

Defect study of Adidas Chimpunes sneakers using the DMAIC method

Estudio de defecto de los tenis Chimpunes Adidas utilizando el método DMAIC

NAVARRO-ENRÍQUEZ, Laura†*, RIVERA-MOJICA, Denisse, TOVAR-VÁSQUEZ, Amado and CHAVEZ-MONTELONGO, Ana Lorena

Universidad Tecnológica Paso del Norte, Procesos Industriales, México.

ID 1st Author: *Laura, Navarro-Enríquez* / ORC ID: 0000-0001-6969-7529, CVU CONACYT ID: 775111

ID 1st Co-author: *Denisse, Rivera-Mojica* / ORC ID: 0000-0003-4382-2197, CVU CONACYT ID: 214879

ID 2nd Co-author: *Amado, Tovar-Vásquez* / ORC ID: 0000-0002-7734-0631, CVU CONACYT ID: 775112

ID 3rd Co-author: *Ana Lorena, Chavéz-Montelongo* / ORC ID: 0000-0003-2794-5672

DOI: 10.35429/JIE.2022.17.6.1.7

Received July 10, 2022; Accepted December 30, 2022

Abstract

In recent years, errors have changed in such a way that a strategy must always be in place to avoid them so that if they are detected they can be counteracted, but for this there are very useful tools that were created to solve errors and why they occur. created the DMAIC method so that there is improvement after having solved a separate error is an interactive tool that helps Define, Measure, Analyze, Control and Verify. The study will be structured in two sections. The first defines the process. Then the measure where is used, the tool will be used to determine the current performance of the process and finally it will be analyzed to see how ineffective the current process is, to later propose improvements. Thanks to this tool, it was possible to detect an error associated with a machine that is a fundamental part of assembling tennis shoes, as well as poor efficiency with some workers. In addition, solutions could be proposed to counteract these problems, and prevention measures were created to prevent show up again. And finally, the last section is the conclusions to know what was learned from the method.

Resumen

En los últimos años los errores han variado a tal forma que se debe tener siempre una estrategia para evitarlos de tal forma que si se detectan se puedan contrarrestar, pero para ello existen herramientas muy útiles que para eso se crearon para solucionar errores y del porque se creó el método DMAIC para que haya mejora después de haber solucionado un error aparte es una herramienta interactiva que ayuda a Definir, Medir, Analizar, Controlar y Verificar. El estudio se estructurará por dos apartados. En el primero se define el proceso. Luego se utiliza el medir donde, se usará la herramienta para determinar el desempeño actual del proceso y finalmente se analizará para ver qué tan ineficaz es el proceso actual, para posteriormente proponer mejoras. Gracias a esta herramienta se logró detectar un error asociado a una máquina que es parte fundamental para ensamblar los tenis como también la mala eficiencia con algunos trabajadores, además, se pudo proponer soluciones para contrarrestar estos problemas y aparte se crearon medidas de prevención contra que nuevamente se presenten. Y finalmente el último apartado se encuentra las conclusiones para conocer que se aprendió del método.

DMAIC, Assembling, Define, Performance, Improvements

DMAIC, Ensamblado, Definir, Desempeño, Mejoras

Citation: NAVARRO-ENRÍQUEZ, Laura, RIVERA-MOJICA, Denisse, TOVAR-VÁSQUEZ, Amado and CHAVEZ-MONTELONGO, Ana Lorena. Defect study of Adidas Chimpunes sneakers using the DMAIC method. Journal Industrial Engineering. 2022. 6-17:1-7.

* Author Correspondence (E-mail: laura.navarro@utpn.edu.mx).

† Researcher contributing as first author.

Introduction

When solving errors in a process, improvement is always sought to avoid an error again and that can put production at risk to satisfy the customer's requirement. When the DMAIC method was created, it has been of great help to all the companies that choose to use it, because, as mentioned, it helps to improve the process (where its acronym tells us that Define, Measure, Analyze, Control and Improve). (Garza, 2016)

With the study of this process, the DMAIC methodology will continue, since I know that there was a direct complaint with the client where his disagreement said that some of the products were not well made and that they were not even well assembled. Therefore, it can generate more complaints with the client, create more losses and apart from that, their expectations and requirements are not met. The study will be structured in two sections. In the first, it will be defined to better understand the process. Then follows Measure where a tool is worn to determine the current performance of the process. Measurement is followed by Analyze to see what is wrong with the process. From there follows the Improvement that will give the best solution or improvements that are most convenient to establish and, finally, Check to see that everything goes according to plan. The second section contains the conclusions to know what was learned in this method. (Ade, 2012)

Theoretical basis

The DMAIC method for improvement

To make improvements consistently within an organization, a standardized improvement model to follow is important. DMAIC is the improvement process that uses the Six Sigma methodology and is a model that follows a structured and disciplined format, DMAIC consists of 5 phases logically connected to each other (Define, measure, analyze, improve, control) illustrated in the figure 1. Each of these phases uses different tools that are used to answer certain specific questions that guide the improvement process (Ocampo, 2012).

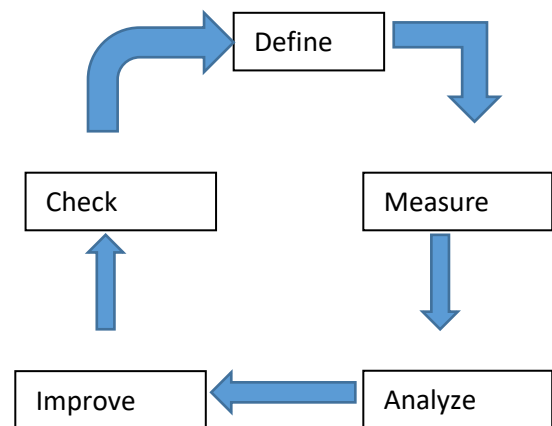


Figure 1 The six-sigma interactive DMAIC process
Source: Ocampo, 2012

Definition: of the problem, client, team.

Measurement: of the performance through a process map in which the reliability of the data is determined.

Analysis: in which the sources of variation and the roots of the problem are identified.

Improvement: development of changes to improve performance.

Control: to keep the improvements made. (Reato, 2019)

I often wonder if Six sigma works for clients' health care, oil exploration, or home construction. My typical answer is that if the process is involved in Six sigma possibly this can help improve this. DMAIC provides a very useful structure to create a closed process for project control. When the goal of the project is to develop a new or radical redesign of the product, process or service, define-measure-analyze-design-verify. Frank Gryna made the following observations about the projects. The DMAIC process was primarily about reducing defects and errors in existing products, services, or processes. Design by six sigma (DFSS) consists of five steps called DMADV (Juran and Gryna, 1988, pp 22.18-22.19)

Legitimacy puts the project on the priority list.(Keller, 2010)

D	Define improvement activity goals and incorporate into project
M	Measure the existing system, establish validation and metrics to monitor progress against goals.
A	Analyze the system to identify ways to close the gap between the current process or system and the desired goals.
I	Improve the system. Being creative finding new ways to do things better, cheaper and faster.
C	Check the new system. Improve the system by modifying incentives, policies, procedures, operating instructions. ISO 9000 can be used to ensure correct documentation and statistical tools.

Table 1 DMAIC Overview

There are many reasons why you should plan carefully before starting a project. (Ruskin and Estes 2003, p.44)

Method description

This is a case study carried out in a company that manufactures Adidas tennis shoes in the state of Chihuahua. Its design is based on the DMAIC methodology that consists of five phases. Six sigma is a methodology that aims to improve processes through the reduction of quality variability, which translates into the reduction of defects or failures in the products or services that organizations generate to satisfy the customer needs. (Bahena,2006 y Urrutia, 2015)

Phase 1, Define

It will start with the most used tool, the flowchart to better understand the process where it will help us to solve the problems that arose and therefore improve it. (Socconini, 2020)

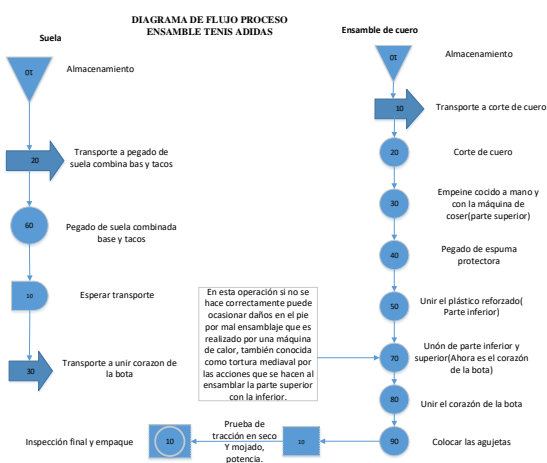


Figure 2 Process flow diagram Source: Own elaboration

This diagram shows how the sequence of making the product is from the warehouse to its inspection, apart from that it is easy to understand this process in case you want to modify some of the operations, but it is not necessary at the moment.

Phase 2, Measure

In the second stage, the existing defects are described, the process is disclosed in its present state with reliable measurements and that they give a validity to the system, ensuring that the information is pertinent and that it allows decision-making, so that the improvement to be developed. whatever suits you best. See Fig 2. Process diagram. (Desimavilla, 2021)

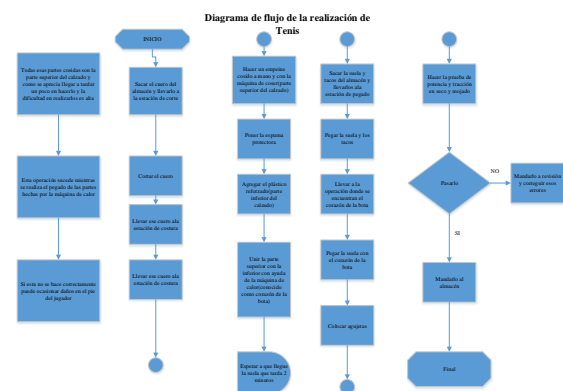


Figure 3 Process diagram. Performing tennis Source: Own elaboration

As shown in the process diagram, the operation where there is a longer duration in the performance of the process is in the sewing operation where it takes time to sew the leather to form the tennis shoe, so it takes time to reach the next operation and apart from she does the easiest parts by hand, but the most difficult ones help the sewing machine, but it is not a problem since it is normal that it takes a long time. Then the heat machine which is responsible for doing the most work since it unites the important parts of the shoe and is a key part for the shoe to come out well since if it is not done correctly it can cause damage to the player and even dislocate a bone in the part of the foot due to the bad placement of the pieces.

Phase 3, Analyze

A block diagram will be made to know the opinions and generate that information that the experts will give us. In this way, it will be discovered what causes the poor performance of the product through the summary information that will be obtained. This can be seen in figure 3.

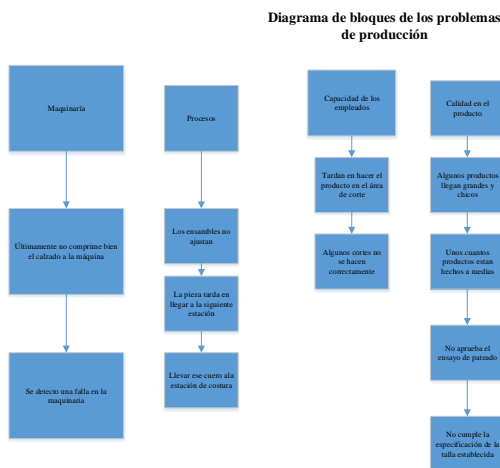


Figure 4 Blocks diagram, production problems

As can be seen in the diagram, where it presents more problems is the machine that performs the footwear badly when compressing or doing the heating act, so that the parts of the footwear are well adjusted, and apart from some employees do not make the cuts correctly and apart from they delay the line since the upper part of the footwear does not arrive on time, even creating downtime in the next operation since they can use it at work, but they cannot because they do not have the piece with which they have to work.

Phase 4, Improve

The improvement is to replace labor with a cutting machine and apart from that, a heat machine will also be replaced, since it is responsible for the defective product. Thus creating two improvements for the process for both the workforce and the heat engine.

Workforce

Expectation 1:

Replace labor by cutting machine.

Goal:

- Reducing errors per cut and increasing strokes per cut.
- When using the cutting machine, about 20 strokes are cut. depending on the type of line being cut.

Expectation 2:

Use the cutting machine to cut all the necessary strokes.

Goal:

- Reduce the time in cutting strokes.
- Reduce the time of elaboration of the product.
- Have precise cuts.

Comparing the new improvement proposal as we can see in the images cutting the strokes by hand and already having the complete strokes with the cutting machine obtaining more production in less time around 80%.

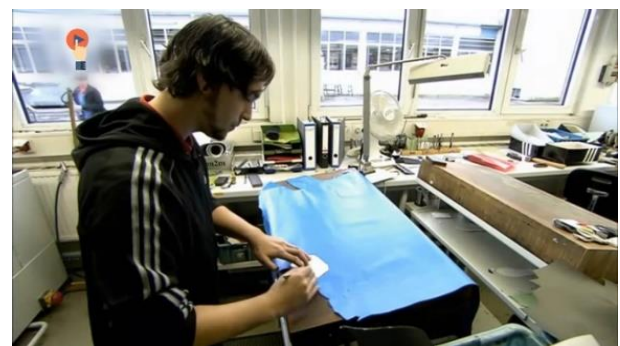


Figure 5 Manual cut
Source: Own elaboration



Figure 6 Complete strokes with the cutting machine
Source: Own elaboration

Method analysis

Current court and proposal

Cutting time per stroke 1.30 min

Cutting time for every 20 pieces: 2 minutes

You have 30 seconds difference and 80% more stroke breaks.

Advantage:

1. Shorter stroke cutting time.
2. Increased production.
3. Error control in court.
4. Fewer errors in cuts.
5. Precise cuts.
6. Reduce labor costs.

Disadvantages:

1. Cost of machinery.
2. Increases the cost of energy.
3. Having to cut staff.

Check	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total	%
Check leather cut of workers	/	/	/	/	/	/	/	14	21.2
Check condition of sewing machines	/	/	/	/	/	/	/	0	0
Check hand sewn indep.	/	/	/	/	/	/	/	0	0
Heat machine	/	/	/	/	/	/	/	17	25.8
Power test	/	/	/	/	/	/	/	15	22.7
Wet and dry pull test	/	/	/	/	/	/	/	14	21.2
Check cycle test	/	/	/	/	/	/	/	4	6.06
Check part quality	/	/	/	/	/	/	/	2	3.03
Defects								66	100

Table 2 Operations checklist

Heat machine

Expectation 1:

Replace the current heat machine with one that meets the needs of the operation.

Goals:

- Reduce the errors that afflicted the client.
- Reduce the times in the union of the upper part with the lower part.
- Increases safety when putting on shoes.

- The footwear must come out according to the specifications.

Expectation 2:

Use the machine to make work easier for employees.

Goals:

- The machine must have a basic configuration for the understanding of the workers.
- Easy putting on and taking off the shoe from the machine.
- Give the worker specific measurements for footwear.

Advantage

1. There will be no more mistakes
2. It will increase productivity
3. Trained staff
4. It will reduce the times in making the piece

DISADVANTAGES

1. The price of the machine
2. No assets will be generated at the time of staff training.

Phase 5, Control

This last phase corresponds to control, and its objective is not to lose the achievements made in the previous phases, that is, to maintain the stability of the processes and their capacity at a Six Sigma quality level. We say that a process is capable when it can be maintained within the tolerances in an interval of admissible variability; thus, a stable process may be available but not capable. (Pellegero, 2015)

Check	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total	%
Check leather cuts from the workers	///	///	///	///	///	///	///	14	21.2121
Check the status of the sewing machines								0	0
Check the stitched instep by hand								0	0
heat machine	///	///	///	///	///	///	///	17	25.7576
power test	///	///	///	///	///	///	///	15	22.7273
tensile test on dry and wet	///	///	///	///	///	///	///	14	21.2121
Check cycle test	///	///	///	///	///	///	///	4	6.06061
Check part quality	///	///	///	///	///	///	///	2	3.0303
Defects								66	100

Table 3 Operations checklist

Source: Own elaboration

These are the checklists of table 3 and table 4 that are regularly used to verify that everything is fine, but lately there were some errors that, as already mentioned in the problem, were so great that a few pairs of sneakers were presented in the client and therefore he complained, since the product was not well made by the heat machine, which is the most important, because, without it, the pieces cannot be correctly assembled from the top to the bottom. In addition, they did not even pass the most important tests, since if they do not pass them, the product cannot be sold to the customer.

Check	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total	%
Check the state of the cutting machine	///	///	///	///	///	///	///	7	2.5
Check hand-stitched instep	///	///	///	///	///	///	///	7	12.5
Check the condition of the sewing machine	///	///	///	///	///	///	///	7	12.5
New heat machine	///	///	///	///	///	///	///	7	12.5
Power test	///	///	///	///	///	///	///	7	12.5
Wet and dry tensile test	///	///	///	///	///	///	///	7	12.5
Check cycle test	///	///	///	///	///	///	///	7	12.5
Check part quality	///	///	///	///	///	///	///	7	12.5
It worked properly								56	100

Table 4 Operations checklist

Source: Own elaboration

Here is another checklist of operations after applying the improvement. See table 4.

As can be seen in the verification sheet in table 2, after applying the improvement, the errors that caused the product to go wrong were reduced, so having applied this improvement that favors the moment it is delivered to the client where there will no longer be claims for not having finished the product.

Apart, as can be seen, the part of verifying workers' leather cuts by the cutting machine mentioned in phase 4 was eliminated, the name of the heat machine was also changed to a new heat machine to know how to differentiate which is the correct one.

Gratitude

I would like to thank the Paso del Norte Technological University, my career director Ángeles Holtzaimer Álvarez, Ing. Amado Tovar, Ing. Denisse Rivera Mojica, Ing. Ana Lorena Chávez Montelongo and all my friends and family who supported in the preparation of this article.

Conclusion

Carrying out a research project with the DMIC method is of great help, since you can find a problem, either directly in the product in the same process, in addition, it gives you the ability to plan and give orders to reach a solution. solution and increase efficiency, as well as your experience in the Labor field. Apart from that, the quality management system itself provides the ability to do things correctly in the product/service and look for possible solutions to the problem.

Finally, it was a success to have changed the workforce for a machine capable of making the cuts without fearing that it will do them wrong or that it will take time, apart from reducing labor costs and although labor continues to be used in the station of the new heat machine is because it is required because without them it cannot be handled automatically, since it is based on the measurements that will be given, but in the same way the product can be made correctly. Besides, there is data that affirms that it is being done correctly, as it can be seen in the checklist.

References

Ade Asefeso MCIPS MBA(2012). Design for six sigma(Dfss). Publisher: AA Global Sourcing LTD. Recovered from: [http:// www. Aaglobalsourcing.com](http://www.Aaglobalsourcing.com)

Desimavilla, Elvis (2021). DMAIC methodological proposal for the reduction of defects in the water packaging process of a beverage industry. Salesian Polytechnic University. Guayaquil, Ecuador. Recovered from: <https://dspace.ups.edu.ec/bitstream/123456789/21464/1/UPS-GT003543.pdf>

Garza, Rosario C (2016). DMAIC methodological proposal for the reduction of defects in the water packaging process of a beverage industry. Salesian Polytechnic University. Guayaquil, Ecuador. Recovered from: Universidad Politecnica Salesiana. Guayaquil-Ecuador. Recuperado de: E-ISSN: 1886-516X. Sevilla España. <https://www.upo.es/revistas/index.php/RevMetCuant/issue/view/283/146>

Juran and Gryna(1988). Juran method (quality analysis and planning). Editorial: Mc Graw Hill. Quinta edición. ISBN-13: 978-970-10-6142-8. Recovered from: <http://sistemasdecalidad6to.weebly.com/uploads/4/6/5/8/46581171/metodo-juran-an%C3%A1lisis-y-planeaci%C3%B3n-de-la-calidad-juran-5ta.pdf>

Keller, Paul. (2010). The Six Sigma Handbook. Editorial: Mc Graw Hill. Recovered from: <https://www.mtcbh.net/mt-content/uploads/2017/01/6-sigma-handnbook.pdf>

Bahena, M y Reyes, P. (2006, Feb.). Curso de Seis Sigma. [En Línea]. Recovered from: <http://www.icicm.com/files/CursoSeisSigma.pdf>

Ocampo, Jared. (2012). Integrating Six Sigma DMAIC methodology with Flexsim Discrete Event simulation. Recovered from: cierrmmi.gvn.mx/users/sign_in

Pellegero, Xavier. (2015). Application of the "DMAIC" methodology in the resolution of quality problems. University of Vic Escola Politecnica Superior. Recovered from: http://repositori.uvic.cat/bitstream/handle/10854/4096/trealu_a2015_pellegero_xavier_aplicacion.pdf?sequence=1&isAllowed=y

Reato, Carlo. (2019). Lean Six Sigma (Management system to lead companies). Retrieved from: <https://books.google.com.mx/books>

Ruskin and Estes (2003). Quality Engineering Handbook. Recovered from: [https://books.google.com.mx/books?id=V0dZDwAAQBAJ&pg=PA52&dq=Ruskin+and+Estes+\(2003\).+Quality+Engineering+Handbook&hl=es&sa=X&ved=2ahUKEwjpu_3uq9H5AhWJg2oFHdq6CTYQ6AF6BAgJEAI#v=onepage&q=Ruskin%20and%20Estes%20\(2003\).%20Quality%20Engineering%20Handbook&f=false](https://books.google.com.mx/books?id=V0dZDwAAQBAJ&pg=PA52&dq=Ruskin+and+Estes+(2003).+Quality+Engineering+Handbook&hl=es&sa=X&ved=2ahUKEwjpu_3uq9H5AhWJg2oFHdq6CTYQ6AF6BAgJEAI#v=onepage&q=Ruskin%20and%20Estes%20(2003).%20Quality%20Engineering%20Handbook&f=false)

Socconini, Luis (2020). Lean Six Sigma Green Belt Certification Manual. Barcelona.ISBN:978-84-17903-53-4. Recovered from:

<https://books.google.com.mx/books?id=adD8DwAAQBAJ&pg=PA4&dq=Socconini+Luis+2020+Manual+de+certificaci%C3%B3n+Lean+Six+Sigma+Green+Belt+Barcelona+ISBN+978+84+17903+53+4&hl=es&sa=X&ved=2ahUKEwi9-OSSrNH5AhV7kmoFHUbcAN4Q6AF6BAgDEAI#v=onepage&q=Socconini%20Luis%202020%20Manual%20de%20certificaci%C3%B3n%20Lean%20Six%20Sigma%20Green%20Belt%20Barcelona%20ISBN%20978%2084%2017903%2053%204&f=false>

Urrutia, Angel(2015). Quality improvement plan in the production of footwear in Mabeliz creations through the application of the Six Sigma methodology. Ambato-Ecuador. Recovered from: https://repositorio.uta.edu.ec/bitstream/123456789/19198/1/Tesis_t1076id.pdf.