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Reducing Warranty Claims and Defects in a Motorbike Industry of Bangladesh Using Lean Six Sigma

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ABSTRACT

The main goal of this study is to reduce the number of defects and warranty claims to improve quality in a local motorbike industry. Therefore, Lean Six Sigma was applied in this company at the Jashore plant. Initially, the top five warranty claims were identified and the four major defect areas: material, welding, paint shop, and assembly. Then the DMAIC was applied methodology to improve key performance indicators such as First-Time Right (FTR) and total pass rate, as well as the Six Sigma level. Various Lean tools, including FMEA analysis, DPMO, control charts, Pareto diagrams, fishbone diagrams, 5S, Poka-Yoke, and 5W+1H. In particular, root cause analysis was applied to identify the main reasons behind the increasing number of defects. As a results, The Six Sigma level increased from 3.53 to 4.0075, and the defect percentage decreased from 8.57% to 2.22%. The total number of defective parts during assembly was reduced from 28,772 to 19,174, and the overall pass rate improved from 90.21% to 97.47%. As a result of this research, the company improved quality and reduce costs by implementing the Lean tools as per our recommendations.

Keywords: Lean Six Sigma, DMAIC, DPMO, Control Chart, Root Cause Analysis

1. Introduction

In today's competitive environment, customers demand high-quality products, greater variety, and faster manufacturing, which can benefit industries from an economic perspective. Lean manufacturing can reduce waste while maintaining the same level of productivity. It is crucial for companies to minimize defects and waste, as this helps save costs and prevents product damage. When waste and defect reduction are combined, they form Lean Six Sigma. This approach helps increase production in a structured way and ensures top-notch product quality. Numerous studies have implemented the Lean Six Sigma system across various industries, providing a framework for this case study. The DMAIC methodology, consisting of five steps, can help manufacturers improve production outcomes [1].The simplest way to understand lean manufacturing is by removing inefficiencies from the manufacturing process. These inefficiencies are wastes that do not provide any effective outcome. If these non-value-added processes are eliminated, lean manufacturing can deliver the desired output according to customer expectations[2]. Bangladesh is a developing country with a large population in a small area and numerous challenges. That is why various studies have implemented Lean Six Sigma to improve efficiency and reduce waste in healthcare[3] , jute industries[4] , leather[5] , sewing sections of garments[6] , apparel [7], construction industries[8] , lead-acid battery industries[9] , dairy processing industries [10], and mobile phone factories[11] .

Several studies have tried to explore Lean Six Sigma implementation in automotive sectors abroad, although none have addressed its use inside the motorbike industry in Bangladesh. When autobikes have excellent quality, they don't need to be changed or serviced as often. This will be helpful for people's finances since they don't have to spend a lot of money mending their autobikes. So, we also want to explore how enhancing quality may be helpful for the economy. Bangladesh is also becoming recognized for creating products, and we want to make sure that autobikes from Bangladesh meet excellent standards.

This study introduces the DMAIC method to reduce defective parts in bikes and improve overall quality. The success of this proposed methodology is examined using data from a Bangladesh motorbike company. This study conducts an analysis of the type, effects, and root causes of defects in motorbike parts. Subsequently, recommendations for defect elimination are provided as input for improvement. To achieve these objectives, the DMAIC Methodology is applied alongside various tools including control charts, Pareto Charts, DPMO, Ishikawa diagrams, Failure Mode and Effect Analysis, 5S, SIPOC, and Casual Loop`Diagrams.

2. Data Analysis Using Dmaic

2.1 Define Phase

First, Top warranty claims and defects were detected. The number of defects and warranty are presented in Fig.1 and Fig. 2.

2.2 Measure Phase

Then a test was conducted whether production and defective products follow a normal distribution whether these follow a normal distribution.

As shown in Fig.3, Normality test was conducted using Minitab. P value is less than .5 which means the datasets follow a normal distribution. The procedure was in terms of defective parts. After conducting normality test, DPMO was calculated DPMO. fast time right, total pass which are mentioned in Table 1.

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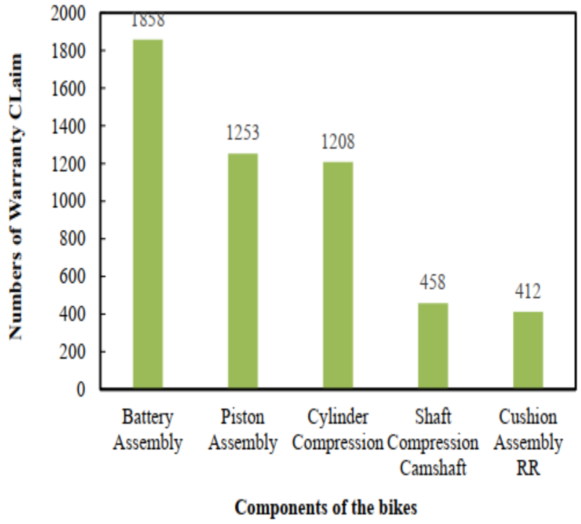


Fig. 1: Bar chart of warranty claims

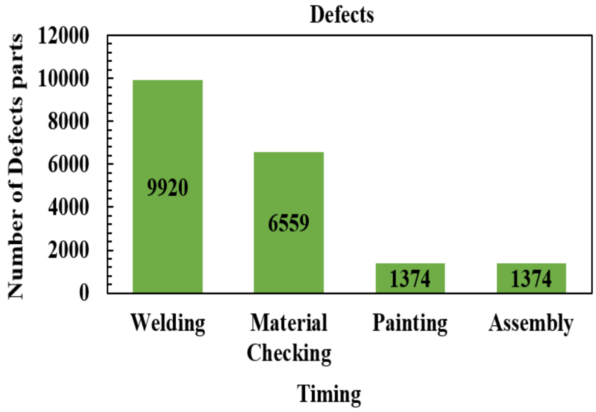


Fig. 2: Number of defective parts in four shop

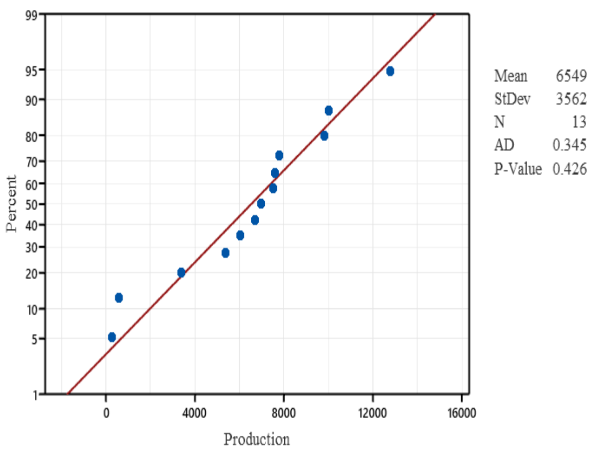


Fig. 3: Normality test for production parts of motorbike

From DPMO, DPU was measured and sigma level which are shown at Table 2.

A control chart is demonstrated using Minitab whether the data was within the control limit. But Fig.4 shows that only 2 months among 12 months was within the control limit. The manufacturing process of other months was not going well.

Table 1: Calculation of DPMO, FTR and Total pass

Month	Production	Defective	DPMO	FTR Pass	Total Pass
November	7008	983	35067.07	76%	85.97%
December	6741	387	14352.47	69%	94.26%
January	9389	229	6097.561	79%	97.56%
February	3412	511	37441.38	76%	85.02%
March	7636	747	24456.52	73%	90.22%
April	7828	1562	49885.03	75%	80.05%
May	9845	1386	35195.53	72%	85.92%
June	10016	1288	32148.56	79%	87.14%
July	6056	583	24067.04	71%	90.37%
August	5406	270	12486.13	76%	95.01%
September	7556	486	16079.94	75%	93.57%
October	12876	334	6484.933	71%	97.41%

Table 2: Calculation of DPU and Sigma Level

Defective Percentage	8.57%
DPU	.0857
Sigma Level	3.5
C_{pk}	.8825

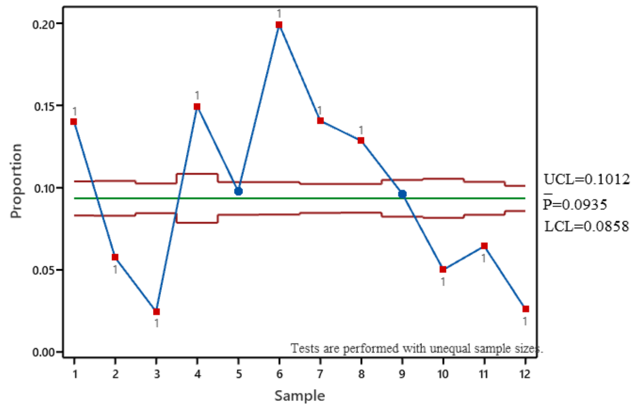


Fig. 4: P chart for the current production process

2.3 Analyze Phase

Pareto chart (Fig. 5) shows which parts of the motorbike were claimed under warranty. It demonstrates that battery and speedometer are claimed more than 80%.

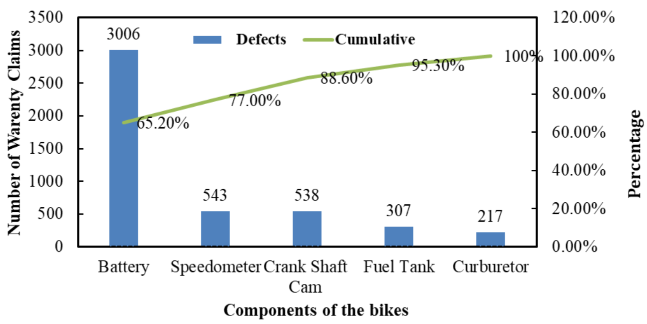
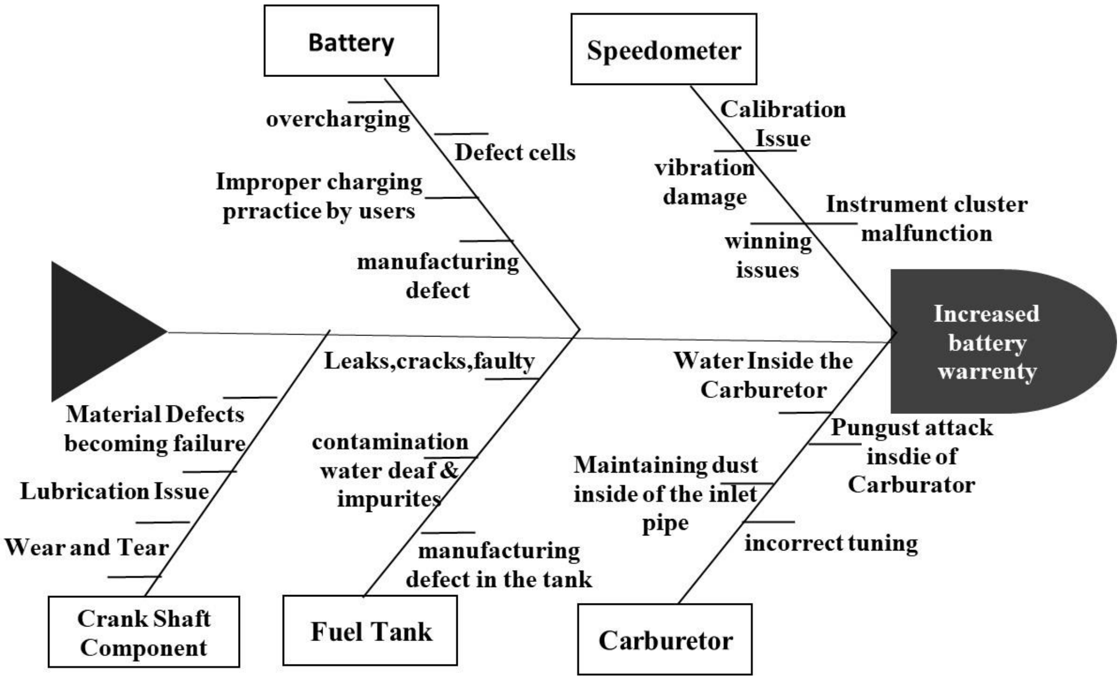


Fig. 5: Pareto diagram of warranty claims

After using the Parato chart to analyze the collected data, an Ishikawa diagram was created to identify main causes for warranty claims for each part. By brainstorming in the project team, the problems connected to each head factor were identified and discussed. The flaws highlighted in Fig.6.



Figu. 6: Fishbone diagram for warranty claims

This causal loop diagram in Fig, 7 highlights the correlation between various automotive issues and warranty claims. Challenges including crankshaft flaws, carburetor malfunctions, fuel tank problems, and calibration mistakes raise the amount of warranty claims. Increased claims put pressure on providers to supply greater training and guidance, resulting in better component testing and inspection.

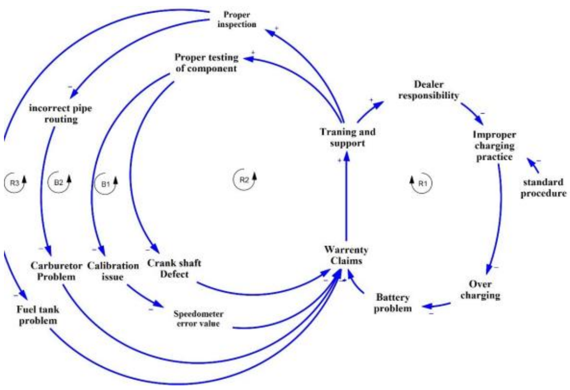


Fig. 7: Casual loop diagram to show the relations among the parameter warranty claims

Potential risk failure in table 3 was assessed in every component to determine which parts need possess great risk and need to solved immediately.

Table 3: Calculation of Rish priority number (RPN)

ITEM	FUNCTION	RPN
Material Checking Shop	Incoming material checking shop, storage	174
Welding	Joining	60
Painting	Surface preparation	114
Assembly	Component fitment, fastener installation	124

2.4 Improve Phase

To minimize warranty claims associated with battery-related difficulties, it is necessary to follow a set of well-defined charging and monitoring practices. Initially, the process requires obtaining the battery from the P&C Box, followed by precise actions such as acid filling and configuring the charging point for a duration of 4 to 5 hours, ensuring completion indicated by the finish charge indication on the dashboard. Subsequently, after the charging procedure, a final check by the designated team certifies that the charged batteries are suitable for assembly which is demonstrated in Fig. 8.

Then the difficulties and solution were given in each case such material incoming, welding process, panting and during assembly time. Fig.9 shows how defects of imported materials were checked and solution was provided.

Figure 8: Standard Battery Charging Procedure & Monitoring

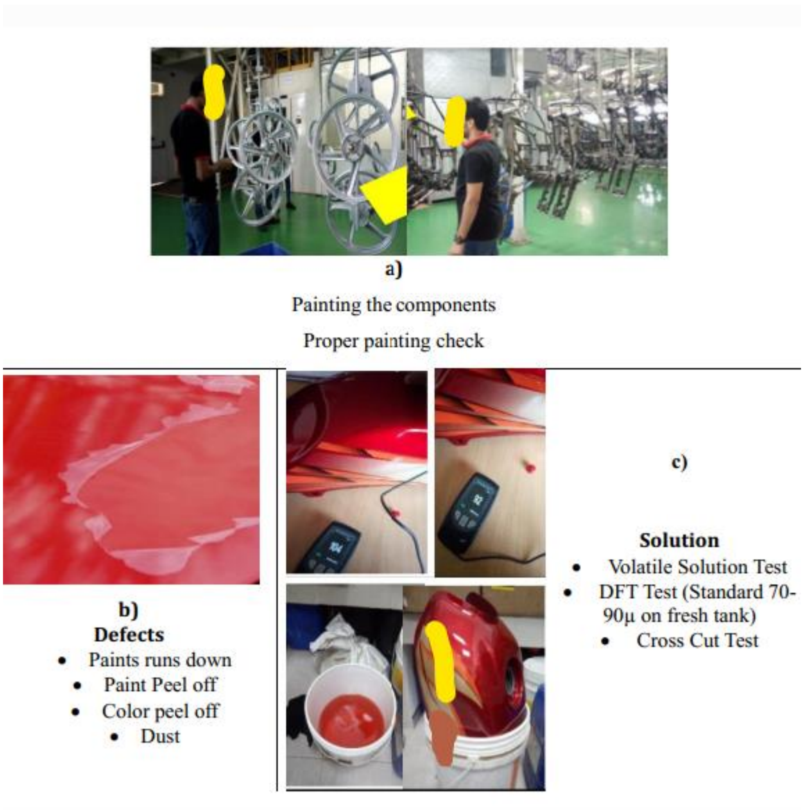


Fig. 9: a) an overview of the material checking process in the material shop, b) highlighting common difficulties, and (c) proposed solutions

Table 4: 5W+1H decrease FTR due to poor material checking process

No	5W+1H	Number of Matters
01	What	Decline in FTR issues in bike
02	Why	Acceptance of defective raw material due to inadequate inspection
03	Who	Materials Suppliers, Quality control inspections
04	When	During the process of materials selections, Supplier evaluation, and material arrival
05	Where	Material inspection area at x motorbike company in Jessore and also defects can manifest in various bike components such as engine, battery
06	How	The resolution for the aforementioned issue involves: Choosing materials and supplies more carefully. enhancing the incoming material inspection procedure.

The optimal strategy or solution to overcome the potential failure of incoming material (BOP) checking at the material shop acquired through 5W + 1H is shown in Table 4.

2.5 Control Phase

Table 5: Check Sheet for the Inspection Schedule for materials shop

Weekly Material Checking sheet			
Week	Date	Inspector	Material Condition
1			
2			
3			
4			
Month:			
Week	Date	Operator	Material Condition
1			
2			
3			
4			

The check sheet in Table 5 is used to track the most likely failure mode for arriving materials in the checking shop, paint shop, welding shop, and machine inspection, which is done once a week.

Operator training sheets are used to monitor workers' training compliance. Training programs are organized two or three times per week

Fig. 10: Arrangement of component using 5S

5S methodology was used y in Fig. 10, all essential components across the material shop, weld shop, paint shop, and assembly shop are systematically organized and arranged to minimize unnecessary downtime and optimize efficiency

3. Result and Discussion:

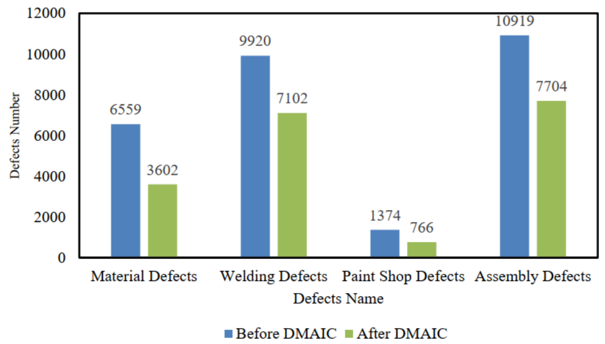


Fig. 11: The number of Defects before and after implementing DMAIC

This Fig.11 illustrates the total amount of defects in four categories—Material, Welding, Paint Shop, and Assembly—before and after the DMAIC method had been applied into place. Although welding remained one of the biggest defect areas, material failures declined from 6,559 to 3,602 and welding defects plummeted from 9,920 to 7,102. The biggest corresponding improvement was in paint shop defects, which decreased from 1,374 to 766. Even after DMAIC, assembly defects—which had the highest defect count—remained the most serious problem, declining from 10,919 to 7,704.

Table 7: FTR and Total pass value after implementing DEMIC

Month	Production	Defective	DPMO	Sigma Level	FTR PASS	Total Pass
December	9372	158	4214.68	4.15	79%	98.31%
January	7762	127	4090.44	4.16	79%	98.36%
February	8710	136	3903.56	4.17	76%	68.44%
March	7194	150	5212.68	4.07	78%	97.91%
April	6003	146	6080.29	4.02	85%	97.57%
May	4812	145	7533.25	3.95	78%	96.99%
June	5179	1123	5937.44	4.03	79%	97.63%
July	5140	143	6955.25	3.97	81%	97.22%
August	3944	167	10585.7	3.802	86%	95.77%
September	4253	130	7641.66	3.94	71%	96.94%
October	3000	123	10250	3.53	77%	95.90%
November	11147	153	3431342	4.21	76%	98.63%
Average	6376.33	304	6319.7	4.03	79%	97.47%

Table 8: Sigma value after implementing DEMIC

Defective	2.22%
DPU	.022
Sigma Level	4.0075
C_{pk}	1.0019

The Sigma Level Control Sheet is depicted in Table 7 and Table 8 based on the production and defect data for the next fiscal year after implementing appropriate quality tools and six Sigma with DEMIC. Sigma value increased from 3.53 to 4.007.

4. Conclusion

The first aim of this study was to reduce the number of defects and warranty claims in the motorbike industry in Bangladesh. To achieve this, Lean Six was successfully implemented Sigma by identifying the top five warranty claims and the four most common types of defects. The DMAIC framework was applied to identify and reduce defects, as well as to improve key performance indicators such as "First Time Right" and "Total Pass." As a result, defects were reduced from 8.57% to 2.22%, and the Six Sigma level increased from 3.53 to 4.0075. Before DMAIC, the number of defective parts was 28,772; after applying DMAIC, it was reduced to 19,174. However, we faced some limitations. Lean Six Sigma was implemented in only one motorbike plant, while future researchers could use data from multiple plants across different locations in Bangladesh. In addition, future projects may examine other key performance indicators, such as financial metrics, supplier quality, and technical assistance tools. Furthermore, this methodology could also be applied in other manufacturing sectors.

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