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ANALYSIS OF MANUFACTURING OF RAILWAYS BOGIES THROUGH QUALITY CONTROL TOOLS

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ABSTRACT

It is very important improve and maintain the quality of manufactured products now a days to survive in global or local market. Some quality control tools have been applied to one of the leading coach manufacturing industry, located in norther India. ThePareto chart, Fishbone diagram etc. have been applied to find the root causes of failures of components and improving the quality of manufacturing products. It has been established that the organization has numerous issues particularly in dismissal and modifications in the assembly lines. Various processes like CNC cutting, welding, machining, assembly of parts are involved, where probability of defects are more and improvement is required. Pareto chart shows that fault in control arms accounted for 35.3%, while Ankerlink block accounts for 29.35% and gap between pair of control arms are approximately 19%.

Keywords: Quality Control Tools, Pareto chart, Cause & Effect Diagram., Railways coach manufacturing

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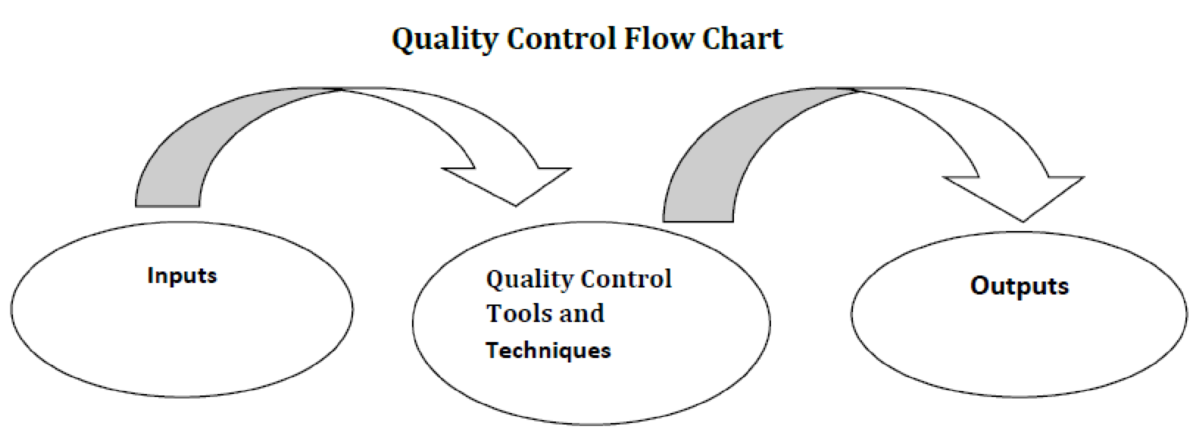
1. INTRODUCTION

The latest challenge in the current worldwide market is an issue converting into a huge requirement for the proceeding with advancement of the manufacturing. Consequently, world business is ceaselessly in scan for the aggressive edge because of the developing requests of client needs and desires. Quality has a significant job in the business procedure over the whole association, to be increasingly proficient and viable in the worldwide market, in this way improving profitability and client dedication just as increment piece of the overall industry. It isn't just important to decrease the wastage, yet additionally to fulfil client's desires, cost decreases and constant upgrades to get by in profoundly focused condition.Quality improvement is an essential prerequisite in any production framework that sends items or administration as its yields. Hence, it is a noteworthy objective in any assembling and manufacturing industry. Assembling and manufacturing industries spend a great deal of endeavours in keeping up and improving quality of their items utilizing an assortment of quality control tools and methods.

Quality control tools can be connected in item improvement, generation and showcasing additionally. Quality concerns influence the whole association in each aggressive condition. It isn't just important to decrease the wastage, yet in addition to fulfil client's desires, nonstop cost decreases and ceaseless enhancements to make due in exceedingly aggressive condition. The quality control is meant to fulfil the clients by conveyance of imperfection free items. The exploration is meant to research the fruitful Implementation of quality control tools and Techniques in assembling and manufacturing industry. Figure 1 shows the Quality control flow chart.



Work Result	Pareto Chart and Pareto Analysis	Quality Improvement
Checklists	Control Charts	Acceptance Decision
Operational Definitions	Flowcharting	Rework
Quality Management Plan	Cause & effect diagrams	
	Scatter diagrams	
	Histogram	
	Run chart	
	FMEA	

Fig.1 Quality Control Flow Chart

The use of Quality control tools is significant, as it could improve process execution by diminishing item fluctuation and improve generation effectiveness by diminishing scarp and modify. These tools are helpful in (i) Minimization of the dismissal (ii) Enhance consumer loyalty by decrease in client complaints. (iii) Beneficial for decreasing the generation cost (iv) Finding the underlying drivers of issue and improving production execution.

1.1 Quality control tools and techniques

By understands the processes with the goal that they can be improved by methods for an orderly methodology requires the learning of a straightforward pack of tools or methods. The viable utilization of these tools and methods requires their application by the general people who really deal with the procedures, and their responsibility to increase quality may be achievable and guaranteed that the executives thinks about improving quality. The tools and procedures most normally utilized in procedure improvement are:

(i) Process flowcharting (ii) Cause and Effect diagram (iii) Brainstorming

(iv) Pareto investigation (v) Control Charts (vi) Check sheets

(vii) Scatter graphs (viii) Histograms and (ix) Failure Mode Effect Analysis (FMEA)

These tools are very common and popular, so details of these tools are not required in this paper.

2. Literature Review

Gaafar and Keats (1984)focused on the Statistical Process Control (SPC) implementation phase in an effort to underline that SPC is not just control charts, and that many steps have to be accomplished before these charts are used. In addition, they highlighted the role of training and presented it as an ongoing process which involves everyone in the organization. Chan et al.

(2003) contemplated consolidating the consequence of two charts to be specific x-diagramand x-bar graph. Control charts assumed a significant job in observing the presentation of activity forms, as far back as their development.

Saniga et al. (2006)looked at the expenses of a monetarily planned CUSUM control diagram and a typical Shewhart control charts, the X–bar graph for some setups of parameters. They found that there are recognizable locales where X–bar graph can be utilized with no considerable monetary weakness.Prajapati and Mahapatra (2007)examined an extremely straightforward and powerful structure of proposed X-bar and R charts to screen the procedure mean and standard deviation. The idea of the proposed charts depends on the aggregate of chi-square (χ^2) to register and analyze Average Run Lengths (ARLs). They compared their proposed charts with VSS, VSI and VSSI joint plans proposed by Costa (1999).

Fricker (2009) portrayed a system for advancing the Shewhart x-diagram working on parallel creation lines in a production line. They utilized non-direct programming to suitably set the diagram control limits which consolidates the data about the likelihood of every generation line leaving control. By utilizing this methodology, production lines can set their control frameworks to ideally recognize crazy conditions. The objective is to expand the production line wide likelihood of recognizing a crazy condition exposed to a requirement on the normal number.Das and Sachan (2013) discussed the importance of control charts in detecting the assignable cause of variation. They discussed the assumption under which these charts are developed. They proposed some alternatives control charts for controlling location parameters based on some robust estimators, because the present charts are not used with assumption in real situations.Prajapati and Singh (2014) processed ARLs (normal run length) at different arrangements of parameters of the X diagram by reproduction, utilizing MATLAB. The presentation of the graph is estimated as far as the normal run length (ARL), which is the normal number of tests before getting a crazy sign. They made an endeavor to counter autocorrelation by planning the X charts utilizing cautioning limits. They proposed different ideal plans for various dimension of connection.

Singh and Prajapati (2016) examined that both management and employees in the service sector can take advantage of SPC techniques to analyse processes and procedures. Processes may be streamlined to save employee hours. Procedures that lead to mistakes may be changed so that the incidence of mistakes is reduced or eliminated. Employee involvement in the use of charts and check sheets can lead to valuable input in improving the service. It is found from the Pareto analysis that maximum percentage of rejection (33.75%) is due to drive shaft run-outs defects. Other two important causes are Crank shaft bearing diameter undersize & oversize (14.61%) and under size of cylinder block depth (13.28%) respectively.Everard and Hardjono (2018)states In quality administration four standards can be observed: the Empirical, the Reference, the Reflective and the Emergence Paradigm. Right now the Emergence Paradigm is the least created. Following the Emergence Paradigm would mean the fuse of frameworks thinking in initiative preparing, quality administration hypothesis and practices. Rehearsing quality administration from the Emergence Paradigm would embroil for an association to be available to change and its specific circumstance.

Chen et al. (2014) examined that first attempt at developing yield based PCIs for non normal processes. In the literature, the use of classical PCIs such as Cp and Cpk is based on the normality assumption of the process characteristic X. If X is non normal, the percentile-based PCIs cannot quantify the process yield, which limits their usefulness in various applications such as the supplier-selection problem. On the contrary, our proposed PCIs degenerate to the classical PCIs when X is normally distributed, and they have the same quantitative interpretation to the process capability

3.0 Industry and Processes

This rail coach factory was laid on 17^{th} August 1985 in the northern part of India and was a timely step towards making good shortfall and complementing the coach manufacturing capacity of Railway's other manufacturing units.The present production capacity of this plant is approximately 2000 coaches per year. Various kinds of coaches- AC, Non-AC, Chair Car,Tejas, MG Diesel Electrical Multiple Units, Main Line Electrical Multiple Units etc. are manufactured in this plant of India. Flow process chart for manufacturing of railways bogies is shown in Figure 2.

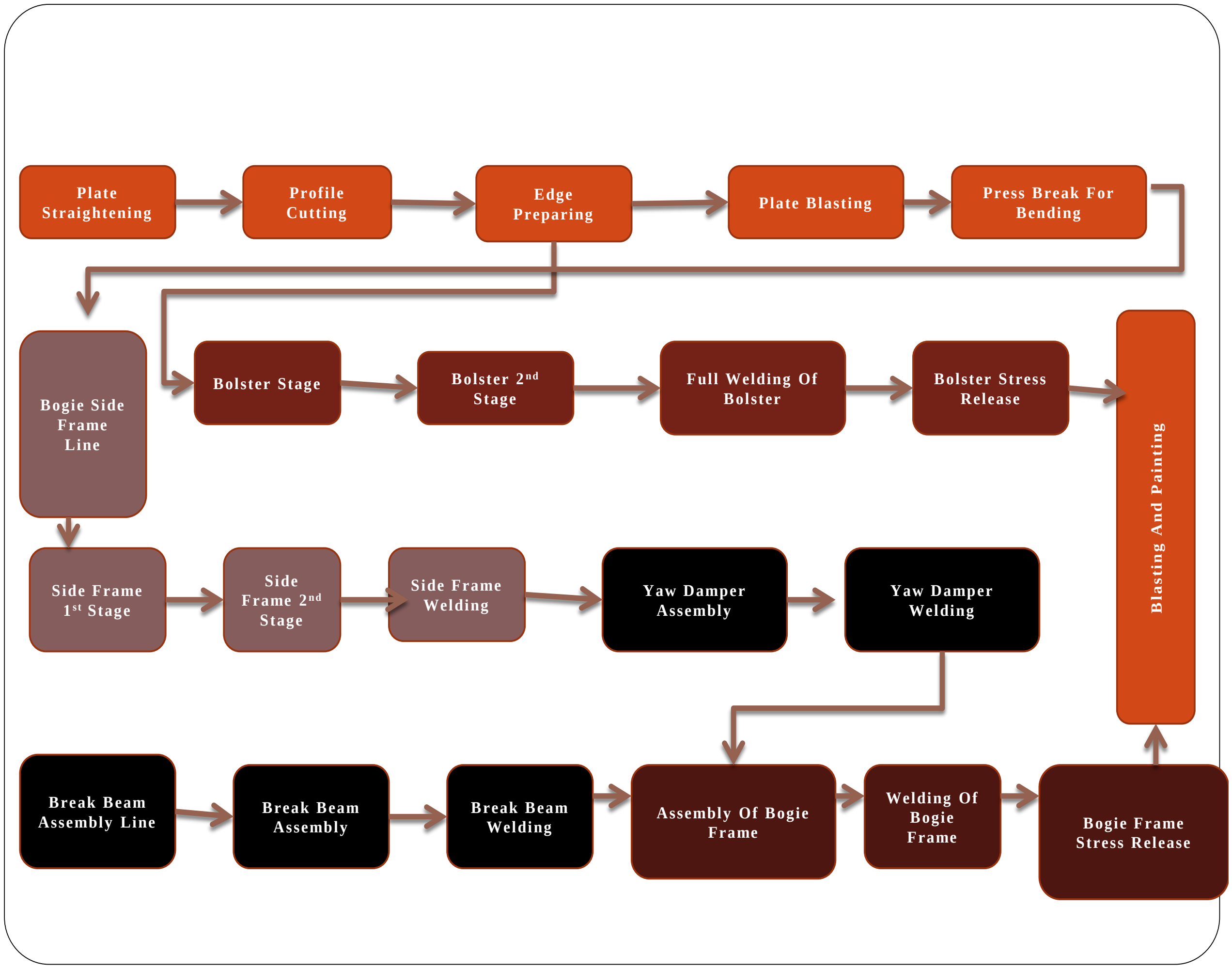
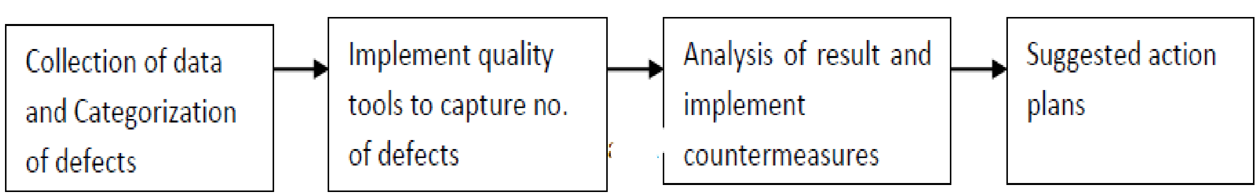


Fig.2 Flow process chart for manufacturing of bogies

4. RESEARCH METHODOLOGY

The Objective of this paper is to find the defects of the components and improve the manufacturing line using Quality control tools in assembly process so as to decrease the dismissals, and to upgrade client satisfaction.



4.1Data Collection

There are so many quality related issues which were seen at the work in industry. Rejection of materials because of imperfections has been observed in the assembly process of the manufacturing; as shown in Table1.

Table 1 List of parts of bogies produced in 2018-19

S. No.	Product Descriptions of bogie parts	Total quantity produced
1.	Mating blocks	2738
2.	Control arms	10882
3.	Bolster guide	2850
4.	Anker links blocks	5929
5.	Guide of conventional bogie frame	1447
TOTAL		**23846**

4. 2 Analysis of Defects

Various defects found during the operations are discussed in this sub-section.

4.2.1Under size of Mating block

Mating block is part of the bogie bolster which is welded on its end. This defect will arise due to the human error. Due to this defect the machining cannot be done as the pointer of the machine cannot detect, from where the machining should be done

As soon as, this defect is observed by the operators, it is to be rectified immediately. This can be removed by the filling of same material at the void (due to which the cutting machine was not able to find the start of cutting point). Fig. 3(a& b) shows the Mating block before and after machining.

(a) **(b)**

Fig. 3 (a) Mating block before machining and (b) Mating block after machining

4.2.2Fault in Control Arm

The Figure 4 shows the control arms; which are welded on the side frame of the bogie. These are used for the fitting of the dampers. This defect occurs when machine did not cut the circumference with proper depth, as shown in Figure 4(b).

(a) **(b)**

Fig.4 (a) control arm before cutting by machine and(b) control arm with improper depth of cutting

If this is not rectified according to drawing then no further operations can be done due to dimensional error in the control arm circumference.

4.2.3 Gap between pair of control arms

There are 8 control arms used in the assembly of single bogie. They are always welded in pairs, so there are four pairs welded to the side frames of the bogie. Sometimes; during the welding the required gap between the control arm pairs may not according to the drawing.To rectify this defect; a rod will be welded between the pair of the control arms, so during the handling or doing other operations the gap between the pairs will remains same but when this assembly will go to the wheel assembly this rod is required to be cut, as shown in Figure 5 (a & b).

(a) **(b)**

Fig.5 (a) Gap between control arms and (b) Gap between control arms after rectification

4.2.4 Unequal levelling of Bolster's guide holes

This defect occurs in the bolster guide hole and this guide hole is used to assemble the bolster with the bogie frame. Figure 6 (a & b) shows the bolster guide holes of both types.

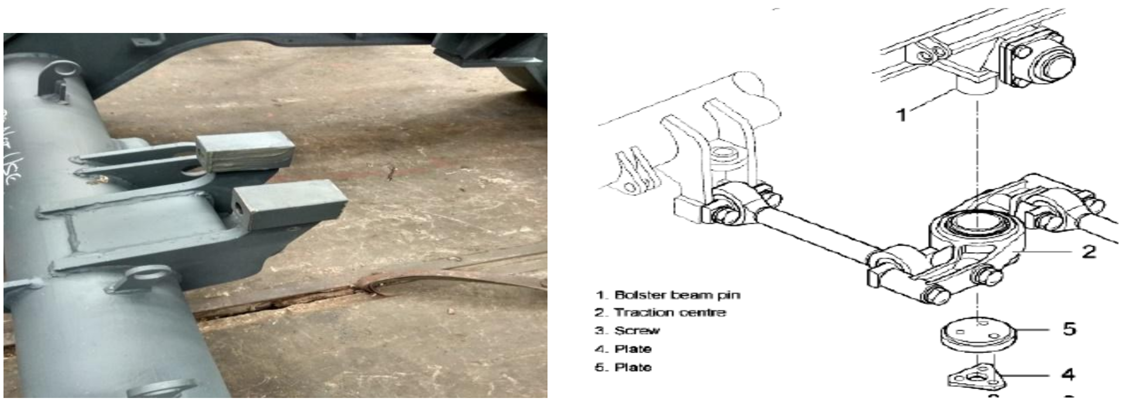
(a) **(b)**

Fig.6 (a)Improper level of bolster guide hole and (b) rectified guide hole after machining and boring

This error can be rectified by heating the unlevelled surface, and now machining can be done properly. There are 4 guide holes on the bolster

4.2.5 Ankerlink Blocks

The Ankerlink blocks are welded on the cross beams. These are welded in pair. There are 2 pairs of Ankerlink block in one bogie. These blocks are used to support the traction centre which is used for the fitting of bolster pin which will come through traction centre.This defect occurs due to improper welding but this defect may be rectified by heating.Fig.7 shows the Ankerlink blocks with improper gap and animated view of the setup.



(a) **(b)**

Fig. 7 (a) Ankerlink blocks with improper gap and (b) Animated view of the setup

4.2.6 Distortion in guide of bogie frame

The guide of the bogie is used to bring bogie to a lower position. Sometimes, there is a distortion in this guide, as it gets tilted in one direction due to the improper welding.This defect can reduce the life of the bogies. Fig.8 shows the distortion in guide of bogie frames.

Fig. 8 Distortion in guide of bogie frames

5. Application of Quality control tools:

In this paper two quality tools namely; Pareto Chart and Cause & Effect diagrams are used to find the numbers and percentages of causes of defects and their possible rectification to improve the quality of the products/ assembly of the Railways.

5.1 Pareto chart

The Pareto principle, suggested by Italian economist; Vilfredo Pareto (also known as the 80/20 rule, the law of the vital few, or the principle of factor sparsity) states that, for many events, roughly 80% of the effects come from 20% of the causes. Pareto chart is a kind of diagram where the plotted qualities are arranged from biggest to smallest. A Pareto chart is used to feature the most regularly happening imperfections, the most widely recognized reasons for deformities, or the most of the causes.Various types of defects in the manufacturing of various parts of bogies are categorized in Table 2 and their graphical representation is shown in Figure 2.

Table 2 Types of defects in the manufacturing of various parts of bogies

S. No.	Name of Defect	No. of Rejections	Percentage of Rejections	Cumulative Rejection	Cumulative Rejection in %age
1	Fault in Control Arm	1829	35.32	1829	**35.32**
2	Ankerlink Blocks	1520	29.35	3349	**64.67**
3	Gap between pair of control arm	980	18.92	4329	**83.59**
4	Unequal levelling of Bolster's Guide hole	331	6.39	4660	**89.98**
5	Undersize of Mating Block	323	6.23	4983	**96.22**
6	Distortion in Guide of Bogie Frame	196	3.78	5179	**100.00**

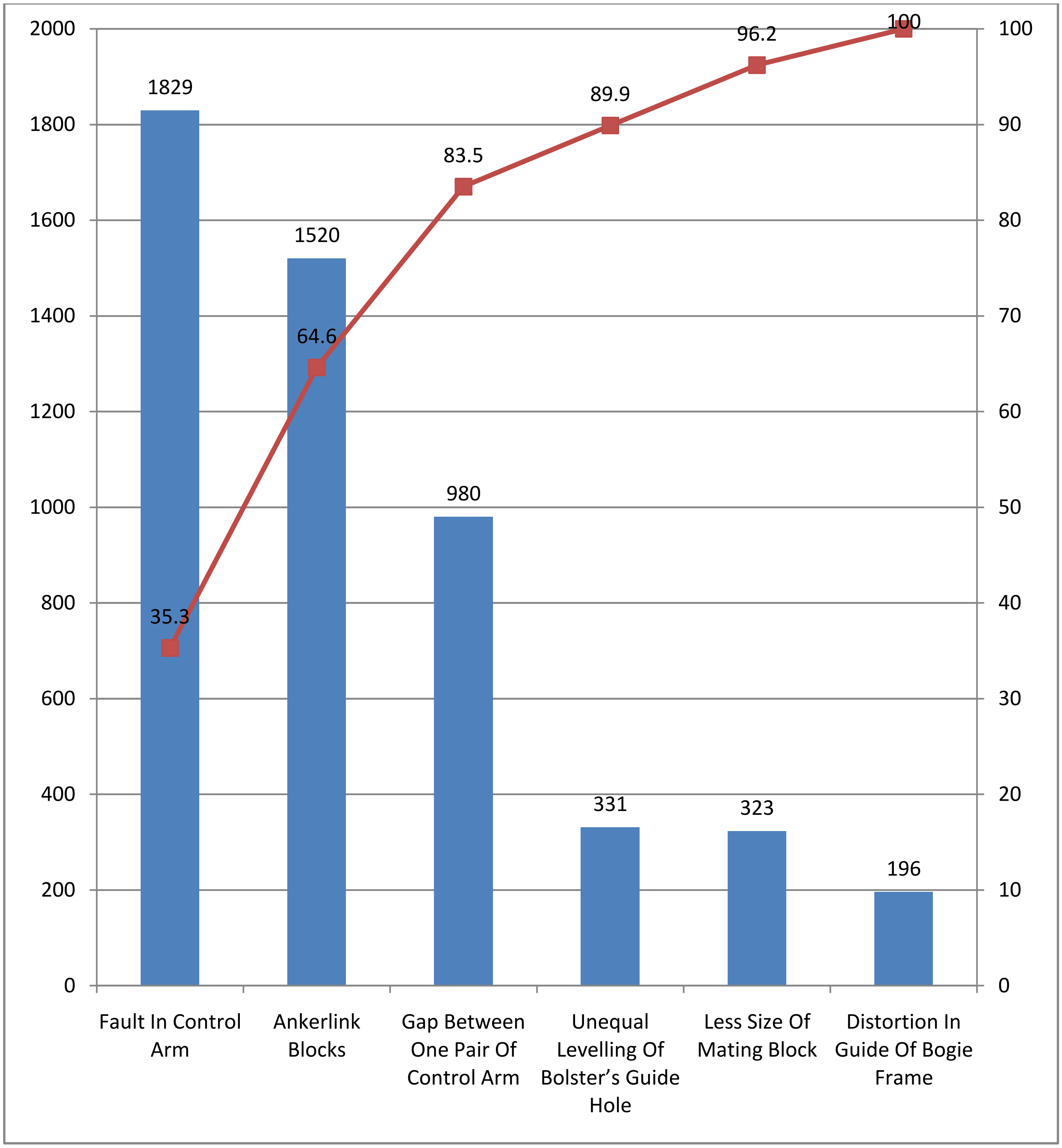


Fig.9 Pareto chart for analysis of defects in manufacturing in bogie shop

It is found from the Pareto chart that fault in control arms accounted for 35.3%, while is Ankerlink block accounts for 29.35%. Similarly, defects due to gap between pair of control arms areapproximately 19%. These are the main defects which are responsible for about 84% of defects. So for these defects, Cause and Effect diagrams for each one are shown in the following sub-section.

5.2 Cause and Effect or Fishbone diagram(Ishikawa diagram)

Cause and Effect diagram are frequently arranged into four major's categories. These categories can be anything: Manpower, Methods, Materials and Machinery. Figure 10 shows the Cause and effect diagram for fault in control arm connection.

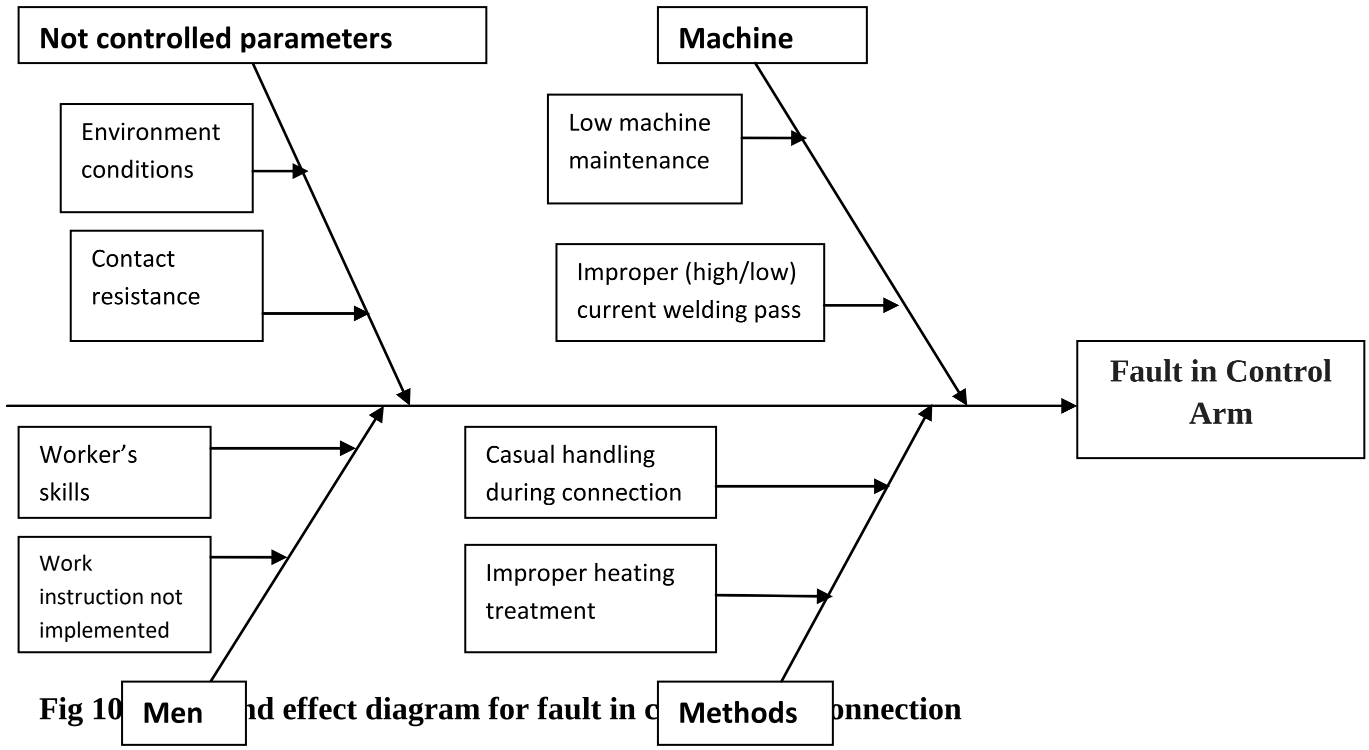


Fig 10 … nd effect diagram for fault in c … nnection

Figure 11 shows the Cause and effect diagram for fault in deflection of Ankerlink blocks.

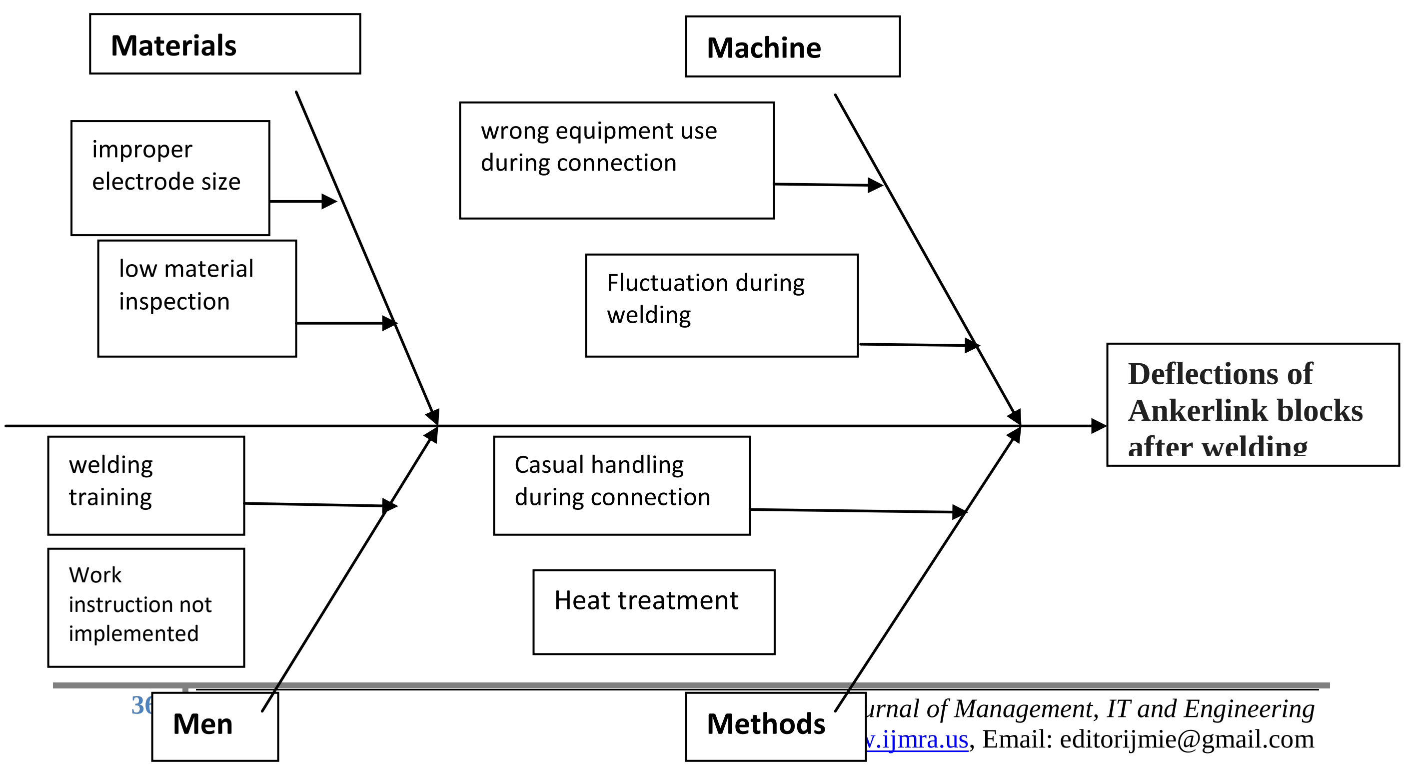


Fig.11Cause and effect diagram for fault in deflection of Ankerlink blocks

Figure 12 shows the Cause and effect diagram for gap between a pair of control arms.

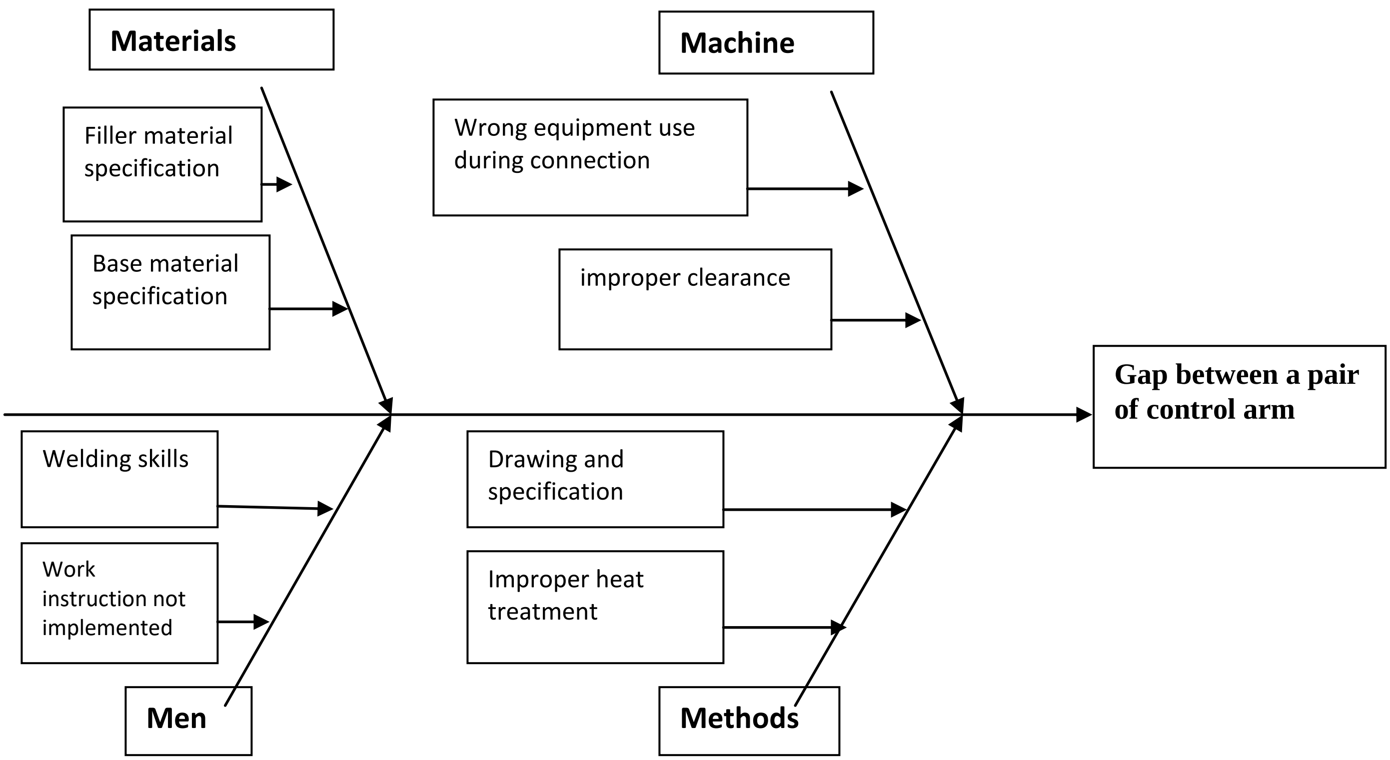


Fig 12 Cause and effect diagram for gap between a pair of control arms

5.3 Suggested action plans

Tables 3, 4 and 5 present the corrective action plans to improve the quality of products.

Tables 3 Action Plan for faults in Control arm

Category	**Suggested actions**
MACHINE	(i) To give the maintenance to the machine time to time, so it will give no fluctuation. (ii) Set appropriate current of welding machine according to the

	requirement.
MEN	(i) To give the required training to the worker. (ii) To give every machine instruction to the worker to avoid the deformities.
METHOD	(i) Do not do any casual handling during the connection. (ii) To give right amount of heat during treatment.

Tables 4 Action plan for deflection in Ankerlink blocks

Category	**Suggested actions**
MATERIAL	(i) Must use right kind of electrode to welding. (ii) Must do the inspection of the material.
MACHINE	(i) Use right equipment during welding. (ii)Set appropriate current of welding machine according to the requirement.
MEN	(i) Give right welding training to the worker. (ii) Give every machine instruction to the worker to avoid the deformities.
METHOD	(i) Avoid casual handling (ii) Appropriate heat treatment after welding

Tables 5 Action plan for gap between a pair of control arms

Type	**Suggested actions**
MATERIAL	(i) Study the specification of filler material (ii) Study the specification of base material
MACHINE	(i) Use right equipment during connection

	(ii) Use proper clearance during operation
MEN	(i) Give every machine instruction to the worker to avoid the deformities. (ii) Give proper training to the semi skill workers
METHOD	(i) Give proper heat treatment (ii) Read properly the drawing.

6. CONCLUSIONS

Quality prompts improvement in efficiency and it likewise upgrade the consumer loyalty and satisfaction. Study has been directed to execute quality control tools and procedures in manufacturing and assembling industry of Indian railways. The principle objective of this research paper is distinguish the deformity and propose a superior reason for improve the manufacturing line by implementing the Quality control tools in manufacturing and assemblyprocess of railways bogies so as to reduce the non conformities. Quality control toolslike Pareto chart and Cause and effect diagram have been used to distinguish various imperfections and reasons for these non conformities. Quality Control Tools can improve process execution by diminishing item variability and improves production effectiveness by decreasing scrap and framework

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