Evaluation Of Adherence To The Model Six Sigma Using Paraconsistent Logic Six Sigma Adherence Assessment Method Using Paraconsistent Logic

Caique Z. Kirilo
Software Engineering Research Group
Paulista University, UNIP
São Paulo, Brazil
caiquez.kirilo@hotmail.com

Jair M. Abe
Graduate Program in Production Engineering
Paulista University, UNIP
São Paulo, Brazil
jairabe@uol.com.br

Marcelo Nogueira
ALGORITMI Centre, School of Engineering
University of Minho
Guimarães, Portugal
marcelo@noginfo.com.br

Kazumi Nakamatsu
School of Human Science and Environment/H.S.E
University of Hyogo
Hyogo, Japan
nakamatu@shse.u-hyogo.ac.jp

Luiz Carlos Machi Lozano
Software Engineering Research Group
Paulista University, UNIP
São Paulo, Brazil
luizmlozano@gmail.com

Luiz A.de Lima
Graduate Program in Production Engineering
Paulista University, UNIP
São Paulo, Brazil
luiz.lima@wcisp.com.br

***Abstract*— This study aims to present a compliance analysis tool to Six Sigma by integrating indicative of success and Paraconsistent Method Decision. This way is contributing to a previous scenario analysis that can help the implementation of Six Sigma with higher chances of success.**

Keywords*— *Six Sigma, Quality, Paraconsistent Annotated Evidential Logic Et, Paraconsistent Decision-Making Method.

I. INTRODUCTION

This Six Sigma is a highly quantitative method. However, many qualitative issues end up interfering with the progress of its deployment. Such issues often transcend the powers of observation of the method as it is implicit errors. Therefore, it is necessary to check the grip that particular organization has six Sigma, using the same indicative factors used in choosing projects, however, now with a more specifically targeted optics.

To assist this check of the grip a Survey is used, however, the same has been modified so that it was possible the integration with its Method, which has Paraconsistent decision-making premise to be a useful tool in the decision-making process.

As a result, this Survey of Six Sigma compliance analysis associated with the Method of Decision becomes a Paraconsistent tool with enough accuracy, due to the fact of Paraconsistent logic use as one of the parameters for decision-making the contradiction.

II. THEORETICAL FRAMEWORK

This item will be exposed the contents used as the basis for this research, after vast bibliographical research on Paraconsistent logic, and Six Sigma was unable to collect the necessary material to develop a reliable path for the present work.

A. Six Sigma

Six Sigma was born at Motorola in the mid '80. At that time, Motorola was spending between 10% and 20% of revenue in low quality-directly and indirectly. As the total cost of quality often is hidden, the benefits of quality improvement may not be apparent. To study the link between the experience of External fault on clients and the experience of internal defects in its factories, Motorola began to understand that low quality had a significant impact on its profitability of primary line [1]

The Six Sigma methodology has been the path chosen by the largest companies in the world for the search for organizational success: higher profitability and higher quality products. The consideration of the use of Six Sigma methodology has led some companies to outstanding results: GE,

For instance, during the period from 1998 to 2003, presented a reduction of costs by more than $12 billion; have Motorola, 1987 to 2003, has reduced its industrial costs in the $15 billion [2]

Since the application at Motorola, the Six Sigma achieved different definitions that were in essence linked to efficiency in operations, business process improvement and process excellence. However, the primary goal remains firm for the stimulus to continuous improvement of the process of standardized troubleshooting methodology, documented and repeatable [3].

Imagining a process with Cp = 1, a specification of the form $\mu \pm t$ is satisfied in limine for a process whose values produced have a normal distribution with mean μ and standard deviation $\sigma = t/3$, or $t = 3\ \sigma$. In this scenario, the normal distribution indicates how being 0.0026% probability of 0.26 or value to be different than expected. The condition Six Sigma works with at $= \sigma\ 6$, shown in Figure 1, in which the probability of obtaining a value outside of the specification is the order of 0.0000034 or 3.4 ppm (part per million). This value means a process so precisely that their variations are tiny and considered irrelevant [4]

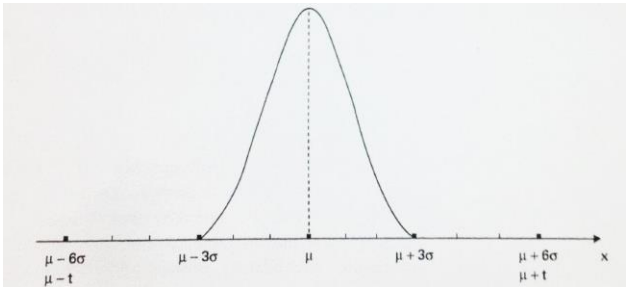

Figure 1 - Condition 6σ /Source: [4]

The pursuit of this privileged position of production happens by the intensification of the results of improvements continues and incremental. In Six Sigma, is used for both the tool DMAIC- Define, Measure, Analyse, Incorporate, Control (define, measure, analyze, incorporate and control), which is a different form of PDCA cycle [4]

D-Define: Define precisely the scope of the project.
M-Measure: Determine the location or focus of the problem.
A-Analyze: Determine the causes of each priority issue.
I-Incorporate (improve): Propose, evaluate and implement solutions for each problem a priority.
C-Control: Ensure that the target range is maintained in the long term.

Based on studies of Cristina Werkema [2], note that each employee of the company, regardless of your hierarchical level assumes a position in the program, the roles and responsibilities are described below:

Champions: Are directors or managers of the company which has the responsibility to support the projects and removes difficulties for its development.

Master Black Belts: they are professionals who advise the Sponsors and Champions, who need to have high ability to teach and serve as mentors of the Black Belts and Green Belts.

Black Belts: they are leaders of teams, which function is to coordinate projects. He must have the high technical knowledge and some qualities that characterized as being able to perform this function.

Green Belts: they are members of the teams led by Black Belts or lead teams in conducting functional projects.

Yellow Belts: they are usually supervisors, adequately instructed and trained to understand the basic concepts of the program. He has to supervise whether the program is being implemented throughout the Organization and also run projects focused on development.

White Belts: they are professionals at the operational level of the company, duly instructed and trained in the program. They have to support the Green Belts and Black Belts.

The human factor is undoubtedly the most sensitive part of Six Sigma.

The experts who are responsible for making it work are the same as they do fail, thinking that [5] addressed this theme based on studies of [6], and the result was a list of factors more significant ES involving human error.

Misinterpretation: To ensure uniform interpretation of the words is necessary to provide precise definitions, plus ancillary tools, such as checklists and examples. Must also be provided detailed information and examples of how to calculate, summarise, register, and so forth. On critical issues, it should provide formal training, along with tests to verify the "capacity" of the candidates the process sensors [5].

Inadvertent Error: The inadvertent error is unintentional, unpredictable and often unconscious, that is, the person who makes a mistake is not conscious at that moment to have him committed. Unpredictable feature produces a random character error in the data, which is useful for identification they are inadvertent type errors. The choice of solution for this kind of error is somewhat limited because the cause of inadvertent errors is a weakness inherent in the human body: the inability to stay alert indefinitely [5].

Lack of technique: The error due to lack of technique is a result of incomplete knowledge by the human sensor. Some people have developed a more skillful – some kind of "trick," that is, a small difference in the method – which accounts for a huge difference in the results. Those who know the "trick" to obtain superior results; the other, not. The solution, in this case, is to study the methods used by those who have superior performance, as for those who exhibit lower performance. These studies identify the "tricks" that can then be transferred to all workers through training or incorporated into technology [5].

Conscious Error: The error is intentional. The person who commits this error does not want the others to know when he commits and intends to continue to commit it, often as a form of defense against real or imaginary injustices [5].

Concealment: Dissimulation is a deliberate change of data collected for a variety of purposes usually selfish: reduction of workload, escape from unpleasant tasks, self-aggrandizement, afraid of being punished for being a bearer of bad news. The reduction of deception can be achieved, in part, by the establishment of an environment that encourages honest communication, which requires leadership, through examples, the top management [5].

Distortion: The distortion and deception are similar, but there are subtle differences. In concealing the human sensor knows the facts, but the changes. The distortion is not necessarily conscious, being possible the existence of Interior forces that influence the response of the sensor (for example, fixed ideas due to the habit). The distortion can even be inherent to the structure of the plan of action of human sensors [5].

Uselessness: The feeling of uselessness is another source of conscious error. If the developers discover that their reports do not lead to anything, they no longer make them. The situation is even worse if workers discover that their reward for acting as sensors is unwarranted guilt [5].

The factors of success for the Six Sigma may have high chances of success are listed by [7] in your survey, these factors are addressed in this research instrument.

Focus on the customer - [8] show that organizations must use information about customers ' needs as main factors that will drive the Six Sigma projects. Also highlights that clients necessarily should feel the effects of the improvements obtained after the implementation of the project. [9] reinforce the importance of engaging with customers in Six Sigma deployment process is to minimize the possibility of frustration with the results.

Connection with the business strategy -One should always prioritize projects according to the KPI's (Key Performance Indicators) of the company, ensuring the support of the direction and contributing strategically to the business. [10] emphasize the importance of ensuring the alignment of Six Sigma projects, to be selected, under the direction of the business.

Financial return according to [11], the success of Six Sigma programs are directly related to your financial return, and not only in the use of exhaustive statistical tools. The subject requires a harmonious integration between process and management guidelines, keeping the focus on the client, in critical processes and results of the company.

Structural problems of unknown causes -Research for a special cause it is not enough work to justify the application of the Six Sigma methodology in most cases. The proper use of the tool Design of Experiments (DOE), for example, provides the discovery of the source of the deviation so that you can take appropriate actions. Therefore, the Six Sigma methodology should be applied to the solution of structural problems; its use should focus on combating the causes of variation, which translates into the increased capability of the process [7].

Proportionality with the available resources According to Pande et al. (2001), it is necessary to be careful to avoid projects with extensive scope, because the resources available may not be sufficient for the development of the work correctly. [12] strengthen the importance of the use of the appropriate tools. In this way, one can observe the great importance of ensuring that, for the solution of the problem proposed, be taken care of the resources made available by the organization.

Potential to end in short time - [13] point out the importance of getting the final results of the work as soon as possible. There is a great interest in projects that have the potential to end in a short period because their benefits will be enjoyed earlier. Adding the fact that long projects present a potential loss of resources made available by the organization.

Measurable Problems -Second [14], to take advantage of the Six Sigma methodology as entirely possible to make, as a first step, a good investment of time and energy to the definition of the measurable output variables. According to [8], it is essential to identify the most significant characteristics of quality.

B. Paraconsistent logic Annotated Evidential Eτ

Identify applicable funding agency here. If none, delete this text box.

This topic introduces as purpose to introduce the Annotated On Paraconsistent logic and Et, which will serve as a basis for subsequent studies.

Roughly speaking, paraconsistent logic allows contradictions in theories based on them without trivialization. The forerunners of this type of logic were Jan Łukasiewicz, and N. Vasiliev in 1907, independently. Some years later, S. Jaśkowski in 1948 and N. da Costa in 1958 independently introduced paraconsistent systems in a modern fashion [15].

da Costa has developed a family of Paraconsistent Logic, propositional and predicate calculus of first-order set theory, that is, all the standard logic levels [15]. The process of decision making is a rational process, in which a plan of action is chosen based on various. Every decision-making process produces a choice. The decision refers to the process of choosing a coherent way in certain situations [16].

By analyzing the real world, uncertain and inconsistent situations, we notice that in most of them we have partial knowledge of the facts. However, this situation does not prevent the development of human reasoning, that is beyond binary relation of truth and falsehood. The need to demonstrate and handle situations of contradiction raised an underlying logic to formal systems, called Paraconsistent Logic [17].

The decision-making process is a great responsibility. Some people have an ease with the decision-making process. However, others attach to the problem a disproportionate value to their reality that wrong choices are made [16].

Paraconsistent annotated evidential logic Eτ has as underlying language atomic propositions of type p(μ, λ), where p is a proposition in the usual sense and (μ, λ) indicates the degree of favorable evidence and contrary evidence respectively.

The pair (μ, λ) is called annotation constant, with the values of μ and λ ranging between the real numbers 0 and 1 [18].

The processing of input data by application of minimizing and maximizing connectives between the Atomic Formulas A and B, that define the resulting state of the output.

Expected operations on lattice τ are the maximization and minimization [19].

Considering the stage of two groups of experts (E1, E2) and B (E3, E4), it can be shown the connective OR application, represented by the disjunction A v B:

E1 (1μ, λ1) OR E2 (2μ, λ2) = (max {1μ, μ2}, min {λ1, λ2}) = air (1μ, λ1)
E3 (1μ, λ1) OR E4 (2μ, λ2) = (max {1μ, μ2}, min {λ1, λ2}) =2(μ, λ2)

Then, the application of connective AND, among the signs noted air and BR, representing the conjunction ∧ AIR BR:

R = (1μ, λ 1) AND BR (2μ, λ2) = (min {1μ, μ2}, Max {λ1, λ2}) = R (1μ, λ1)

After applying the maximization and minimization, the degrees of certainty and uncertainty are obtained by the degree of certainty: **GC (μ, λ) = μ-λ; Degree of Uncertainty: GCT (μ, λ) = μ + λ-1.**

With the values of GC and GCT obtained, identifies the logical State arising through the analysis of τ in lattice Figure 2.

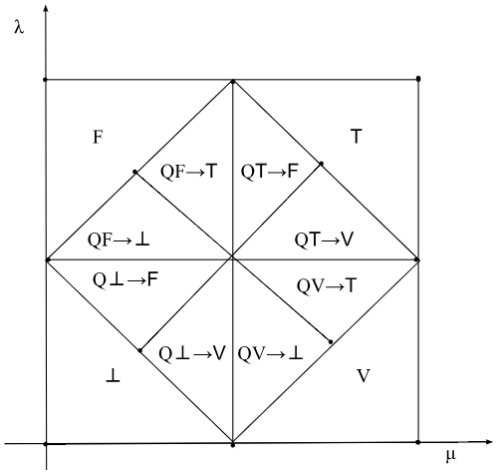

Figure 2 – Extreme and non-extreme States Source: [15]

Extreme States	**Symbol**
True	V
False	F
Inconsistent	T
Paracompleto	⊥

Table 1 – Extremes States Source: [15]

Non-extreme States	Symbol
Quasi-true tending to the Inconsistent	QV→T
Quasi-true tending to Paracomplete	QV→⊥
Quasi-false tending to the Inconsistent	QF→T
Quasi-false tending to Paracomplete	QF→⊥
Quasi-inconsistent tending to the True	QT→V
Quasi-inconsistent tending to False	QT→F
Quasi-paracomplete tending to True	Q⊥→V
Quasi-paracomplete tending to False	Q⊥→F

Table 2 - Non-States extremes - Source: [15]

C. Paraconsistent Method of Decision

Based on studies of [20], you can synthesize Paraconsistent method definition of decision (MPD), which is a method that assists decision-making using Paraconsistent Logic.

Paraconsistent method of Decision was developed by [21], which sought to identify factors that influence the success or failure of a project, namely, that end up influencing the decision to carry out a project or not. His analysis made it possible to identify what attributes can in some cases indicate favorable conditions in other unfavorable and other cases indifferent. These factors may be of different orders: economic, social, legal, environmental, political, technical, among others [21].

MPD uses as "input" (in) the experience of the participants in the decision-making process that are called experts as an essential tool of assessment of the particular issue, enabling or precludes a situation any [17].

Starting a problem, question or note, which gets its name from the proposition, the method determines the need to finish the so-called factors, which as the name implies are the factors that impact on the viability or infeasibility of this proposition [18].

The factors can be severed to increase the accuracy of the analysis of a particular factor, sections created can extract more from the knowledge of the experts who are evaluating the [17].

Paraconsistent decision method is consisted of basically eight steps [20]:

1. Define the degree of demand that is parameterised on the decision-making process.

2. Define the factors that impact the proposition that will be parsed.

3. Set the sections that constitute the factors, to explain better the factor limits; there is no limit of sections to give the factor or a pattern to be followed.

4. Form the database, which can be formed by the weights also assigned factors and by evidence favorable factors and evidence to the contrary, that are deposited to each factor and its sections; such weights and opinions are taken from people who are considered experts in the field of knowledge that the proposition is inserted.

5. Carry out field research to establish, in which condition each of the factors.

6. Get the value of the favorable evidence (ai, R) and the value of the evidence to the contrary (bi, R) ($1 \leq i \leq n$), for each of the factors (Fi) chosen. Also, apply it for each section considered in the search (Spj). Therefore, apply maximizing (MAX operator) and minimizing (MIN operator) of logic $E\tau$.

7. Obtain the degree of favorable evidence (aw) and the degree of evidence to the contrary (bw) of the centroid of the points representing the chosen factors in the lattice t.

8. Finally, decide with the aid of the data obtained.

The application of the rules of maximization and minimization can be performed in two ways:

1. Making the maximization of degrees of evidence to a set of notes, to get:

The best evidence that is favorable (The highest value of favorable evidence μ)
The worst evidence that would be contrary (The highest value of favorable evidence λ)

2. Consider the maximization or minimization of the certainty degree:

Gce = μ - λ, the certainty degree, reflects how much the information contained in this set allow to infer the truth or the falsity of the premise. (This form is more intuitive and leads to more predictable and consistent results).

Maximizing the degree of certainty (Gce) is seeking:

The best evidence that is favorable (The highest value of favorable evidence μ)
The best evidence would be contrary (The lowest value of favorable evidence λ)

Moreover, consequently, minimizing search:

The worst evidence that is favorable (The lowest value of favorable evidence μ)
The worst evidence that would be contrary (The highest value of favorable evidence λ)

The MPD, as a tool to aid decision making based on paraconsistent logic plays a vital role in the treatment of the views of its members, taking into account its contradictions and that in some instances it is significant for decision-making more accurate, therefore, has much to contribute to human relations within the Six Sigma.

Six Sigma has tools contribute to the improvement of quality, but these tools are subject to human intervention, which can change the results and create a false impression of success, however, which does not hold in the long run.

III. OBJECT OF STUDY

The instrument featured in this study is an adaptation of the work of [7], which in your time was imagined to the selection of Six Sigma projects.

Fill in the fields "I believe" with the percentage of how much you believe in the affirmation and the field "I do not believe" with the percentage of how much you do not believe in the statement.		
Focus on the customer		
	I believe	**I cannot believe**
Has as the main reason, the selection of Six Sigma projects, customer satisfaction?		
Does the use of flagged information by customers to determine critical factors to the selection of Six Sigma projects?		
The internal or external client is involved in the project selection process Six Sigma?		
Is the client involved as to the vision for the main problem to be solved (interest)?		
Is the client involved as to the vision for the critical process to be improved?		
Before the start of a Six Sigma project, the collection of clients ' requirements, for the establishment of relations?		
Make use of tools for collecting information on customers ' needs to the selection of Six Sigma projects?		
Connection with the business strategy		
Have we set clear business strategy (all levels)?		
The evaluation of the project in step, check the existence of a connection with the business strategy (in all cases).		
Six Sigma projects are born of KPI ´ s of the Organization (in all cases).		
Financial return		
The financial return to the business is among the leading "drives" of the Organization, explicitly.		
In step six Sigma projects selection has assessed the financial impact to the Organization (potential gains from work)?		
The financial return to the organization is one of the criteria for the selection of Six Sigma projects?		
Structural problems of unknown causes		
The concept of structural problem and "outbreak" is clear to everyone involved with Six Sigma in your organization.		
Before the beginning of the development of a Six Sigma project, the assessment of the problem as to whether it is an "outbreak" (particular cause).		
Before the beginning of the development of a Six Sigma project, the assessment of the problem as to whether the cause is known.		
Proportionality with the available resources		
My job is secure in the company, meaning it does not run the risk of being fired without cause.		
Is assessed the resources required for the implementation of the Six Sigma project to be selected.		
The evaluation is carried out as to the sufficiency of resources for the development of Six Sigma project successfully.		
The evaluation is carried out as to areas involved in the project, Six Sigma instep.		
A careful consideration of the scope of Six Sigma project to be selected.		
Is performed the assessment tools to be used at work, according to the size of the Six Sigma project to be selected.		
Potential to end in a short time		
Is performed any assessment as to the time needed for the development and completion of the Six Sigma project (in step of selection)?		
In the process of selection of the Six Sigma projects, the assessment of the potential for termination of work within six months.		
Measurable problems		
The mapping of the measurable output variables to identify opportunities for improvement.		
In the process of selection of Six Sigma projects, take care of case problems measurable.		

A. Data collection procedures

This survey collected bibliographic data to solidify a new way to assess adherence to Six Sigma from a particular organization. Were merged two concepts that demonstrate success indicators that can be measured and then used in a decision-making process.

B. Data analysis procedures

After collecting the data obtained through the survey, there will be an array of knowledge compatible with a paraconsistent system, which works as follows:

• Step 1: receipt of the information.

The information is obtained using two independent variables, which are between 0 and 1, the first being the degree

of favorable evidence and the second, the degree of evidence to the contrary.

• Step two: Data Processing.

The data are processed using the following equations:

a) GCT = (λ + μ)-1 to find the degree of contradiction.

b) GC = (μ-λ) to find the degree of certainty

• Step three: conclusion

To perform the completion, the following conditions:

a) and there is a high degree of contradiction, there is no certainty yet about the decision. Therefore, they must seek new evidence.

b) and there is a low degree of Contradiction, one can formulate the conclusion since it has a high degree of certainty.

IV. Results

The survey results from this research can be used as a pillar to a broader and more in-depth analysis of the deployment of Six Sigma in a given organization, as shown in Figure 3, where the same concepts presented in this research are presented in such a way as to cover all the DMAIC.

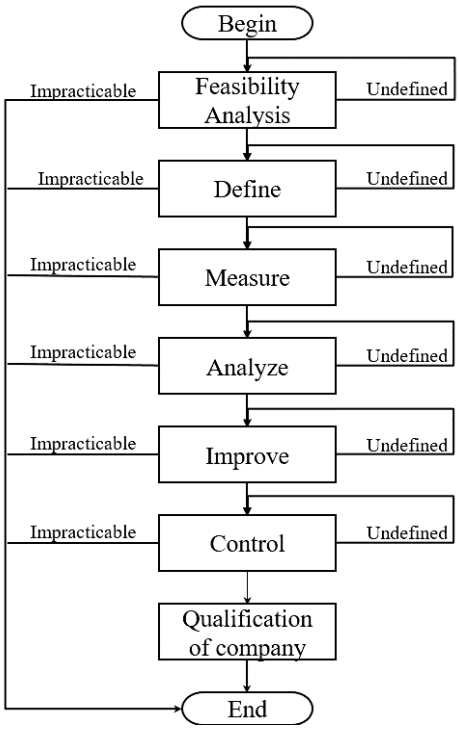

Figure 3 – Macro Flow Chart a broad analysis

V. Discussion

Inconsistencies arise naturally in the description of the real world. Such concept occurs in various contexts and threads, without detracting from the human being in his essence can reason correctly. However, the analysis of these inconsistencies is fundamental parts of a decision-making process.

Both the Six Sigma as any other quality improvement methodology inconsistencies may have a negative impact on the results. Therefore, it is necessary to analyze them more thoroughly with tools that facilitate the treatment of these inconsistencies.

Conclusions

This Work, with a broad view on the subjects addressed, invites the reader to reflect on the use of paraconsistent logic as a way of improving the implementation of Six Sigma and mitigate their vulnerabilities. By studying the deployment of Six Sigma process, both in theory and in practice it was possible to analyze that even being a quantitative process based on statistical techniques of high reliability, is still fragile in the human factor.

The bibliographic survey was of extreme importance to elucidate all the way by which the research would pass, many authors have dedicated much of their lives to consolidate the concepts employed in this research, denoting the importance of potential areas that have been addressed.

The present study demonstrates a methodology proposal that as future work can be implemented in software that will assist more didactically Six Sigma deployment and all processes and stages of the Sigma Paralogic. Considering that all the logical process can be transcribed into lines of code without changing the methodology presented here.

The Surveys can be reworked and customized according to each case study, keeping the main base and adding the desired score to each particular job.

Acknowledgment

FCT – Fundação para a Ciência e Tecnologia has supported this work in the scope of the project: PEst-OE/EEI/UI0319/2013 by Portugal and University Paulista - Software Engineering Research Group by Brazil.

References

[1] H. L. M. D. M. Quintella, R. F. D. Toledo e S. Mokdisse, “Maturidade Cmm, Six Sigma E Sua Relação Com A Qualidade Percebida Pelo Cliente”.

[2] C. Werkema, Criando a Cultura Seis Sigma, Nova Lima: Werkema Editora, 2004.

[3] M. S. Pestorius, “Aplicando o Seis Sigma às vendas e ao marketing.,” Banas Qualidade, pp. p.40-50, Março 2007.

[4] P. L. d. O. Costa Neto e S. A. Canuto, Administração com qualidade: conhecimentos necessários para a gestão moderna, São Paulo: Bluncher, 2010.

[5] C. Werkema, Perguntas e Respostas sobre o Lean Seis Sigma. 2 Ed., Rio de Janeiro: Elsevier, 2011.

[6] P. Schmidt, J. L. dos Santos & C. H. Arima, Fundamentos de Auditoria de Sistemas, São Paulo: Atlas, 2006.

[7] M. M. Fernandes, “Análise Do Processo De Seleção De Projetos Seis Sigma Em Empresas De Manufatura No Brasil,” Dissertação submetida ao Programa de Pós-Graduação em Engenharia de Produção como requisito parcial à obtenção do título de Mestre em Engenharia de Produção - Universidade Federal De Itajubá, maio 2006.

[8] P. Fundin & P. Cronemyr, “Use customer feedback to choose Six Sigma projects,” Six Sigma Forum Magazine, 2003.

[9] J. Antony & R. Banuelas, “Key ingredients for the effective implementation of Six Sigma program,” Measuring Business Excellence, 2002.

[10] H. Young & T. Frank, Benefits, obstacles and future of six sigma approach., Elsevier, 2004.
[11] M. M. Carvalho, Medindo o sigma do processo. In: Rotondaro, R.G.(Org.) Seis Sigma: estratégia gerencial para melhoria do processo, produtos e serviços., São Paulo: Atlas, 2002.
[12] K. Bengt, H. Wiklund & R. Edgeman, "Six Sigma seen as a methodology for total quality management," Measuring Business Excellence, 2001.
[13] R. D. Snee & R. Jr., "The project selection process.," Quality Progress, Setembro 2002.
[14] T. Bertels e G. Patterson, "Selecting Six Sigma projects that matter," Six Sigma Forum Magazine, November 2003.
[15] J. M. Abe, S. Akama e K. Nakamatsu, Paraconsistent Intelligent-Based Systems - New Trends in the Applications of Paraconsistency, 1 ed., vol. 1, Switzerland: Springer International Publishing, 2015.
[16] T. Shimizu, Decisão nas Organizações, vol. 2 ed., São Paulo, SP: Atlas, 2006.
[17] J. M. Abe, J. I. da Silva Filho, U. Celestino e H. C. d. Araújo, Lógica Paraconsistente Anotada Evidencial Et, J. M. Abe, Ed., Santos: Comunicar, 2011.
[18] J. M. Abe, H. F. Lopes e K. Nakamatsu, "Paraconsistent artificial neural networks and EEG.," International Journal of Knowledge-Based Intelligent Engineering Systems, vol. 17, nº 2, pp. 99-111, 2013.
[19] J. I. Da Silva Filho, "Métodos de Aplicações da Lógica Paraconsistente Anotada com Dois Valores - LPA2v com Construção de Algoritmo e Implementação de Circuitos Eletrônicos," Tese de doutorado apresentada a EPUSP, 1999.
[20] F. R. Carvalho, "Aplicação de lógica paraconsistente anotada em tomadas de decisão na engenharia de produção. Tese de Doutorado," 2006. [Online]. Available: http://www.teses.usp.br/teses/disponiveis/3/3136/tde-13032007-155453/pt-br.php. [Acesso em 14 Março 2016].
[21] F. R. Carvalho & J.M. Abe, Tomadas de Decisão com Ferramentas da Lógica Paraconstistente Anotada, São Paulo: Edgard Blucher Ltda., 2011.