</tr>
<tr>
<td>5</td>
<td>Grooving</td>
<td>HSS</td>
<td>650</td>
<td>1000</td>
<td>0.65</td>
</tr>
<tr>
<td>6</td>
<td>Reaming</td>
<td>Carbide</td>
<td>1250</td>
<td>20,000</td>
<td>0.0625</td>
</tr>
</tbody>
</table>

**Total tooling costs/ piece** 1.86

Tool holder cost: Rs. 3000

3000*6 (for above six operation) = Rs. 18,000

1.5 lakh is the life of the tool holder so the cost of tool holder per piece is 18000/150000= Rs. **0.12 /piece**.

**lubricant cost:-**

SAE20W40 IS USED.

5 LIT. Tank per shift.

Rs125/lit.

5*125 = Rs625/shift.

90 Parts are produced in one shift.

652/90 = Rs**6.94/piece**.

**Coolant cost:** - Kerosene is used as coolant in order to improve the surface finish & to avoid the corrosion.

5 lit require per shift.

Rs35/lit

35*5=Rs175/shift.

90 Parts are produced in one shift.

175/90=Rs**0.50/piece**

**Cotton waste:** It is approximately Rs0.10/piece
Cleaning Agents: solvent 2445 is used as coolant. 10 lit require per day.
Rs 65/lit, Rs 650 /day, 650/300= Rs.2.16 /piece

Inspection cost
1. Gauging Cost: It is approximately Rs2/piece.
2. Inspector Cost: The salary paid to the inspector is Rs.5000/month. He works for 26 days in one month. So the money paid by the company for 1 day = 5000/26= Rs192/day. He inspect approximately 300 parts in 1 day.
Cost for inspecting one piece = 192/300 = Rs0.64/piece.

Machining Cost
Labour Cost
The salary paid to the labour (machine operator) is Rs3500/month. He works for 26 days in one month. So the money paid by the company for 1 day = 3500/26= Rs134/day. He produce a 90 parts in 1 day. Cost for producing one piece = 134/90=Rs.1.49/piece

Machine Depression Cost
Generally there is 10-15% depression cost, But machine are in maintained condition so there is only 10% depression cost in 1 year.
Cost of machine is Rs18 lakh. If we consider for 5 years 180000/5 = Rs3.6lakh
180000-36000=RS 144000 in 5 years.
For 1 year = 30,000/year.
For 1 month =30,000/12=Rs. 2500/month.
For 1 day = 2500/26=Rs. 96/day.
For 1 part = 96/270parts in one day=Rs.0.35/piece.

Total Cost Associated In Operation 67 =
All cost associated in tooling + all cost associated Inspection cost + machining cost + Raw material cost.
Total cost=0.3+0.29+0.28+0.28+0.65+0.0062+0.12+6.95+0.5+0.10+2.16+2.00+0.64
+1.49+0.35+248 = Rs.264.116 / piece in op67

There are 3 to 4 Parts are rejected due to diameter 15.840/15.862mm over size in 1 month.
Costs saved per month = 264.116 *4 = Rs 1056.46 /month
Cost saved per year = 1056.46*12 = Rs 12,677.57/ year

Conclusion
Quality leads to an improvement in productivity. Quality, productivity & cost of operation relatively depended to each other. The main goals of quality management are customer satisfaction by delivery of defect free products at quality cost. In operation 67 of control valve cylinder head (as shown in Figure 6) of the diameter
15.840/15.862 mm was getting oversize. We have studied the problems and actually solved the problem by using seven quality control tools which result in good amount of saving in cost of product and overall reputation of the company get improved.

References


Appendix