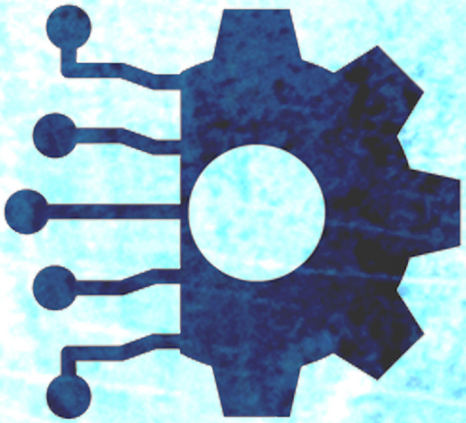
Marcos William Kaspchak Machado
(Organizador)



Engenharia de Produção: What's Your Plan? 4

Atena Editora
Ano 2019

Marcos William Kaspchak Machado
(Organizador)

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Atena Editora
2019

2019 *by Atena Editora*

Editora Chefe: Profª Drª Antonella Carvalho de Oliveira
Diagramação e Edição de Arte: Natália Sandrini e Lorena Prestes
Revisão: Os autores

Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)

E57 Engenharia de produção: what's your plan? 4 [recurso eletrônico] / Organizador Marcos William Kaspchak Machado. – Ponta Grossa (PR): Atena Editora, 2019. – (Engenharia de Produção: What's Your Plan?; v. 4)

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Inclui bibliografia
ISBN 978-85-7247-256-2
DOI 10.22533/at.ed.562191204

1. Engenharia de produção – Pesquisa – Brasil. 2. Inovação. 3.Segurança do trabalho. I. Machado, Marcos William Kaspchak. II.Série.

CDD 620.0072

Elaborado por Maurício Amormino Júnior – CRB6/2422

www.atenaeditora.com.br

APRESENTAÇÃO

A obra "*Engenharia da Produção: What's your plan?"* é subdividida de 4 volumes. O quarto volume, com 24 capítulos, é constituído com estudos contemporâneos relacionados a inovação em gestão organizacional, gestão de segurança do trabalho, ferramentas de gestão da qualidade e sustentabilidade.

A sequência, os estudos de gestão da qualidade e sustentabilidade apresentam a utilização de princípios e ferramentas para o aumento de produtividade sustentável. Na gestão da qualidade são abordadas ferramentas como QFD, CEP e MASP. Estas ferramentas auxiliam as organizações na melhoria dos processos e redução de desperdícios o que gera um resultado, não só financeiro, mas também ambiental e social.

Aos autores dos capítulos, ficam registrados os agradecimentos do Organizador e da Atena Editora, pela dedicação e empenho sem limites que tornaram realidade esta obra que retrata os recentes avanços científicos do tema.

Por fim, espero que esta obra venha a corroborar no desenvolvimento de conhecimentos e inovações, e auxilie os estudantes e pesquisadores na imersão em novas reflexões acerca dos tópicos relevantes na área de engenharia de produção.

Boa leitura!

Marcos William Kaspchak Machado

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CAPÍTULO 1

QUALITY TOOLS FOR REDUCING THE AVERAGE SERVICE TIME OF NON-SCHEDULED OCCURRENCES IN AN ELECTRIC POWER DISTRIBUTOR

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RESUMO: Este estudo propõe analisar o indicador de qualidade do Tempo Médio de Atendimento (TMA) no setor de atuação, em uma distribuidora de energia elétrica em Juazeiro do Norte - CE, com base no uso das ferramentas básicas de qualidade, para elaborar uma proposta de melhoria na gestão de atendimento do setor, devido a uma improdutividade acima do objetivo. O trabalho partiu de uma base teórica sobre o tema discutido no desenvolvimento da pesquisa e foi estruturado pelo PDCA, por sua capacidade de sequenciar de forma lógica e organizada, os passos que levaram à elaboração e implementação da proposta de melhoria, oferecidos ao processo de estudo a partir da aplicação do Brainstorming, Diagrama de Ishikawa, Cronoanálise e 5W2h, que auxiliou na identificação de falhas e sua redução. A proposta sugerida aderiu ao processo e trouxe resultados extremamente significativos, como a redução da TMA em média 25% abaixo da meta estabelecida pela empresa, a média desse tempo até abril de 2017 era de 506 minutos e a meta era de 419 minutos, no primeiro mês de implantação da proposta, a TMA apresentou 324 minutos, liberando a possibilidade de custos com multas e insatisfação dos clientes internos e externos. As contribuições consistiram no mecanismo de análise e identificação de déficits no processo para realizar as atividades envolvidas, garantindo métodos eficientes que sustentasse a rotina de trabalho.
PALAVRAS-CHAVE: Indicador de Qualidade. T*MA*. PDCA. Melhoría Proposta.

ABSTRACT: This study proposes to analyze the quality indicator of the Average Service Time (*TMA*) in the operating sector, in an electric

energy distributor in Juazeiro do Norte - CE, based on the use of the basic quality tools, to elaborate a proposal for improvement to the management of the attendance in the sector, due to an unproductiveness above the goal. The work began with a theoretical basis on the subject discussed in the development of the research and was structured by the PDCA, for its ability to sequence in a logical and organized way, the steps that led to the elaboration and implementation of the improvement proposal, offered to the study process at from the application of the Brainstorming, Ishikawa Diagram, Chronoanalysis and 5W2h, which aided in the identification of faults and their reduction. The suggested proposal adhered to the process and brought extremely significant results, such as a reduction of *TMA* averaging 25% below the goal set by the company, the average of this time until April 2017 was 506 minutes and the goal was 419 minutes, in the first month of implementation of the proposal, the *TMA* presented 324 minutes, freeing possibility of costs with fines and internal and external customer dissatisfaction. The contributions consisted of the mechanism of analysis and identification of deficits in the process to carry out the activities involved, ensuring efficient methods to sustain the work routine.
KEYWORDS: Quality indicator. *TMA*. PDCA. Proposal for improvement.

1 I INTRODUTION

The Persistence in the current competitive market, require organizations to captivate their clients by adopting new strategies whithout leave provide delivering their goods and services (Beuren and Florin, Hein, 2014). Thus, good quality management of information and communication flowing within a company is like considered a critical factor (WEISS; BERNARDES, 2014). This factor, when effectively implemented, ensures compliance with all stages of the process within the deadlines and goals established previously by the company (TEIXEIRA, 2016).

One way of monitoring the performance of this management is through indicators. The use of indicators allows the evaluation of quality in a broad way in quality management and consequently in the management of the organization (CARVALHO, PALADINI, 2012). When these indicators are not meeting the pre-established goals, an investigation and analysis of the process is required to score failures and propose improvements in the study area.

In the light of the above, this study proposes to analyze the Average Service Time (TMA) in the operation sector, in an electric energy distributor located in Juazeiro do Norte / CE, using the basic quality tools to prepare a proposal improvement in the management of costumer care in the sector. Once this sector is exceeding the goals of performace indicators pre-established by the company in reference to non-scheduled occurrences.

The work is justified by the use of the basic quality tools for the contribution with reduction of the TMA through analyzes made during this study, which are essential to

ensure that the objectives are achieved. Regarding the financial contribution, this study will present means that reduce costs with failures and loss of time, besides providing an analytical and systematic view of the service process.

2 I THEORETICAL REFERENTIAL

2.1 Evolution of quality

At the beginning of the nineteenth century, the concept of quality went back only to the finished product or service focused on the conformity of goods or services sold. During the decade of the 30, the control of the productive process began, where the statistical analyzes are part allowing more efficient inspection. Later the importance was given by the prevention of defects along the entire production chain, until reaching the 50's where Total Quality Management was predominant, which encompasses the specifications of the product, the needs of the market and of the consumers (LOPES, 2014).

There are different interpretations on the definition of quality, Frame 1 below shows this definition according to interpretations of the main quality gurus, as well as the emphasis given by each one.

Author	Definition	Emphasis
Deming	Predictable level of uniformity and reliability at low cost, appropriate to market needs	Conformity of the product with its technical specifications. Continued commitment to top management
Juran	Suitability to use	Satisfying customer needs
Feigenb	All characteristics of a product or service, related to marketing, engineering, manufacturing and maintenance, whereby a product or service meets customer expectations	Customer satisfaction and improved collaboration and communication between functional departments of the organization
Crosby	Compliance with technical specifications	Production without defects. Involvement and motivation of the organization's human resources

Frame 01 - Different interpretations for quality definition

Source: Lopes (2014)

Among the definitions cited in Table 1, it can be stated that the one that comes closest to quality in service operations is Juran and Feijenbaun's interpretation, which emphasize that quality is defined according to the customer's expectations, with the service provided or experienced. Communication is one of the shortcomings in the provision of services that directly interfere with the quality of the service provided, and it is essential to eliminate deviations of attention to make good use of what is being transmitted and avoid anomalies in attendence (SOUSA et al., 2014).

2.2 Quality in services

The quality of services is basically the combination of expectations and the

conformity of a product or service, when a consumer's point of view is considered about a product offered (SLACK, 2009). Thus, it is noticeable that service companies must know how to manage the improvments that their customers want, to be included in company strategic management, where will be consolidate a vision of that can used to or disposable for the absorption of new markets(MOURA, 2017).

Quality management is therefore critical to the success and survival of any organization, as the current market is buoyant where consumers demand better products at lower prices. If in a given situation the internal customer is dissatisfied, he tends to be discourteous with external clients, while when stimulated, he / she can surprise the other (HORA; MOURA; VIEIRA, 2009). One means of avoiding this discontent of the client, whether internal or external, is through a previous study or adoption of tools or models of process management.

2.3 Quality tools

According Dos Santos et al. (2016), quality tools consist of methods and instruments used to improve processes, development, measurement, analysis, improvement of the quality of organizations and especially problem solving, which still effectively operationalize the principles of quality management. Several techniques, tools, systems and procedures are being made available to companies, among which we can mention: PDCA, Diagram of Ishikawa, Brainstorming, 5W2H.

2.3.1 PDCA

It consists of a simple, sequenced and organized method divided into four stages named in: P - Plan, D - Do, C - Check and A - Action, as shown in Figure 01 Was developed in the 1950s by the American physicist Walter Andrew Shewart with the mission to rebuild companies, being widely used to seek solutions to problems and improvements of processes in order to maintain goals achieved, taking the information as a factor for directing decisions (MARTINS; MARTINS; FERREIRA, 2016).

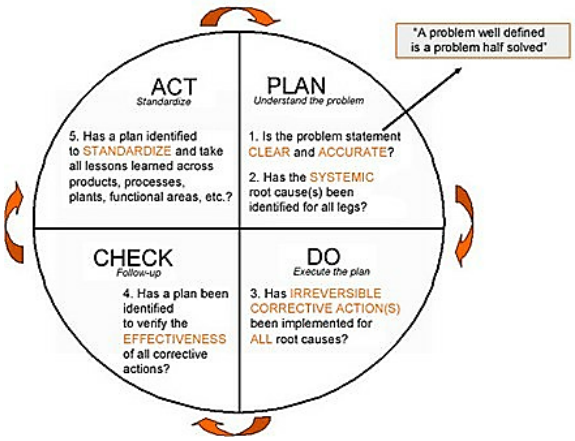


Figure 01 - Method PDCA

Source: Chart it now (2017)

Perdoná et al. (2016) arguement that this constant concern for continuous improvement represents small cost reductions, which in the long run become very attractive.

2.3.2 Ishikawa diagram

This diagram is indicated to verify the main causes that are generating a given problem, where are analyzed in circumstances that surrounds the 6Ms (BARROS; BONAFINI, 2015) as it is represented in Figure 02:

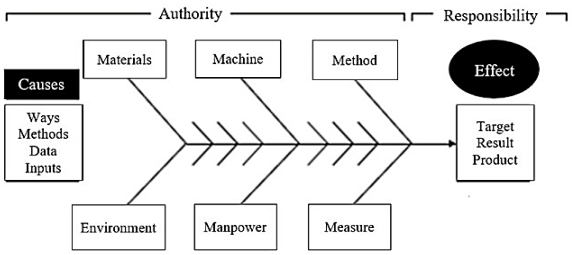


Figure 02 - Representation Ishikawa Diagram's

Source: Adapted from Seleme and Standler (2012)

2.3.3 Brainstorming

Brainstorming was created by the American consultant Alex Faickney Osborn in 1950 with the purpose of reducing individual or group distractions and potentiating the amount of solutions to problems detected. The technique consists of the informal interaction between individuals in a group to collect ideas (BUCHELE et al., 2017), as shown in Figure 03.

Figure 03 – Brainstorming representation

Source: Hansen (2017)

According Gaião Filho and Campos (2015), this classic technique can be divided into the following stages: Orientation (orient the team, presenting the problem to be worked on), Preparation (stipulating the time for providing ideas), Analysis (step of association association of ideas, proposals, according to defined criteria) Ideation (step of choice those of the most relevant ideas), Synthesis and Evaluation (phases consist in detailing and describing the ideas chosen and confronting them by checking their adherence).

2.3.4 5W2H

The 5W2H or 5W1H consists of a practical tool that allows the identification of data and routines of a plan of action or of a production unit, consisting of questions in English initiated by W and H, as shown in Frame 02. 5W1H it acts when there is not data referring to one of the factors initiated with H, where the study situation does not apply (SELEME; STANDLER, 2012; SALVADORI, 2013).

5W	What	What action will be taken?
	Who	Who will perform / participate in the action?
	Where	Where will the action take place?
	When	When will the action be performed?
	Why	Why will the action be performed?
2H	How	How will the action be performed?
	How much	How much will it cost to perform the action?

Frame 02 – Method 5W2H

Source: Adapted from Salvadori (2013)

2.3.5 Chronoanalysis

It can be defined as a process focused at measuring and determining the standard times of the study process, through timing (TAKAASHI; LIMA; WAR, 2016). According Slack (2009), a time study consists of evaluating the operator's rhythm, process steps and tolerances, by means of timed records for activity performed, and for data analysis capable of providing the time needed to perform the work with a defined level of performance.

In this way, the manager will be able to define the actual installed capacity of its productive flow, which is crucial for a correct planning and goaling of its available resources (human, machines and equipment), as a means to meet commercial demand in the market (FELIPE et al., 2012). In order to maintain the pace of work within the standard time determined in the chronoanalysis, goals known as indicators of service quality are established.

2.4 Quality indicators through guidelines

The National Electric Energy Agency (*ANEEL*), in its normative resolution n ° 395/2009, establishes a procedure related to the quality of electric energy, which are evaluated as: product quality and service quality. Product quality refers to constant voltage compliance. The quality of the service encompasses the goal audience, which evaluates aspects such as: duration, and the Average Service Time (*TMA*) to emergency occurrences.

The same rule indicates that "attendance to emergency occurrences should be supervised, evaluated and controlled by means of indicators that express the values linked to consumer units". Normative Resolution nº 728/2016, deals with the procedures for recording and monthly calculation of these indicators, and should be observed by

the distributor for each set of consumer units. The available indicators are:

- Average Time of Preparation (*TMP*): From the client's complaint until the appointment of the event to the emergency response team;
- Mean Time of Displacement (*TMD*): Displacement of the emergency care attendance team for the occurrence;
- Average Execution Time (*TME*): Execution of the service until its reestablishment by the emergency response team;
- Average Service Time (*TMA*): Average time for emergency care, verified in the sum of the other times presented previously (*TMP*, *TMD* and *TME*).

3 I RESEARCH METHOD

3.1 Search Classification

The nature of this work is classified as an applied research, aiming to solve a specific problem and the objectives are classified as exploratory, because it is a problem little explained, complicating the formulation of precise hypotheses about such phenomenon (GANGA, 2012). Regarding the approach, it is characterized as qualitative, because it uses qualitative data, once focused on the objectivity of meeting the goal stipulated by the company in reference to the *TMA*.

The research procedure is a case study, whitchi is an empirical investigation capable evaluates a current phenomenon within a day-to-day environment being highly recommended when the research involves several sources of evidence, favoring the development of the work by conducting data collection and analysis (YIN, 2015).

For the beginning of this work, a bibliographical survey was made, with the purpose of providing a theoretical basis, on the subjects that were discussed in the development of this study. As for the structuring of the execution of this research, the PDCA was used, due to its ability to sequence in a logical and organized way, the steps that led to the elaboration and implementation of the improvement proposal, offered to the study process, being fragmented as exposed in the Frame 03.

Phases of PDCA	Quality tools	Description of the tools used
Plan	Flowchart	Graphical representation of the process and knowledge of the steps that competes
	Timing	Quantitative analysis obtained in the managerial reports of the study company that presents the timing given in minutes
	Microsoft Excel 2013 Software	Preparation of the line graph to detect the bottleneck time of the process under study. In which the reduction of TMP was detected as the main objective of PDCA
	Brainstorming	Identification of causes that led to high TMP time
	Ishikawa diagram	It assisted in the knowledge of the influencing factors to the bottleneck, proceeding the study to analyze these causes
Do	5W2H	It structured the proposal for improvement, and clearly presented the reasons for the suggestion, as well as those responsible for implementing them. The proposal was then presented and accepted by those in charge of the sector that allowed the implementation of improvements
Check	Timing	Quantitatively show the significant result obtained after implementation of improvements
Action	Flowchart	Graphical representation of the new process after implementation of improvements

Frame 03 - PDCA Fragmentation in the Study

Source: Prepared by the author

The tools cited helped to identify faults and reduce them according to the need of the study process.

4 I RESULTS AND DISCUSSION

4.1 Object investigated

The study company is known for acting with generation, distribution, conversion, transmission and commercialization of electric energy, where it currently serves more than 61 million end users in the world. In Brazil, it is one of the largest private companies in the electricity sector, with headquarters located in Niterói / RJ and Fortaleza / CE and companies operating in 18 states.

The operation's sector (study sector), located in the city of Juazeiro do Norte / CE, operates 24 hours with direct customer service in reference to scheduled and unscheduled occurence related to the electric power system, in addition, assist also request of cut, reconnection, and new connection of the southern region of the state of Ceará.

The process that competes for this research, is summarized in the attendance to non-scheduled occurrences. The conduction of this study for this process was due to the deficiency of the sector in not being able to meet the goal of the *TMA*, resulting in a fine to company once regulated by Normative Resolution n ° 728/2016, deals with the registration procedures and monthly calculation of these indicators, as will be presented in the following sections, with PDCA.

4.2 Application of PDCA

4.2.1 Plan

The study process begins at the time of preparation, where the client makes the complaint through the relationship central, which records the occurrence and sends through the operation system BT, to the Regional Control Center (*CCR*). Receiving the occurrence, the *CCR* analyze the claim and designate the field team closest to the complaint address. The *TMP* process starts when *CCR* receives the complaint and assigns to the field team closest to the service

Therefore the complaint is received, the displacement time starts, where the team is directed to the occurrence. Upon arrival at the place, starts the *TME*, in which the team identifies the problem with the client. Being simple service, in a short time the team is released to another occurrence, otherwise the class prepares the place of attendance, executes the service and ends with the return to the *CCR*, being responsible for finishing the service after receiving the return. The study process is shown in Figure 04.

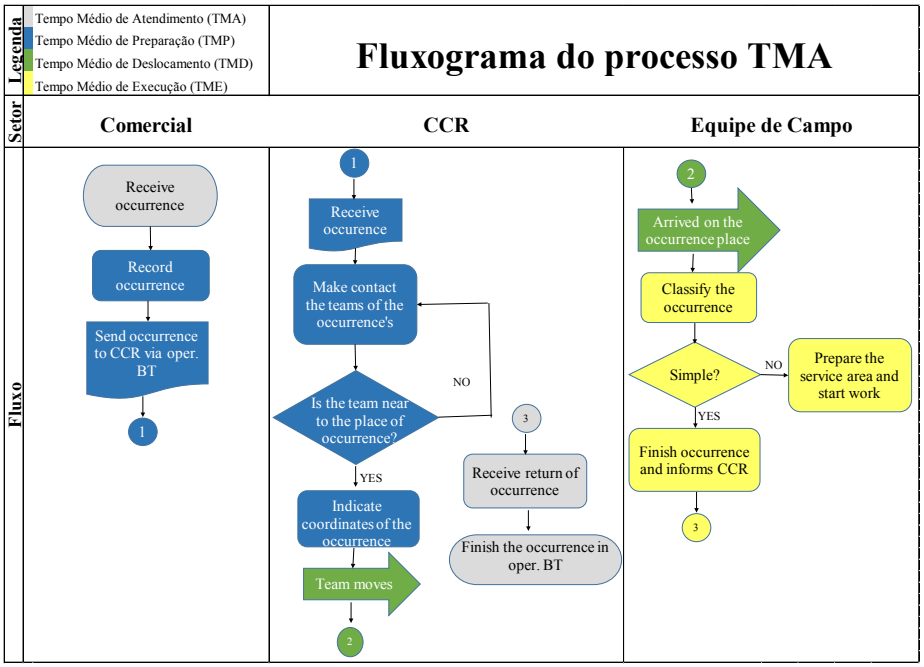


Figure 04 - Flow of *TMA*

Source: Prepared by the author

According Figure 04, the preparation phase requires a lot of time in reference to the others because there are adverse conditions that can influence the quality index of the *TMA*, such as: knowing which group of the same municipality is working close to the occurrence, the lack of prior knowledge of the reason for the occurrence and availability of the vehicle.

Next, it searched for the daily monitoring reports of the non-programmed occurrences, based on the time taken (minutes), performed by the system of the

company under study, evaluated within a period of six months, as represented in Figure 05. This information was adopteds as a data collection tool for further analysis.

Network analysis area
Follow-up of the average time of service attendance- South- 2017
Period: 01/01/2017 to 19/11/2017

Follow-up of the average time of service attendance- South- 2017

Month	Qty of incidents	Average time of preparation (min)	Average time of displacement	Average time of execution (min)	Average time of service (min)	Goal	Advance
JAN	3125	438	48	34	520	419	0%
FEV	2812	434	37	33	504	419	0%
MAR	2914	391	38	37	466	419	0%
APR						419	
MAY						419	
JAN TO MAY	8851	421	41	35	497	419	0%

Figure 05 - *TMA* record observation control

Source: Data of the company studied

The Figure 05 shows that the company was not able to meet the goals established until March 2017. Adding this information to a line chart, as shown in Figure 06, it is possible to notice that there is a high variation in the *TMP*, in reference to the other times in the *TMA*.

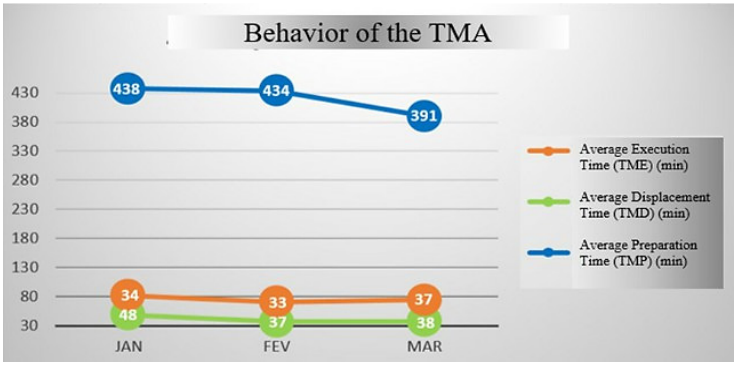


Figure 06 - Variation of TMP, TMD, TME

Source: Prepared by the author

Thus, Figure 06 makes it clear that the *TMP* step can be considered as a bottleneck, thereby making the PDCA objective to reduce this time. By placing the *TMP* step on an Ishikawa diagram (Figure 07), and collecting the possible causes through Brainstorming, carried out with the professionals responsible for performing these activities, it was possible to glimpse the adverse conditions that influenced the months of January and March 2017.

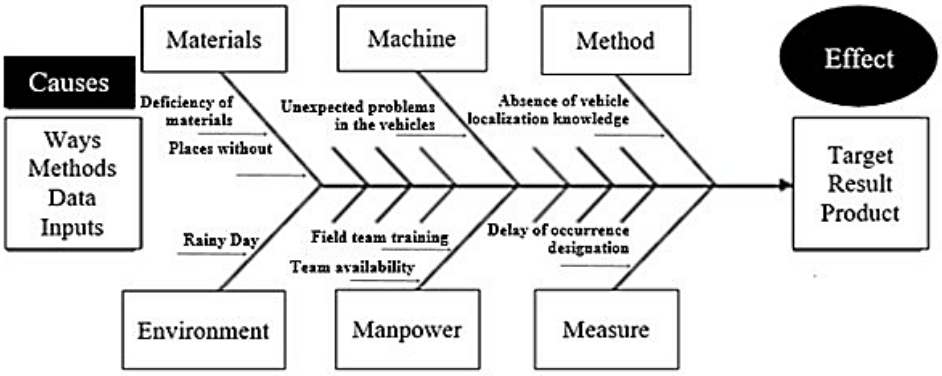


Figure 07 - Ishikawa diagram of *TMP* variation

Source: Prepared by the author

These failures were scored on 5W1H for analysis and verification o f possible improvements in the next phase of PDCA.

4.2.2 Execution

In this phase 5W1H was constructed, where the cause of the problem and the proposed improvement are found, as shown in Figure 08.

What?	Who?	Where?	When?	Why?	How?
Call Back	Operator	Control Center	Daily	Eliminate occurrences unproductive	Hiring the client
Zoning	Commercial	Follow-up worksheets	Daily	Location of vehicles by region	Sending information via email to operation center
MOV	Company of this study	Control center	Daily	Location of teams in real time	Via GPS
Integration of Field teams	Central and partner	In technical and commercial processes	Daily	Increase number of teams, optimize resources, reduce displacement	Integrating roles between teams

Figure 08 - 5W1H

Source: Prepared by the author

The proposals cited in 5W1H were presented to those responsible for the process and were acceded to evaluate the possibility of reducing *TMA*. In this way, the last phase of the PDCA presents the results of the improvement actions implemented in the study process.

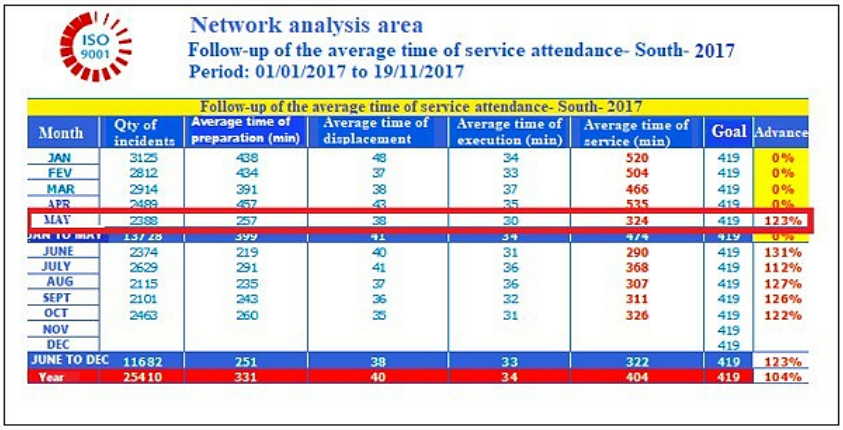
- Implementation of Call back within the control center: Before, the teams moving to occurrences that could be resolved by telephone with the Control Center;

- Zoning of the region: It was not known where the vehicles were. So the communication was with the team coordinator to identify the vehicle nearest occurence, and he would call the team leader to see if they were still on site or near the desired location. With the zoning the contact is direct with the head of the team closest to the occurrence;
- Monitoring of the teams through the mov: The mov informs the exact coordinates where the vehicle is located through GPS, as well as the information received from the occurrence;
- Integration of technical and commercial teams: The teams had their functions separated, where one could not perform activity of the other, even being close to the occurrence. Mult skil teams were created, capable of meeting any commercial or technical demand.

The implementation of there proposals led to the results observed in phase 3 of the PDCA.

4.2.3 Verification

This phase begins with the demonstration of the results through timing (Figure 09) presented in the company's management reports, evaluated after improvements are implemented.



Network analysis area

Follow-up of the average time of service attendance- South- 2017

Period: 01/01/2017 to 19/11/2017

Follow-up of the average time of service attendance- South- 2017

Month	Qty of incidents	Average time of preparation (min)	Average time of displacement	Average time of execution (min)	Average time of service (min)	Goal	Advance
JAN	3125	438	48	34	520	419	0%
FEV	2812	434	37	33	504	419	0%
MAR	2914	391	38	37	466	419	0%
APR	2489	457	43	35	535	419	0%
MAY	2388	257	38	30	324	419	123%
JAN TO MAY	13728	399	41	34	474	419	0%
JUNE	2374	219	40	31	290	419	131%
JULY	2629	291	41	36	368	419	112%
AUG	2115	235	37	36	307	419	127%
SEPT	2101	243	36	32	311	419	126%
OCT	2463	260	35	31	326	419	122%
NOV						419	
DEC						419	
JUNE TO DEC	11682	251	38	33	322	419	123%
Year	25410	331	40	34	404	419	104%

Figure 09 - Result of deploying improvements

Source: Data of the company studied

The improvements were implemented in May / 2017, where the positive result persisted in the subsequent months. The representation of these results is shown in Figure 10, below.

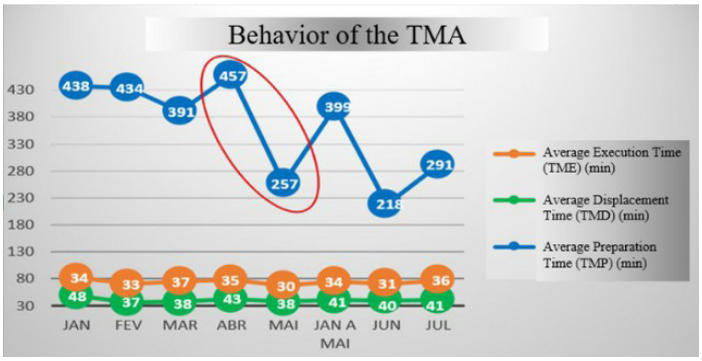


Figure 10 - Significant reduction in *TMA*

Source: Prepared by the author

4.2.4 *Improvement actions*

The new flowchart presents quick and direct responses, as shown in Figure 11: the customer complains in the central of relationships and in real time the information arrives to the operation's sector by the oper. BT, in case of simple occurrence the problem is solved by telephone, when it really needs the visit of the team, without restriction of groups by municipalities, the team closest to the occurrence, according to the mov, is directed to the place through the coordinates the mobile device of the team where it is possible to terminate the service after the end of the work.

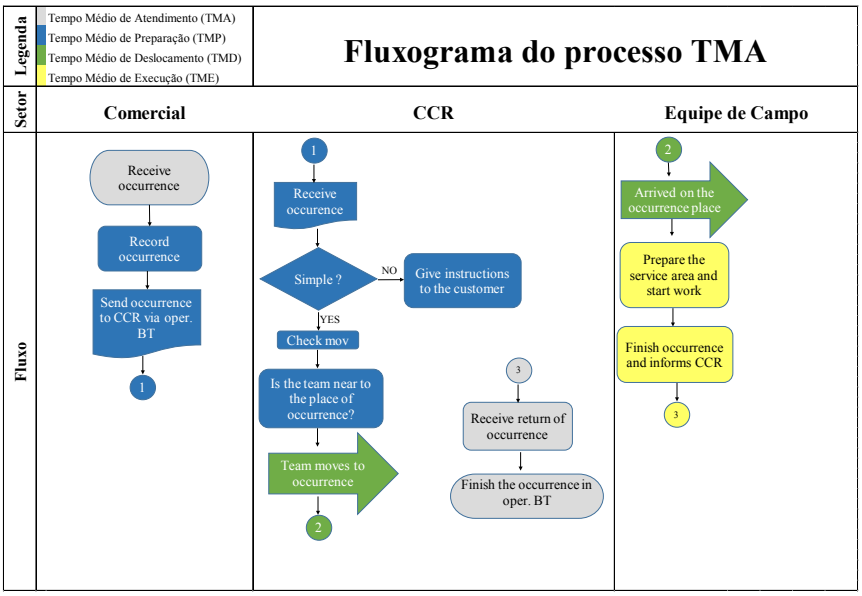


Figure 11 - Improved flowchart

Source: Prepared by the author

These improvements presented here and discussions generated during the work show that there will be security in communication, agility in supply energy, flux information, and location of teams, showing an average increase of 25% below the pre-established goal (419 min.) by company. On average, that means that by April 2017 it was 506 min. for 2835 unscheduled occurrences. In the first month of implementation of the proposal, the *TMA* presented 324 min. to 2388 occurrences, freeing it from

fines and internal and external customer dissatisfaction. This leads to lower numbers of complaints, expenditure reduction, a leaner and less bureaucratic process.

5 I FINAL CONSIDERATIONS

The results show that the objectives of the work were achieved, which consisted in elaborating an improvement proposal for the *TMA*, using basic quality tools in order to increase the efficiency index. The proposal was adhered to and demonstrated significant results for the company, with a 25% productivity increase over the average time.

The company's chronoanalysis was used as a data collection tool presented in internal reports. Line charts representation demonstrated the behavior of this data. The Ishikawa was carried out together with the team, where the brainstorming was carried out and the main causes of the bottleneck were obtained, as well as the lack of some work methods. The 5W1H and flowchart, respectively, showed the proposed improvements succinctly and characterized the process by means of a graphic representation.

The contributions of this work consist of the mechanism of analysis and identification of deficits in the process to execute the activities involved, fulfilling the goals established by the company and avoiding location uncertainties, ensuring efficient methods. For future work, it is recommended to use the same logical sequence to analyze any productive process, as well as to other sectors of the same study company.

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Agência Brasileira do ISBN
ISBN 978-85-7247-256-2