RESEARCH ARTICLE OPEN ACCESS

Application of Quality Control Tools in Taper Shank Drills Manufacturing Industry: A Case Study

Pratik J. Patel*, Sanjay C. Shah**, Sanjay Makwana***
*(PG Student, Department of Mechanical Engineering, G. H. Patel College of Engineering & Technology, Gujarat, India)
** (Assistant Professor, Department of Mechanical Engineering ,G. H. Patel College of Engineering & Technology, Gujarat, India)
*** (R&D Department, MIRANDA TOOLS, GIDC, Ankleshwar, Gujarat, India)

ABSTRACT
The aim of this paper is to improve the quality level by finding out the root causes of the quality related problems. Quality control tools are important tools used widely at manufacturing field to monitor the overall operation and continuous process improvement. Check Sheet, Pareto Diagram, Histogram, Cause-and-effect diagram, Control Chart, Run-Chart and Scatter-Diagram are used in enhancing the process by continuous monitoring through quality tools. The Quality Control tools are used to find the root Causes and eliminate them, thus manufacturing processes can be improved. A case study has been carried out at MIRANDA TOOLS, GIDC Ankleshwar.

Keywords **–** Quality, Continuous improvement, PDCA Cycle, Check-Sheet, Pareto -analysis, Cause-and-effect diagram, Histogram, Control-Chart, Run-Chart, Scatter-Diagram

I. INTRODUCTION

Quality tools can be used in all phases of production process, from the beginning of product development up to product marketing and customer support. [1] Edwards Deming, explained chain reaction in his book "Out of the Crisis" published in 1986. The benefits from quality and process improvements to organization are:

a) Improved Quality.
b) Costs reduction because of less rejection.
c) Capture the market through customer satisfaction by better quality and lower price.
d) Improved Business
e) Improved productivity[2]

The most common process of continuous improvement is the PDCA Cycle shown in Fig.1 which was first developed by Walter Shewhart in the 1920s and promoted by quality preceptors Dr. Edwards Deming. PDCA-cycle consists of four consecutive steps, as follows:

- Plan: Identifying and analyzing the problem for improvement.
- Do: Establish experiment to test hypothesis.
- Check: Analyze data on the solution, Validate hypothesis.
- Act: Take corrective action for Continuous improvement

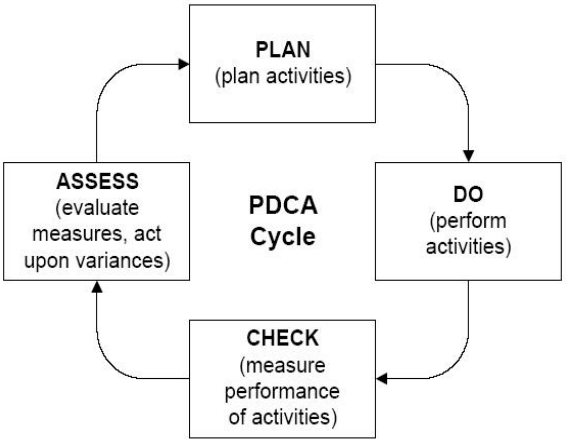

Fig. 1 PDCA Cycle

PDCA-cycle is required in process improvement. When the process improvement starts with careful planning results in corrective and preventive actions supported by appropriate Quality Control tools. Application of seven basic quality tools in correlation with four steps of PDCA-cycle is shown in Table.1 [2]

Table.1 Seven basic quality tools (7QC tools) in correlation with PDCA-cycle steps

Steps of PDCA-cycle			
Plan	**Do**	**Check**	**Act**
Problem identify-cat ion	**Establish Hypothesis**	**Validate hypothesis**	**Continuous Improvement**
Run-Chart		Run-Chart	
Cause-and-effect diagram	Cause-and-effect diagram		
Check sheet	Check sheet		Check sheet
Pareto diagram	Pareto diagram		Pareto diagram
Histogram	Histogram		Histogram
Scatter Diagram	Scatter Diagram	Scatter Diagram	Scatter Diagram
Control Charts	Control Charts		Control Charts

II. Literature Review

This Case-Study was carried out at tire retreading company. Here authors used main three tools i.e. Pareto Chart, Fishbone Diagram and Matrix Diagram.Pareto Chart is very basic tool which identify the problems i.e. Tread Separations and Ply separations. According to problems established Fishbone Diagram and Matrix diagram are used to analyze the problems. [5]

This Case-Study was carried out at Jordanian manufacturing company. Here Pareto chart is used for problem identification and it was found that 72% the problem was related to the steel tensile strength according to problem draw control chart which shows that data sampling technique was not proper after it was held effective brainstorming session to established the Cause-and-effect diagram for analyzed the problems [4]

This case-study was carried out at metal composite castings, here main two basic Quality Control tools i.e. Pareto chart and Ishikawa diagram used for Quality improvement. By using Pareto Chart it identified the main problems on metal composite casting and to analyze this problem author drawn the Ishikawa diagram for the Continuous Quality improvement. [6]

The purpose of this study was continuous Process improvement at Mindarika Private Limited. For this basic quality tools like the histogram and cause-and effect diagram were used. Here histogram identified the major Problems related to Lever Combination Switch. According to major Problems author drawn the cause-and-effect diagram and according to causes took action plan to improving productivity at certain level. [7]

The aim of this study was to improve the productivity. Pareto Chart is very useful Quality tool which defines problems in the process. After this effective brainstorming session was held to establish the Ishikawa Diagram which analyzed the problems. According to problems drawn Control Chart which shown if Process was stable or not and after this took action plan and then again collect data and again drawn control chart which shown the all samples were in-control and which lead to quality improvement. [8]

III. Introduction to Industry and Products

This Firm is recognized as the largest manufacturing company in the field of Machine Tools in India. It has also achieved ISO 9002-1994 and ISO 9001-2000 standards of quality assurance. The company manufactures following class products:

- Taper-Shank Drills
- Parallel-Shank Drills
- Single-Point Cutting Tools
- Metal Cutting Band-saw Blades
- Reamers

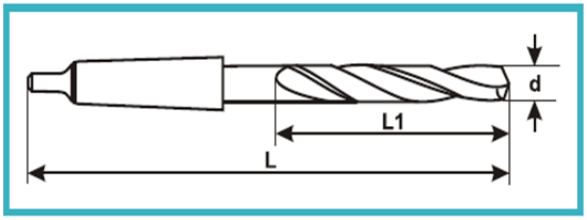

Fig.2 Taper Shank Drill

3.1 Brief Description of the Case Study

Quality tools can be used in all phases of production process, from the start of product development up to product marketing and customer support.[1] The 7 QC Tools are simple statistical tools used to monitor the overall operation and continuous process improvement. These 7 QC tools were developed by the Deming and Juran. Ishikawa has stated that these 7 tools can be used to solve 95 percent of all problems. The following are the 7 QC Tools: [2]

1. Check-Sheet
2. Pareto Diagram
3. Cause & Effect Diagram
4. Scatter Diagram
5. Histogram
6. Run-Chart
7. Control-Chart

3.2 Check-Sheet

The check sheet is used for collecting and analyzing data in real time at the location where the data is generated. Data Collection is staring point of useful process improvement and problem-solving tools. This data should be used with others quality tools such as Pareto Diagram, Histogram. Table.2 is shown example of a check sheet with modes of defects of Taper Shank drills while during Production Process. It shows the type of defects, rejection of each types occurred during that period.

Table.2 Check sheet for various modes of defects of Taper Shank drills while during Production

Product		**Taper Shank Drills**			
Type Of Defects	**Total Qty. Produced**	**Rej. Qty.**	**Rej. %**	**Cum. % Rej.**	**Rej. Of Prod.**
Margin over size(MOS)	14415	325	44.7658	44.7658	2.2545
Body dia. Test(BDT)		128	17.6308	62.3966	0.8879
Flute grinding defect(FGD)		95	13.0853	75.4820	0.6590
Grinding defect(GRD)		76	10.4683	85.9504	0.5272
Body Dia. Under Size(BDU)		39	5.3719	91.3223	0.2705
Unclean (UCN)		19	2.6170	93.9393	0.1318
Flute charting (FLC)		12	1.6528	95.5922	0.0832
Flute Length Over-size(FLOS)		9	1.2396	96.8319	0.0624
Flute milling defect(FMD)		8	1.1019	97.9338	0.0554
Pitting(PIT)		5	0.6887	98.6225	0.0346
Length Under Size(LUS)		4	0.5509	99.1735	0.0277
Margin Cut-Off(MCO)		4	0.5509	99.7245	0.0277
WOS		2	0.2754	100	0.0138
Total	14415	726		100	5.034

3.3 Pareto Diagram

A Pareto Chart is simply a frequency distribution (or Histogram) of attribute data. [2] The chart is named after Italian economist/sociologist Vilfredo Pareto (1848-1923). It consists "a series of bars whose heights reflect the frequency or impact of problems. The bars are arranged in descending order of height from left to right. It states that about 80 percent of the problems come from 20 percent of the causes and it is extremely useful to identify the factors that have the greatest cumulative effect on the system, and will able to classify them according the weight of effect to focus on them. [3]

On Fig.3 Pareto diagram shows mode defects of Taper shank Drills While during Production Process. According to Table.2 most effective defect was Margin over size, second major defect was Body diameter test and third major defect was Flute grinding defect.

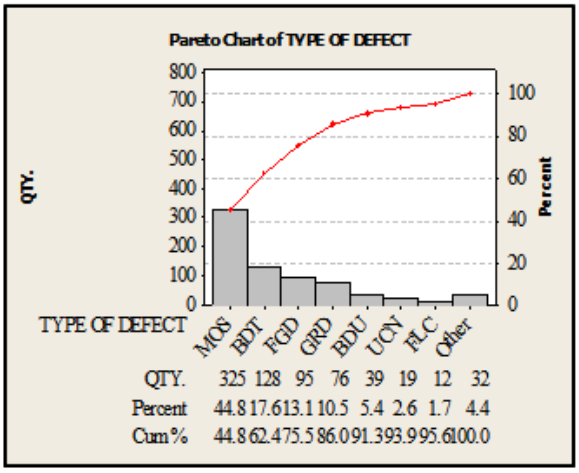

Fig.3 Pareto diagram modes of defects of Taper Shank Drills.

3.4 Histogram

A Histogram is one of the basic quality tools. It is used to graphically summarize and display the distribution and variation of a process data set. A frequency distribution shows how often each different value in a set of data occurs. The main purpose of a histogram is to determine the shape of data set. [2]

Data related to the Web-Centrality is shown in Table.3 and used to show the histogram in Fig.4.

Table.3 Web-Centrality Boundaries

Sr.No.	**Web-Centrality Boundaries**		**Frequency**
1	0.04	0.12	3
2	0.12	0.20	6
3	0.20	0.28	8
4	0.28	0.36	4
5	0.36	0.44	3
6	0.44	0.52	0
7	0.52	0.60	1
8	0.60	0.68	1

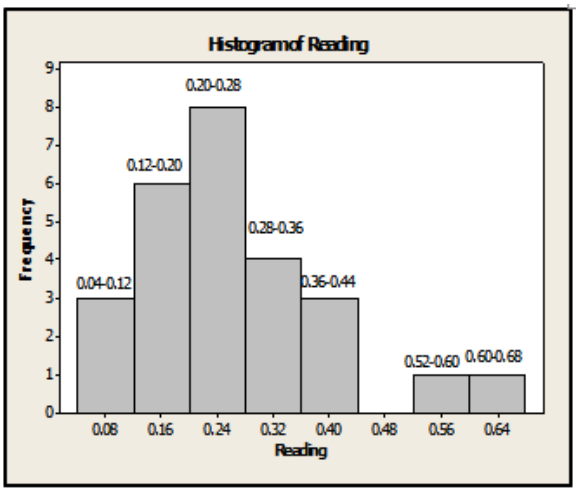

Fig.4 Histogram diagram

3.5 Cause -and-Effect Diagram

A cause and effect diagram, also known as an Ishikawa diagram or fishbone diagram which shows the graphically the defects and causes. Cause-and-effect diagram use under the six parameters likes Methods, Measurements, Man, Mother-Nature, Machine, Materials.

While developing this diagram brainstorming technique very helpful because this technique involves more numbers of experts and it helps to identifying maximum number of causes.

On fig.5 shows the Cause-and-effect diagram which defines the causes of margin of oversize during production Process with the help to brainstorming technique.

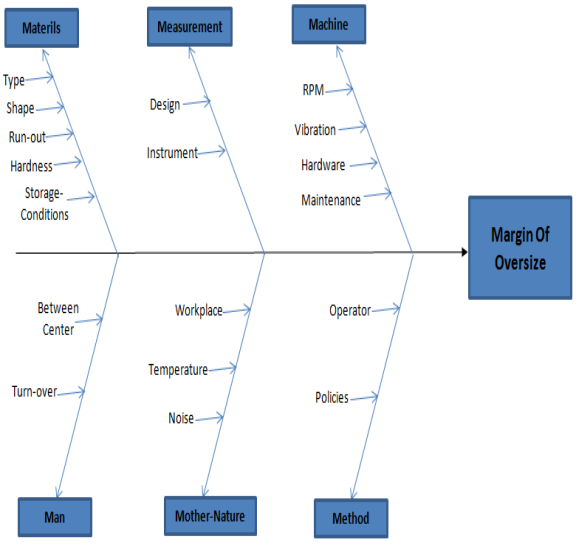

Fig.5 Cause-and-effect diagram

3.6 Control-Chart

Control-Chart is most important quality tool to determine organization performance. Control chart works with two controls limit i.e. Upper Control limit and lower Control limit. Control chart is most important to tell about the process stability and variability. [2] There are main two types of Control Chart. 1 variable Chart 2 attribute chart. In Variable Chart dimensions is measurement like length, height etc while in attribute chart requires like yes/no, good/bad etc. Control Chart helps to determine the Process capability and Process performance to determine that if process work within specification limits.

Following are some advantages from using a Control Chart:

1. Monitor process variation over time.
2. Distinguish between special cause and common cause variation.[2]
3. It helps managers to make some intelligent decisions.

On Fig.6 shows the X-R Bar Control Chart for Lip-Height.

Table.4 Lip-Height Reading

Machine Description: Winslomatic							
Parameter: Lip Height							
Tolerance:- 0.090±0.000							
UCLx= 0.096 LCLx= 0.044							
Sr.No.	**1**	**2**	**3**	**4**	**5**	**X-Bar**	**R-Bar**
1	0.050	0.090	0.040	0.070	0.230	0.096	0.190
2	0.100	0.000	0.100	0.020	0.000	0.044	0.100
3	0.020	0.020	0.070	0.070	0.140	0.064	0.120
4	0.100	0.010	0.080	0.020	0.060	0.054	0.090
5	0.060	0.090	0.080	0.200	0.030	0.092	0.170
6	0.070	0.060	0.090	0.090	0.130	0.088	0.070

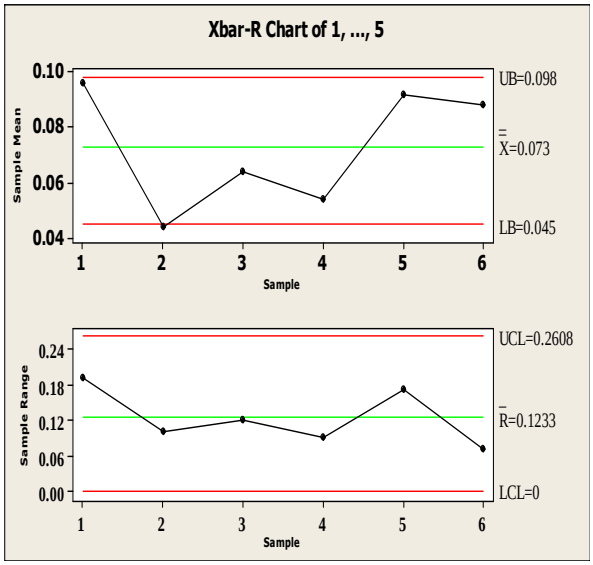

Fig.6 X-R Bar Control Chart

3.7 Run-Chart

A Run Chart consist multiple data points and these data points shows process performance over time.This data points plotted in chronological order and sequence of graph shows that how process occurred.

Following are some advantages from using a Run-Chart:

1. It monitors the process over time.
2. By using Run-Chart it helps to managers to take important decision when various problems are occurred.

On Fig.7 shows the Run-Chart for Web-Centrality.

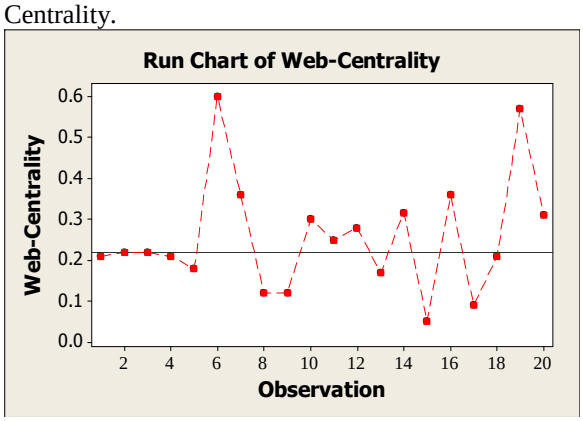

Fig.7 Run-Chart for Web-Centrality

3.8 Scatter-Diagram

A scatter diagram is tool which shows relationships between two variables. Among the two variables one variable is plotted on horizontal axis and other and other variable is plotted on vertical axis. For this case study Scatter Diagram is not shown because there is no correlation between two variables.

IV. Results and discussion

After applying 7 Quality tools at Drill manufacturing industry we found the Root-Causes, quality level of drill, Process Performance, cost due to wastage and rejection of drills are mention below in Table.5 & Table.6

Table.5List of Root Causes

Root-Causes	Discussion
Run-out	Due to Heat-Treatment
Design	Margin-Cutter
Instrument	Calibration Problem
Between Center	Due to Human Error
RPM	Due to Machine Capability
Operators Turn-Over Rate	Due to wage problems

Table.6 Result and Discussion

Seven Quality Tools	Result
Check-Sheet	Maximum Problem due to Margin over size and Grinding defect.
Pareto-Chart	Product rejection rate is 5.034%
Histogram	Maximum variation between 0.20-0.28 mm.
Cause-and-Effect Diagram	It graphically show the problem and its causes for margin over size
Control-Chart	Lot 1 and 2 are almost out of control limit.
Run-Chart	Process not stable over time.
Scatter-Diagram	No-Correlation between two variables

V. Conclusion and Future Work

This Paper describes the application of seven Quality tools in Taper Shank drill Industry. This Quality tools are used to monitor the overall Process and continuous process improvement. These basic tools applied on Company data and analyzed this data and find the Root-causes. On the basis of root causes we are going to make action plan for further improvement.

As a part of Future work, Process Capabilities studies will help to find the natural variation during production process. Process capability indices like Process capability ratio (Cp) and Process performance index (Cpk) will be useful for continuous process improvement.

References

[1] Paliska, G.; Pavletić, D. & Soković, M., "Application of quality engineering tools in process industry", advanced engineering, ISSN 1846-5900.

[2] Samadhan D. Bhosale, S.C.Shilwant, S.R. Patil, "Quality improvement in manufacturing processes using SQC tools", ISSN: 2248-9622, IJERA, Vol. 3, Issue 3, May-Jun 2013, pp.832-837.

[3] Bahmankhah Behnam, Helena Alvelos, "Exploring the Potential of Quality Tools in Tire Retreading Industry: a Case Study", ISSN: 0975-5462, IJEST, Vol. 3 No. 6 June 2011.

[4] Rami Hikmat Fouad, Adnan Mukattash, "Statistical Process Control Tools: A Practical guide for Jordanian Industrial Organizations" ISSN 1995-6665, Volume 4, Number 6, December 2010.

[5] Bahmankhah Behnam, Helena Alvelos, "Exploring the Potential of Quality Tools in Tire Retreading Industry: a Case Study", IJEST, ISSN: 0975-5462 Vol. 3 No. 6 June 2011.

[6] K. Gawdzińska, "Application of the Pareto chart and Ishikawa diagram for the identification of major defects in metal composite castings", ISSN (1897-3310), Volume 11, Issue 2/2011.

[7] Anil Kumar, Sanjay Kumar Bagri, "Improving the Productivity of Lever Combination Switch using Continuous Improvement Process", IJSCE, ISSN: 2231-2307, Volume-3, Issue-2, May 2013.

[8] Yonatan Mengesha Awaj, Ajit Pal Singh, Wassihum Yimer Amedie, "Quality improvement using statistical process control tools in glass bottles manufacturing company"ISSN 1800-6450.

[9] Rallabandi Srinivasu, G. Satyanarayana Reddy, Srikanth Reddy Rikkula, "Utility Of Quality Control Tools and Statistical Process Control to Improve the Productivity and Quality in an Industry'', IJRIC, ISSN: 2076-3328.

[10] Ali Rıza Motorcu, "Abdulkadir Gu¨ llu, Statistical process control in machining, a case study for machine tool capability and process capability'', Materials and Design 27 (2006) 364–372.

[11] Maizirwan Mel, Mohd Azmir Arifin, Mohd Hider Kamarudin, Mohamed Ismail Abdul Karim, Faridah Yusof, "Simple process capability analysis and quality validation of monoclonal antibody production in benchtop bioreactor'', ISSN 1684–5315, African Journal of Biotechnology Vol. 10(81), pp. 18824-18828, 16 December, 2011.

[12] Shinde. J.H, Katikar R S, "Importance of Process Capability and Process Performance Indices in Machine Tool", IJREAS, Volume 2, Issue 2 (February 2012), ISSN: 2249-3905.

[13] Mats Deleryd, "A pragmatic view on process capability studies" Int. J. Production Economics 58 (1999) 319-330.

[14] M. Dudek-Burlikowska, "Quality estimation of process with usage control charts type X-R and quality capability of process *C*p, *C*pk" Journal of Materials Processing Technology 162–163 (2005) 736–743.