APPLICATION OF QUALITY CONTROL TOOLS IN A BICYCLE INDUSTRY: A CASE STUDY

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Abstract

Quality plays very important role in today's highly competitive industrial environment. Quality leads to an improvement in the productivity. By improving quality, the method of optimization reduces process operational cost and variations in product. Quality control (QC) tools are used to solve more than 90 percent of the problems faced by the organizations for improving its effectiveness and meeting or exceeding the customer expectation on a continuous basis. The success of the quality control procedure depends greatly on method of data collection and its accuracy. The Present study is aimed toward reducing the rejection of Bicycle rims by application of Quality Control (QC) Tools. A case study has been conducted in a bicycle industry in Ludhiana to improve the quality of the bicycle rims. The Quality tools such as Pareto chart, Fishbone diagram have been applied to improve the quality of the products. It has been found that monthly defects were reduced to greater extent. The various process parameters such as heating voltage, temperature of heated water, time of chemical coating processes, chemical composition of the material and quality of heated water etc. which have influence of the quality of final product have to be controlled in order to reduce the wastage and also there has been observed a need of improvement in guide mechanism and storage methods to reduce the problems that results from manufacturing process by using the quality control tools. The rusty boiler tubes and rusty pipelines also need proper cleaning at regular intervals. The Company where the study was carried out is Partap Bikes, Ludhiana.

Keywords: *7 Quality Control tool, Cause-effect Diagram, Pareto Diagram, Scrap Reduction,*

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1. INTRODUCTION

Quality improvement is a continuous process which assumes the implementation of quality control tools. Quality is very important in today's competitive environment. It is not only necessary to reduce the wastage, but also to satisfy customer's expectations, continuous cost reductions and continuous improvements to survive in highly competitive environment. In today's competitive economy quality with minimum cost are dependent factors. Quality control tools can be applied in product development, production and marketing also. The quality control is aimed to satisfy the customers by delivery of defect free products. The research is aimed to investigate the successful application of quality control tools in industry. Quality, productivity and cost of operation relatively dependent on each other [4]. The main goal of quality management is customer satisfaction by delivery of defect free products at minimum cost. By application of quality tools cost of Rs.12677.57 saved per year. Jha et al. (2013) conducted a case study to reduce the scrap in automotive assembly lines using quality control tools [16]. It results in huge saving in cost to the company. The study conducted by Fouad and Mukattash (2010) in steel industry helps to reduce majority of problems related to the quality[5]. In this research, the rejection of bicycle Rims has been reduced by application of quality control tools in Bicycle Rim manufacturing industry located in Ludhiana. The study will be highly beneficial for bicycle industry.

1.1 Benefits of Quality Control Tool

- Helps in controlling the rejection and rework.
- Helps in customer satisfaction by reduction in customer complaints.
- Beneficial for reducing the production cost.
- Improvement in the process.
- Helps in finding the root causes of problem.

1.2 Quality Control tools

Quality Control tools are statistical tools for solving the quality related problems. The following are the quality control tools used to solve problems.

1.2.1 Check Sheet

Check sheet is a table created by tallying each type of defect for a specified time. It shows the defects and how many time each type of defect occurred during that period. On the basis of information obtained the improvement actions can be taken.

1.2.2 Pareto Chart

Pareto chart is frequency distribution of attribute data arranged by category. These are extremely useful to find the factors which have greatest effect on system and allow the users to focus attention on these factors and screen out the less significant factors.

1.2.3 Flow Chart

Flow charts are pictorial representation of process by breaking the process down into its constituent steps. Flowcharts are helpful in identifying where errors are likely to found in the system. In quality improvement process flowcharts are particularly useful for displaying how a process currently functions or could ideally function.

1.2.4 Cause and Effect Diagram

The cause and effect diagram is used to associate multiple possible causes with a single effect. Causes in cause and effect diagram are frequently arranged into four major's categories. These categories can be anything: Manpower, Methods, Materials and Machinery.

1.2.5 Histogram

Histogram is a special bar chart for measurement data. It is used to chart the frequency of occurrences.

1.2.6 Scatter Diagram

Scatter diagram graphical representation to determine correlation between two variables. The shape of scatter diagram indicates the relationship between two variables.

1.2.7 Control Chart

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

2. LITERATURE REVIEW

The Continuous process improvement requires appropriate quality control tools and is of matter of facts collected with precisions. [3] implemented the QC tools in Cement Industry to control the quality of ready mix cement. [5]proposed key ingredient for successful quality management by application of statistical process control and seven basic quality control tools. [9] implemented two Quality Control (Pareto analysis and Cause & effect diagram) tools to reduce the rejection of casting components in an automobile industry. This study results in reduce from 10% to 8.23% and saving of Rs. 27.7 Lakhs per year. [18] planned a study to reduce the rejection of castings using Quality control tools (QC) in North India. The study results in annual saving of Rs. 10 lakhs. [14] conducted a study aimed to find out the causes of quality related problems. Quality tools like cause and effect diagram, histogram, Pareto diagram and check sheet were used in the study. The major causes of rejection i.e. seal ring pore, latex coating damage and mating ring chip were controlled by appropriate action and defects were reduced from 9.6% to 7.9%.

3. RESEARCH METHODOLOGY

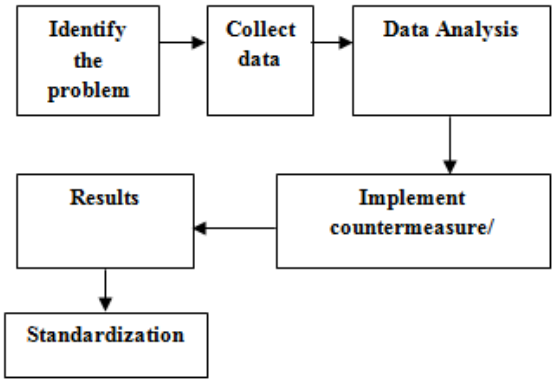

Fig -1: Research methodology

3.1 Identify the Problem

Defects in rim manufacturing includes corrosion in storage conditions, scratches/ marks, incorrect hole alignment, dents, weld gaps, rim explosion, incorrect cross section geometry, non-circularity in shape which were observed. This leads to high monthly rejection.

3.2 Data Collection

The rejection data has been collected from the industry using daily inspection reports and rearrange the data defect wise.

3.3 Data Analysis

Two Quality tools namely Pareto chart and Fishbone diagram has been used for data analysis in the study.

3.4 Corrective Actions

To reduce the rejection of rims corrective and preventive actions were taken.

3.5 Results

On the basis of outcome of previous steps results, conclusions were taken regarding key issues.

3.6 Standardization

Standard operating procedures were revised after analysis the results.

4. PROBLEM FORMULATION

There are many quality related problems which were observed during the work in industry. The Rejection observed was 9.45% which was alarming due to some critical manufacturing defects. The temperature of water for coating the chromium is (55^0 C- 60^0 C)but the actual coating temperature was below the specified range. Raw material was also rusty. The time of chromium plating (5 minutes) was less them actual time (8-10 minutes) required for ensuring the effectiveness of coating. Boiler tubes also to be cleaned for ensuring the proper heat transfer to water to raise the water to desired temperature without overheating

the tubes of the boilers. Unskilled handling of components leads to non-circular shape of rim. Material should also be cleaned and rust free before butt welding to ensure a sound welded joint. Misaligned welded joint was also a problem in manufacturing. Due to all these reasons there are many defects in rim which includes corrosion in storage conditions, scratches/ marks, incorrect hole alignment, dents, weld gaps, weld breakage, incorrect cross section geometry, non-circularity in shape.

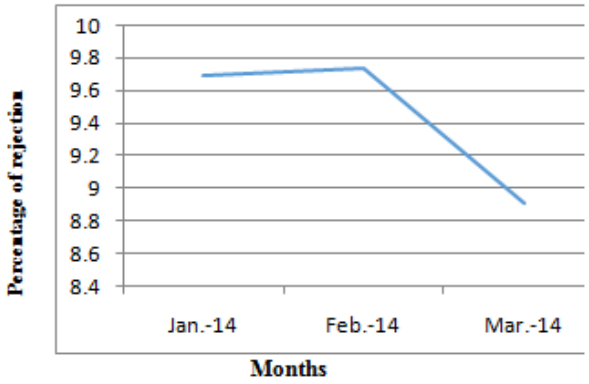

Chart -1: Rejection Trend of ISO Rims

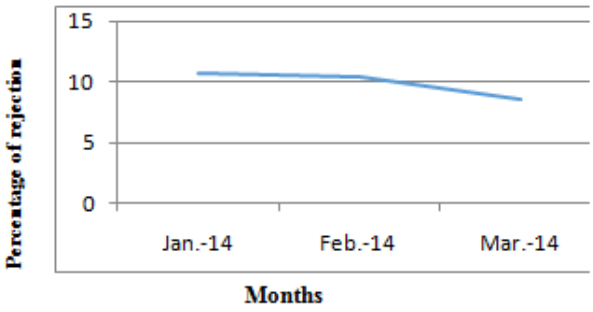

Chart -2: Rejection trend of ISO 26”Rim

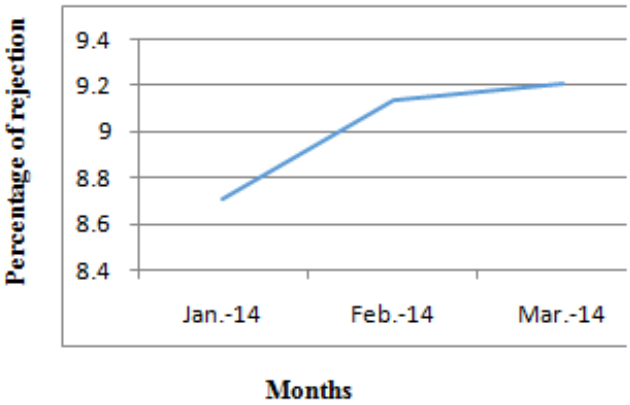

Chart -3: Rejection trend of ISO 28”Rim

Chart No 2 and Chart No.3show the rejection trend ISO 26” & ISO 28”rims. The rejection trend is different for both of rims due to different sizes. Figure 3.3 shows the Pareto analysis of the Rims. First five defects contribute more than 80% of rejection. Corrosion contributes 35% of total. Cumulative percentages are also given in the table. The defects were arranged in descending order so as to focus more on few important factors and less on least significant defects with least contribution to the total defects.

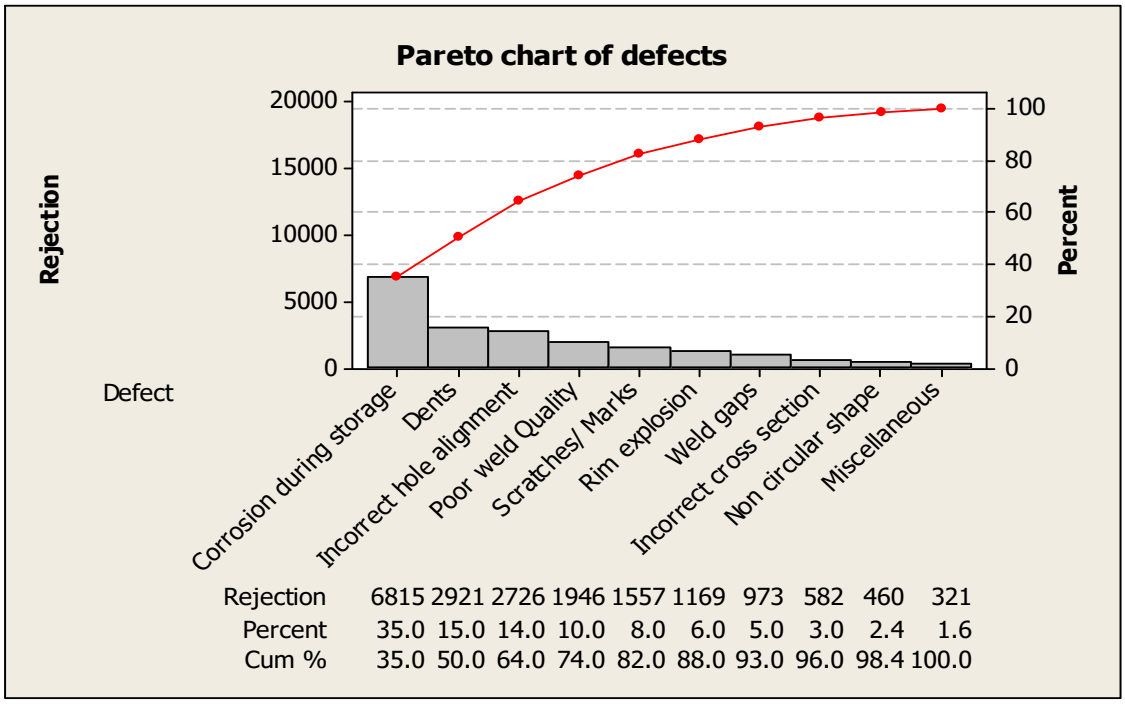

Fig -2: Pareto Chart of Rim Defects

Table -1: Rim defects

S.No	Name of defect	Rejection	Cumulative Rejection	Cumulative %
A	Corrosion	6815	6815	35.01
B	Dents	2921	9736	50.01
C	Incorrect hole alignment	2726	12462	64.01
D	Poor weld Quality	1946	14408	74.02
E	Scratches/ Marks	1557	15965	81.99
F	Rim explosion	1169	17134	88.02
G	Weld Gaps	973	18107	92.99
H	Incorrect cross section	582	18669	95.88
I	Non circular shape	460	19149	98.35
J	Miscellaneous	321	19470	100

5. RESULTS AND DISCUSSIONS

5.1 Corrosion of Rim

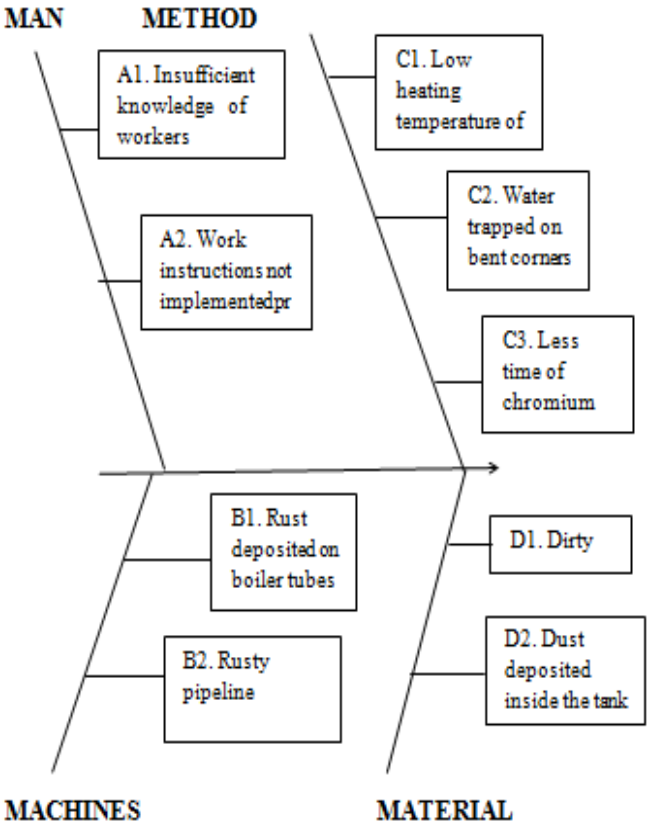

Fig -3: Fishbone diagram for Corrosion of rim

Table -2: Counter Measures for corrosion of rims

S. No	Counter Measure for Man
A1	Sufficient knowledge given to operators about the method of chromium dipping.
A2	Specific work instructions provided to the workers regarding the causes of corrosion defect. (i) Check the cleanliness of rims before dipping, if found unclean then separate and report to quality persons. (ii) Not to insert more than 50 rims at a time. (iii) Temperature of water should be checked after every 2 hours. (iv) Clean the boiler tubes and pipelines after three months.
	Counter Measures for Method
B1	It has been found that the heating of water is done at range of 40^0 C-45^0 C which is low. The heating temperature increased in the range of 55^0 C-60^0 C to have proper chemical reaction of chromium to increase the corrosion resistance.
B2	To have escaping of water trapped on side bent corners Provide two holes on the bent corner opposite to each other for escaping and reducing the tendency of corrosion on sides.
B3	The actual time of chromium dipping process observed was 5 minutes very less then the actual time. So it was suggested to Set the dipping time in range 8 minutes-10 minutes.
	Counter Measures for Machines
C1	It was observes that the boiler tubes were rusty due to which the rate of heat transfer reduces and also efficiency of boiler reduces by 10% and even with having the proper fuel supply the required temperature (55-60 degree) was not reached. So after careful inspection the boiler tubes were cleaned.
C2	The pipeline also found rusty which was cleaned.  **Fig -4:**Rusty rims
	Counter Measures for Material
D1	Check the cleanliness of water before mixing in the tank.
D2	Before starting the chromium coating process tank should also be cleaned properly.

5.2 Dents

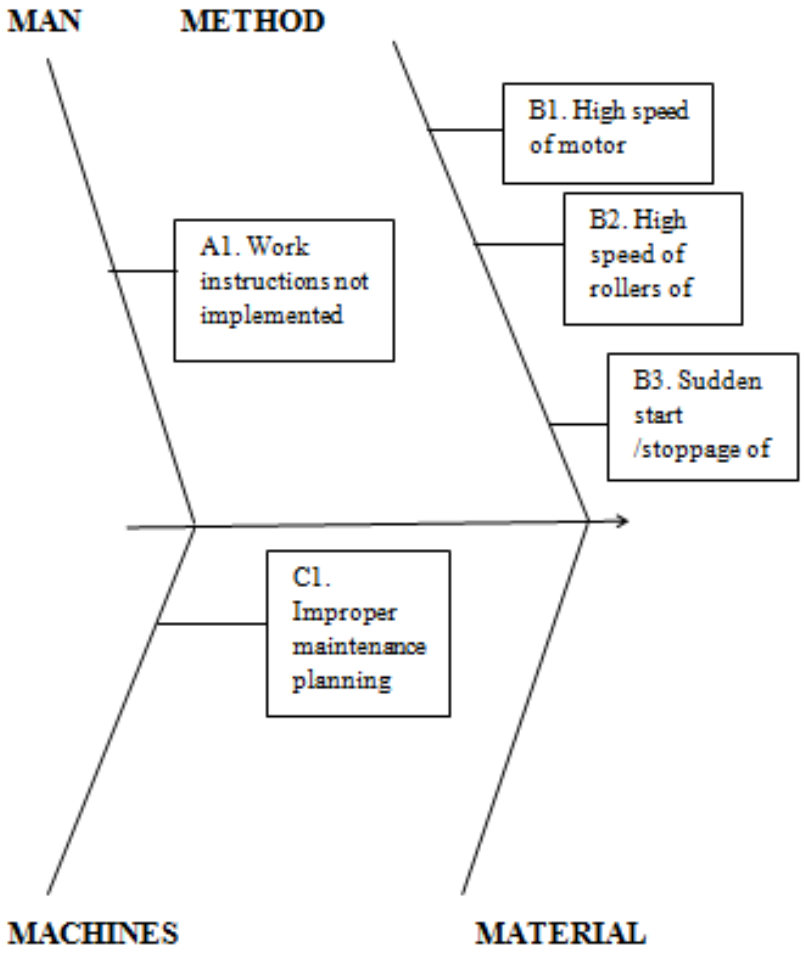

Fig-5: Fishbone Diagram for Dents

Table -3: Counter Measures for Dents

S. No	Counter Measure for Man
A1	Specific work instructions provided to the workers regarding the causes of Dents. (i) Handle the rims carefully and avoid hitting with each other. (ii) Hand gloves should be used to have proper grip of hands while handling the rims
	Counter Measures for Method
B1	Speed of motor should be increased from starting to operational (1440) r. p.m. in 2 minutes.
B2	Speed of rollers not to exceed 10 r.p.m
B3	Allow rollers to run freely for 1minute and then increase the speed slowly and also allow one minute for reducing the speed and then stopping the machine in order to reduce the shocks which can cause dents on rims.
	Counter Measures for Machines
C1	Maintenance of rolling machines should be done once in three months to avoid breakdown especially in the running conditions.

Table -4: Details of rejection of ISO 26" Rims

	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Rejection % (Jan-Mar)	Rejection % (Apr-Jun)	Net Reduction
Monthly Rejection	9.69	9.74	8.90	7.88	7.87	7.50			
Item	**ISO 26"**	**ISO 26"**	**ISO 26"**	**ISO 26"**	**ISO 26"**	**ISO 26"**			
% age Rejection	10.64	10.33	8.60	7.97	7.93	7.36			
OK	30481	31985	32723	35711	35099	30116			
Not OK	3633	3686	3079	3093	3025	2396			
Rej. Pts.									
Corrosion	1205	1309	1229	1098	1036	901	3.54	2.77	0.77
Dents	623	521	416	520	496	344	1.47	1.24	0.23
Incorrect Hole alignment	459	583	414	452	425	313	1.37	1.08	0.29
Poor Weld quality	420	308	311	354	285	211	0.98	0.77	0.21
Scratches/ Marks	311	255	269	203	283	197	0.89	0.62	0.27
Rim Explosions	159	295	159	173	185	153	0.57	0.47	0.10
Weld Gaps	205	198	121	143	152	125	0.50	0.38	0.12
Incorrect Cross Section	138	120	67	86	93	71	0.31	0.23	0.08
Non Circular Shape	68	71	41	39	48	38	0.17	0.11	0.06
Miscellaneous	45	26	52	25	22	43	0.12	0.08	0.04
Total piece (Jan-Mar)	105587								
Reject (Jan-Mar)	10398								
Rejection (Jan-Mar)%	9.84								
Total piece (Apr-Jun)	109440		**Reduction in Rejection= 9.84-7.77=2.07=176 pieces per month**						
Reject (Apr-Jun)	8514		**Cost of one piece= Rs.102**						
Rejection (Apr-Jun)%	7.77		**Saving in one month =176 X102= 17952**						
			Saving in one year= 17952X12=215424						

Table -5: Details of rejection of ISO 28" Rims

	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Rejection % (Jan-Mar)	Rejection % (Apr-Jun)	Net Reduction
Monthly Rejection	9.69	9.74	8.90	7.88	7.87	7.50			
Item	**ISO 28"**	**ISO 28"**	**ISO 28"**	**ISO 28"**	**ISO 28"**	**ISO 28"**			
% age Rejection	8.71	9.14	9.21	7.75	7.80	7.61			
OK	30157	31977	29279	32020	32299	32700			
Not OK	2880	3220	2972	2690	2734	2695			
Rej. Pts.									
Corrosion	962	1024	935	853	897	862	2.90	2.48	0.42
Dents	419	452	437	387	392	365	1.30	1.08	0.22
Incorrect Hole alignment	322	298	325	295	279	320	0.94	0.85	0.09
Poor Weld quality	296	280	258	228	192	195	0.80	0.58	0.22
Scratches/ Marks	259	269	236	222	211	215	0.76	0.62	0.14
Rim Explosions	213	240	219	197	193	198	0.66	0.55	0.11
Weld Gaps	174	215	227	202	184	200	0.61	0.56	0.05
Incorrect Cross Section	102	198	174	115	124	132	0.47	0.35	0.12
Non Circular	81	142	58	64	117	69	0.27	0.23	0.03

Shape									
Miscellaneous	52	112	103	127	145	139	0.26	0.39	-0.13
Total piece (Jan-Mar)	100485								
Reject (Jan-Mar)	9062								
Rejection (Jan-Mar)%	9.02								
Total piece (Apr-Jun)	105138		**Reduction in Rejection = 9.02-7.72 = 1.30 = 105 pieces per month**						
Reject (Apr-Jun)	8119		**Cost of one piece = Rs.110**						
Rejection (Apr-Jun)%	7.72		**Saving in one month =105 X 110 = 11550**						
			Saving in one year= 11550 X12= 138600						

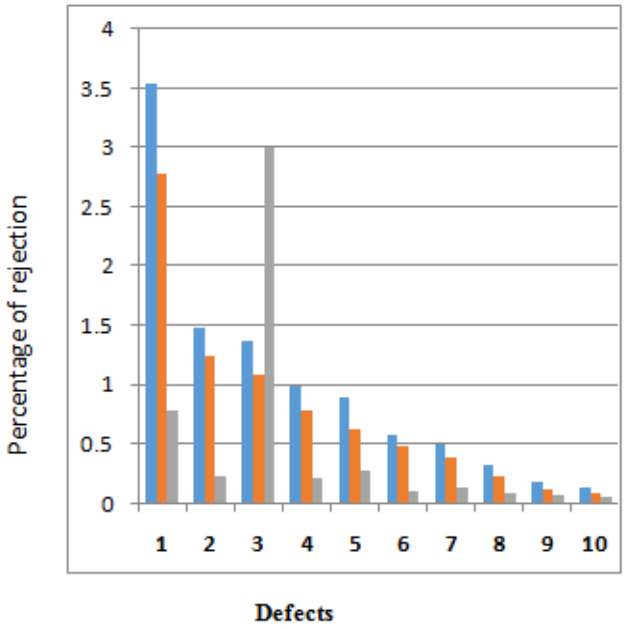

Chart -4: Rejection of ISO 26"Rims

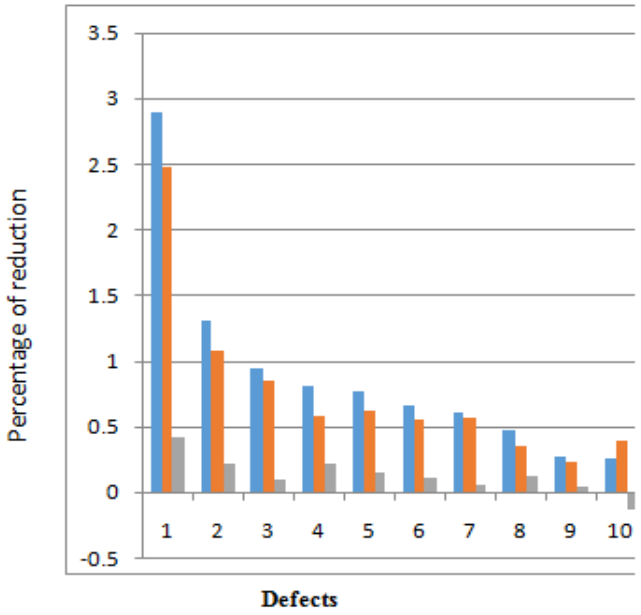

Chart -6: Rejection of ISO 28" Rims

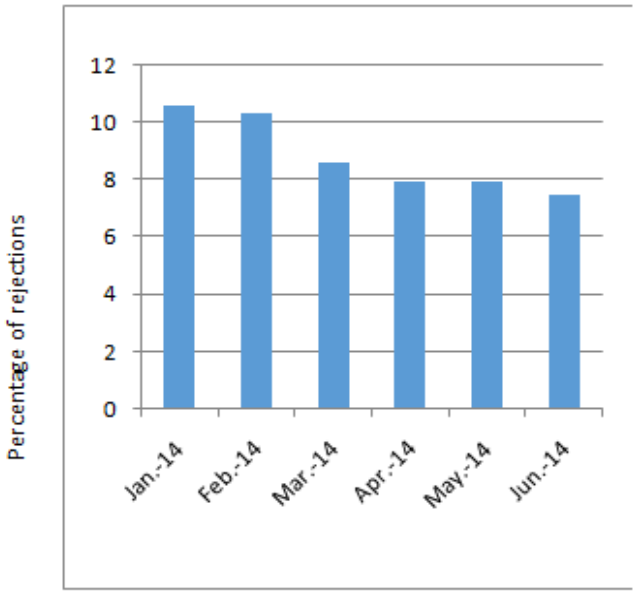

Chart -5: Monthly rejection of ISO 26" Rims

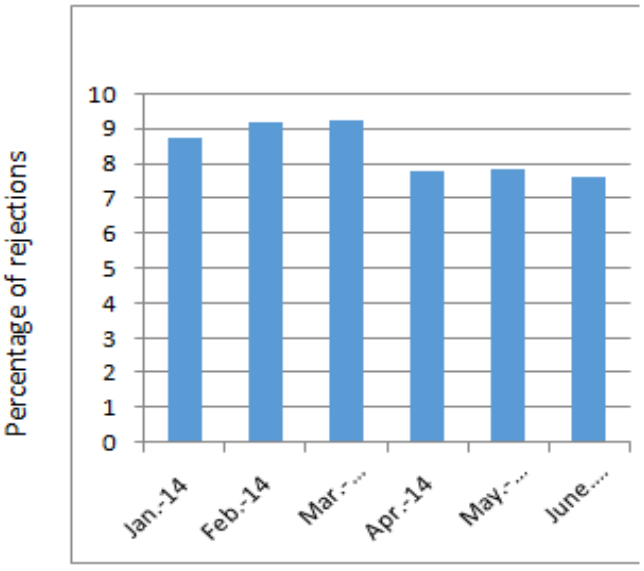

Chart -7: Monthly rejection of ISO 8" rims

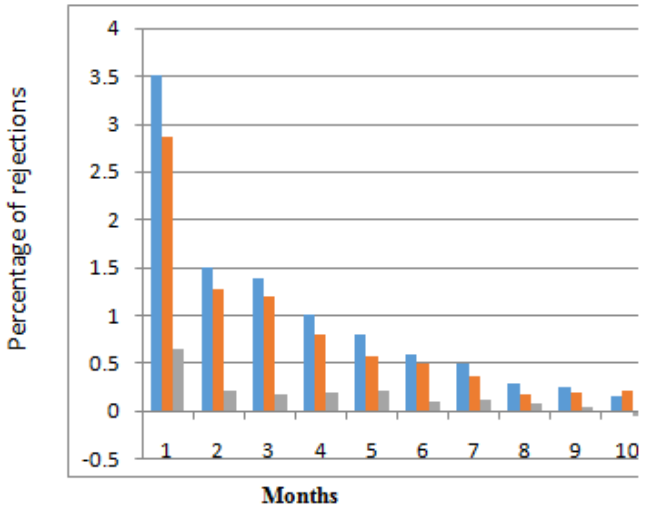

Chart -8: Overall Rejection of Rims

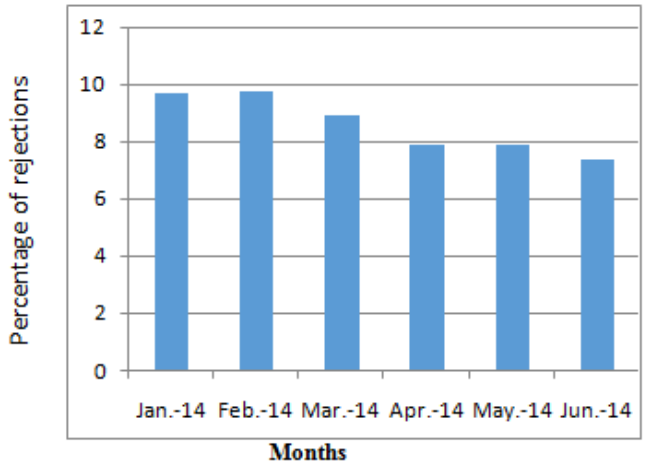

Chart -9: Overall Monthly rejections of Rims

6. CONCLUSION

Quality leads to improvement in productivity and at the same time it also leads to customer's satisfaction. Study has been conducted to define the role of quality control tools in Bicycle rim manufacturing industry. In the Quality management system these tools can be much wider applied with certain success. Quality tools are not so wider spread as expected although they are quite simple for application an easy for interpretations. Main goal of the study is to reduce the cost per component by reduction in monthly rejection of the components After studying the problems, various parameters affecting the quality of the final product were identified and data was collected with accuracy and precision and some standard working procedure were proposed for chemical coating, stacking and material handling and remedies were also proposed. Quality tools i.e. Pareto chart, Cause and Effect Diagram were used in the study. The main conclusions of the study are summarized as below.

- Rejection of the rims has been reduced from 9.45% to 7.75% for overall production of the components.
- Saving of Rs. 3.54 lakhs per year.
- Material handling and stacking process are also standardized.
- By proper regular cleaning of boiler tubes the higher efficiency can be obtained and saving in fuel (up to 10%) can be achieved.

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BIOGRAPHIES

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