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Method of Problem Analysis and Solving applied to Quality and Productivity in a Furniture Industry

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Abstract**—** *This study proposes the application of the Method of problem analysis and solving (MAPS) in conjunction with the quality tools, aiming to reduce requests for the number of technical assistance in a planned furniture industry. The methodology used in this research was a case study, in which the eight steps of the method were applied in order to identify the root cause of the problem and to point out through its action plan its solution. At the end of the process, the method obtained satisfactory results, with a 58% reduction in the number of technical assistance and with savings of around 49% in the costs generated by the occurrence of failures, causing financial gains for the company surveyed. In addition, this research contributes to the dissemination of the concepts of quality tools for solving problems, as well as optimizing the performance improvement of production processes and quality management in the fabrication of planned furniture.*

Keywords**—** ***Quality Tools. Quality. CQ Story. Quality Control.***

I. INTRODUCTION

Nowadays, obtaining quality index combined with productivity, cost reduction, customer satisfaction and respect for the environment have become essential for the permanence and survival of organizations in adapting to the competitive pressures of the competitive market (JITPAIBOON; RAO, 2007; COBERO *et al.*, 2014).

Within this context, the challenge of companies to seek productivity with the least possible loss depends not only on the modernization of process technologies, but also on an engaged and specialized team, a fast service and efficiency in the management of production costs(LAKHAL *et al*, 2006; BOURKE; ROPER, 2017).

According to GALINARI *et al*, (2013), in this respect, one of the markets that stands out in the search for standardized management projects is that of planned wood furniture. This is due to the fact that the sector has differentiated characteristics, such as the high use of natural inputs, with customized designs to the consumer's taste, furniture design with the incorporation of new technologies and concepts, aiming the durability of the products.

The furniture sector in Brazil is evident in the transformation industry segment, gaining notable gains in the manufacturing area due to the significant improvement in quality, due to the advent of new methodologies in the area of production aimed at the pursuit of excellence (ABIMOVEL, 2017). One of the methodologies we can highlight is the Method of Analysis and Problem Solving (MAPS).

The MAPS has emerged as a strategy to improve the quality and productivity of organizations, widely used in Japan, is one of the managerial level tools that has the purpose of acting against an undesirable problem or to improve the current condition of a productive process. The problems are identified, treated and improved through sequential steps aimed at reducing costs in manufacturing processes (HERRON; BRAIDEN, 2006; ORIBE, 2012).

The application of MAPS aims to collect, organize and analyze information related to the process flow diagram of the products, being composed of actions of prevention and reduction of problems, using tools such as Cause and Effect Diagram, Pareto Chart Action Plan (5W1H), among others (HORA; COSTA, 2009).

The MAPS is a disciplined management strategy that seeks continuous improvement by reducing waste and emphasizing the company's profitability, based on speed

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and efficiency. Promotes gains in quality through defect reduction (AVRILLON, 2005).

The method, according to Teixeira *et al (*2012), can be applied in any organization or segment, and can be applied in several sectors simultaneously, and for this, there is a need for participation of all the employees who are involved in the process.

The proposed model aims at applying tools that minimize or eliminate the occurrence of product failures and reduce the technical assistance they provide to ensure productive competitiveness. These tools seek problem-solving in a step-wise manner that helps improve processes and consequently the quality of what is offered in order to achieve customer satisfaction in the short term.

The MAPS methodology appears in this context to help visualize and reduce the number of technical assistance, presenting the changes and gains resulting, judging the viability of its use. The choice of this object of study was due to the important role that companies of the furniture industry represent for the economy of a country, considering that these companies constitute a field of study little explored.

According to GODOY *et al*., (2012), there are several obstacles in the implementation of quality concepts in the furniture industry. This involves a number of factors, such as variety in raw material prices, unit production, process steps being mostly handcrafted, need for skilled labor, productive structure and complex equipment to serve various segments and market niches related to larger contact with demanding customers. These factors have a direct impact on the quality of the products, resulting in customer dissatisfaction and consequent disloyalty of the company to the market.

Thus the application of MAPS in the planned mobile industry resulted in adding value to the final product, generating satisfaction to its target audience and as a consequence the reduction of calls in after-sales services (technical assistance) and cost reduction. To INGLIS (2002), the after-sales service is an important sector for collecting data on the customer's vision in relation to the performance of the final product and should be used to strengthen the customer relationship and generate profit for the organization, not costs due the delivery of products outside the specifications.

II. LITERATURE REVIEW

2.1 METHOD OF PROBLEM ANALYSIS AND SOLVING OR QC STORY

The MAPS, also known as Quality Control Story (QC Story), started in Japan in the 1950s, resembles the history of Quality Control activities and has the ability to systematically improve company performance through competencies and learning skills to solve organizational problems (CASTRO *et al*.,2011).

In Brazilian companies, the introduction of MASP was made by Falconi Campos in 2004, which adapted the Japanese version of the *Union of Japanese Scientists and Engineers* (JUSE), called QC Story to the Brazilian context (ORIBE, 2012).

According to CASTRO *et al*. (2011) and CARPENETTI (2012), MAPS or QC Story is the most detailed management tool of the Shewhart cycle or Deming cycle, originating from the PDCA cycle: Plan (planning), Do (execution); Check and Act. Although MASP derives from the PDCA cycle, they are commonly confused in the literature.

According to CARNEIRO *et al* (2012) the methodology focuses on quality improvements to make processes more organized and avoids waste related to time and money until its solution through corrective and preventive actions in an orderly manner. It is formed by a set of principles or methodological steps that help to evaluate, control or improve a process from the perspective of quality and must be dominated by all the people of the company (PUJO; PILLE, 2002).

O MAPS "Is one of the methods of systematic solution of problems currently recommended by the Brazilian Quality Union for the development of quality improvement projects" (ORIBE, 2012).

According to COLENGUI (2007), "MAPS is a prescriptive, rational, structured and systematic method for developing an improvement process in an organizational environment, aiming at solving problems and obtaining optimized results."

2.2 HISTORY OF MAPS OR QC STORY

According to ORIBE (2012), started in the scientific revolution between the sixteenth and eighteenth centuries in Europe with the thinkers Copernicus, Kepler, Descartes, Bacon and Galileo, who laid the scientific method for describing nature, accurate measurements and induction of new theories based on experiments. This methodology served as the inspiration for several philosophical tendencies such as rationalism, empiricism and pragmatism.

In the 1930s, in the United States, Walter Shewhart, created the cycle, called Shewhart, inspired by Taylor, following the production of 3 stages. This precept had the objective of scientific knowledge as a means to obtain a concrete and practical result for life. This model is taken by Deming to Japan in 1950, which became known as the Deming cycle (CAMPOS, 2012)

In Japan this cycle was adapted with new roadmaps, emphasizing the documentation and

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presentation of the history of improvement work, hence it was known as QC Story. In the beginning, this method had a descriptive character, in order to report simply how the improvements were made on the factory floor and called them QC Story (the history of quality control) (ORIBE, 2012)

Later, QC Story shifted from a staff-focused reporting method to communication and learning to a problem-solving method that focused on the organization for continuous improvement and profit (CAMPOS, 2012). In the 1980s, QC Story, through Kume, came to be known as an effective method to solve organizational problems, with optimized results, through stages and tools giving more distinction to each activity (COLENGUI, 2007).

In Brazil, in 2004, through Falconi Campos, QC Story became known as the Problem-Solving Method (PSM). This method became popular as MAPS, Method of Analysis and Problem Solving and became a fundamental part for Quality Control to be exercised.

It is one of the most widespread methods for solving problems in organizations, and according to CAMPOS (2012), it can be used both to maintain quality and to eliminate chronic errors.

Table.1: Process Control Method / QC-Story.

PDCA	**Flow chart**	**Phase**	**Target**
P	1	Problem identification	Clearly define the problem Recognize its importance
	2	Observation	Investigate the specific characteristics of the problem with a broad view and from various points of view
	3	Analyze	Discover the root causes
	4	Action plan	Develop a plan to block root causes
D	5	Action	Block the root causes
C	6	Verification	Check that the lock has been made
		Blocking was effective	If yes, continue to step 7, otherwise return to step 1
A	7	Standardization	Preventing recurrence of the problem
	8	Conclusion	Recap the whole process of solving the problem for future work

Source: MARIANI (2005), HOSKEN (2005), CARPENETTI (2012) e CAMPOS (2012)

First step: Identification of the problem

It is the first step of MAPS, where the type of problem to be solved is clearly identified. Data is used to check for inconsistencies in an equipment or process. Once the problem is identified, the goals and indicators that can help in the final stage of the process are defined. Nominating those responsible, proposing dates and limits for solving the problem Segundo LAU (2015), the identification of the problem has the objective of selecting a topic from a series of possibilities and applying criteria such as the comparative analysis of losses, gains and frequency on a problem and to ascertain its outstanding priority over the others.

To ROONEY; HOPEN (2004), the identification of the problem has to be well structured and the root cause must be identified so that the problem is eradicated, that is, that there is no risk of the problem returning. Table 2 presents the steps in how to identify the problem.

Table 2 – Identify the problem.

Step 1 - Identify the problem	
Flow	Tasks
1	Define the problem
2	Issue history
3	Present current losses and gains
4	Analyze the pareto chart
5	Nominate those responsible

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015)

Second step: Observation

In this step the complete investigation phase of the problems occurs. The issues in question should be investigated and the team should collect the most current data, which is critical to the success of the third step. The objective is to develop a solid understanding of the current state of the company in relation to the problem and its consequences (CARPENETTI, 2012).

According to CAMPOS (2012), also insert at the end of this stage, that well-made observation minimizes the amount of factors to be considered and with this

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facilitates the process of analysis of causes. For this the observer needs to collect information about the time, the moment the problem occurred, the location and in which types of products or services occurred and the symptoms, such as their manifestation characteristics.

Thus, the observer should not focus on the causes, but only look at how the problem is inserted. Table 3 shows the steps of observing the problem.

Table 3: Step 2 – Observation of the problem.

Step 2 – Observation of the problem	
Flow	Tasks
1	Discover the characteristics of the problem through data collection,
2	Local observation

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

Third step: Analysis to discover the causes

The objective of this step is to analyze the root causes of the problem, because when they are not properly identified, time and money are wasted in the organization. In this step it is fundamental to test and confirm if the chosen causes are in fact responsible for the problem (CAMPOS, 2012).

Because it is a problem of unknown causes, it is a stage that needs more time to be executed, because many difficulties appear and this is when more than one cause affects the result and their effect is not easily separable, which can make confusing the analysis of the causes (ANDERSEN; FAGERHAUG, 2006).

The analysis of the causes must be done in a scientific way, using the quality tools, so that the actions to be determined in the next steps are precise and the efforts minimized. Table 4 presents the steps in how to analyze the problem.

Table 4 – Analysis of the problem.

Step 3 - Analysis of the problem	
Flow	Tasks
1	Define the root causes
2	Choice of the most likely causes
3	Verification of the hypothesis
4	Confirmation of the actual cause

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

Fourth stage: Action plan

It is the stage that occurs the development of a plan of actions that makes possible the solution of the problem. The purpose of this step is to define actions on the root causes and not on the side effects (LAU, 2015). CAMPOS (2012), suggests the division of two steps: the definition of the strategy, where it is the choice of the best alternative solution among the possible causes and the elaboration of a plan of action, where the corrective actions necessary to eliminate the causes of the problem are defined.

Finally, a plan of action needs to be developed to identify the actions, the people responsible and deadlines for implementing the chosen solution. It should answer at least five basic questions: what, how, when, where and by whom it should be done. Table 5 presents the steps of the action plan.

Table 5 – Action plan.

Step 4 - Action plan	
Flow	Taks
1	Define the action strategy
2	Develop a plan of action to achieve goals

Source: adapted from de ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

Fifth stage: Execution of actions

The purpose of this step is to apply the action plan and block the root causes of the problem and to ensure that all those involved in the process have understood and agreed to the proposed measures. It is a step where all good and bad actions and results should be noted with the date they were taken.

The fifth stage of MAPS is divided by two tasks: The training of the employees involved and the execution of the actions.

ANDERSEN; FAGERHAUG (2006), mention the need to record all the results obtained so that they are used in the verification phase and recommend that follow-up activities be reviewed and corrected until the desired results are achieved. Table 6 presents the steps in the execution of the problem.

Table 6 – Execution of the problem.

Step 5 – Execution of the problem	
Flow	Tasks
1	Training of those involved in the process
2	Execution of the action

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

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Sixth step: Checking action effectiveness

In this step we check the action plan solved the problem, and make sure that the problem will not occur again. If the solution fails to return to the second step (observation).

To CARPENETTI (2012), the verification of the results consists of collecting data on the positive and negative variations on the final effect of the problem, making it possible to conclude whether or not the improvement actions are effective. The problem can only be completely resolved if the actions implemented are under control and present results in accordance with the established goals, with no negative and undesirable effects. In addition, verification should not be done only in terms of quantitative results. It should also be related to the intangible benefits such as improving leadership, skills and teamwork and not forgetting about the learning gained from the process. Table 7 shows the steps in how to verify the problem.

Table 7 – Check the problem.

Step 6 - Check the problem	
Flow	Tasks
1	Compare results
2	List the positive and negative effects
3	Finding whether or not the problem is continuing

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

Seventh stage: Standardization

The action plan is adopted by default. At this stage you need to establish a system of periodic checks to verify compliance with standard operating procedures. To CAMPOS (2012), the standardization has to follow a formal procedure so that the task is performed without problem recurrence. Standards should become a habit of employees. Standardization includes documents, employee training, communication and monitoring of results in the use of the standards defined by the action plan. One of the typical problems at this stage is the elaboration of documents by people who are unaware of productive areas, which impairs labor productivity and interferes with the expected result. Table 8 presents the standardization steps.

Table 8 – Standardization.

Step 7 - Standardization	
Flow	Tasks
1	Define the standard
2	Communication
3	Training
4	Tracking the use of the standard
5	Prevent against recurrence of the problem

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

Eighth stage: Conclusion

Eighth stage objective is to evaluate the application of MAPS to this problem, strengthening the lessons learned in new opportunities for improvement.

Carpenetti (2012) recognizes that the solution of a problem can never be perfectly solved, the search for perfection can be unproductive and demotivating, even if the goal has not been achieved, a list of what has been and has not been accomplished during the development of the method to increase the efficiency of future work, that is, aiming at a new cycle of Maps application.
Table 9 shows the completion steps.

Table 9 – Conclusion.

Step 8 - Conclusion	
Flow	Tasks
1	Relate the remaining problems
2	Plan future work
3	Reflection

Source: adapted from ANDERSEN; FAGERHAUG (2006), SELEME; STADLER (2008), CARPENETTI (2012) e CAMPOS (2012), LAU (2015).

MAPS AND QUALITY TOOLS

The concept of "quality" in industries is defined as meeting customer needs, preventing and managing failures including actions for their patches (ZU, 2009).
Quality tools are tools used by organizations to improve the effectiveness and efficiency of the quality system in an organization (ALSALEH, 2007).

To CARNEVALLI *et al*. (2008), meeting the needs of the customer, aiming at continuous improvement of products and services produces considerable advantages to organizations compared to their competitors. This practice is one of the functions of quality tools.

Quality tools can be divided into two groups, according to TAGUE (2005); SOUZA (2008):

– Non-statistical tools: 5W1H, operational definitions, sequential charts, cause and effect diagram, flowchart, check sheet and brainstorming;

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– Statistical tools: stratification, Pareto graph, histogram, correlation diagram and the statistical process control chart (PCP).

When applying MAPS to solve problems, organizations need to use some quality tools. This means that only MAPS is not enough to address the root causes of problems effectively. It is necessary that the tools assist the process, that is, they are the resources to be used in the method (CAMPOS, 2012).

To TAGUE (2005), the tools of quality are the materials that will be used in a work (method) to build an enterprise and shelter people (problem).

In the present work, some of these tools will be applied, in which the following concepts are demonstrated.

Brainstorming:

To PASQUALINI; SILDENBERG (2012, p. 53), brainstorming "is a group process in which individuals express ideas freely, without criticism, in the shortest possible time in order to generate innovative ideas or solutions that take a particular project forward."
In this sense, brainstorming arises to propose solutions to the identified deficiencies in organizations (Cooper et al., 2008; Garcia et al., 2016).

The brainstorming was created in 1957 by Osborn, who realized that the generation of ideas stimulates creativity and is a critical part of the innovation process (KOHN et al, 2011).
In a brainstorming session, groups are encouraged to think and express their ideas, providing a basis for problem solving in organizations (COSKUN; YILMAZ, 2009).

According to RAWLINSON (2017), brainstorming can be performed in both structured and unstructured ways. When each participant expresses their opinion, one at a time, the application is done in a structured way. Already in the unstructured form, participants say more than once with ideas that arise in the head without a specific goal. According to HESLIN et al. (2009), in order to improve the quality and creative capacity of the group, brainstorming is divided into four norms as shown in table 9.

Table 10 - Standard do Brainstorming.

Standards	Description
1 Any criticism is ruled out	Expressing ideas without fear of judgment
2 The more creative the better the idea	All creative ideas are welcome
3 Quantity is more important than quality	The more ideas, the greater the likelihood that the objectives of the problem will be met
4 Improve ideas that have been suggested	Through the ideas explored by the group, try to combine them and try to improve them

Source: HESLIN (2009).

2.4.2 ISHIKAWA DIAGRAM (FISHBONE):

The Ishikawa diagram, also known as fishbone, was developed in 1943 by chemical engineer Kaoru Ishikawa at the University of Tokyo. It aims at visualizing the problem (cause) and its possible solution (effect) (FERNANDEZ et al., 2012).

For ROMERO (2016), the Ishikawa diagram is an important quality tool that aims to identify the problems and all their possible causes and determine corrective measures.

According to BASU (2014), to apply the Ishikawa diagram it is necessary to:

a) Summarize the relationship between causes and effects;

b) Obtain a global and structured vision to facilitate analysis of the causes;

c) To promote the improvement of the processes and to favor the human relations within the organizations;

d) All members should understand the problems and their possible causes.

It was structured in 6 known causes as 6M: labor, machine, method, raw material, measures and environment, according to Figure 2.3 (GWIAZDA, 2006; BEHNAM, 2011).

a) Machine: equipment and machinery;

b) Method: procedures, routines and techniques that may interfere in the process;

c) Material: raw materials, spare parts, spare parts etc .;

(d) Labor: includes all aspects of staff;

(e) Measures: gauging and calibration of measuring instruments;

f) Environment: conditions or environmental aspects that may affect the process.

Figure 1 shows a model of the Ishikawa Diagram.

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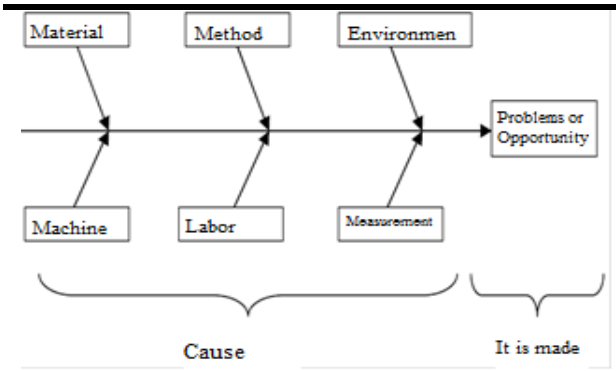

Fig.1: Modelo de Diagrama de Ishikawa.
Source: FERNANDEZ *et al;* (2012).

Pareto's chart:

According to ZASADZIEŃ (2014), the Pareto chart is a very useful tool in the identification and prioritization of the problems that impact the objectives of the organizations, helping in the decision making. It is used to set the priorities of the most problematic items of a company, based on the volumes of occurrences.

According to the principle that 20% of defects are responsible for 80% of the damage, it can be stated that 1/5 of the causes of problems can solve approximately 4/5 of all problems detected (GONZÁLEZ, 2014).

For PRÍSTAVKA (2016), the Pareto chart identifies and eliminates the most serious problems, studies in depth the causes of the problem, decides which elements should be improved and concentrates the analysis on the key problems to improve and facilitate improvement decisions. Figure 2 shows a Pareto Chart Example

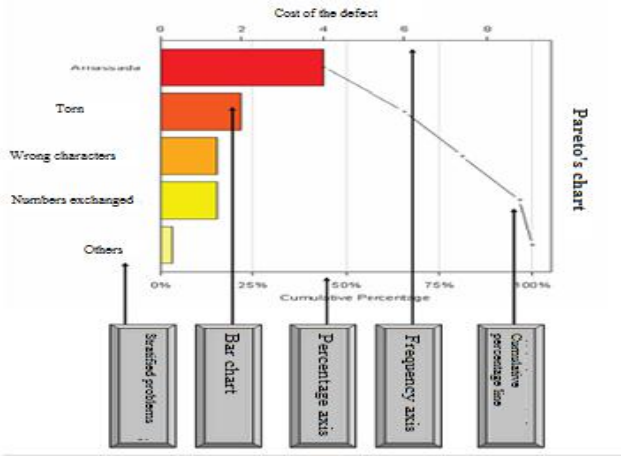

Fig.2 Shows a Pareto Chart Example
Source: GONZALEZ (2014).

Diagram 5W1H:

The 5W1H tool is an introductory method of analysis to clarify the root cause of the system failure, which aims to facilitate the implementation of corrective and preventive actions. The importance of this tool is in the checklist of activities that are developed in a clear and efficient way by all involved in the project (JIA et al., 2016).

For JIANG et al. (2015), the 5W1H diagram is a tool that assists in structuring action plans from key issues: What? (what); Who? (who); When? (when); At where? (Onde); Because? (why), and; As? (how).

According to LIN et al. (2016), explains the application of the questions as follows:

a) (What) - What will be done: defines the tasks that will be executed, through a plan of action;

b) (When) - When will be done: the schedule is established stating the deadline for the accomplishment of the task;

c) (Who) Who will perform: Who will be the person responsible for each task;

d) (Where) - Where it will be done: determines where the tasks should be performed;

e) (Why) - Why it will be done: shows why the tasks should be performed;

f) (How) - How it will be done: determines the economic and rational way in which the task should be performed.

PANORAMA OF MOBILE ENTERPRISES IN BRAZIL

With the impact of the economic instability generated mainly in the civil construction sector, the furniture industry faced major challenges in recent years. Many companies were closed and those that remained had to adapt to a process of repositioning the market. They needed to develop strategies that seek differential through innovation, cost reduction with greater efficiency in both management and processes, without giving up the production of products with quality and added value (ABIMOVEL, 2017).

Even in the face of the difficulties faced by the furniture industry in Brazil, Brazil ranks fifth in the world's furniture production and is the 32nd largest exporter (SEBRAE, 2017). In the first two months of 2018, data published in the Quarterly and Foreign Trade Report showed a 12.4% increase in the volume of furniture production compared to the same period in 2017. In the twelve-month period (February 2017 to January 2018) there was growth of 5.9% (ABIMOVEL, 2018). In 2017, furniture companies generated 258,95 thousand direct and / or indirect jobs, with annual revenues of R $ 38 billion (ABIMOVEL, 2018). The vast

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majority of establishments, around 80%, employ up to nine employees. The small establishments with 10 to 49 employees correspond to around 16.5%, while the medium-sized establishments of 50 to 249 employees, around 3% and large 0.5%, over 250 workers (BRAZIL, 2017). The largest concentrations of formal jobs are in the Southeast (São Paulo and Minas Gerais) and South (Rio Grande do Sul, Paraná and Santa Catarina) regions, representing around 77% in these five states, according to table 11.

The regions with the most representative number of companies are the south and southeast regions around 72.1% of the Brazilian market, according to table 10.

Table 11 - Furniture Jobs.

States	Jobs	%
São Paulo	53687	22,91%
Rio Grande do sul	35414	15,11%
Paraná	34561	14,75%
Minas Gerais	30839	13,16%
Santa catarina	27378	11,68%
Other states	52464	22,39%
TOTAL	**234.343**	**100,00%**

Source: BRASIL (2017).

Table 12- Mobile establishments

States	Establishments	%
São Paulo	4036	9,26%
Rio Grande do sul	2916	6,69%
Paraná	3024	6,94%
Minas Gerais	3000	6,88%
Santa Catarina	2744	6,29%
Others states	6077	13,94%
Brasil	21797	50,00%
TOTAL	**43.594**	**100,00%**

Source: BRASIL, (2017).

In relation to the trade balance of the furniture industry, Brazilian exports were US $ 625.9 million between January and December / 2017, up 5.1% over the same period of 2016. Historically the country's furniture trade balance is surplus. Santa Catarina ranks first in the ranking in relation to exporting federal units, around 34.6% of the total, followed by Rio Grande do Sul of 30% (MOVERGS, 2018).

The main exported items are bedroom furniture, about 40% of the total exported value followed by wooden kitchens and others such as dining room, office. According to statistics from the United Nations Trade Database (COMTRADE), in 2016, the furniture sector ranked 9th among the leading exporters of wooden furniture in the dormitory category, while in the category cuisines Brazil was in the 20th position. The main destinations for Brazilian exports are the United States, United Kingdom, Peru and Uruguay, according to table 11. In relation to the trade balance of the furniture industry, Brazilian exports were US $ 625.9 million between January and December / 2017, up 5.1% over the same period of 2016. Historically the country's furniture trade balance is surplus. Santa Catarina ranks first in the ranking in relation to exporting federal units, around 34.6% of the total, followed by Rio Grande do Sul of 30% (MOVERGS, 2018). The main exported items are bedroom furniture, about 40% of the total exported value followed by wooden kitchens and others such as dining room, office. According to statistics from the United Nations Trade Database (COMTRADE), in 2016, the furniture sector ranked 9th among the leading exporters of wooden furniture in the dormitory category, while in the category cuisines Brazil was in the 20th position. The main destinations for Brazilian exports are the United States, United Kingdom, Peru and Uruguay, according to Table 12.

Table 12 – Main destinations of furniture exports in Brazil.

Main destinations of furniture exports in Brazil			
Millions			
Ranking	**Destiny**	**Value US$**	**Value US$ 2017**
		2016	
1	United States	10.360	13.124
2	United Kingdom	6.442	6.826
3	Peru	3.129	3.174
4	Uruguay	2.142	2.364
5	Chile	1.727	2.087
6	Paraguay	1.178	1.591
7	France	915	1.514
8	Argentina	666	1.483
9	Spain	505	774
10	Bolivia	99	722

Source: MOVERGS, (2018).

As for imports, about one-third originate in China. In 2017, the country's participation generated around 39.4%. Next, the United States (8.3%), Mexico (6.2%), South Korea (6.1%), Germany (5.3%) and Italy (5.1%). On average 80% of imports are in the seat and upholstery segment, basically plastic and metal components (MOVERGS, 2018).

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Regarding investments, according to IEMI (2016), the Brazilian furniture sector invested around 1.1 billion. Of this amount, 30% of these resources were used to purchase machinery and equipment imported from Italy (29.3%), Germany (22.5%) and China (18.7%) as a sawing and bending machine, that is, they are machines for nailing, stapling, gluing or assembling parts applied to hardwood, cork, rubber or plastics. The remainder of this amount was destined to the manufacture of furniture and production of mattresses. Nevertheless, these investments do not match the reality of most furniture companies in Brazil. Innovations in the Brazilian furniture industry are technologically low. Modernization occurs most of the time in some stages of production, once in the same factory environment one observes modern machines operating alongside obsolete equipment. In addition, large portions of the Brazilian manufacturers can not keep up with the technological pace applied to the sector. Therefore, this makes it difficult to standardize parts and pieces, preventing the standardization of these items in new projects, especially those of diversification of the final product (COSTA; HENKIN, 2012; SPEROTTO, 2016).

Most of the manufactured parts are intended for dormitory residences, around 67.7%. The other representative categories in numbers of pieces are office furniture, 13.7% and others, such as furniture for kitchen, dining room and upholstery, all three with participation of 18.6%, according to figure 2.4 (IBGE 2017).

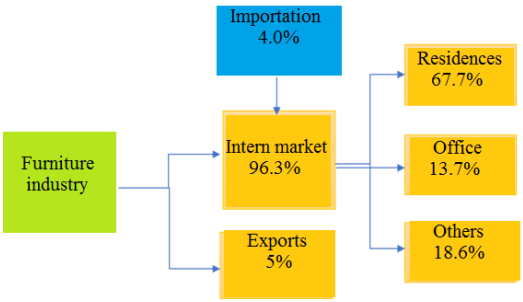

Fig.3 - Furniture industries in 2017.
Source: IBGE (2017).

In the region of Manaus, the object of this study, the furniture sector is characterized by the predominance of small and medium enterprises, inherited in the great majority of past generations. Most of them have 3 to 8 employees who still work artisanally. They face great difficulties because of the lagged technological structure, disqualified labor with low added value in comparison to other sectors, furniture decapitalized and the use of wood without certification. This scenario reflects in low competitiveness in the Brazilian market (AIMAZON, 2017),

The data recorded on the number of companies in the furniture branch of plans that operate in the city of Manaus, are obsolete and incomplete. It is believed that there are 170 to 180 planned furniture companies in Manaus, the majority being informal. According to SEPLAN data (2017), around 50 formal establishments operate in Manaus.

As possíveis explicações para esse pequeno número são as seguintes:

a) Small planned furniture companies open and close in the same year;

b) Illegalities of the planned furniture sector, dominated by micro-enterprises and informality of them;

c) There is no way to separate furniture factories from backyard workshops;

d) Small companies when registered in the SEFAZ-AM register, are registered in the register for many years, even if they have been inactivated.

III. MATERIALS E METHODS

3.1 METHOD OF ANALYSIS AND TROUBLESHOOTING (MASP)

Through literature review, it was sought to find studies that prove the effectiveness of MASP in reducing or eliminating occurrences of failures and the losses caused by them. Ten recent papers have been identified, but none of the articles are intended for the planned furniture industry. Table 4.1 shows the studies identified.

PIECHNICKI et al. (2011) applied MASP to combat volume losses produced by a sanitation company. The losses and the application of quality tools were analyzed and the root causes of the anomalies were discovered and it was possible to propose solutions for the reduction and elimination of water losses. Thus, the authors concluded that the method is linked to the process of continuous improvement and proved to be an effective tool in the fight against water losses in the Sanitation Company.

According to a study conducted by GABILLAUD (2011), in the 2nd largest retail chain in the North-Northeast, the MASP method was effective in its purposes. As a result, maintenance information restructuring was implemented through the implementation of a computerized management system that enabled an adequate registration of equipment, quick access to reports and more efficient decision-making capacity, contributing to the reduction of losses in the retail context. CORREA et al. (2011), in research conducted at a food company in Valle del Cauca in

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Colombia, managed through QC Story (MASP) to identify the machines that were working below their productive capacity and to correct the factors that were generating errors and leading increase in the number of stops. The method improved the reliability of the information generated by the production control system of these machines.

For MOTA and MARINS (2012), the MASP method was used in one of the largest companies in the steel industry in the country to reduce divergences in inventory that reached 30% of total inventoried equipment. These divergences caused a number of disadvantages for the company, such as the loss of service level to the customer, difficulty to resupply, planning in unrealistic data and possible production stoppage. It was possible to reduce divergences through the tools Brainstorming, Pareto Diagram, and 5W2H, which detected that the failures were related to the human factor and that needed training of the personnel involved in the process. Another study in one of the largest glassmaking industry in Brazil sought to improve production that was below standard and much variation over a period of 24 h. With the application of the MASP method, the process improved in relation to the past, not only in the increase of its yield, which was 98.03%, and became 98.831%, but also in relation to its variation that became more stable (SANTOS et al., 2012). Another work that demonstrates the feasibility of applying MASP was developed by CANO and NOÉL (2013), which evaluated the application of the method in a poultry slaughtering industry in Lima-Peru, minimizing the cost of the sector with the improvement of the quality of poultry feeds both in the nutritional part and in the shelf-life of the product. With the application of MASP, there was an improvement in the quality of food produced in the industry, reflecting in the shortest time the development of poultry for slaughter without compromising the quality of the meat and the clients' side, the certainty of the purchase of good quality poultry and with weight right. SINI (2013), proposed a workflow management model in organizations based on the MASP method. The study was conducted in France and it was possible through the application of Masp to formalize a workflow application, which allowed productivity improvement and process optimization in companies.

Already, CORRAL et al. (2014) studied the application of QC Story (MASP) to train workers on the assembly line at a cable factory in Mexico, in order to reduce the index of defective products. After application of the method, there was reduction of defects in the final product and as a consequence the reduction of costs around 964 pesos per defective product (whips) and manufacturing time where the reduction reached 5s in the average time of manufacture of the product. In the TADDESE study (2017), the method was used in an empirical exploratory research in 14 companies from Japan, India and Thailand. The research results indicated that the method facilitates the ability to innovate in organizations through customer-focused management practices and the human resources of companies. This innovation brings organizational transformation in several areas of the companies and the improvement in the productive process. ANDRADE and RODRIGUES (2017) used MASP in a manufacturing industry to solve problems with defective parts from their suppliers. He used the tools: Brainstorming, Check Sheet, Cause and Effect Diagram, Pareto Chart and Flow Chart. The results showed the need to control suppliers. With the application of MASP it ended up reducing the lead time of the company's production and consequently a reduction in the rate of parts with defects and reduction of costs. Therefore, the survey of works with the application of MASP, in other areas, showed efficient and positive results, in which they were able to eliminate process failures, reduce costs and improve the productive capacity of equipment and operators.

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Table 13 - Studies identified.

Reference	Study	Results
Piechnicki et al (2011)	Use of the methodology of analysis and solution of problems in the reduction of water losses: A case study	It has proven to be an effective tool in combating water losses in the sanitation
Gabillaud (2011)	Method of analysis and solution of problems (MASP) - application in the management of maintenance of a retail network in the state of Sergipe.	Restructuring of maintenance information through the implementation of a computerized management system.
Correa et al.(2011)	Identification and elimination of low reliability of the data capture system M.E.S. em a food company in Valle del Cauca.	Improved reliability of the information generated by the production control system of production control system of the
Mota e Marins (2012)	Analysis of the application of the masp tool in the inventory control of a steel mill.	Reduced the divergences found in the stock by 30%.
Santos et al (2012)	The implementation of the MASP tool for continuous improvement in a vine industry.	It improved the yield of production that before was of 98.03% and happened to be 98.83%. Becoming more stable.
Cano e Noél (2013)	Improvement of quality in pelleted balanced feed for birds, through the quality route method.	Improved quality in poultry feed reflecting the shorter development time of poultry for slaughter without compromising quality of
Sini (2013)	Méthodes et outils pour la gestion des workflow -modélisation ontologique des processus pour l 'analyse.	Formalized a workflow application and allowed for improved productivity and optimization of business processes.
Corral et al. (2014)	Implementation of visual aids for the manufacturing area. Avancos engineering research in the state of Sonora.	Reduction of failures in the final product, as a consequence of the reduction of costs around 964 pesos per defective product.
Taddese (2017)	Application of TQM for innovation: na exploratory Research of japonese, Indian na Thailand companies.	Organizational transformation in various areas of the company and improvement of the productive process.
Andrade e Rodrigues (2017)	Implementation of the methodology of analysis and solution of problems (MASP) to reduce losses in manufacturing companies.	Reduction of the production lead time of the company.

IV. APPLICATION OF THE CASE STUDY - RESULTS AND DISCUSSIONS

COMPANY PROFILE

The study was carried out in a furniture industry located in the southern part of the city of Manaus, in the production and after-sales sectors (technical assistance).

The plant has about 20 years, employs 50 employees in four sectors: sales (projects), administrative, operational and after-sales (technical assistance). The sales and after-sales sectors are located at the point of sale of the brand and are headed by a director who is responsible for the department and staff. The other sectors are located in the factory and are headed by a production manager and an administrator.

The sales industry is responsible for the projects and sales. The aftermarket, also called technical assistance, is responsible for the logistics, installation, maintenance and correction of the products. The administrative sector is responsible for the processes related to HR and financial and operational is responsible for the costs, purchases and execution of production. The industry currently counts on the production of furniture with high technology machines and with an annual manufacturing capacity of around 13000 items. In 2011 it made new investments in equipment and human resources in which it increased its production capacity. In 2016 with the crisis in the area of civil construction had to remodel its factory park to ensure its brand in the market Manauara. In terms of strategic business management, it has made available a comprehensive and innovative portfolio to meet the diverse needs of its customers, in a culture based on the ethics, quality and safety of its products. It is recognized in Manaus for producing furniture rich in detail, with quality raw material and high added value.

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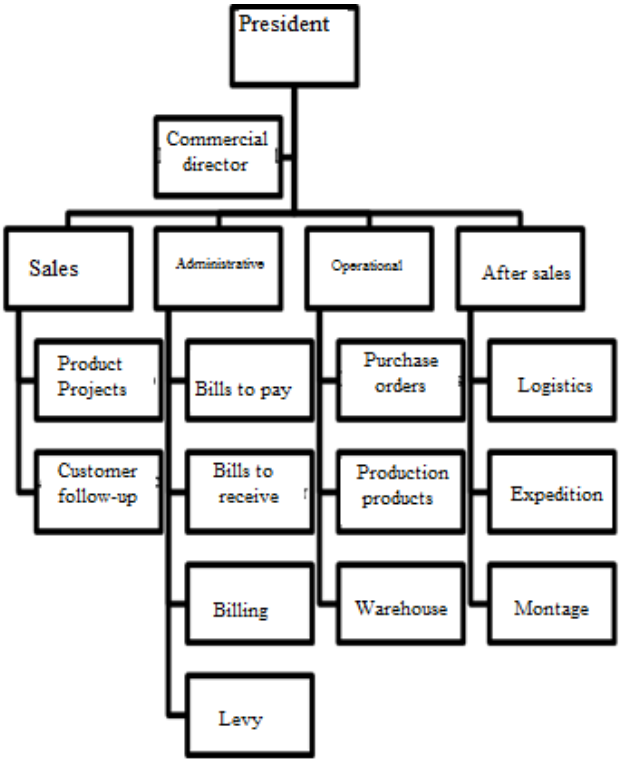

Fig.4 - Company organization chart.

5.2 SCENÁRIO

The information provided by the management, through the technical assistance sheets, there was no period from June to October 2017, 268 requests for technical assistance occurred. During this same period 3600 items were manufactured. The accumulated cost for the sector was calculated around R $ 40,000.00.

Based on data, 7.44% of what was manufactured is not in compliance, ie manufacturing failures, adding a cost to the factory. This cost has mainly been due to repairs, such as the demonstration of failures in Table 5.1, which can be controlled in the production line.

Table 14 - Description of faults

Types of failures / June to October 2017	Description
Finishing	Damaged paint with bubbles, pen scratches, blemishes, edges taking off.
Mounting error	Holes out of measure, feet off, doors uneven.
Damaged components	Defective puller, loose slides, and defective bulbs.
Incorrect shipment of components	Mounting hardware, small handles.
Transport failure	Risks, crunches, broken glass and broken components, broken lamps.
Missing pieces	Impossibility to complete the project on schedule.
Generated by customer	Glass broken, small beats, scratches, handle break, infiltration of water.
Wrong order	Incorrect color and design measurements
Pests	Changing of closet, ballast of bed.
Environmental	Moisture

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5.3 PROCESS IN THE FABRICATION OF FURNITURE

According to HARRINGTON (2007), a process is "the specification of work activities in time and space with a beginning and end, with inputs and outputs, identified and defining a structure for action." The process in a furniture factory is characterized by producing a large variety of parts in a small quantity and by requiring a longer time in the production of the products and in the planning of the production in relation to the time of manufacture (AZEVEDO and NOLASCO, 2009). The process involves various machines and equipment such as planer, circular saw, sectioning machine, sander, drill and border collator. The main products manufactured by the furniture factory planned in the case study are listed according to table 15:

Table 15 - Main products manufactured.

Main products manufactured	
Products	**%manufactured**
Bedrooms (beds, wardrobes)	39%
Kitchens planned	33%
Bathrooms (cabinets)	12%
Home Theaters (shelves and racks)	7%
Home Offices (tables, shelves and cupboards)	6%
Closets	3%

Source: Adapted by the authors, (2017).

5.3.1 Stages of the product development process

Currently the process of manufacturing the company obey three steps:

First step:

Firstly, the client requests the technician's visit to the property for the measurements and already informs the type of service that will be realized. These measurements are carried out millimetrically in the environment obeying setbacks, beams, recesses and points of water and energy and sent to the designers who use a *computer-aided design* (CAD) to generate drawings.

The project with the specifications of the furniture is carried out at the point of sale of the brand and transferred to the factory, so that the quotation and the list of materials and the deadline of the products are elaborated. The 3D design is presented to the customer with the specifications of the furniture and the final price of the project in order to get approval for the beginning of the manufacturing. After approval of the client, the project returns to the factory and starts programming the furniture manufacturing by the production management sector.

Second stage: The second stage of the production process is on the factory floor. Cutting is the first process. The production scheduling sends the list for cutting the MDF sheets. The sectioner operators perform the programming instructions, part by piece, without the need for project interpretation. The pieces are cut into the machine and deposited in an intermediate place. There are no issues missing in this process. The batch is transferred to the next laminating machine. The mill operating team performs the blade application instruction, as per the part label. Then the pieces are sent to the drilling process, where they are screwed together and receive the so-called edge tape, material that protects and finishes the sides of the plates. Sometimes carpenters perform trimming cuts. When they reach the specifications the pieces are sent to the paint sector for the final finish.

Third stage: When ready, the parts are sent for conference according to design and packed in a way to facilitate the assembly process in the customer's environment. The last process is the output of production parts. Parts are hipped to the off-site warehouse. Parts are tagged, ensuring exact delivery of the design.

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5.3.2 Flow chart of the product development process - current and proposed.

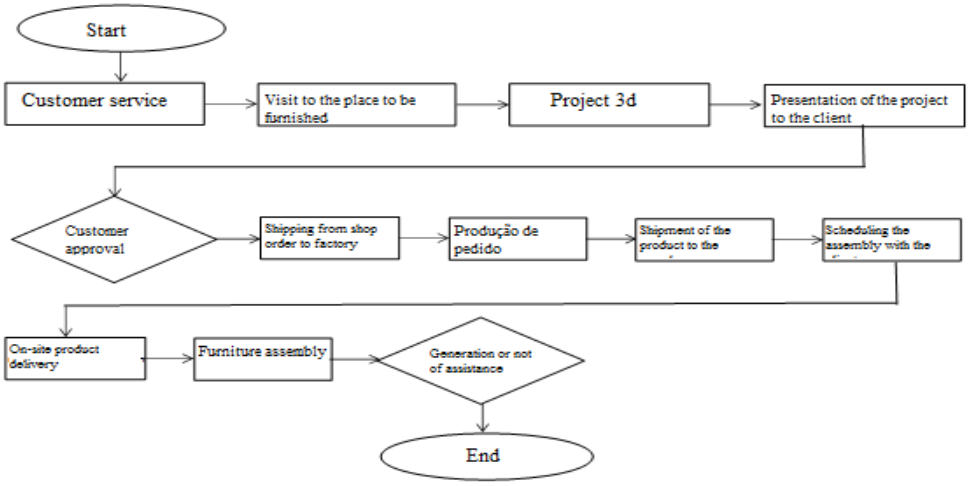

Figure 5 - Current flowchart of the product development process.
Source: Adapted by the authors, (2017).

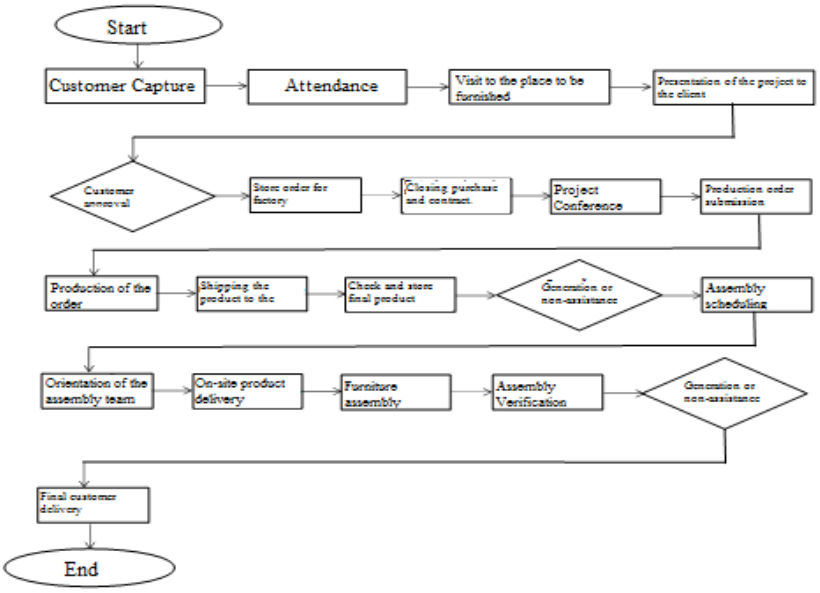

Fig.6 - Proposed flowchart of the product development process
Source: Adapted by the authors (2017).

5.4 APPLICATION OF MASP

In this section we will present the application of MASP in the productive sector with the purpose of eliminating / reducing the failures in the process and will be transcribed here the eight steps that comprise the method, and quality tools such as the Pareto chart, Ishikawa diagram, brainstorming, 5W1H, as well as their analyzes, identifying the root causes and the circumstances in which the failures happen and proposing actions to correct them as well as the verification and conclusion of the process.

5.4.1 Step 1 - Problem identification

The industry studied had an average of 53.6 calls per month of technical assistance caused by failures in the production process during the period from June to October 2017. This problem always bothered the industry. The Board of Directors' dissatisfaction is justified by the fact that these flaws in the process tarnish their image vis-à-vis customers, in addition to taking on all expenses causing loss and reduction of their profit, not counting the loss of a day worked by the assemblers. The verification of this problem was carried out quantitatively, through information in the technical assistance sheet according to the period of study mentioned above. The Pareto chart, represented by the Graph of Figure 8,

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illustrates the respective failures noted by the information on the service chart. As the purpose of the Pareto Chart is to identify the most influential cause and focus on solving the problem, we can identify that the finishing that corresponds to 33% of the requests received in the period is the task where there is a greater number of failures, stage to be prioritized for the study. This is not to say that not all the problems listed in the Pareto chart are important, but rather that some need to be solved more urgently.

Graphic 5.1 - Identification of the problem.

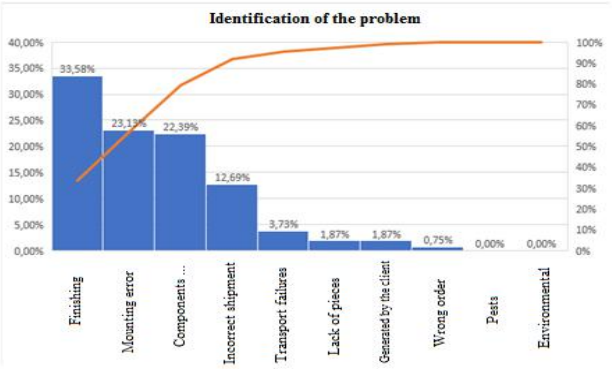

Fig.7 – Graphic 5.1 - Identification of the problem.
Source: Authors, (2017).

5.4.2 Step 2 - Watching for the problem

Meetings were held with the purpose of tracing negative points that were affecting the final quality of the product. The following members took part in the meetings: 01 production leader, 01 person in charge of the after-sales department (technical assistance) and the general director. It was clearly defined the problem to be debated and listed a number of potential problems with care not to criticize suggestions not to inhibit membership participation. The director participated as moderator, noting all the suggestions discussed and the meeting lasted about 45 minutes and coordinated by the researcher. In this stage it was established that the problem should be solved in the period from November 2017 to January 2018. By the end of January 2018 the 10% goal in reducing the failures in the production process should be achieved. This goal was established at the meeting with the members of MASP and the researcher. The Ishikawa Diagram tool was used through the data obtained by the brainstorming methodology, and it was identified the causes that could be affecting the finishing of the pieces, according to Figure 9.

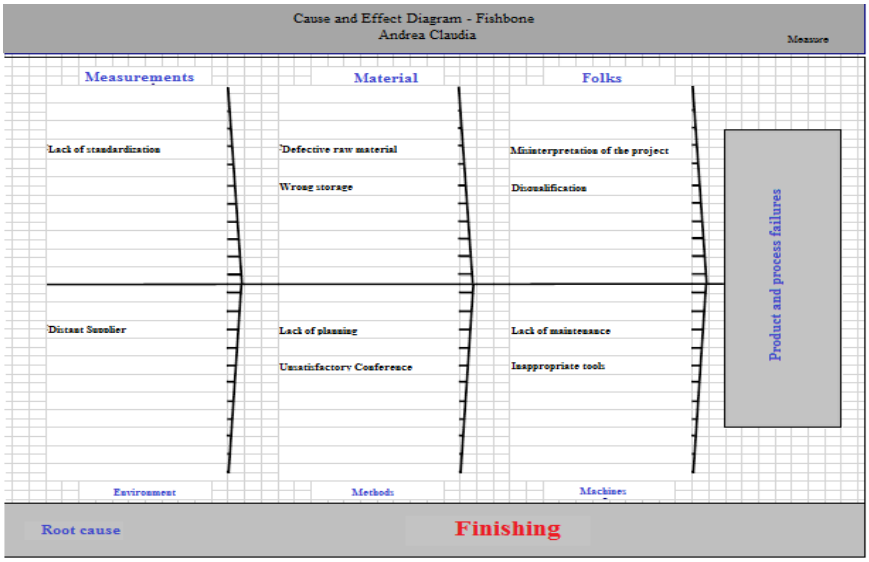

Fig.8 - Cause and Effect diagram for process and product failures.
Source: Authors, (2017).

5.4.3 Step 3 - Problem analysis

To analyze the problem, a chart was created with the causes responsible for the occurrence of the problem under study, according to the Ishikawa diagram.

This scenario enabled the author of the project to go further, questioning the members why the causes listed above are happening, thus generating a branch of secondary causes. The main causes raised by the members, named by Toledo (2014) of secondary causes (second level), are listed in table 14. Each member listed through note (1 to 10) the main causes for the failures in the finish of the final product. It is worth mentioning that the score was based on the data verified in projects, the information in the reports of requests for technical

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assistance and also in the lived experiences of the members in the furniture factory.

The causes that scored above 20 points, that is, the most influential ones for the process losses, were taken as classification criterion. They were: disqualification of labor, machines with defects, scratches in painting and painting without adhesion. Table 5.3 shows the secondary causes identified in the final product from the primary causes of the Ishikawa Diagram and the scores assigned by the members.

Table 16 - Secondary causes identified in the final product from the primary causes of the Ishikawa Diagram.

Identified Cause / Product Finish	Total score assigned by members
Disqualification of labor	21
Accumulation of functions	10
Defective Machines	22
Scratches in paint	20
Paint without adhesion	25
Fissure in wood	18
Out of measure	16

With regard to disqualified labor the causes involved refer to unsatisfactory training, leading the employee to inappropriate attitudes such as: recklessness, sloppiness, hurry leading to errors in both the production of the final product and its installation.

For defective machines, there is a lack of regular maintenance and improper operation. For the case study the causes related to lack of maintenance are included. In this case, the maintenance of the measuring equipment for the preparation of the ink.

With regard to scratches in painting and painting without adhesion, the problem is linked to the standardization of procedures and quality standards. In this stage, the causes related to the preparation of the product of the varnish, as well as its application and the minimum curing time, that according to the norms established by the company are of the minimum of 6 hours and the inadequate storage of the wood.

In the graph of figure 10 are presented in percentages the alleged causes in relation to the problematic evaluated.

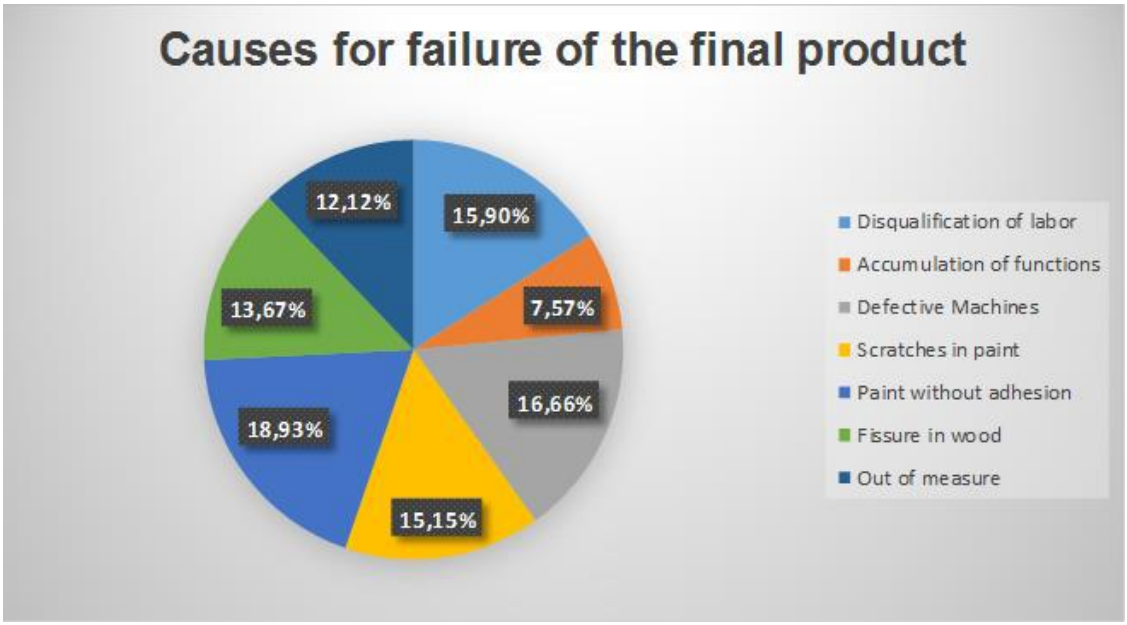

Fig.9 - Graph - Percentage of causes identified in the final product.

Source: Authors, (2017).

5.4.4 Step 4 - Action Plan

After analyzing the main causes of failure of the final product, an action plan was elaborated using the 5W1H quality tool. The objective of the action plan is to define preventive and corrective actions on the identified causes. This plan of action was made jointly with the

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members through a meeting, where it disseminated the plan to all the people involved in the process, taking into account the daily experiences in the store and on the factory floor, defining the counter measures to be performed , informing those responsible for the actions, why it should be executed, the deadline for execution, the location and the manner in which the proposed action will be executed, as shown in Table 3.

Table 17 - 5W1H action plan.

ACTION PLAN					
General objective	**Reduce requests for technical assistance services in a Furniture Industry in Manaus applying the MASP (Analysis and Problem Solving Methodology).**				
Area:	**Production**	**Responsible**	**Andrea Claudia**		
PLANNING					
Origin of the Action (Why?)	**What to do / Objective (What?)**	**How - Method (How?)**	**When - Deadline (When?)**	**Who - Responsible (Who?)**	**Where - Location (Where?)**
Avoid improper preparation of the product	Cleaning the ink preparation equipment	Cleaning nozzles and needles	At the end of each month	Sector of painting	In charge of the painting sector
Damage the painting	Replacement of measuring equipment for ink preparation due to wear	Running Product Review	6 months	Sector of painting	In charge of the painting sector
Due curing time does varnish	Packaging of furniture	Wait 6 hours after painting	daily	Packaging Sector	Warehouse
Avoid paint and take-off problem	Cleaning in the glue reservoir	Cleaning the applicator waste	daily	Sector of cutting	In charge of the sector of cut
Standardization of MDF sheets	Timber monitoring (MDF) in the warehouse	Check that the timber is cracked	When receive the goods	Storage of materials	Warehouse
Avoid painting and disruption problem	Verification moisture woods in	Visual analysis of the MDF board	Before cutting the MDF board	Production sector	In charge of production
Generates imbalance in the plate and Empenamento	Wood Storage	Away from sources of heat and moisture	When receiving the supplier's woods	Storage of materials	Warehouse
Improvement of the productive process	Training of employees, standardization of procedures and quality standards	Course improvement after the record.	Every 6 months and new Employees - immediately	Sector of production / sector and after-sales / sales	Board of Directors

The trainings of the employees of the production sector were carried out during the month of October. It was perceived a greater commitment of the employees since the failures in the final product began to be fought. Regarding the sectors, such as after-sales and sales, the deadline for starting the training is for January / 2018.

The action plan made it possible to better monitor the members, especially the management (director) who did not have to open several documents to monitor the activity.

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5.4.5 Etapa 5 – Ação

After the action plan, the next step of MASP is action, ie if the action plan is already being implemented by the relevant sector. The implementation of this plan had a follow-up through the director and researcher. Due to the commitment of all members, the planned actions had a low cost, since those responsible used internal resources of the company itself, respecting the deadlines and tasks defined. In this stage, a table containing the tasks, the sector responsible and how much has already been done was implemented, under the supervision of the board of directors, as shown in table 15.

Table 18 - Execution of tasks of the action plan.

Tasks	Responsible sector	%conclusion
Cleaning of painting measuring equipment	Painting	100%
Cleaning the glue reservoir	Lamination	80%
Replacement of measuring equipment for ink preparation due to wear	Painting	100%
Follow-up of MDF sheets	Warehouse	100%
Wood humidity checking	Production	70%
Training contributors	Board of Directors	40%
Furniture packaging	Warehouse	98%
Wood Storage	Warehouse	55%

5.4.6 Step 6 - Verification

Nesta etapa foram coletados dados de números de solicitações de assistência técnica de novembro de 2017 a janeiro de 2018 depois da implantação do MASP, estabelecidas pelo plano de ação e posteriormente comparadas com o período de junho a outubro de 2017. Os resultados correspondentes aos 3 meses citados acima, houve uma redução do número de solicitações de assistência técnica em torno de 58% (cinquenta e oito por cento), conforme gráfico da figura 11.

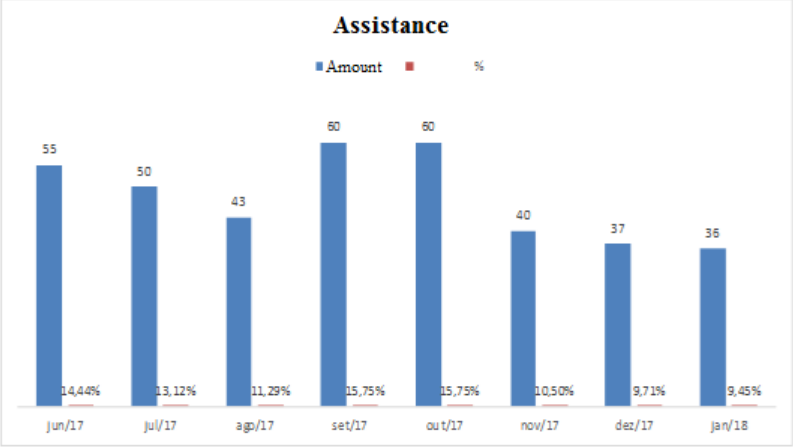

Fig.10 - Assistance Chart.

Regarding the finishing, the cause studied, the number of requests was 90 in the period from June to October 2017. After application of MASP, in the period from November 2017 to January 2018 reached 29, a

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reduction of 68% in the number of requests, according to the graph of figure 12.

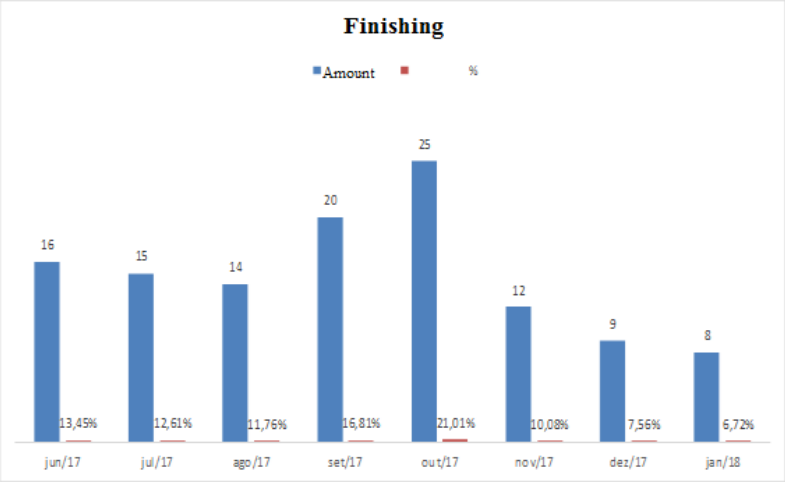

Fig.11 - Finishing Chart.

The costs and quantity of fabricated items were tabulated based on the information provided by the person in charge of the company. The graph of Figure 13

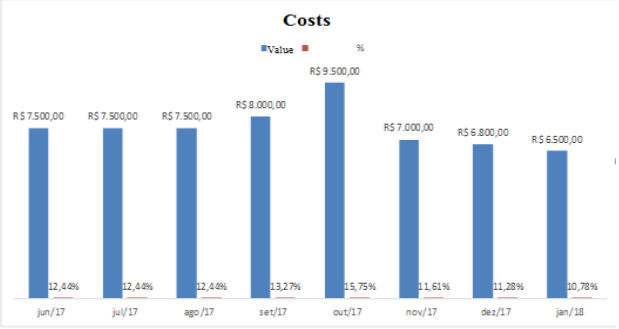

Fig.12 - Graph - Costs.

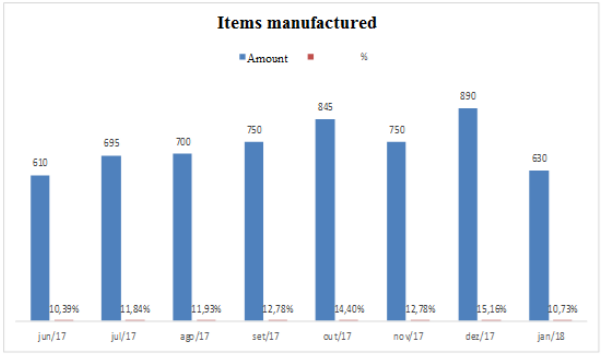

Fig.13 - Graphic - Items manufactured.

The results presented demonstrated the effectiveness of MASP and not forgetting the commitment of the team involved, who began to worry more about the quality of the final product and paid more attention to their daily activities.

shows the period from June 2017 to January 2018, with a 49% decrease in costs and the graph of Figure 14 shows the items manufactured in the same period.

5.4.7 Step 7 - Standardization

As the company did not use quality tools, there were difficulties in the application of MASP by the members. However, the difficulties were diminishing with the good results obtained by the method in the months of its implantation and with that the activities identified in the action plan were standardized and each employee was trained before starting their activities. In order to achieve a positive result in the achievement of the goals, it was also necessary to standardize the documents such as: MASP file, training manual, final product assembly manual, which was still being discussed by the board and the actions follow-up form. Finally, after application of the method, the members of the MASP Group personally followed and monitored the tasks to remedy any doubts of the collaborators.

5.4.8 Step 8 - Conclusion

The last stage of MASP allowed the factory to create a fertile ground for change by correcting problems detected in its operations, making adjustments to the processes of existing products and systems.

5.5 ANALYSIS, RESULTS AND DISCUSSIONS

Production failures are always arising in any productive process in factories, and they need to be

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flexible in order to identify the presumed causes of the problems and try to reduce or eliminate them, thus guaranteeing the improvement of the quality of their processes (JAGER, 2004).

The validation of MASP applied in the furniture industry occurred based on the reduction in the number of requests for technical assistance in the period from November 2017 to January 2018 compared to the months of June to October 2017.

In the period from June to October 2017 the company under study received 268 requests for technical assistance and 3600 items were manufactured, generating failures of 7.44% of the final product. In the period from November 2017 to January 2018, after application of the MASP model, it received 113 requests for technical assistance and 2270 manufactured items, generating failures in the final product of 4.97%. The value of the percentage demonstrated was based on the number of requests for technical assistance divided by the number of products produced in the month.

The results obtained showed that the actions performed through the MASP methodology were effective, obtaining a reduction of 33% in the number of failures of the final product, achieving the target set by the members of the reduction group of 10% and consequently a reduction around 58% of the number of requests for technical assistance. In relation to the main root cause, the finishing, from November 2017 to January 2018 were 29 requests, a monthly average of 9.66 requests, a reduction of 68% compared to the period in which MASP was not applied.

The technical assistance generated a cost in the period in which MASP was applied (November 2017 to January 2018), of R $ 20,300.00 compared to the period from June to October 2017, which was around R $ 40,000.00 resulted in a reduction of 49%. The results achieved in the study were similar to the main national and international studies using the MASP cited in the dissertation, such as the reduction of failures and the resulting losses, continuous improvement of the productive process, improvement in final product quality, reduction of rework and the cultural change in relation to quality in the internal environment of the factory and the store.

These results have only been achieved with the creation of a MASP form, the implementation of the training manual for employees, the final product assembly manual and a new flowchart in the product development process with a checklist before the product is delivered to the customer and after assembling the furniture, giving the delivery of the final product with quality. The MASP form was created to prevent process steps from being skipped or forgotten and could compromise the efficiency of the method. The form was created prior to the application of MASP in the company and presented to members in a self-explanatory and simple to use form and can be viewed in Appendix D. In the employee training manual, it was studied by the board and implemented in November 2017. The company realized its importance and the need to provide the employee with a fast understanding, interaction and explicit duties and rights before the company. It was proposed to update it annually and deliver the copy for both the old and the new employees. The items included in the manual are: Mission, Vision and Values of the Company, Organization Chart, Company History, Main Products Manufactured, Human Resources Processes, Rights and Duties of Employees.

For Manville (2003); Oliveira (2009), the employee integration manual aims to socialize the employee and make him feel motivated and an integral part of the organization, becoming a disseminating element of the organizational culture. As for the manual for assembly of the final product, it is being elaborated by the board, waiting for some items related to the best procedures. However, the assemblers are already using a checklist, where customers sign up at the end of the product installation.

Thus, as the method was applied in the company, involving people from different departments, the members of the MASP group were able to perceive the effect of the interaction in the company. The progress of the work was constantly communicated to all to be aware of the problem and to make contributions. With this, there was a transmission of knowledge both from the members who learned about the details of the furniture production line, and from the operators who knew and learned about MASP and the importance of a quality product.

It should be noted, however, that the company does not have a quality management system in place, but it is already reaping the benefits of MASP. As evidence of this, the board intends to continue the method, involving more employees to constantly seek to improve the company.

V. CONCLUSIONS

The search for the dream of home ownership, the reduced spaces of the current housing configuration in Brazil, and technological advances in machinery and equipment have driven the growth of the national furniture industry in the last decade. In this context, quality in products and services in furniture companies appears as a basic need for business maintenance and a means to gain competitive advantage. A product made

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with zero defect reduces rework, decreases the number of non-conformities and returns, waste, costs, increased productivity and profit and as consequence generates customer satisfaction. In addition, the quality management within a furniture factory improves its productive processes and the valorization of its clients, thus promoting the organizational improvement and therefore increasing its competitiveness. In this way the quality has become a basic strategic to ensure the survival of the furniture companies and make the production of products more diversified and high value-added and aligned the needs of customers. In this respect, quality tools and methods are highly important for organizational differentiation, since they allow the identification and solution of the main problems and continuous improvement in order to meet and exceed the expectations of the consumer taking the competitive advantages. However, the use of quality methods still faces difficulties in its implementation due to several factors such as the financial problems faced by medium and small companies, disqualification of labor and low value wages in comparison with other sectors and companies managed by relatives. This work is part of this theme by making use of the MASP method together with the quality tools in order to identify the factors that lead to the increase of technical assistance requests as a consequence of the increased cost in a planned furniture company. Based on this method, we analyzed the collected data prioritizing which problems were affecting the production process generating failures and impacting the final product. Finishing, delivery failure, damaged components, incorrect shipment of components, transportation failure, customer-generated parts failure, incorrect ordering and plagues were listed, but the finishing was most evidenced by the Pareto chart tool, arriving around 33% of requests received. After this step, the Ishikawa Diagram was analyzed, analyzing the possible causes of the failures in the final finishing of the products in each of the 6Ms suggested as methodology, identifying the failures in the final product, with emphasis on disqualified labor, machines with defects and the lack of standardization of procedures and quality standards. The action plan (5W1H) was then formulated together with the members of the company, with proposals for improvements in the production processes.

At the end of this study, satisfactory and positive results were obtained, as there was a 58% reduction in the number of requests for technical assistance. In relation to the costs generated by the occurrence of failures, the reduction reached 49%, causing financial gains for the company surveyed. It is important to emphasize that the use of methodologies such as MASP are very helpful tools to determine the root causes of an organization's problem and only with constant use in a problem solving routine can the quality of the services desired be guaranteed.

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REFERENCES

[1] ALSALEH, N. A. Application of quality tools by the Saudi food industry. The TQM, Magazine, v. 19, n. 2, p. 150-161, 2007.

[2] ANDERSEN, B; FAGERHAUG, T. Root Cause Analysis: simplified tools and techniches. Milwaukee: ASQ, 2006.

[3] ANDRADE,M.M. Introdução à Metodologia do Trabalho Científico. 7ed. São Paulo:Atlas, 2006.

[4] ANDRADE, R.S; RODRIGUES, A. Implementação da metodologia de análise e solução de problemas(MASP) para redução de perdas em empresas manufatureiras. Revista universidade Vale do Rio verde. v. 15, n.1, p.73-82, 2017.

[5] ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS DO MOBILIÁRIO - ABIMOVEL disponível em http://www.abimovel.com/ acesso em 01 de fevereiro de 2018.

[6] AVRILLON, L. Démarche de résolution de problémes qualité dans le cadre de produits nouveaux de haute technologie. Annecy, 2005. Tese (Docteur de l’Unviersité de Savoie – Spécialité Génie Industriel) – Université de Savoie. 200 p.

[7] AZEVEDO, P.S; NOLASCO, A.M. Fatores de incorporação de requisitos ambientais no processo de desenvolvimento de produtos em indústrias de móveis sob encomenda. Ciência Rural, v.39, n.8, p.2422-2427, 2009.

[8] BASU, R. Managing quality in projects: An empirical study. International Journal of Project Management v. 32, p. 178–187, 2014.

[9] BEHNAM, B; ALVELOS, H. Exploring the Potential of Quality Tools in Tire Retreading Industry: a Case Study. Journal of Engineering Science and Technology (IJEST), 2011.

[10] BOAVENTURA.E.M. Metodologia da pesquisa: Monografia, dissertação e tese.São Paulo: Atlas, 2004.

[11] BOURKE, J; ROPER, S. Innovation, quality management and learning: Short-term and longer-term effects. Research Policy, v.46, n.8, p1505-1518, 2017.

[12] BRASIL. Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC). Sistema de Análise das Informações de Comércio Exterior (AliceWeb).

https://dx.doi.org/10.22161/ijaers.6.5.76 *ISSN: 2349-6495(P) | 2456-1908(O)*

Brasília, DF, 2018. Disponível em:<http://aliceweb2.mdic.gov.br>. Acesso em: 20 fevereiro de 2018.

[13] BRASIL. Ministério do Trabalho e Emprego (MTE). Relação de Informações Sociais (RAIS). Brasília, DF, 2017.Disponível em: <http://bi.mte.gov.br/bgcaged/ >. Acesso em: 20 de janeiro de 2018.

[14] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total: no estilo japonês. São Paulo: Campus, 2012.

[15] CANO, S.C.M; NOÉL, D.M.G. Mejoramiento de la Calidad em alimentos balanceados pelletizados para aves, mediante el método de ruta de la calidad. 2013. 241f. Tese (Engenharia Industria), USMP-San Martin de Porres, Lima, Peru.

[16] CARDOSO, C.C, WIEMES, L. Análise dos processos de pedido de compra através da Gestão da Qualidade. Revista Eletrônica Conhecimento interativo. São José dos Pinhais, Paraná, v.7, n.1, p.3-15, 2013.

[17] CARNEIRO, V. T. S *et al*. Aplicação da ferramenta MASP para redução de custos de demurrage de frete de importação: Estudo de caso em uma indústria farmacêutica. Anais do *VII SEPRONE*, 2012.

[18] CARNEVALLI, J. A.; MIGUEL, P. A. C.; CALARGE, F. A. Proposta de um modelo conceitual para minimizar as dificuldades no uso do QFD. Revista Produção, v. 18, n. 1, p. 126-141, 2008.

[19] CARPENETTI, L. C. R. Gestão da qualidade: Conceitos e técnicas, 2ª ed, São Paulo: Atlas, 2012.

[20] CASTRO, A. D. J, PINHEIRO, A, YOVANKA PÉREZ GINORIS, Y. P. Aplicação do Método de Soluções de Problemas em um sistema de tratamento de efluentes de indústria frigorífica de aves. Revista Ambiente & Água - An Interdisciplinary Journal of Applied Science, v.6, n.3, 2011.

[21] CERVO, A.L; BERVIAN, P.A; DA SILVA, R. Metodologia Científica. 6 ª ed. São Paulo: Pearson Prentice Hall, 2007.

[22] COBERO, C; OLIVEIRA, M.C.F. PATUDO, P.H. Implantação da ferramenta de qualidade 5S em uma fábrica de esquadrias de alumínio. Revista Cientifica da FAEX. 6 ed. Ano 3. 2014.

[23] COLENGHI, V.M. O & M e qualidade total: uma integração perfeita. 3. ed. Uberetama: Ed. V. M. Colenghi, 2007.

[24] COOPER, R. G.; EDGETT, S. J. Ideation for product innovation: what are the best methods? PDMA Visions, v. 32, n. 1, p. 12-17, 2008.

[25] CORRAL, K.M.O; ACOSTA,M.L; SOLANO,G.M.M; PADILHA, J.E.S; RODRIGUEZ, L.C.M. Implementación de Ayudas visuales para el área de manufactura. Avanços de Investigación en ingeniería en el estado de Sonora. v.4, p. 81-89, 2014.

[26] CORREA, A. MEDINA, P. CRUZ. E. Identificación y eliminación de generadores baja confiabilidade em la captura datos de um sistema M.E.S. em una empresa de alimentos en el Valle del Cauca. Revista Avance em Sistemas e Informática.v. 8, n.3, p. 91-102, 2011.

[27] COSKUN, H; YILMAZ, O. A new dynamical model of brainstorming: Linear, nonlinear, continuous (simultaneous) and impulsive (sequential) cases. *Journal of Mathematical Psychology*, v. 53, p. 253-264, 2009.

[28] COSTA, A. B.; HENKIN, H. Organização industrial e inserção internacional da indústria brasileira de móveis. Ensaios FEE: Porto Alegre, v. 33, n. 1, p. 143-176, 2012.

[29] CRESWELL, John W. Projeto de Pesquisa: Métodos Qualitativo, Quantitativo e Mistos. 3ª ed. Porto Alegre: Artmed, 2010.

[30] FERNÁNDEZ, I., EIZAGIRRE, A., ARANDIA, M., RUIZ, P. Y; EZEIZA, A. Creatividad e innovación: claves para intervenir en contextos de aprendizaje. REICE, v.10, n. 2, p. 23-40, 2012.

[31] FIGUEIREDO, A.M; SOUZA,S.R.G. Como elaborar projetos, monografias, dissertações e teses: da redação científica à apresentação do texto final. 4ª ed. Rio de Janeiro: Lumen Juris, 2011.

[32] GABILLAUD, A.M.P. Método de análise e solução de problemas (MASP)- aplicação na gestão de manutenção de uma rede varejista no estado de Sergipe.2011.86f. Dissertação (mestrado em engenharia de produção). Universidade federal de Pernambuco-UFPE.

[33] GALINARI, R.; TEIXEIRA JUNIOR, J. R.; MORGADO, R. R. A competitividade da indústria de móveis do Brasil: situação atual e perspectivas. Bens de Consumo. BNDES Setorial 37, São Paulo, p. 227-272, 2013.

[34] GARCIA, S.M.R; RODRIGUEZ, J.M.R; QUINTANA, A.C. Crea, Innova: Uma propuesta formativa para incentivar la innovación em las organizaciones. IV Congreso Internacional Online sobre Transformación e Innovación en las Organizaciones, p. 170- 183, 2016.

[35] GIl, A.C. Métodos e técnicas de pesquisa social. 6ª ed. São Paulo: Atlas, 2008.

[36] GODOY, L.P; EVANGELISTA, M.L.S; PIZZOLATO, M; FERREIRA, A.R.A. Utilização do designer como vantagem competitiva no setor moveleiro de Santa Maria/RS. REVISTA PRODUÇAO. v. 12, n. 3, p. 779-805, 2012.

[37] GONZALES, F.J.G. Herramientas de calidad y el trabajo em equipo para diminuir la reprobación escolar. Conciencia Tecnológica.v. 48, p. 17-24, 2014.

[38] GWIAZDA, A. Quality tools in a process of technical Project management. Journal of Achievements in Materials and Manufacturing Engineering.v.18, p.1-2, 2006.

[39] HARRINGTON, J. Business process improvement workbook: documentation, analysis, de-sign and

https://dx.doi.org/10.22161/ijaers.6.5.76 *ISSN: 2349-6495(P) | 2456-1908(O)*

management of business process improvement. New York, McGraw-Hill, 2007.

[40] HERRON, C.; BRAIDEN, P. A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies. International Journal of Production Economics, v. 104, n. 1, p. 143-153, 2006.

[41] HESLIN, P. A. Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations. *Journal of Occupational and Organizational Psychology*, v. 82, n. 1, p. 129-145, 2009.

[42] HORA, H. R. M., COSTA, H. G. Tomada de Decisão do MASP: Uma Contribuição para Decisões Utilizando a Matriz AHP. ENEGEP. In:Encontro Nacional de Engenharia de produção. 24. Anais. Salvador, 2009.

[43] HOSKEN, Márcio José de Campos. Produzindo e Montado Sua Qualidade. 2ª Edição, 2005.

[44] IEMI — INTELIGÊNCIA DE MERCADO. Brasil Móveis: Relatório Setorial da Indústria de Móveis no Brasil — São Paulo: v. 11, p. 274, out. 2016.

[45] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Pesquisa Industrial Mensal. 2017.Disponível em: <http://www.ibge.gov.br/>. Acesso em: 22 fevereiro 2018.

[46] INGLIS, P.F. O lucro está no pós-venda. HSM Management, n. 32, p. 119-124, 2002.

[47] JAGER, B. et al. Enabling Continuous improviment: a case study of implementation. Journal of Manufacturing Technology Management, v. 15, n. 4, p. 315-324, 2004.

[48] JIA, C; CAI, Y, TAK YU, Y; TSE, T.H. 5W+1H pattern: A perspective of systematic mapping studies and a case study on cloud software testing. Journal of sistems and software. v.15, p. 206-219, 2016.

[49] JIANG, G. et al. Lean Shipbuilding for Project-based manufacturing. IIE anual conference proceedings: Norcross.p.1730-1739, 2015.

[50] JITPAIBOON, T., RAO, S. S. A meta-analysis of quality measures in manufacturing system. *International Journal of Quality & Reliability Management*, v.24, n.1, p. 78-102, 2007.

[51] JUNG, C. F. Metodologia Para Pesquisa & Desenvolvimento: Aplicada a Novas Tecnologias, Produtos e Processos. Rio de Janeiro: Axcel Books, 2004.

[52] KOHN, N. H.;; PAULUS, P. B. CHOI, Y. Building on the ideas of others: an examination of the idea combination process. *Journal of Experimental Social Psychology*, v. 47, p. 554–561, 2011.

[53] LAKATOS, E.M; MARCONI, M A. Fundamentos de metodologia cientifica. 7 ed. – São Paulo: Atlas, 2010.

[54] LAKHAL, L.; PASIN, F.; LIMAM, M. Quality management practices and their impact on performance. International Journal of Quality & Reliability Management.v. 23 n. 6, p. 625-646, 2006.

[55] LAU, C. Y. Quality Improvement Tools and Processes. Neurosurgery Clinics, Califórnia –USA, n. 26, p. 177-187, 2015

[56] LIN, D. How can we systematically develop an app software? In: Applied System Innovation (ICASI), International Conference on. IEEE, p. 1-4, 2016.

[57] MALHOTRA, Naresh K. Introdução à pesquisa de marketing. São Paulo: Pearson Prentice Hall, 2005.

[58] MANVILLE, B.; OBER, J. Beyond empowerment: Building a company of citizens. Harvard Business Review, p. 48−53, 2003.

[59] MARIANI, C. A. Método PDCA e ferramentas da qualidade no gerenciamento de processos industriais: um estudo de caso. Revista de Administração e Renovação, São Paulo, v.2, n.2, 2005.

[60] MOTTA, S. C. S.; MARINS, C. S. Análise da aplicação da ferramenta masp no controle de estoque de uma usina siderúrgica. Trabalho apresentado no IX Simpósio de Excelência em Gestão e Tecnologia, 2012.

[61] MELO, EAS. Gestos de autoria: construção do sujeito da escrita na alfabetização. In: Baronas RL, organizador. Identidade cultura e linguagem. Campinas (SP): Pontes Editores; 2006.

[62] NAÇÕES UNIDAS. Comtrade - Database. Disponível em: <https://comtrade.un.org/>. Acesso em: 10 de março de 2018.

[63] OLIVEIRA, D.P.R. Sistemas, Organização & Métodos: uma abordagem gerencial. 18ª ed. São Paulo: Atlas, 2009.

[64] ORIBE C. Y. Método de Análise e Solução de Problemas (QualyproConsultoria & Treinamento). Contagem, 2012.

[65] PACAIOVA, H. Analysis and identification of nonconforming products by 5W2H method. Center for Quality, 2015.

[66] PASQUALIN F.; SIEDENBERG, R.D. Estratégias de operações – Ijuí : Ed. Unijuí, 2012.

[67] PIECHNICKI, P.S; KOVALESKI, J. L; SOUZA,M.V; PIECHNICKI, L; BARAN, R. Utilização da metodologia de análise e solução de problemas na redução das perdas de água: Um estudo de caso na SANEPAR. Revista de engenharia e tecnologia.v.3, n 2, 2011.

[68] PRÍSTAVKA, M; KOTOROVÁ, M, SAVOV; R. Quality Control in Production Processes. Acta Technologica Agriculturae. v. 19, n.3, p.77-83, 2016.

[69] PRODANOV, C.C; FREITAS, E.C. Metodologia do trabalho científico: Métodos e técnicas da pesquisa e do trabalho acadêmico.2ª ed.Novo Hamburgo: Feevale, 2013.

[70] PUJO, P.; PILLET, M. Control by quality: proposition of a typology. Quality Assurance, v.9, p.99-125, 2002.

https://dx.doi.org/10.22161/ijaers.6.5.76 *ISSN: 2349-6495(P) | 2456-1908(O)*

[71] RAWLINSON, J.G. Creative Thinking and brainstorming. 2ª ed. New York: Routledge, 2017.

[72] RELATÓRIO SETORIAL 2018 – Pólo moveleiro do Rio Grande do Sul - MOVERGS – Associação das Indústrias de Móveis do Estado do Rio Grande do Sul. Estudo realizado por Instituto de Estudos e Marketing Industrial (IEMI). Disponível em: http://www.movergs.com.br/arquivos/relatorio_setorial_2018_moveis_do_rs.pdf

[73] ROMERO, J.M. Técnicas de criatividade como dinamizadoras de processos formativos. Revista CEF GESTIÓN, v. 212, p.89-96, 2016.

[74] ROONEY, J.; HOPEN, D. On the trial to a solution: part 2 – what is in? what is out?Defining your problem.The Journal for Quality and Participation, v. 27, n. 4, 2004.

[75] SANTOS, O.S; PEREIRA,J.C.S; TSUGIO,M.O. A implantação da ferramenta MASP para melhoria contínua em uma indústria vidreira. Anais.XV SIMPOI.Simpósio de Administração da Produção, Logística e Operações Internacionais, 2012.

[76] SEBRAE. Serviço Brasileiro de Apoio a Micro e Pequenas Empresas. Demanda por móveis planejados aumenta e estimula profissionalização do setor. Disponível em:http://www.sebrae2017.com.br/Sebrae2017/Alertas/Demanda-por- Acesso em: 02 de fevereiro de 2018.

[77] Secretaria de Estado de Planejamento e Desenvolvimento Econômico disponível em http://www.seplan.am.gov.br/. acesso em 02.de maio de.2018

[78] SELEME, Robson. STADLER, Humberto. Controle da Qualidade – As Ferramentas Essenciais. Curitiba –PR: Editora IBPEX.2008.

[79] SEVERINO, A.J. Metodologia do trabalho cientifico. 23ª ed. São Paulo: Cortez, 2008

[80] SINI, G. Méthodes et outils pour la gestion des workflow-modélisation ontologique des processus pour l 'analyse.2013.189f. These de doctorat. Universite Mouloud Mammeri de Tizi Ouzou.

[81] SOUZA, C. H. M. DE. Uma ferramenta para avaliação da qualidade em serviços –a janela do cliente. Revista Perspectivas online, v. 5, n. 1, p. 65–79, 2008.

[82] SPEROTTO, F. Q. Arranjo Produtivo Local Móveis da Serra Gaúcha. In: MACADAR, B. M. de; COSTA, R. M. da.(Org.). Aglomerações e Arranjos produtivos Locais no Rio Grande do Sul. Porto Alegre: FEE. p. 405-443, 2016

[83] STAKE, R.E. Investigación comestúdio de casos. 4ed. Madrid: Ediciones Moreta, 2007.

[84] TAGUE, Nancy R. The Quality Tool Box. 2. ed. Milwaukee: ASQ Quality Press, 2005.

[85] TADDESE, F. Application of TQM for innovation: na exploratory Research of japonese, Indian na Thailand companies. International Journal of Innovation and technology management.v.14, n. 4, p.1-20, 2017.

[86] TEIXEIRA, J.F.; DIAS, V. A.; PIMENTA, E. P.; MACIEL, M. C.; SILVA, B. Metodologia para análise e solução de problemas: Conceito, ferramentas e casos Sadia Concórdia S/A e Albras Alumínio Brasileiro S/A. In:XXXII Encontro Nacional De Engenharia De Produção, 2012, Bento Gonçalves, RS.

[87] VERGARA, S. C. Método de pesquisa em administração. São Paulo: Atlas, 2012.

[88] ZASADZIEŃ, M. Using the Pareto diagram and FMEA (failure mode and effects analysis) to identify key defects in a product. Management Systems In Production Engineering, v.16, n.4, p.153-156, 2014.

[89] ZU, X. Infrastructure and core quality management practices: how do they affect quality? International Journal of Quality &Reliability Management, v. 26, n.2, p. 129-149, 2009.