AIP Conference Proceedings

RESEARCH ARTICLE | DECEMBER 07 2023

Application of six sigma in the car seat production process: A case study

Gabby Florencia; Wilson Kosasih ✉; Lina Gozali; Agustinus Purna Irawan; Didi Widya Utama

AIP Conf. Proc. 2680, 020212 (2023)
https://doi.org/10.1063/5.0126173

Application of Six Sigma In The Car Seat Production Process: A Case Study

Gabby Florencia[1,b)], Wilson Kosasih[1,a)], Lina Gozali[1], Agustinus Purna Irawan[2], Didi Widya Utama[2,3]

[1]*Department of Industrial Engineering, Faculty of Engineering, Universitas Tarumanagara Jakarta, Indonesia*
[2]*Department of Mechanical Engineering, Faculty of Engineering, Universitas Tarumanagara Jakarta, Indonesia*
[3]*Department of Mechanical Engineering, College of Engineering, Khun Shan University, Tainan, Taiwan*

[a)]*Corresponding Author: wilsonk@ft.untar.ac.id*
[b)]*gabby.545180049@stu.untar.ac.id*

Abstract. Continuous quality improvement is needed so that the number of products, which meet the expected quality standards, can be increased. The number of defective products can make the company suffer cost and time losses because the company needs to rework the defective product. This study aims to reduce and control the percentage of defective products. This study uses a case study approach, which was conducted in a manufacturing company engaged in the automotive sector. Data collection was carried out by interviewing, observing, and reviewing documents. The method used is Six Sigma with Define, Measure, Analyze, Improve, and Control (DMAIC) phases. In the end, several corrective actions were recommended such as inspection and making check sheets of each assembly process, routine supervision and control by the production leader, and conducting incoming inspections of the materials used for car seat products.

INTRODUCTION

The quality of a product plays an important role and must always be endeavored by the company so that its products can excel and compete in the market. All manufacturing industry players strive to produce products that have a high level of comformity to the standards.[1] Product quality is the ability of a product to perform its functions, this includes overall durability, reliability, accuracy, ease of operation, and product repair, as well as other product attributes.[2] Quality is a loss to society, which means that if there is a deviation from the target, this is a function of reduced quality. On the other hand, the reduced quality will incur costs.[3]

The more defective products produced can make the company suffer losses, this happens because the company must carry out a repair process that requires cost and time. In fact, if the resulting defect cannot be repaired, the company can dispose of the defective product. Resulting poor product quality cost companies more than they fully accounted for, including damage to a company's reputation that led to a loss of customers.[4] Meanwhile, reducing production costs will lead the company to remain competitive in an aggressive global market and increase their market share in the future.[5]

In order for the quality of a product to be in accordance with the standards that have been set so that it is not categorized as a defective product, a continous quality improvement is needed. Quality improvement are actions taken to increase product value for customers through increasing the effectiveness and efficiency of processes and activities through the organizational structure.[6] Quality improvement is develop a process to create the product and then optimize that process.[4] One way to improve quality is to use the six sigma method.

Six Sigma is a method that provides tools and techniques for process improvement. These process improvements help lead to reduced defects and increased profits, employee morale, and product or service quality. This method was first developed at Motorola and has become popular after the great success at General Electric.[7] Six Sigma focuses on eliminating variations and defects in a company's production process.[8] By implementing Six Sigma,

Proceedings of the 4th Tarumanagara International Conference of the Applications of Technology and Engineering (TICATE) 2021
AIP Conf. Proc. 2680, 020212-1–020212-8; https://doi.org/10.1063/5.0126173
Published by AIP Publishing. 978-0-7354-4698-4/$30.00

companies can pursue excellence and perfection by producing only 3.4 defective products for every one million production opportunities.[9]

The method used to improve quality towards the target in this study is Six Sigma with Define, Measure, Analyze, Improve, and Control (DMAIC). Define is the stage of identifying the product or process to be improved. Measurement is the stage of validating the problem, measuring and analyzing the problem from the existing data. Analysis is the stage of finding the root of the problem by identifying the cause of the problem or the source of the defect. The next stage is improvement, namely the stage of establishing an action plan to implement Six Sigma quality improvement. The control stage is the last operational stage where the results of quality improvement are documented and disseminated, procedures are documented, successful best practices in process improvement are standardized and used as standard work guidelines.[10]

METHODS

This study uses a case study approach, which was conducted in a manufacturing company engaged in the automotive sector and producing car seats located in Cikarang, West Java, Indonesia. Data collection is done by interview, observation, and document review. The data collected are total production of car seats and number of defective car seat products in January 2020 - December 2020.

Data was processed using statistical software. The systematic method used in quality improvement is Six Sigma with the Define, Measure, Analyze, Improve, and Control (DMAIC) phases. Statistical tools used such as SIPOC diagram, Failure Mode and Effect Analysis (FMEA), P-chart, Pareto diagram, and Fishbone Diagram. The steps taken in this study can be seen in Figure 1.

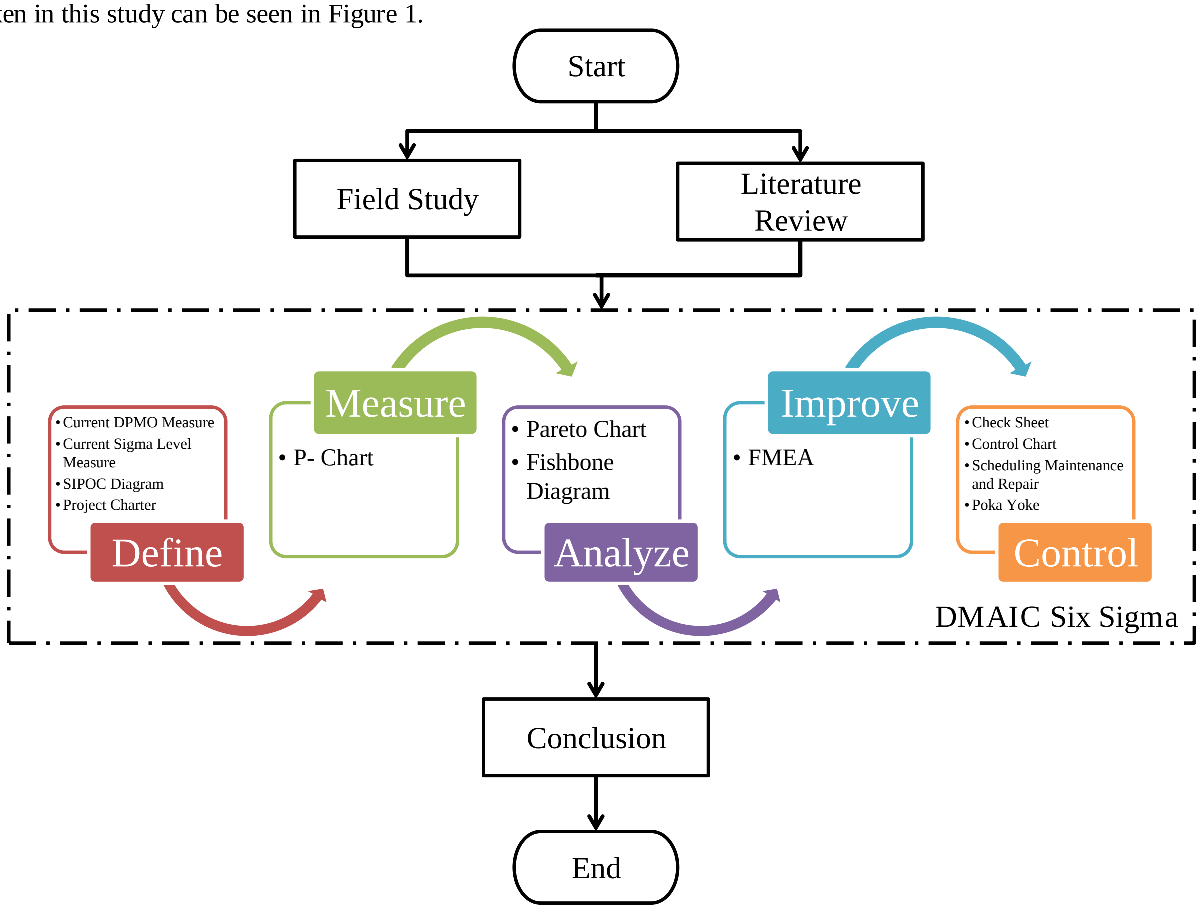


FIGURE 1. Research Methodology

RESULT AND DISCUSSION

The car seat production process in this manufacturing company has 3 inspection stages, namely process inspection, outgoing inspection, and aftersales. Process inspection is the process of checking product quality during the production process, which aims to prevent defective parts from being processed in large quantities and flowing to the next process. Outgoing inspection is the process of checking the quality of products that are ready to be sent to customers, which aims to prevent defective products from being sent to customers. Aftersales is a process to maintain standards in service to customers by providing guarantees for products sent to customers. In the production process, this company still often encounters various problems that must be faced. Problems that are often faced are problems related to defective products or products that are not in accordance with standard specifications. Six Sigma method with DMAIC approach used to analyze and solve this existing problems.

1. Define

This stage describes and defines the quality problems faced and determines the goals to be achieved. Based on field studies and literature studies that have been carried out, the problem faced by the company is the large number of car seat defects in 2020, which are 1,140 pieces with 72 types of defects, and the value is 3.17σ. Measurement of DPMO and sigma level can be seen in Table 1.

TABLE 1. DPMO Measurement

Number of Product Defect (D)	1,140
Number of Defect Chances (P)	1
Number of Units (U)	23,926
DPMO	47,646.91
Sigma Level	3.17

The sigma level is obtained from the DPMO conversion table to the sigma value based on the motorola concept. This number of defective products certainly has a negative impact on the company because it requires additional costs and time for the repair process. The purpose of using the Six Sigma method with the DMAIC approach in this company is to reduce and control the percentage of car seat defects. This can increase the DPMO value to 22,750 and the sigma level to 3.5.

SIPOC diagrams are used to define key processes and the customers involved in those processes. The key process in making seats at this company is the selection of raw materials and seat assembly processes. The raw materials used in the manufacture of seats must be of good quality. Good quality raw materials are materials that are not damaged, such as dents, breaks, holes, and other damage. While the production process is expected to improve the quality of the resulting product so as not to produce defective products. Customers of car seat products are companies engaged in the automotive sector. The SIPOC diagram of the seat product manufacturing process can be seen in Figure 2.

FIGURE 2. SIPOC Diagram

2. Measure

The next stage is the measurement stage of the car seat. Performance measurement on seat products includes statistical process quality control for attribute data. Quality control of statistical processes is carried out by making p-charts. Control chart is implemented to see if the defective products are still between the upper and lower control limits; in other word, still in control or passing the boundaries.[11] The following is the calculation data for making the p-chart can be seen in Table 2.

TABLE 2. P-chart Measurement

Month	Number of Defect	Number of Production	Proportion of Defect	CL	UCL	LCL
January	396	5188	0.076329992	0.047646911	0.056519240	0.038774582
February	124	3356	0.036948749	0.047646911	0.058678210	0.036615612
March	273	2880	0.094791667	0.047646911	0.059554981	0.035738841
April	125	1126	0.111012433	0.047646911	0.066691361	0.028602461
July	0	3356	0.000000000	0.047646911	0.058678210	0.036615612
August	0	2880	0.000000000	0.047646911	0.059554981	0.035738841
September	61	1126	0.054174067	0.047646911	0.066691361	0.028602461
October	17	765	0.022222222	0.047646911	0.070751961	0.024541861
November	109	1896	0.057489451	0.047646911	0.062323275	0.032970548
Desember	35	1353	0.025868441	0.047646911	0.065020468	0.030273355
Total	1140	23926				

In Table 2, there are no calculations for the months of May and June because in that month there is no production process. After doing the calculations, the next step is to make P-chart which can be seen in Figure 3.

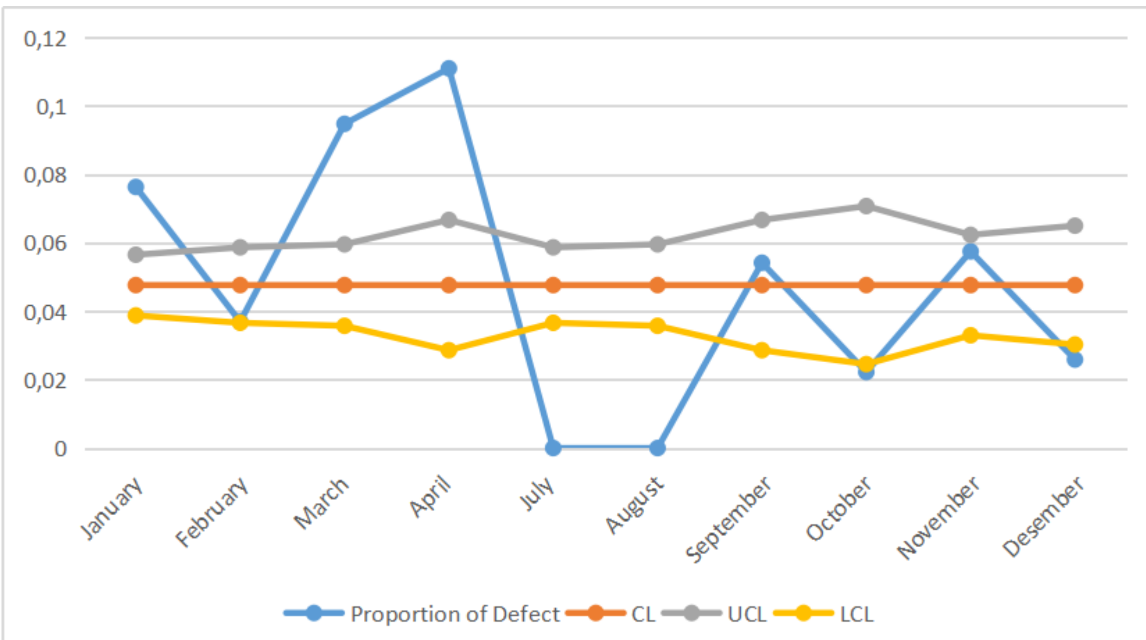


FIGURE 3. P-chart Plot

The data was out of limit control in January, March, April, July, August, October, and December 2020, as shown in Figure 3. This happens because the defective product produced exceeds the limit in those few months, and the causes of the defective product will be discussed in the next stage, namely the analyze stage. After analyzing the causes of defects, it is necessary to make improvements so that defective products can be controlled.

3. Analyze

The next stage is analyze, which aims to examine the data collected at the measure stage to determine a priority list of variations and root causes of car seat defects. This priority list of defects is measured using a Pareto Diagram, as can be seen in Figure 4. Pareto diagrams are created for indicates the type of product defect starting from the largest to the type of defect that as well as the smallest number of defects and proportions product defects.[12]

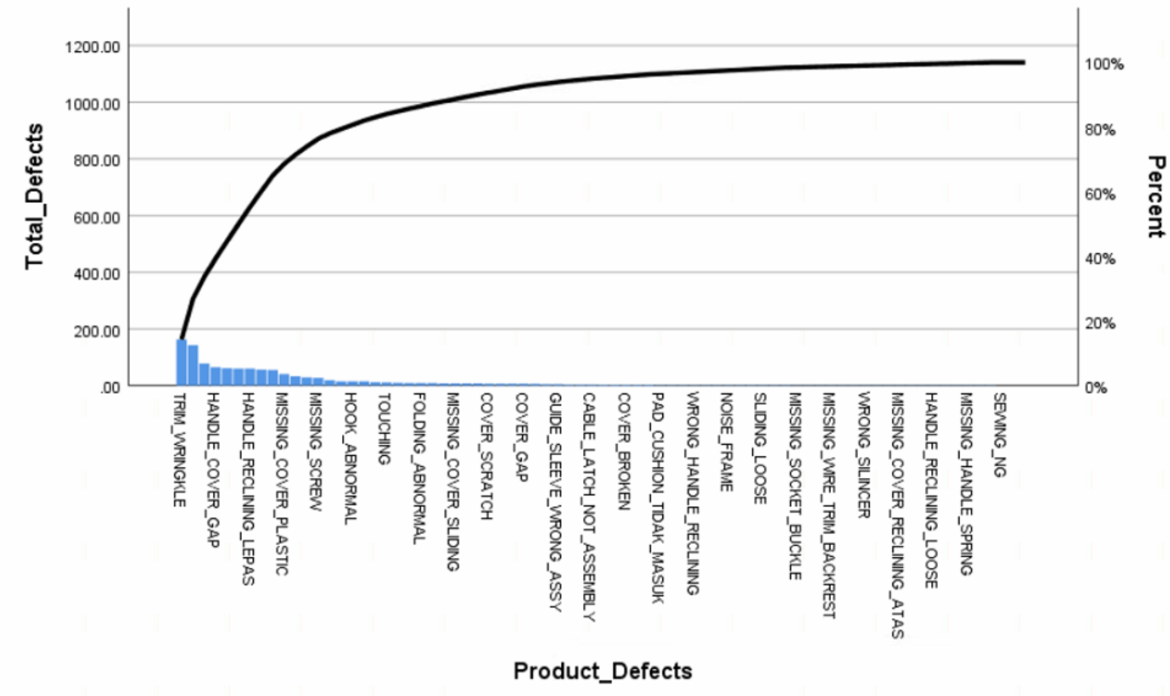


FIGURE 4. Pareto Diagram

From the diagram, there are 15 dominant types of defects out of 75 types of defects, namely, trim wringkle, oblak, isofix covered by trim, handle cover gap, noise, loose reclining handle, abnormal locking/latch, trim pad/untidy, missing strapler, missing cover plastic, cover armrest loose, abnormal reclining, missing screw, wrong foot adjuster, abnormal hook. The determination of the 15 dominant types of defects follows the 80/20 rule on the Pareto diagram principle. After 15 types of dominant defects have been identified, the next step is to identify the causes of these defects using a fishbone diagram as can be seen in Figure 5.

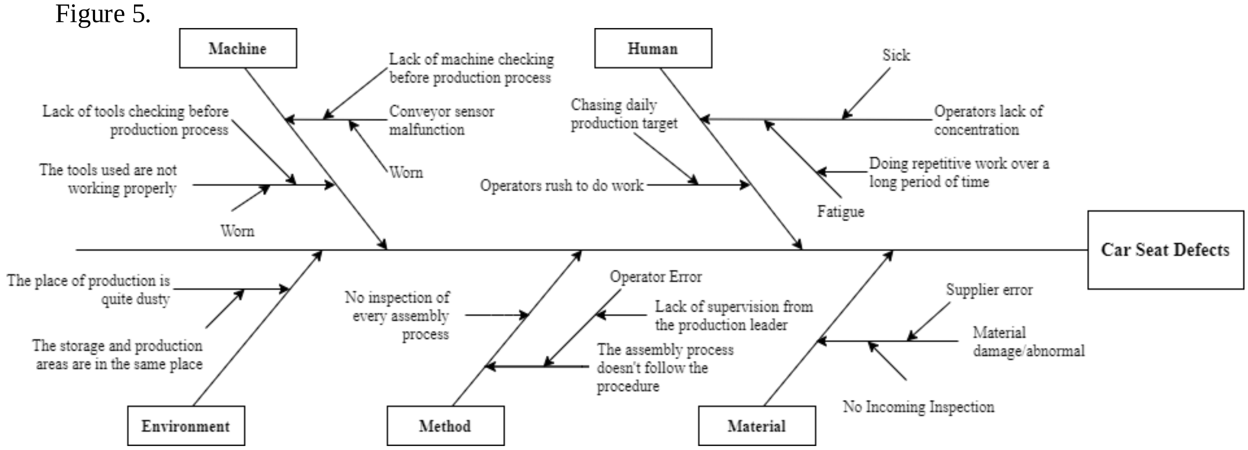


FIGURE 5. Fishbone Diagram

4. Improve

In the improve stage, an analysis of the causes of defects is carried out using the FMEA method. FMEA is a structured procedure to identify and prevent as many failure modes as possible. A failure mode is anything that includes a defect, a condition outside the specified specifications, or a change in the product that causes the product to malfunction. In FMEA, the SOD (Severity, Occurrence, Detection) numbers are weighted to determine which effects need to be prioritized for improvement.[10] Identification of failure modes and their effects on companies with numerical weighting based on the concept of Failure Mode and Effect Analysis (FMEA) can be seen in Table 3.

TABLE 3. FMEA

Potential Failure Mode	Potential Failure Effect	Potential Cause	Value S	Value O	Value D	RPN	Recommendations of Improvement
Missing components on the car seat	Seat not working properly	Operators lack of concentration when assembling car seats	8	6	7	336	Conduct inspections and make check sheets of each assembly process
Material Abnormal	The quality of the car seat does not meet the standard	Supplier error and no incoming inspection	7	6	7	294	Conduct incoming inspection of materials used for car seats
Loose components on the car seat	Car seat can't function properly	Operators rush to do work	8	4	6	192	Regular supervision and control by the production leader
Wrinkles on the car seat	The quality of the car seat does not meet the standard	No inspection of every assembly process	6	5	6	180	Conduct inspections and make check sheets of each assembly process
The tool is not working properly	The results of the operator's work become untidy	Worn tool	5	4	5	100	Scheduling for periodic equipment maintenance and replacement
Conveyor Sensor Malfunction	Ineffective assembly process	Lack of maintenance and checking	5	4	5	100	Conduct machine checks before the production process and scheduling for periodic machine maintenance.
The installation of components on the car seat is not neat and causes gaps	The quality of the car seat does not meet the standard	Operators rush to do work	7	5	7	245	Regular supervision and control by the production leade
Oblak	Wide hole, difficult to assemble in the next process	The hole is opened and closed too often	5	5	6	150	Preparation of work standards and training for operators
Closed isofix	Isofix can't be installed so the car seat can't function properly	No inspection of every assembly process	8	5	6	240	Conduct inspections and make check sheets of each assembly process
Noise	The quality of the car seat does not meet the standard	Rusted iron and no incoming inspection	8	5	6	240	Conduct incoming inspections of the materials used for car seats, and if the iron is rusty, then painting it first
Wrong component installation	Car seat can't function properly	Operators do not use established work procedures	7	4	6	168	Training for operators and regular supervision by production leader

From the several recommendations for improvement contained in Table 3, the main recommendation given is to prioritize repairs on the types of defects marked with red boxes. The type of defect with the red box has high RPN value and severity value of 8. This 8 severity value is classified as high, at this value consumers can feel a decrease in quality that exceeds the tolerance limit. This can reduce customer satisfaction. The following are the main recommendations for improvement:

a. Perform inspections and make check sheets of each assembly process.

In process inspections that are usually carried out by companies, inspections are only carried out by marking the components that have been assembled, but only on certain components. This causes missing components due to operator negligence. The company should carry out inspections of every part and assembly process, this can be done by making a check sheet. With this check sheet, the operator can indicate the parts that have been installed properly and the assembly process that has been carried out, thus preventing the occurrence of missing parts and reducing defective products.

b. Regular supervision and control by the production leader.

One of the main causes of product defects is the human factor. Humans often make many mistakes because of fatigue, illness, lack of concentration, or rushing to do work because they are chasing daily targets. Therefore, it is necessary to have regular supervision and control by the production leader to ensure that operators work according to established procedures.

c. Conduct incoming inspection of materials used for car seats.

In the car seat production process, inspections are only carried out during the production process, before the product is sent to the customer, and after sales. Meanwhile, inspection of seat material that comes from suppliers is very important to do to prevent damaged or abnormal material. If the material is not checked first, the material that is possibly damaged/abnormal will flow to the next process and cause product defects such as not meeting the established standards or the car seat not functioning properly.

5. Control

The control stage is the final stage in the DMAIC approach.Basically, this stage is a control measure against the steps that have been previously carried out, so that control and documentation are important things to maintain the consistency of the improvements made to continuously improve the quality of car seats. The following is a control process that the company can do to maintain consistency of improvement, among others:

a. Check sheet

Make a check sheet. Check sheet is a very effective tool that is easy to use, so this tool is very suitable to be used in data collection and also control production defects.

b. Control chart

Create a control chart. The control chart can be used to see a production process and the quality of the resulting product, whether it is still in a control system or not. This tool is very effective for controlling a production process.

c. Scheduling of Maintenance and Repair

Make a schedule of maintenance and repair of machines/tools. Scheduling maintenance and repair of machines/tools on a regular basis is very important to avoid damage that can hinder the assembly process.

d. Poka Yoke

Poka Yoke is a technique to overcome and avoid simple mistakes caused by humans or workers in the workplace by preventing the root causes of errors and drawing special attention to a job or task so that it does not have the possibility to make mistakes. Poka yoke that can be made in controlling seat quality is using a check list to ensure all tasks have been done, small parts used in the assembly process are stored in boxes of different colors to prevent the wrong parts from being used, and so on.

CONCLUSION

Continuous quality improvement is needed by the company in order to produce products that meet standards, so that defective products are not produced which can cause additional costs and time for repairs. The Six Sigma method with the DMAIC approach is used to reduce and control the percentage of defects so that continuous quality improvement can be created. The problem faced by the company is the large number of car seat defects in 2020, which are 1140 pieces with 72 types of defects, and the value is 3.17σ. Therefore, recommendations for improvement are given for the company. The main recommendation given is to prioritize repairs on types of defects that have high RPN value and severity value of 8. This severity value of 8 is considered high, at this value consumers can feel a decrease in quality that exceeds the tolerance limit. This can reduce the company's image in the eyes of consumers. The main improvement recommendations are checking and making check sheets for each assembly process, routine supervision and control by the production leader, and conducting incoming inspections of the materials used for car seats. Suggestions for further study are to calculate the Cost of Poor Quality (COPQ), DPMO, and Sigma Level before and after the study, so that the effectiveness of the suggestions for improvement can be assessed.

ACKNOWLEDGMENTS

Praise and thank God the Almighty for His blessings and grace, the authors can complete this paper. The Authors would like to thank the Production Manager and Quality Manager of the company who provide his assistance and guidance during the research study.

REFERENCES

1. W. Kosasih, I.K. Sriwana, E.C. Sari, C.O. Doaly, "Applying Value Stream Mapping Tools And Kanban System For Waste Identification And Reduction (Case Study: a Basic Chemical Company)", in Materials Science and Engineering 528 (2019) 012050, IOP Conference Series.
2. P. Kotler and G. Amstrong, *Principles of Marketing*, Prentice Hall, New Jersey, 2012.
3. G. Taguchi, *System of Experimental Design (Vol. 1-2)*, UNIPUB/Kraus International Publication, White Plains, 1987.
4. J.M. Juran, *Juran's Quality Control Handbook 1&2, 4th edition*, McGrawHill, Inc., 1988.
5. W. Kosasih, "Usulan Peningkatan Kualitas Proses Menggunakan Pendekatan Metodologi DMAIC Six Sigma", In Proceedings of 8th Temu Ilmiah Dosen Teknik (Fakultas Teknik, Universitas Tarumanagara, Jakarta, Indonesia), 2009.
6. V. Gazpers, *Total Quality Management*, PT Gramedia Pustaka Utama, Jakarta, 2001.
7. H.C. Martin and B. Philip., "The role of variation, mistakes, and complexity in producing nonconformities", Journal of Quality Technology, Vol. 27 No. 3, pp. 242-249, 1995.
8. R.B. Pojasek, "Lean, Six Sigma, and the systems approach: management initiatives for process improvement", Environmental Quality Management, Vol. 13 No. 2, pp. 85-92, 2003.
9. V. Gasperz, *Lean Six Sigma for Manufacturing and Service Industries*, PT. Gramedia Pustaka Utama Jakarta, 2006.
10. V. Gasperz, *Pedoman Implementasi Program SIX SIGMA Terintegrasi dengan ISO 9001 : 2000, MBNQA, dan HACCP*, PT Gramedia Pustaka Utama, Jakarta, 2002.
11. A. Handriany, W. Kosasih, "Quality Control on Bucket Production Process Using Quality Tools Method (Case Study: A Medium Sized Company)", in *Materials Science and Engineering 1007 (2020) 012051,* IOP Conference Series.
12. W. Kosasih, Adianto, & Erickson, "Analisis Pengendalian Kualitas Produk Bucket Tipe ZX 200 GP dengan Metode Statistical Process Control dan Failure Mode and Effect Analysis (Studi Kasus: PT. CDE)", Jurnal Ilmiah Teknik Industri, Vol. 3 No.2, pp. 85-93, 2015.

Scopus

Source details

AIP Conference Proceedings

Scopus coverage years: from 1973 to 1978, from 1983 to 1984, 1993, from 2000 to 2001, from 2003 to Present

ISSN: 0094-243X E-ISSN: 1551-7616

Subject area: Physics and Astronomy: General Physics and Astronomy

Source type: Conference Proceeding

View all documents > Set document alert Save to source list Locate full-text(opens in a new window)

CiteScore 2022
0.7

SJR 2022
0.164

SNIP 2022
0.247

CiteScore CiteScore rank & trend Scopus content coverage

Year	Documents published	Actions
2024	1,926 documents	View citation overview >
2023	27,855 documents	View citation overview >
2022	12,839 documents	View citation overview >
2021	7,711 documents	View citation overview >
2020	10,861 documents	View citation overview >
2019	13,172 documents	View citation overview >
2018	12,878 documents	View citation overview >
2017	11,831 documents	View citation overview >
2016	9,184 documents	View citation overview >
2015	6,317 documents	View citation overview >
2014	4,903 documents	View citation overview >
2013	6,855 documents	View citation overview >
2012	7,498 documents	View citation overview >
2011	7,873 documents	View citation overview >
2010	9,413 documents	View citation overview >
2009	8,686 documents	View citation overview >

Year	Documents published	Actions
2008	7,079 documents	View citation overview >
2007	8,098 documents	View citation overview >
2006	6,605 documents	View citation overview >
2005	5,434 documents	View citation overview >
2004	1,308 documents	View citation overview >
2003	864 documents	View citation overview >
2001	391 documents	View citation overview >
2000	234 documents	View citation overview >
1995 and before	741 documents	View citation overview >

AIP Conference Proceedings

COUNTRY

United States

Universities and research institutions in United States

Media Ranking in United States

SUBJECT AREA AND CATEGORY

Physics and Astronomy
- Physics and Astronomy (miscellaneous)

PUBLISHER

American Institute of Physics

H-INDEX

80

PUBLICATION TYPE

Conferences and Proceedings

ISSN

0094243X, 15517616

COVERAGE

1973-1978, 1983-1984, 1993, 2000-2001, 2003-2022

INFORMATION

Homepage

How to publish in this journal

confproc@aip.org

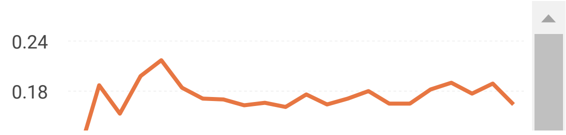
SCOPE

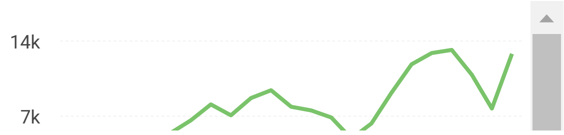
Today, AIP Conference Proceedings contain over 100,000 articles published in 1700+ proceedings and is growing by 100 volumes every year. This substantial body of scientific literature is testament to our 40-year history as a world-class publishing partner, recognized internationally and trusted by conference organizers worldwide. Whether you are planning a small specialist workshop or organizing the largest international conference, contact us, or read these testimonials, to find out why so many organizers publish with AIP Conference Proceedings.

Join the conversation about this journal

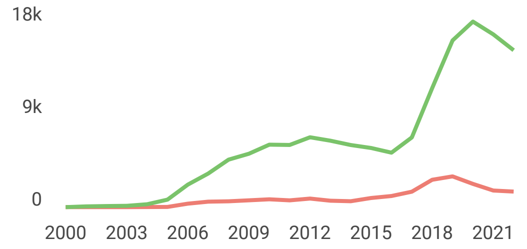
SJR

Total Documents

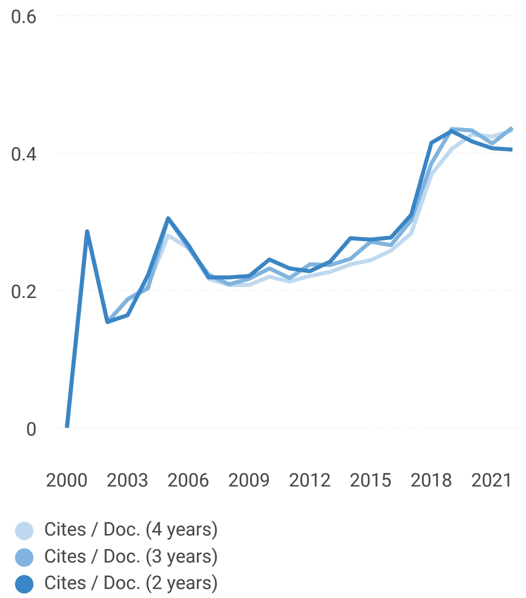




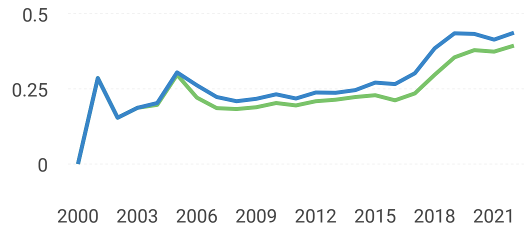
Total Cites Self-Cites



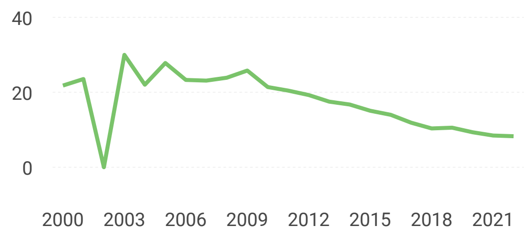
Citations per document



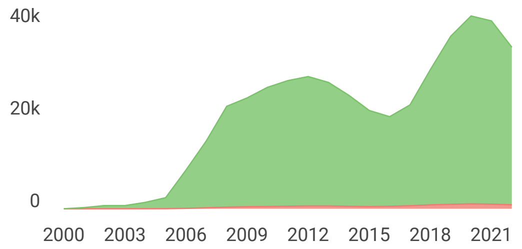
External Cites per Doc Cites per Doc



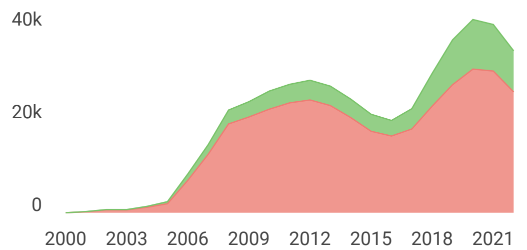
% International Collaboration



Citable documents Non-citable documents



Cited documents Uncited documents



← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scimag