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Proposal of Cost Reduction in the Production Process of Soft Drinks Concentrate from Tholor Do Brasil Based on the Use of Integrated PDCA/DMAIC Tools

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Abstract

The general aim of this work was to show a proposal of cost reduction, for the production process of soft drinks concentrate from Tholor do Brasil Ltda in Manaus, using the integrated PDCA/DMAIC tools, based on the philosophy of lean manufacturing system and six sigma methodology. About the methodology, it is a case study that contemplates a documental field research, carried out with the use of questionnaires to 12 employees from the soft drinks concentrate production area of the company, which made possible to achieve the goals of this work, highlighting from the production employees' perspectives, what improvements can be implemented in the general production process of the soft drinks concentrate production. The results show that with the implementation of the integrated PDCA/DMAIC tools, in the course of six months, the loss rate will be reduced by at least 30%, proving the efficiency of the present proposal, demonstrating the opportunity and modification viability in this company process, emphasizing the project integration Lean Six Sigma to the production, through integrated PDCA/ DMAIC tool, standardizing methods to optimize the use of equipment's, increasing the labor productivity at all stages and operational actions of the entire production process, avoiding waste, reducing cost and increasing the operational efficiency.

Keywords: Concentrate, Tools, Six Sigma, Lean System, Soft drinks.

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Introduction

The problematic situation detected in the production area of Tholor do Brasil, are related to the equipment that perform the processes of mixing and homogenizing in the soft drinks concentrate production. It is a problem relatively easy to be solved, however, it has a great impact in the production. The solution proposal does not cause major difficulties in its, allowing the company, to obtain significant gains in the process of search of better continuous improvements, lean production, and integration with the company necessities, eliminating the failures, reducing time, costs, and operations.

In this context, there was a concern that can be summarized in the following question: how the philosophy of lean manufacturing system and the six-sigma methodology can be applied to improve the Tholor do Brasil LTDA company soft drinks concentrate production process? The hypothesis of the work start from the assumption that the processes carried out by mixing and homogenizing that are used in soft drinks concentrate production of Tholor do Brasil Ltda, add great value to the final product of the company, and must be continuously analyzed in search of elimination failures and waste, aiming at continuous improvement and lean production, as well as gains in the production chain, which should be integrated with the quality tools and collaborate this way with waste reduction, standardization, and continuous improvement.

Rodrigues (2014) clarifies that the philosophy Lean Manufacturing with its and techniques have been applied in various sectors of a company, in some cases with changes in the, in others maintaining the initial terms, but the important is the understanding of the Lean thought, which search for better results struggling the waste in a broad concept and in all levels, once the organization is lean, without loss, it is not a more differential, but yes, one more condition of survival in this global and competitive market.

Considering the high demand for technological innovations by its customers, Tholor do Brasil Ltda must have a strong model of product design that acts in all sectors involved in manufacturing. Therefore, constant monitoring of the machines minimizing disruption in the development of products with speed, safety, and reliability. To produce quality, efficiency and safety is fundamental and in recent years, the actions of continuous improvement based on lean production process is gaining prominence in the industrial sphere, given that they subsidize and monitor the decisions that will be

essential to obtain quality and lower costs. In the context of engineering of industrial processes, a key reason motivates the accomplishment of works like this: the need to recognize the importance of continuous improvement and lean manufacturing in a company.

The scarcity of resources coupled with the advent of globalization and fierce competition, demand of today's enterprises continuous search for ever higher standards of efficiency and quality, and this pursuit of efficiency and quality is carried through solutions such as continuous improvements in production process, for example. From an industrial perspective, it is understood as the production process, the route, which is performed by an input or raw material, from when it enters the company until when it comes out with a certain degree of transformation, which involves different operations.

However, even when a production process is well designed and its activities are properly planned and controlled, all operations are subject to improvement. And in recent years, the emphasis on process improvements has been characterized increasingly as one of the main responsibilities of production engineering. Moreover, it is important to note that the continuous improvements in production processes can also contribute to the prevention of faults and how to optimize the process, when a failure occurs.

Literature Revision

Martins and Laugeni (2006) emphasize that the management of production (GP) is the way in which companies produce goods and services. It is goal of production management, effective management of the process that transforms inputs such as raw materials into finished products and / or services, after all, all activities undertaken by a company to meet its short-, medium and long term, interrelate often extremely complex.

According to Peinado and Graeml (2007), the management of production or production management comprises a wide range of activities that should not be seen just in isolation. The production management activities always occur in number and much larger than you can imagine frequency. Therefore, the current scenario is to immerse ourselves in such a way, in production activities to visualize and understand the functioning of these activities, to be able to manage them more appropriately. It is essential to start with a general and comprehensive view of the topic and its scope.

According Baldam et al. (2008), the process involves a chain of activities performed within a company, which transform inputs into outputs. So, a process is generally made up of different operations and even when it is well designed and its planned and controlled activities, all operations are subject to improvement.

Int the management processes, it is not the rate of improvement that is important in continuous improvement, is the momentum of improvement. Whether successive improvements are small. What really matters is that every month (week, quarter, or whatever period) some improvement has really happened. In addition, continuous improvements can also contribute to the prevention of failures and how to recover the process when this failure occurs (De Sordi, 2008).

The philosophy of continuous improvement is configured as an endless process, questioning the work cyclically detailed repeated nature of operation and cyclic continuous improvement (Slack et al., 2006).

On the quality, according to Rodrigues et al., (2011, p.22), quality has a broad meaning and, as a result, generates numerous interpretations: for some, "it is the pursuit of customer satisfaction"; for others, "beyond customer satisfaction, encompasses the pursuit of excellence for all the activities of a process." In the context of companies, Paladini (2004) emphasizes that it has directed the Management of Quality for the creation of a quality culture, understanding “culture” as a set of values that society attaches to certain elements, situations, beliefs, and ideas.

In the view of Chiavenato (2014), a long time ago, the quality is no longer a prerogative of certain companies. Today is a normal requirement in the market, a question of survival of a product. However, when the quality is unsurpassed, it becomes an important competitive advantage and leave competitors behind. On equal price terms and payment conditions, the best quality is the tie breaker element. Undoubtedly, the quality today is synonymous with a product has the features and specifications offered by the company to the market.

In this context, it may be noted that the quality policy must have the support of all staff and all production sections and advisory company. The basic reasoning is that quality costs money, but its absence costs a lot more money still.

According to Slack et al., (2006), Lean Production and Lean Manufacturing and their tools include a management and operation of the production system, which has its foundations in a philosophy of its own manufacturing rationalization of operations, instrumented by a set of tools and techniques that provide operating conditions to support this philosophy.

Lean goal is to maximize the value delivered to the customer through the following principles: "production JIT, minimum inventory, geographic concentration assembly and component production, demand manually pulled using kanban cards, level production, fast setups" and the "rationalization of the machines and the production line, work standardization, fast equipment failsafe, workers with multiple skills," contemplating a "high level of outsourcing, selective use of automation and continuous and incremental process improvements" (Santos, Casagranda and Nakamoto, 2015, p.22).

Rodrigues (2014) points out that there are several tools used in Lean Manufacturing which are applied in the various sectors of a company, in some cases with some differences in nomenclature, other keeping the initial terms presented by their creators. Ishikawa initially organized eight tools and techniques highlighting: list or check sheet (checklist), flowchart, histogram, control chart, Pareto diagram, Ishikawa diagram and scatter plots.

The Six Sigma methodology has clear parameters for comparison and positioning of a company in relation to its competitors: this parameter is the sigma level. Often, companies believe that reducing by 10% or 20% their level of losses would be enough to compete with advantages in the current market. But what differentiates companies with high performance is often a factor of 100 or even more than 1000 times better. Measuring the sigma level, discover the size of the opportunity that you have and to what extent it is possible economically. Most of the best companies are located below 4 in sigma standard (Harry, 2000). In statistics, "Sigma" is a measure of the variation of the process equivalent to the standard deviation (Klefsjo et al., 2001).

As Goh and Xie (2003), the comparison of defect level of a theoretical process short term or focused (no shift sigma of 1.5 over time) is a real process, long-term or displaced 1.5 sigma central value. Einset and Marzano (2002) in turn explain that it can be said that the average of the industry operates on a quality level of 3 sigma, and this represents around 20% of its revenues in waste, among which are: rework, inspection, testing, losses, wear the image and finally, even loss of customers. With the Six Sigma methodology to expenses are minimized. The estimate of market analysts is that in the short term, the processing industries are not a quality level Six Sigma will be no competitive capacity. Having level Six Sigma means operating in world class.

In designing Linderman et al., (2003), a process should aim at sigma level 6, only if this is important to the client and provided that the investment for the jump in sigma level is not so high as to economically derail this process. It is evident that improving the level 2 or 3 to 4 is exponentially easier to improve the level 4 for 5 or 6. Six Sigma is a measure of statistical variance regard to the frequency with which a certain operation of a production process uses more than the minimum resources to satisfy the customer (Trad and Maximiano, 2009).

In fact, it is an organizational initiative that is designed to build production processes, services or administrative that can generate up to 3.4 defects per million opportunities (DPMO). The main tool of continuous improvements used in the implementation of Six Sigma projects is the DMAIC: Define-According to Rath and Strong (2001), a comparison between a classic vision of Quality and Six Sigma vision presents a huge difference between levels of acceptance of what is quality. In Classic view, a highly optimized process achieves 99% efficiency, while for a Six Sigma vision, a process is only appropriate when this reaches 99.99966% efficiency.

According Rudisill et al. (2004), the most common metrics on a project Six Sigma are four: DPMO, CPK, COPQ and sigma level (Figure 1).

Figure 1
Common design metrics in a 6-Sigma

Common Design Metrics in a 6-Sigma	Brief Description

1. Defects Per Million Opportunities (DPMO)	Equation defined by the number of defects 1,000,000 times divided by the number of units times the number of opportunities per unit.
2. CPK	Distance between the process mean and the nearest specification limit divided by 3 sigmas, where sigma is the standard deviation of the process.
3. Cost of Poor Quality - COPQ	A percentage of sales; low quality costs are those associated with loss or waste, rework assessment tests.
4. Sigma Level	Number of standard deviations, sigma between the process mean and the nearest specification limits.

Source: Adapted by the author from Rudisill (2004, p.104).

About PDCA Marshall Jr. et al. (2008) point out that, in general, the PDCA is applied to the standards of management systems and should be used, from the perspective of theory, in any company to ensure success in business, regardless of the area or department.

Regarding to the integration of tools PDCA / DMAIC, Brito et al. (2015) point out that an adaptation of PDCA for projects in Six Sigma strategy is the DMAIC cycle (Define, Measure, Analyze, Improve, Control). The phases: definition of the project; measure and evaluate the project; Passive analysis; developing assays; methods and proactive action lawsuits; and control the results, ensure organizations the use of Six Sigma in a disciplined and methodical manner, and the correct execution of the projects.

Rodrigues (2014, p.37) clarifies that, Six Sigma seeks to associate actions of continuous improvement processes with breaks of projects, called "Six Sigma projects", seeking the best and most effective results. treating "the quality of systemic manner, considering all actions and sectors of an organization, and not only the non-conformities of isolated processes".

To discuss the critical success factors in the process of implementing Six Sigma, Coronado and Antony (2002) noted that several companies have adopted the methodology, however, not all were successful. By analyzing some companies, it was observed that some factors were critical in determining the success or failure, among which stand out 12, as follows: 1) involvement and commitment of senior management; 2) cultural change; 3) communication; 4) infrastructure of the company; 5) training; 6) connecting the six sigma methodology with the business strategy; 7) connection of Six Sigma with the client; 8) connecting the Six Sigma with the human resources of the company; 9) binding of Six Sigma with suppliers; 10) understanding of the tools and techniques inserted in the six sigma methodology; 11) skills of project management area; and finally 12) selection and prioritization of six sigma projects.

In this sense, Challener (2004) adds that the continued support and enthusiasm of senior management, is of great importance to the successful implementation of six sigma methodology in a company.

Methodology Applied to The Study

As for the means of research, this research was performed in three basic steps: bibliographical research, documental study case and field. The literature on production management, process improvement and quality, lean manufacturing system, lean Six Sigma and PDCA and DMAIC tools, which constitute the theoretical framework of the work. The literature search was conducted to obtain information for analysis of the case study results and was performed taking as a basis scientific works, published, and cataloged through publications loose, newspapers, magazines, books, monographs, dissertations, and theses, as well as virtual libraries on the Internet. It was intended that effect, obtain enough material for the technical-scientific basis and theoretical foundation that served as subsidies for the presentation and analysis of the case study. For the construction of the theoretical framework a simplified methodology was used to enable the best possible use of the information collected, which provided the theoretical basis for the construction and elucidation of knowledge about the processes and quality improvement, lean manufacturing system, lean six sigma and PDCA and DMAIC tools. Therefore, we carried out a literature review to know what the authors say about these theories. Armed with this information, we proceeded to the case study.

The case study was carried out in the Company Tholor do Brasil Ltda located at Av. São João, 4, Santo Antonio, in the city of Manaus and uses the tax incentives of the Industrial Pole of Manaus (PIM), administered by the Free Trade Zone Superintendence Manaus (SUFRAMA). The collection of primary data was through documentary records, case study and field research conducted in Tholor Company do Brasil Ltda, located in Manaus, in the year 2016. The data collection, another instrument was a questionnaire with twelve (12) closed questions of multiple choice and open applied to employees of the operational area of production. The research population was composed of 39 (thirty-nine) employees Tholor Company of Brazil Ltda and the sample (research subjects) was delimited to 12 (twelve) employees of soft drink concentrate production area. Currently, this company's production area has a staff of 12 employees.

In literature the information was selected to establishing relationships between the objectives outlined, still checking up the consistency of such information, is performing thus an analytical reading, which led to work. Data were arranged in tables and graphs using Excel and Word. The results were then analyzed based on the knowledge of the researcher in relation to the theme and the studied company. The proposed improvements from the integration of PDCA / DMAIC tools for Tholor of Brazil, used the bibliographical survey on the subject as a subsidy for the submission of the proposal.

Results Presentation and Discussion

Tholor do Brasil Ltda was founded on February 4, 2004, acting in the concentrates market, with the manufacture of soft drinks, syrups, and powder flavor, except fruit juice. It has its headquarters in Manaus Av. São João, 4 in the Santo Antônio neighborhood. The company produces the following product: concentrate for non-alcoholic beverages (part 1: liquid and part 2: solid). Aiming at the quality of its products, Tholor Ltda of Brazil decided to adopt a Quality Management System (QMS) based on ABNT / ISO 9001: 2008, with the quality policy guidelines, mission, and vision of the company. The company's mission is: "to produce quality products, seeking through continuous improvement, always meet the requirements and needs of our customer.

"The company's vision is:". To be a reference in the supply of concentrates for non-alcoholic beverages with quality, always seeking continuous improvement in standards specified "Company policy is to be a focused company to non-alcoholic beverages, seeks the satisfaction of. Its customers by producing products with safety and quality through continuous improvement of the QMS, that understood politics and widespread among all employees the values established by Tholor Brasil are commitment, ethics, honesty, leadership, technical and human knowledge, and respect for human beings. The company seeks a permanent basis, the continuous quality improvement through internal programs and quality planning, so that each employee performs their work correctly permanently. Tholor do Brasil Ltda currently has 39 (thirty-nine) employees, 12 (twelve) employees of soft drink concentrate production area.

From that moment, all the steps contained in the procurement process will be briefly described and is given according to the step by step below:

1) Register of suppliers: Any supplier may be registered. The purchasing department requests the data to the register of the company for possible supply product / service. These data are entered in the register file folder suppliers with the following information: CNPJ, State and Municipal register, phone numbers and e-mail contact, certification ISO 9001: 2008 or another if necessary. The inclusion of this registration does not imply temporary or permanent contract, as well as regular consultations for the supply of products or services as the need for Tholor do Brasil Ltda.

2) Approval of suppliers: The supplier to be approved by Tholor do Brasil Ltda, must meet the criteria set by the company and receive the final report of company management.

3) Purchase / service request: The applicant shall send a description of the product / service to the purchasing department via e-mail with the data and the types of product / service, the amount by which the industry needs. The purchasing department will fill the form with such information and shall transmit to the supplier with a product price request / service, sent by e-mail so that it provides a price list (price) to the company.

4) Share price: after sending the supplier the form, it refers its price list to the purchasing department via email and possession of this is drawn the Price Quotation Map. It is performed every time that occurs request of the sectors by product / service.

5) Price quote Map: after evaluating the request for purchase / service is requested one (01) quotation to the approved supplier selling product / service to meet the company's requirements. If there is the need to acquire new products services not offered by approved providers, a new purchase request with other suppliers will be held. The price quote map is sent to the signed board and dated by the head of the sector, so that it approves the price quote map, and if you disagree with the values, there will be a new price and a new price map for the purpose of reaching the lowest value without affecting the quality of the product / service required. The board approves the price quote map must sign the document by adding the date in the specified field and returns it to the purchasing department to be filed.

6) Purchase orders: After the approval of the price by the board the purchasing department map prepares the document purchase order and sends it to the supplier via e-mail and print a copy and signed by the head of the purchasing department and delivered to warehouse sector for product items conference / service delivery in the act with the invoice and then returning to the purchasing department signed by the storekeeper to be filed. The application has the following data: name and requesting the sector, date, and application number; address of the supplier, CNPJ, telephone, payment terms; description of the product / service to be delivered; quantity, unit, item, delivery date; unit and total price; signature of the buyer and warehouse.

7) Vendor Evaluation: The evaluation is made by the purchasing department as the criterion service assigning notes from the moment that initiates contact with the supplier. Being evaluated this criterion, this is transferred to the warehouse sector to assess the criterion product upon receipt. In the case of services, the assessment is sent to the maintenance sector that apply notes according to the degree of compliance of the specification and realization of this aspect. The values of the marks awarded are: 0 to 2.5 is considered bad from 2.6 to 5 points is considered good. This review is held every order placed with suppliers of Tholor of Brazil that during the month will be added. These notes are the basis for monthly assessment of the formulation of suppliers.

The process of receiving, storage and release of raw materials takes place according to the following step by step and warehouse duties:

1) Organize the landing of the received material, visually checking its physical characteristics and repacking, quantities, and specifications of the same as invoice and corresponding emissions of the material identification tag.

2) Make the entry registration materials, noting the report receipt of material data on the type of material received, quantity, supplier, invoice number and lots of products for tracking this by the Quality Control (QC)/Laboratory.

3) Preserve the raw material properly to processing, identifying, inspecting packaging, handling correctly and properly to preserve the product specifications.

4) The warehouse keeps track internally and distribution of raw materials, given the production by requesting material, locating, sorting and delivering the amounts requested in the request.

5) When receiving the raw materials, the storekeeper should go to the laboratory sector and inform the arrival of these materials, deliver their technical reports to the sample collection in due to have the physio-chemical analyzes also with the order to verify if they are within the required specifications. The Laboratory signaling that the product is conforming, the Storekeeper will refer to the raw materials warehouse to await new production order. If the product is out of specification, the laboratory will report to the supplier by e-mail to be exchanged, and warehouse will remove the product to the area of the segregated product until its replacement by new raw material.

The inspection process of the raw material takes place according to the step by step described below.

1) Collection of samples of raw materials of guarana extract. For sampling raw material liquid part, the chemical technician must collect two samples, one for microbiology and another to hold, approximately 300 ml per sample in each batch received counting the different types of products in one invoice.

2) Care in the collection: chemical technician must be with EPIs (Safety equipment), be careful when handling so that there is no cross-contamination, sterilize packaging using 70% alcohol

on the outside and inside of the packaging and allow drying in the oven, before collecting the sample. You should use sterile plastic bottles for microbiological sample collection and retention identifying the sample batch, product name, date of manufacture and expiry and name of the person responsible for the analysis and use the EPI'S suitable as glove, cap, and mask. The results must follow the parameters specified in Figure.

Figure 2
Parameters of the analytical result of soft drinks concentrate of Tholor do Brasil.

Analytical Results					
Feedstock	**Analyses**	**Specifications**			
		Units	**Minimum**	**Maximum**	**Results**
Extract Guarana	Aspect				Dark liquid
	Odor				Distinctive
	Alcoholic strength	%	30	50	
	Relative density 20 ° C	g/cm³	0,845	1,045	
	PH at 25 ° C		5,00	6,50	
	Refractive index		1,360	1,370	
	Caffeine	%	1,10	1,30	

Source: Tholor do Brasil Ltda, 2016.

The production processing takes place according to the following step by step.

1) Preparation of all production planning (document prepared by the production supervisor), which describes the amount to be produced of each product supplied to production leaders. The planning and production control is prepared by the supervisor, according to the following activities.

2) Prepare the monthly plan charges, which the defendant containing product, destination, and quantity to serve customers within certain time limits.

3) Develop the manufacturing schedule, to ensure the best hand of the allocation of labor, equipment, and materials.

4) Develop the production planning, calculating the time and the quantities that are to invest in their implementation, as well as the needs of equipment and manpower, to determine the actions and desired goals.

5) Analyze and evaluate the economic aspects of the production process, with respect to labor, work and quantity of materials consumed, to identify opportunities or alternatives to reduce costs.

6) Develop procedures and determining guidelines for maintaining the visual factory, (cleaning, painting, and maintenance), to keep the place under conditions that provide the best performance (staff and equipment).

7) Set the shifts necessary for balancing the hand labor, to maintain the flow of production and productivity of human resources factory.

8) To study, develop and / or improve processes, equipment, tools, and establish process controls to ensure better quality and higher productivity.

9) Monitoring and systematically monitor the performance of production, through the analysis of appropriate management indicators, proposing plans and necessary actions to ensure compliance with established goals and objectives.

10) Supervise the activities of material inspection and quality control of raw materials, to ensure and guarantee compliance with established specifications and quality standards as well as the storage of finished products activities.

The release of the finished product takes place as follows.

1) Through the release of the product, the laboratory must demonstrate that all product requirements requested by the customer are met. The release includes the evaluation of the production or service process, based on their documents, samples and production, to ensure that the requirements will be met to produce products in accordance with the specifications.

2) The processing of the product should follow the Manual of Good Manufacturing Practices (MBPF.01) as defined in CVS-6 concierge / 99, as well as the maintenance of cleaning, sanitizing and controls applied to products and processes, ensuring that they reach the customers and consumers with quality and free from any contamination. For the process parameters are determined of the products as mixing time.

3) The finished products must undergo physical and chemical analysis and microbiological, such as coliforms 35 and Salmonella sp. The specification for these parameters can vary according to the product and the customer. To produce liquid-collecting two samples for each batch produced early in the production and comparison of results, to ensure product homogeneity. The physical and chemical standards of the intermediate product to guarana soda concentrate Guarana, must meet the specifications shown in Figure 3.

Figure 3
Soft drinks concentrated parameters (finished product) of Tholor do Brasil.

Parameter	Standard
Aspect	Dark liquid
Odor	Distinctive
Alcoholic strength	Max 15° GL
Refractive index	1,360 ~ 1,390
Density	0,960 ~1,000
PH	3,50~5,50

Source: Tholor do Brasil Ltda, 2016.

The processing occurs in accordance with the work instruction as shown in figures 4, 5 and 6.

Figure 4
Production processing – Step 1 in Tholor do Brasil – Filling and Mixing.

PRODUCT: Guarana extract	CUSTOMER: Inventory

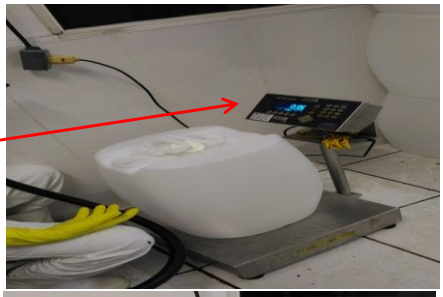
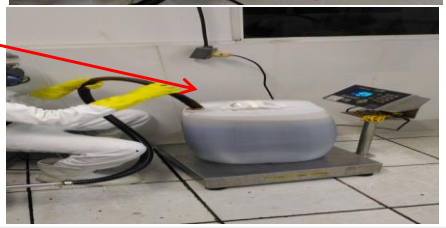
ITEM	DESCRIPTION OF OPERATIONS	TOOLS	PICTURES
1	First make a check-list on the equipment, making sure that they are clean and sanitized. At the reception of raw materials, make a cleaning in drums with 70% alcohol with the help of wipall paper as shown in the picture.		
2	Add the raw materials by means of hoses to feed the mixers.		
3	Add caramel color with the guarana extract as the standard formulation and mix for 60 minutes.		

ITEM	MATERIAL DESCRIPTION	Equipments for Individual Safety (EPI)
1	Jerricans Raw Material 50 liters	White Farda, Mask
2	Suction Pumps	PVC White Boot
3	Alcohol 70%	Disposable cap, glasses
4	Wipall Paper	Rubber gloves, strap Ergonomic
5	Hoses	

Fonte: Tholor do Brasil Ltda, 2016.

Figure 5
Production processing – Step 2 in Tholor do Brasil - Bottling.

PRODUCT: Guarana extract	CUSTOMER: Inventory

ITEM	DESCRIPTION OF OPERATIONS	TOOLS	PICTURES
4	The head of the laboratory should collect a sample of the finished product to perform the appropriate analyzes and thus make the release of the product if there is any problem with it.		
5	Store the drums for the filling according to the schedule. Start balance for 15 minutes prior to stabilize the activity. Place the bombona on the scale to start.	Mixers and pumps	
6	Before starting the filling process it is necessary to remove all the canisters, as there is variation in the weight of a bombona to another. Maintain the standard weight of 47 kg per bombona.	Balance	 

ITEM	MATERIAL DESCRIPTION	Equipments for Individual Safety (EPI)
6	Pails 50 kg	White farda, Strap Ergonomic
7	Balance	PVC White Boot
8	Hoses	Disposable cap, glasses, mask
9	Beater	Rubber gloves

Fonte: Tholor do Brasil Ltda, 2016.

Figure 6
Production processing – Step 3 in Tholor do Brasil – Finished product

PRODUCT: Guarana extract	CUSTOMER: Inventory

ITEM	DESCRIPTION OF OPERATIONS	TOOLS	PICTURES
7	After filling the bombona, close the lid carefully so that does not break the seal.	Seal Key	
8	Receive bombona of 47 kg and organize the pallet as the photo, using disposable paper wipall type for waste cleaning	Pallets and matrim	
9	Piling up to 15 drums per pallet. Labeling and inspect if all canisters are properly idenfificadas and undamaged.		 

ITEM	MATERIAL DESCRIPTION	Equipments for Individual Safety (EPI)
10	Jerricans	Blue/White farda
11	Labels	Security Boot
12	Pallets	Ergonomic strap
13	Matrim	Rubber gloves / pigmentary
14	Seal key	

Fonte: Tholor do Brasil Ltda, 2016.

On the survey of the twelve (12) employees of soft drink concentrate production area in Tholor do Brasil, they present then the main results. When asked to rank the current standard formulation of the geometric variation of mixing and homogenizing the overall process of coolant concentrate

production in Tholor do Brasil, 66.67% of the employees of the production classified as good and 33.33% rated as excellent, which reflects a positive result.

When asked about the current standard time (in minutes) of the check list in equipment cleaning and sanitizing process: 91.67% of employees responded correctly with a time of 60 minutes and only 8.33% said more time, which shows a good knowledge of the current standard check list time in the cleaning and sanitizing process.

To be invited to opine whether the check list of time the equipment (cleaning and cleaning) could be lower: 75% of employees responded surely not; 16.67% answered yes; and 8.33% answered that need to improve, which may signal a possibility of check list time be improved.

Sobre o tempo padrão atual no processo de alimentação dos misturadores com as matérias primas (através das mangueiras): 75% dos colaboradores responderam corretamente com o tempo de 60 minutos e 25% respondeu um tempo menor de 45 minutos, o que revela que a padronização do atual não está sendo devidamente cumprida por alguns colaboradores. On the current standard time in the feeding process of mixing with the raw materials (through the hoses): 75% of employees responded correctly with a time of 60 minutes and 25% answered less time of 45 minutes, which shows that the standardization the current is not being properly enforced by some employees.

When asked to opine whether the current standard time in the feeding process of mixing with the raw materials (through the hoses) could be lower: 75% of employees responded surely not; 16.67% answered yes; and 8.33% answered that need to improve. Again, these results point to the possibility of reducing the charging time of mixing with the raw materials, through the hoses.

When asked if, in the process of adding caramel color with the guarana extract, homogenization 60 minutes could be lower: 91.67% of the employees safely said no and only 8.33% said yes. These results show that there is no possibility of reduction in time (60 minutes) the process of adding caramel colorant by the guarana extract.

When asked whether, in the filling process, the stabilization time of the balance for 15 minutes could be lower: 66.66% of employees responded that certainly is not in the same proportion (16.67%) and needs to improve. These results show the possibility of reducing the time (15 minutes) to stabilize the balance in the filling process. When asked if the weight of 47 kg per bombona can be improved: 83.33% of the employees surely answered no and 16.67% answered yes. These results reveal that there is no possibility of reducing the weight (47 kg) bombona.

In the context of the improvements that could be implemented in the overall process of soft drinks concentrate production and structure of the production area of Tholor do Brasil, the results can be seen that most of the sample employees, about eleven (11) employees, the total of twelve (12) participating in the survey, reported physical and structural changes in the production environment, and common rooms of the division of observations (liquid and solid) and a better climate.

About three (3) employees, the total of twelve (12) participating in the survey, reported that the targets are satisfactory and has been met, given the production planning, but can still improve with the training of employees to acquire more knowledge of concentrates.

As for improvements that could be implemented in the soft drinks concentrate production process itself, three (3) employees, the total of twelve (12) participating in the survey, said changes such as nameplates with the weight of the number of each concentrated and finished product; better cooling to improve the hygiene and cleaning process; and exchanging the product feed pump by more powerful pumps.

The data used for the assessment of loss statement based on the analysis of the monthly control Tholor company's production of Brazil Ltda, which were accounted for using a variable "average", which according Salsa (2005), is a measure that acts as the balance point of a set of data. As well explains Crespo (2002), the statistics will help in the work of analysis of processes aimed at reducing costs and troubleshooting as well as the selection and organization of the strategy to be adopted in the organization and also the choice of verification techniques and evaluation of the quantity and quality of the product and also the possible profits and / or losses.

In the study, it was possible to detect that about 600 kg (six kilograms) of raw materials are wasted each month, and the standard deviation is about 45 kg (forty-five kilos). According to Ribeiro (2015), the standard deviation is a measure that allows interpret data in the same unit of the variable values.

Taking into consideration that the company typically needs 10 tons of raw material, this value indicates that there is a monthly loss of about 6% with only waste directly related to production inputs. Tholor do Brasil Ltda adopts the loss limit raw material around 4% of total inputs purchased.

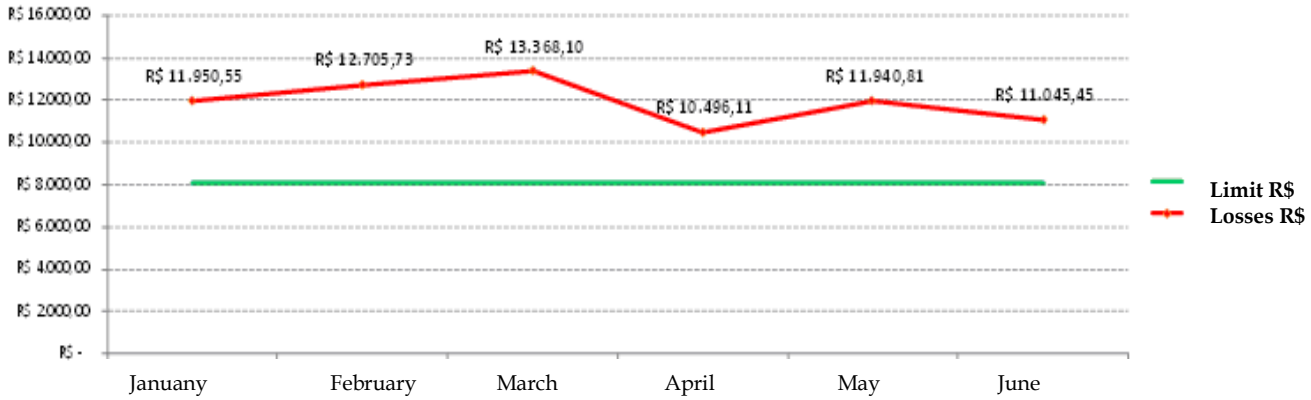
To have greater understanding of the reality of the company, calculated the average monthly losses, the monthly standard deviation and also how much has already been lost only in the first half of the year 2016.

It is estimated that about 3.6 tons or 6% of total production, are semiannually wasted by failure account in the production process failures that can be significantly reduced by the frequent search for continuous improvement of processes, aiming at the leaner production possible.

It is known that this waste has its costs and financial disadvantages. Such as the real amounts shown in Figure 7.

Figure 7

Monthly loss of the values referred to the acceptable limit– 1st semester of 2016.



Source: Tholor do Brasil Ltda – Manaus, 2016.

The values shown in Figure 7 shows a simple and objective way how really Tholor do Brasil Ltda, has left the bill. Then it presents the proposed improvements from the integration of PDCA / DMAIC tools.

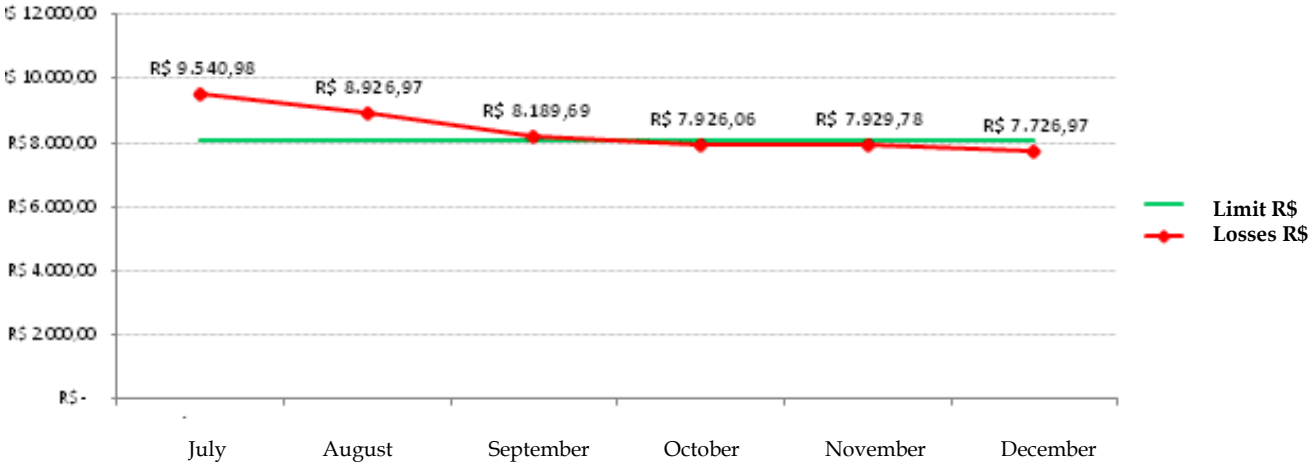
The PDCA / DMAIC tool is already very applied in the field of production engineering and consolidated about its implementation aimed at improving processes, which is widely demonstrated and published in national and international literature, however, in Tholor do Brasil Ltda this tool has not yet been implemented.

In this context, the company's management and production sector should turn their attention to the prevention of anomalies and waste, working and interacting directly with employees to clarify doubts and process monitoring, still seeking to minimize the financial impact.

Figure 8 shows that, in the proposed implementation of *Lean Manufacturing* philosophy and Six Sigma strategy, by integrating the PDCA / DMAIC tool, there will be a gradual decrease in relation to waste. This figure also shows that we can estimate that over six months this ratio will be reduced by at least 30%, proving the efficiency of the presented proposal and duly detailed and then showing the appropriateness and modification viability in this process of the company, emphasizing the integration of the project *Lean* Six Sigma and production, through the PDCA / DMAIC methodology.

Figure 8

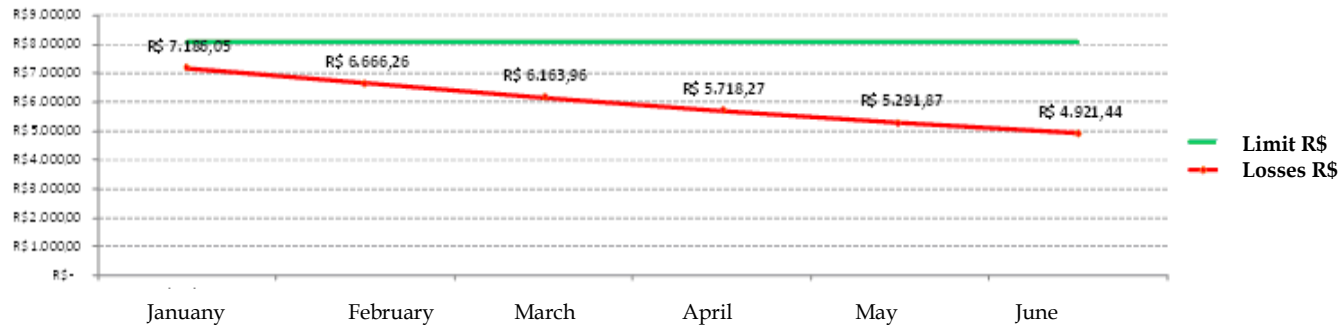
Proposal for reduction in monthly loss values (R$) referred to the acceptable limit in the 2nd semester of 2016.



Source: Tholor do Brasil Ltda – Manaus, 2016.

Figure 8 also shows the outlook for the second half of 2016, where the implementation of the proposal already in progress. As highlighted earlier, there is the expectation that, within six months the waste is reduced by the previous semester. However, for the project to be truly effective, it is necessary to be continually improved and adapted. Thus, it is believed that the reduction of costs can be decreased further to the course of activities. Thus, the costs can be reduced by about 7% monthly regarding the value of the previous month. On figure 9 shows the future perspective the reduction in the monthly loss of values (R $) for the acceptable limit in the 1st half 2017.

Figure 9
Proposal for reduction on the monthly loss of values (R$) reffered to the acceptable limit in the 1st semester of 2017



Fonte: Tholor do Brasil Ltda – Manaus, 2016.

The total amount to be saved in the first year of the proposed deployment would be R$ 54,824.63 (fifty-four thousand, eight hundred and twenty-four reais and sixty-three cents).
One fact to be mentioned is that, one of the goals of Tholor do Brasil Ltda is always the quality of their products. The company invests about R $ 40,000.00 (forty thousand reais) in its workforce through training and other means to value them. Thus, the value to be saved can easily be used for such investment, and still give to invest in other activities such as, for example, security infrastructure and processes.

According to the overall direction coming from the extreme competitiveness, Tholor do Brasil Ltda, located in the Industrial Pole of Manaus, in order to improve their production processes, need to adopt production strategies and continuous improvement, as well as tools whose efficiency is felt especially in terms of productivity for the company and value for the customer. And in this scenario, the Six Sigma strategy, using the integration of PDCA / DMAIC tool is configured as an efficient and

effective methodology to achieve positive results in performance, standardization and leveling of the processes by reducing failures and waste.

The proposed project submitted must be approved and authorized by the top management of the company, initiating the project related to soft drink concentrate production process, which must be designed and developed by a multidisciplinary team of at least ten (10) employees of the company with the advice of a corporate office as well as the hierarchical levels that should come from the managers to the workers of this company, and should be trained in Six Sigma methodology in the levels of *Black, Green and White Belt.*

According to Rodrigues (2014), in Six Sigma projects, professionals receive proper training and take up specific functions named:

- Master Black Belt: instructors and mentors of actions to achieve the methodology.
- Black Belt (Black belt): leader of Six Sigma project teams.
- Green Belt (Green belt): project team members Six Sigma

- White Belt (White belt): executives or employees who need to know the most basic principles of process improvement and receive a small amount of training hours for information. The White Belt training is used to assist in managing change and cultural integration of employees who do not use the tools but may suffer the impacts from the project.

- Champion: facilitator or sponsor of Six Sigma projects to do the link between the strategic level and the operational.

First it is important to emphasize that the project should have as sponsor or the director of the production area to be assisted by a Master Black Belt external to the company, conducting the DMAIC project activities expected to last about five months, one month for each phase , and at the end of each phase must be presented to the board and the conclusions referred to results obtained by the team, in order to seek approval to proceed to the next stage. This process is very important because in addition to showing the progress of the project to upper management must align with team options and directions.

D - Stage Set - In PDCA P (Plan - Plan)

Initially should be collected data in the internal processes of the company with employees working with the mixing and homogenizing during the soft drinks concentrate production process. After defining the improvement opportunity as "map to reduce waste in the production process of mixing and homogenizing" should be defined project scope, to meet the top management needs of the company, which is the most interested in the expected results completion of the project, mapping the current process, and setting improvement targets in the development environment with the reduction of production costs made possible by a more efficient management of inputs in the production process.

After collecting the data, the information will be treated using quality tools such as Pareto Diagram and Ishikawa Diagram to map and delimit the project and draw up the preliminary definition of the problem found in the area, searching for determine the impact of mixing and homogenization during the soft drinks concentrate production process in the company's results and from there, will decide on the activities that will change this process.

According to Rodrigues (2014), the Pareto diagram is characterized as a vertical bar graph that displays the items analyzed from the most frequent to the less frequent and aims to establish priorities in decision making, from a statistical approach. But the diagram of cause and effect, also known as Ishikawa diagram, or popularly as "fishbone diagram," is designed to clearly illustrate the various factors affecting a process, classification and relationship of causes that can contribute to this It is made. For each effect there are certainly numerous causes within categories such as 6 M's: method, hand labor, raw materials, machines, measurement, and environment.

The main point to be determined in step D are the ultimate goals, but for this it is necessary to consider a solid database. Another important point to be considered is the financial measure of the problem, namely the impact of the mixing process and homogenization during the coolant concentrate production process in the company's revenues, because there is awareness that there is no need nor interest to invest in low-return projects.

The reduction in production costs, the mapping of the waste and the identification and control of waste should be presented as CTQs (critical to quality) to the company's management. It should also be discussed and defined management indicator to measure improvements, as well as to check the results that are obtained over time.

M - Step Measure - The PDCA P (Plan - Plan)

In the measurement phase of problem size, first must map the movement of the various inputs and homogenizing the mixture in the soft drinks concentrate production process in detail. Through functional diagrams are to identify the points which are critical to waste for each input and due to collect data for the purpose of evidence them statistically, using a Pareto Diagram, for example, performing the stratification of waste, with to define which inputs represent a higher percentage of waste, and then the team try to solve the most financially representative.

In the phase measurement must still establish a standard form of analysis of the quality measurement system. To carry out this stage of the work will be selected soft drinks concentrate samples order to cover the company's management requests, as regards the geometric influence of the mixers and homogenizing the soft drinks concentrate production process. Then, the samples necessary tests will be special tested, for later approval, if samples conform to specifications.

At that stage employees must receive proper training and training to perform the analysis. Later, should begin the study of the status of the case, arising from the collected data, to detect the presence or absence of special causes, aiming the implementation of improvements, as well as to check the actions that will be required, among which are: adjusting systems, define responsibilities, train people, among others. Then be calculated the potential capability indices of the process.

Step A- Analyze - In PDCA P (Plan - Plan)

After identifying, the process critical points must begin the analysis phase with the aid of some analysis tools such as brainstorming, Ishikawa diagrams and with the project team and employees. The team should seek to correlate the alternatives with the problem, identifying and classifying even the possible causes in groups to verify the true root causes. In data collection should be carried out on site and alternatives should be analyzed graphically and through photographic record.

This phase should be completed with the quantification of the relations of cause and effect, and validation of alternatives to problem root causes, through a process flow diagram where the common causes will be identified, that somehow can interfere in it.

Identifying these causes allows one to plan and carry out a design of experiments, to seek the degree of influence of these variables in the process and determine an optimal process of coolant concentrate production, as the company's management specifications related to the geometric influence mixers and homogenizing the coolant concentrate production.

At this stage the focus should be directed to the determination of the causes that interfere in the process, so the use of quality tools can help diagnose more easily such interference.

Stage Improvement - in PDCA D (Do - Do)

With the identified causes should work on possible solutions. This phase should involve not only the project team, but also other stakeholders, such as suppliers of inputs, as these are those who have more technical know-how on inputs and equipment, which provides the meeting of optimal solutions for processes.

In this context, we should again use the brainstorming survey of various possible solutions. After that the team should, through a solution selection matrix, conduct a cost / benefit analysis and

risk solutions and what will be the most viable solutions to the project, without forgetting the importance of training for employees directly involved in the process.

This phase should be complemented with the conduct and analysis of a pilot product in the process for evaluating the effectiveness of solutions. Ideally, this phase of improvements difficulties is not found since the project team and stakeholders should be free to make suggestions for the improvements. Production of soda concentrate should be standardized, and the dissemination of information should be carried out through the meetings that will take place in the company and often the information should be reviewed and updated.

Stage To Control – In PDCA CA (Check – and Action)

This phase should begin with the development of the internal documentation of the control procedures and improved processes such as new operating standards, and setup process. All employees involved in the soft drinks concentrate production process should receive operational training on inputs handling equipment and operating standards.

The control of the process to be effective, for it, the dissemination of results should take place at all levels and sectors involved. In addition, a better monitoring plan process performance should be drawn up by the team, thus building a more effective control of production, even allying better dissemination of the study in various levels of the company. Finally, it should be statistically evidenced improvements in the process and this step must be calculated the potential capability indices of the process and the performance capacity index that will reach the goal that will be established by the company.

Conclusions

The survey results show that with the implementation of integrated tool PDCA / DMAIC, in six months, the loss rate will be reduced by at least 30%, proving the effectiveness of the proposal. The total amount to be saved in the first year of the proposed deployment would be R $ 54,824.63. One of the goals of Tholor do Brasil Ltda is the quality of their products always. The company invests about R$ 40,000.00 in its staff through training and other means to value them.

Thus, the amount to be saved can be used for such investment, and still would invest in other activities such as infrastructure and safety of production processes.

The integration of the project Lean Six Sigma production through integrated tool PDCA / DMAIC in Tholor Brazil, will enable the standardization of methods to optimize the use of mixing equipment and mixing of soft drinks concentrate production process, avoiding waste, increasing the productivity of labor in the stages of the production process, reducing costs, increasing operational efficiency, for improvements in the production process, it also prevents waste levels causing negative impacts on the real cost of the final product, and the company's profits.

Based on case study in Tholor do Brasil Ltda, it can be inferred that, in general, the PDCA / DMAIC tool is compatible and perfectly feasible for the solution of their problems, with the goals outlined possible.

However, meetings with employees of production are necessary and extremely important and should be planned and carried out. Furthermore, it is necessary that the control and inspection of the soft drinks concentrate production process, come to be performed before problems occur, thus avoiding that the production coolant concentrate incur rework condition and waste. Among the benefits that the proposal presented can generate, it is emphasized that, with the implementation of PDCA tool / DMAIC and the creation of modification of the structure of production documentation, according to the methodology of integration, the board of Tholor of Brazil Ltda in Manaus, can only relate to the production team of the Manaus unit to perform the modification.

Allied to this, the board of directors, along with the local production team, can modify and / or adapt to the soft drinks concentrate production structures to meet local legislation of the Basic Productive Process (PPB) of the Manaus Free Zone (ZFM) or even attending arising suggestions ideas of continuous improvement and that will benefit the Tholor do Brasil Ltda, as a whole.

The financial measure with a better process control and dissemination of results, will make the Lean philosophy and implementation of methodological procedure based on the PDCA / DMAIC, best

measured in all levels of Tholor do Brasil Ltda, enabling and requiring further work, which They can be more easily developed. Allied to this, it is important for continuous training, clarifying best to all employees, which will be held and what their contribution to the attainment of the production process.

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