

Application of MASP to Paper Waste Control in a Manaus X Institution

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Abstract

The paper analyzes the reduction of waste of A4 paper used in prints in the finance section of a department of Institution X. The research is a case study in which the collection and analysis of data follow the steps of the Method Analysis and Problem Solving (MASP) in conjunction with the tools: Brainstorming, Check Sheet, Cause and Effect Diagram, Pareto Chart and 5W1H. After analyzing the data, it is concluded that operator error, faulty printer tray and sudden change of document content account for 77.52% of paper waste in the department. In the end, for each of these cases, it is proposed an action plan that together with other proposals, total seven actions of improvements for the managers of the department in question.

Keywords: Reduction of Waste; MASP; PDCA;

1. Introduction

Waste reduction is a common goal for all organizations and adding this philosophy process in the company's routine is relevant. Overproduction, downtime, transportation waste from the processing itself and producing defective products are some examples. Eliminating these wastes increases the operations' efficiency by a wide margin [1]. The use of quality tools for problem-solving such as these are implemented in all types of companies and organizations.

According to [2], the Problem Analysis and Solution Method (MASP) is an excellent problem analysis tool in which problems are prioritized and solved. This method consists of taking corrective and preventive actions to eliminate not only the problems, but also the causes of nonconformities, and is divided into eight steps: Problem Identification, Observation, Analysis, Action Plan, Action, Verification, Standardization and Conclusion [3].

The Institution X, thus designated in respect of the information security policy, is an Organization that stands out on the national scene for its performance in the Amazon region in support of numerous federal, state and municipal agencies. Its organizational structure has a several departments subdivided into sections. For this study was chosen the finance section of one of the departments of the organization, which is responsible for managing the burdens arising from missions carried out by the employees of this department

outside the headquarters, Manaus, capital of Amazon, Brazil.

This department has a printer located in the finance section and is connected to the internal computer network, receiving print orders from five computers. Most of the print volume is for the preparation of Administrative Management Processes (PAG) for each employee's financial rights, and a smaller portion is for general document prints.

The printer is available through a contract signed between this institution and a local company, which establishes a franchise of 48,000 annual impressions. The warehouse supplies A4 on demand.

It was then realized that the paper franchise is overestimated, because at the end of 12 months does not reach 48,000 impressions, which makes the analysis of waste impracticable, masking it within the franchise. Another relevant factor is the absence of an adequate study of print demand, as well as the monitoring and control of these prints, which are often unnecessary, leading to the excessive consumption of A4 paper. Thus, it is necessary to find out the root causes of this waste, as well as adopt measures that can prevent its recurrence to generate savings at the end of each month and consequently enable a balanced contractual renewal for each department.

This research is relevant for the following reasons:

- a) The more paper is produced, the more trees are cut down, the more water is spent in the production process and more waste and landfill space are taken up. According to [4], an institution that encourages conscious consumption, paper production is among the most water-consuming industrial processes. The production of one kilogram of paper consumes 540 liters of water, and for each ton of paper 12 trees are felled;
- b) Avoiding paper waste can save the organization significant financial resources; and
- c) Given the search for knowledge through research and the application of a method for solving a problem little known in the Federal Organs, this work is relevant to the academic environment.

Thus, the main objective of this paper is to analyze the reduction of A4 paper waste in the finance section of an Institution X department, by applying the first four steps of the Problem Analysis and Solution Method (MASP) together with other basic quality tools.

2. Theoretical Referential

2.1 Examples of waste

We live in a society used to waste, from the waste of energy resources such as water, electricity, and gas, to the unfulfilled use of what we buy to eat [5].

Wastewater is a very serious social and environmental problem, as only 3% of all water available on Earth is fit for consumption. The idea of wasting water is not only associated with household habits, such as indiscriminate use of the shower and the poorly closed tap, but this also occurs largely in agriculture and industry [6].

Electricity loss and waste rates in Brazil correspond to 40 million Kilowatts. Industries, households, and commerce waste 22 million Kilo Watts; Power utilities due to distribution problems and technical losses account for 18 million Kilo Watts [7].

Natural gas is wasted by burning it. Among the many reasons for natural gas flaring in Brazil, we can

mention the following: problems in the compression systems, scheduled maintenance, commissioning of new production units and long-term testing [8].

When a portion of food is wasted, all the resources involved in the process, such as water, land, and energy, are also wasted. Besides, the treatment of food waste also has a significant impact on the environment, as landfilling of waste generates methane, a potent greenhouse gas [9].

2.2 The PDCA Cycle

Walter A. Shewhart developed PDCA as a statistical process control cycle that can be continuously repeated over any process or problem originally in the 1930s at Bell Laboratories in the USA. However, the method only popularized in the 1950s by quality expert W. E. Deming, becoming known worldwide when applying it to quality concepts in works developed in Japan [10].

The PDCA (Plan - Do - Check - Action) cycle is a method that aims to control and achieve effective and reliable results in the activities of an organization, being an efficient way to present an improvement in the process [11]. The ideas proposed by this method were used in the process of quality improvement on production lines, but its application was soon expanded to improve team-based collaboration [12].

The first step of the PDCA cycle is planning where objectives are defined. In the second step, data is collected and problems are recognized. In the third step, the problems are examined and analyzed. Finally, in the next step, the failures in the processes to eliminate the problems to reach the objectives will be observed, otherwise, they should be improved and the steps restarted [13].

At PDCA, once an improvement is achieved, it becomes the standard to be challenged with new plans for further improvement. The completion of the cycle will flow at the beginning of the next cycle, and so on [14]. The results of the use of the PDCA cycle in recent times are quite satisfactory and have proven its usefulness in budget cuts by assisting in the decision-making process, since discussions are based on objectivity, ie, less about assumptions and more about objective numbers [15].

2.3 MASP

2.3.1 MASP Definitions

The Problem Analysis and Solution Method (MASP) is the name given in Brazil by QC-Story, the Japanese problem-solving method [16]. It is a systematic way of using facts and data to solve problems. The fundamental difference between structured problem solving and other methods is root cause determination because if it is not eliminated the problem will occur again, causing loss of resources used in its investigation [17].

QC-Story originated from the Komatsu factory in Japan as a tool for easier reporting. As more groups began writing their reports in the format used by QC-Story, it was noted that the procedures served as an excellent guideline for their activities, and through it, people would be able to deliver better reports and get better results. Thus, QC-Story was then adopted as a method of problem-solving [18].

The basis of QC Story is two: PDCA as a concept and scientific methodology as a philosophy. Decisions that are often made based on common sense in QC-Story and MASP are based on facts and data, thus demonstrating the great importance of this method [19]. Also, MASP is based on obtaining data that justifies or proves facts previously raised and that are proven to cause problems. Some quality tooling

techniques are used as deployment aids during their deployment, namely: Stratification, Verification Sheet, Pareto Chart, Cause, and Effect Diagram, Brainstorming, and 5W1H [2].

2.3.2 MASP Steps

According to [19] the eight steps of MASP are as follows:

- 1) Problem identification: Clearly define the problem and recognize its importance; through the survey of its history and its consequences;
- 2) Note: Investigate the specific characteristics of the problem with a broad view and from various points of view by dividing the problem into smaller parts that are easier to solve;
- 3) Analysis: Find out the root causes, once identified ensure effectiveness in solving the problem, avoiding waste of resources;
- 4) Action Plan: Design a plan to block the root causes;
- 5) Action: Block the root causes, aiming the reappearance of the problem;
- 6) Verification: Verify if the block was effective;
- 7) Standardization: Avoid the reappearance of the problem;
- 8) Conclusion: Review the entire problem-solving process and record it for future work.

For better understanding, Chart 1 demonstrates MASP distributed within the PDCA.

Cycle	MASP Steps	Objective
P	Problem Identification	Clearly define the problem and recognize its importance
	Note	Investigate the specific characteristics of the problem with a broad and multi-point view
	Analyze	Discover the root causes
	Action plan	Design a plan to block the root causes
D	Action	Block the root causes
C	Verification	Check if the lock was effective
A	Standardization	Prevent against reappearance of the problem
	Conclusion	Recap the entire problem solving process for future work

Chart 1 - MASP steps and correlation with PDCA cycle

Source: Adapted from [2]

With the MASP steps defined, it is important to emphasize that quality tools act as the resource to be used in the method, act as tools for collecting, processing and arranging the information. What solves the problems is not the tools but the method [20].

2.2.3 MASP Application Cases

MASP is a scientific and effective solving-problems tool. Its use provides organizations with a management process focused on corrective and preventive actions to detect problems and propose actions focusing on continuous improvement [21].

Below is the cases found in articles about the use of MASP.

- a) Case Study of the Application of MASP in a Paper Industry: MASP reduced whole losses in a paper mill, as these directly affect productivity. The application of MASP in this work made it possible to solve the problem through simple actions without costing the company, generating a reduction in whole losses in the first month of implementation [22].
- b) Process Management and Improvement in a Public Pharmaceutical Industry: Drug Development Project Management Case Study: This research aimed to clarify the causes of the large number of redevelopment projects of a public pharmaceutical industry in Rio de Janeiro, as well as how to propose corrective actions by applying MASP. The main causes of the problems raised were found and four actions were traced using the 5W1H tool, aiming at the correction of the problems and the consequent reduction of the recurrence of redevelopments [23].
- c) Implementation of Problem Analysis and Solution (MASP) Methodology for Loss Reduction in Manufacturing Companies: The MASP methodology was implemented in a Lavras - MG manufacturing industry, which produces irrigation machines, whose problem was the high number of defects parts from its suppliers. With the results found, it was noticed the need for supplier control which implied the installation of a system that verified the nonconformities of the parts. With the application of MASP, it was possible to observe a reduction in the rate of defective or out of specification parts, thus reducing the production lead-time of this company [24].
- d) Application of the methodology of analysis and problem-solving - MASP in the logistics of a large retail chain: With the aid of the MASP tool, 11 problems were identified in the logistics of a Hypermarket belonging to a Large Retail Network, located in João Pessoa-PB. The most relevant problem is the excess inventory, treated through the eight stages of MASP, with the help of other quality tools already established in the specialized literature [25].

3. Data Collection and Analysis Methodology

The development of this research is exploratory, which according to [26] occurs when there is a few accumulated and systematized knowledge. In this type of research, the problem in question gains clarity through interviews with experienced people and bibliographic surveys [27].

The method used was the case study, which consists of an in-depth study of one or a few objects in a broad and detailed manner [27].

The location chosen for this research was the finance section of Institution X, composed of eight employees. The research steps carried out from March to June 2018 (Chart 2) are described bellow:

- a) Bibliographic survey: all the foundations for MASP application were reached through this survey, which gathered ideas and methods from several authors found in scientific articles and books;
- b) Problem identification:
 - b1) for the first stage of MASP, a questionnaire consisting of five questions was applied. Questions were elaborated that sought to identify the main problems existing in the study place, as presented in Chart 3;
 - b2) through a spreadsheet provided by the contract inspector, data regarding actual print consumption as well as costs between May 2017 and April 2018 were collected;

Steps	March	April	May	June
Bibliographic research	19	13	-	-
Identification of problems	-	16 - 18	-	-
Observation	-	23 - 25	-	-
Analysis	-	27	-	6
Action planning	-	-	-	7 – 12
End of research	-	-	-	20 - 25

Chart 2 - Research Steps

Source: Own elaboration

1.	What are the main problems in the finance section?
2.	Since when do problems occur?
3.	How often do they occur? Sort By: D – Daily; W – Weekly; M - Monthly
4.	Have you heard of the Analysis and Problem Solving Methodology - MASP?

Chart 3 - Questionnaire applied to collaborators

Source: Own elaboration

c) Observation of the problem:

c1) observation of the most relevant problem in loco. The conditions under which the problem occurs were ascertained and their specific characteristics were raised through the 5W1H;

c2) Figure 1 represents the data collected in the second part of the problem identification step;

d) Problem analysis:

d1) a brainstorming was performed on April 27 with the eight collaborators of this study, to survey the variables that influence the problem. An Ishikawa diagram was created to verify the causes;

d2) the causes were described for better understanding;

d3) a Verification Sheet was prepared to quantify the frequency of occurrence of the causes identified in the Ishikawa Diagram over a month. The people involved in this process were instructed in completing the form correctly and emphasized the importance and purpose of data collection;

d4) with the data collected from the verification sheet, the use of Pareto Chart was admitted, whose principle says that 20% of vital causes are responsible for 80% of problems in an organization;

e) Action planning: the action plan was prepared using the 5W1H tool to block the main causes of paper waste, identified in the previous step. The eight employees were involved through a Brainstorming held on June 8, at which time the actions to be taken, the responsible, the deadline and the place where it would be applied were decided;

f) Conclusion of the research: after applying the first four stages of the MASP, the research was completed, highlighting the main lessons learned, suggestions for improvements, limitations of the study and recommendations for future work.

It is noteworthy that this research used spreadsheets and text editor.

4. Results and discussions

4.1 Basic section profile

The finance section has eight male employees, six of them aged 25 to 30 and two aged 50 to 55. All employees are career-oriented, being the two with the largest age in the process of transfer to retirement.

4.2 Problem Identification

As a result of question 1 of the questionnaire applied to the research collaborators, which dealt with the main problems existing in the finance section, there were a total of eight problems (Figure 1).

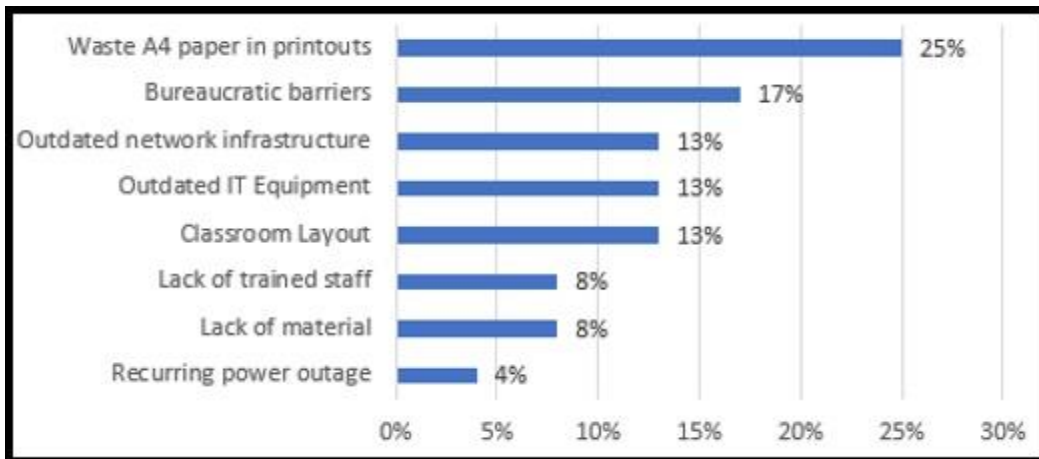


Figure 1 - Problems identified in the investigated department

Source: Own elaboration

As shown by Figure 1, Waste A4 paper used in printing is the main problem point out by 25% of employee opinions. Another important information obtained from the application of the questionnaire is that this problem occurs daily. Thus, the waste of A4 paper used in printing was chosen as the most relevant problem to be addressed by MASP. Other problems identified were bureaucratic barriers (17%), outdated network infrastructure (13%), outdated IT equipment (13%), classroom layout (13%), lack of trained staff (8%), etc.

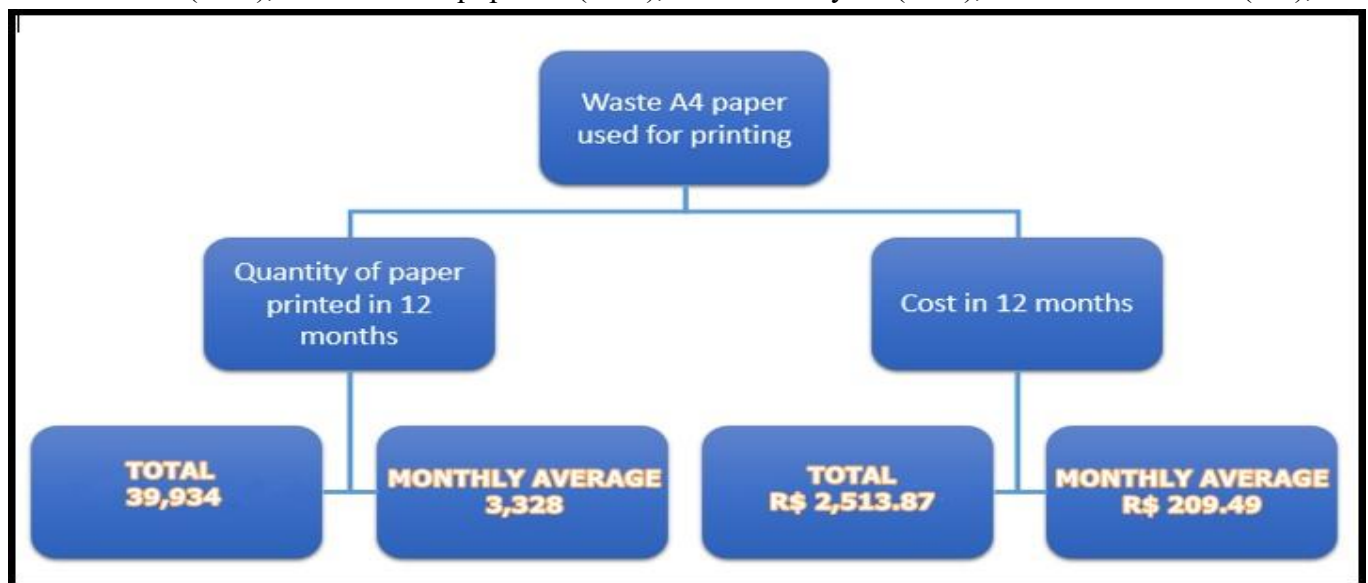


Figure 2 - Number of impressions and costs in one printer (May 2017 to April 2018)

Source: Own authorship

Figure 2 shows tabulated print quantity and cost one of the 50 printers contracted by the institution. The data indicate that in 12 months (from May 2017 to April 2018), the department used only 39,934 impressions of the 48,000 contracted. As this is an annual service contract, the value of the contract is not changed over the 12 months, even when the impressions are not used in full.

The cost (in R\$) shown in Figure 2 is the sum of the amount paid for the printer contract and the paper supplied by the warehouse, as the print contract does not include the supply of A4 paper.

5W1H	Question	Answers obtained to characterize the problem
What?	What is the problem?	Waste A4 paper used for printing.
Why?	Why does it occur?	High number of unnecessary printouts, leading to excessive A4 paper consumption.
Where?	Where is it?	On the printer located in the finance section of a department of Institution X.
Who?	Who are the stakeholders?	Military in the finance section.
When?	When does it occur?	It occurs during office hours, in the morning and afternoon shifts.
How?	How it happens?	Lack of a demand study and enforcement control of the number of impressions.

Chart 4 - Problem characterization by using 5W1H

Source: Own elaboration

4.3 Observation of problems

The conditions under which the problem occurs and its specific characteristics raised through 5W1H are presented in Chart 4 and Figure 3 shows the relationship between the accumulated average monthly deductible (by franchise) and the accumulated real impression consumption between May 2017 and April 2018.

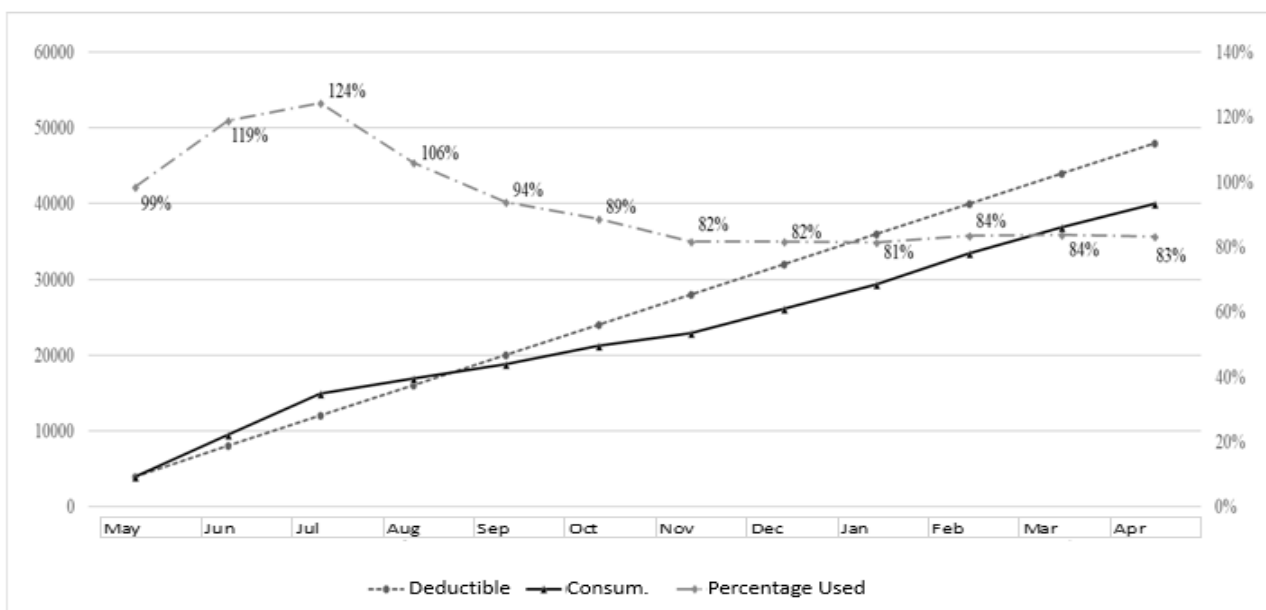


Figure 3 - Cumulative average monthly franchise and cumulative real impression consumption

Source: Own Preparation

Since the annual deductible by the franchise is 48,000 impressions, so the monthly average is 4,000. In Figure 3, the dotted line refers to this monthly average accumulated each month (Deductible), the continuous line refers to the actual accumulated consumption and the dash-dotted line refers to the percentage used, that is, the relationship between the accumulated actual consumption and the accumulated average monthly deductible.

It is noted that over the course of 12 months, 83% of total contracted impressions were used, it means 39,934 of the 48,000 impressions. In monetary terms, the unused resource was R\$ 291.26 out of the R\$ 1,733.28 paid annually. As a result, the contracted printing franchise is overestimated, and it covers both print demand and waste. It is noteworthy that this study is limited to only one printer out of 50 hired by Institution X.

4.4 Cause Analysis

After Brainstorming process with collaborators, a Cause and Effect Diagram (Figure 4) was constructed assuming that the only way to solve a problem is to know its causes well. Around eight causes of the problem were identified and described in Chart 5 for a better understanding,

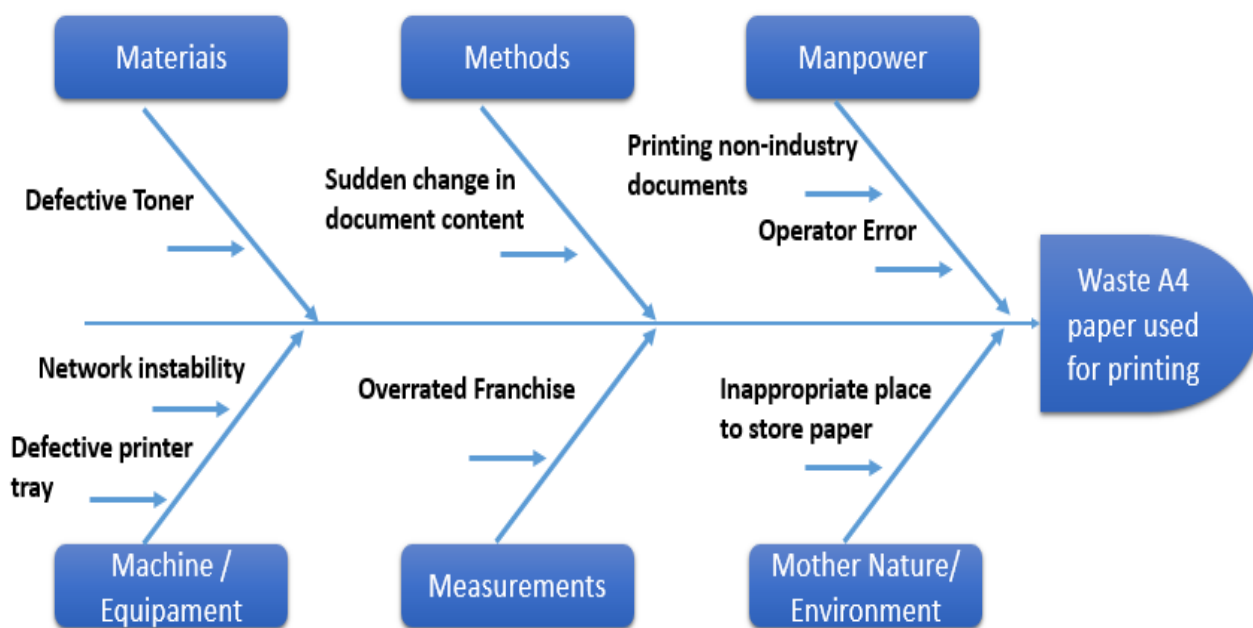


Figure 4 - Cause and Effect Diagram on A4 Paper Waste
 Source: Own Preparation, Adapted from [21]

With the causes defined and described, the employees filled out the Verification Sheet to quantify their frequency of occurrence for 1 month. Chart 6 shows the Verification Sheet template delivered to employees. Then, the data regarding the frequency of occurrence of paper waste causes were verified, making clearer the relationship between the causes and the problem studied.

To find out the priority causes to be treated, it was allowed to use the Pareto Chart. Figure 5 shows the cumulative frequency and relative frequency for each cause analyzed, where those with the highest score should be treated as a priority. This makes clear the three vital causes of paper waste: operator error,

defective printer tray, and sudden change in the document content. These account for 77.52% of paper waste and if resolved, much of the problem will be effectively eliminated. The other four cases represent 22.49% of the problem and are therefore considered trivial.

Cause	Description
Operator Error	Inexperience and inattention when commanding an impression. Due to the numerous documents with varying formatting, the layout needs to be adjusted in advance, which is sometimes overlooked and new printing is required.
Instability in the internal computer network	Makes the printer unavailable by making print commands "queue". Operators send more print commands as there is no clear indication of the offline printer. When the network returns to normal there are several repeated prints, and these copies are rendered unusable.
Defective Toners	They cause scratches and smudges on prints.
Inadequate place to pack paper reams	The reams of paper are packed in a wooden cabinet that shows wear, with an incidence of moisture and mold, causing roughness, stains and consequently the paper waste. Besides, printer operation is impaired when receiving a wet paper.
Defective printer tray	Wrinkles the paper inside the printer.
Printing of documents unrelated to the department.	There is no effective way to control impressions, and it is common to see personal printed material such as copies of school documentation or work.
Sudden change of document content.	The same multi-page document printed more than once due to changes in content, caused by bureaucratic and/or administrative adjustments.
Overrated Franchise	There is no effective demand for study.

Chart 5 - Description of the main causes of paper waste

Source: Own authorship

Check sheet	
Date:	
Causes	Frequency
Operator error	
Network instability	
Defective Toner	
Inappropriate place to store paper	
Defective printer tray	
Printing non-departmental documents	
Sudden change of document content	

Chart 6 - Verification Sheet

Source: Own Preparation

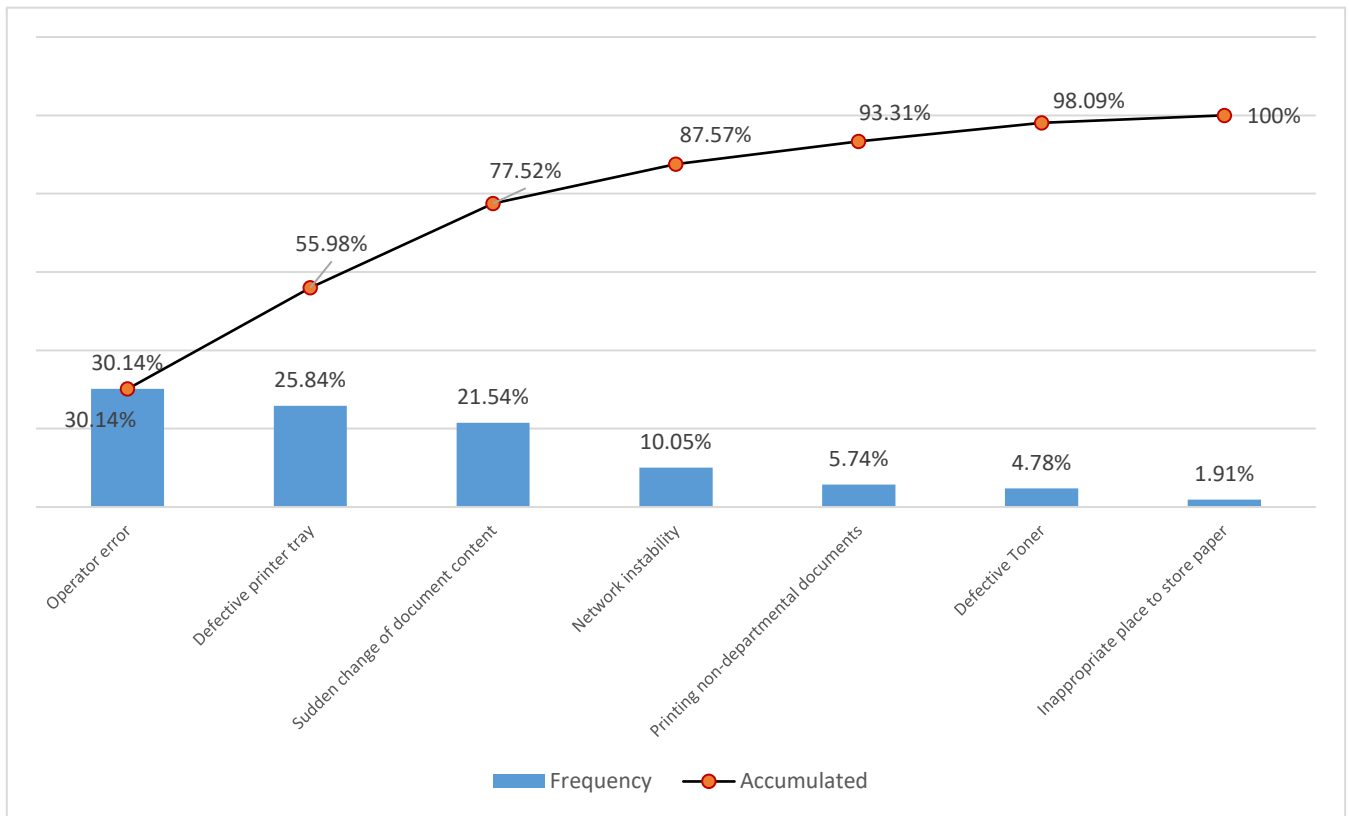


Figure 5 - Analysis of the causes of paper waste A4

Source: Own Preparation

4.5 Action Plan

The next step was to build with the employees an action plan for each cause selected as priority. Charts 6, 7 and 8 were prepared using the 5W1H tool for the three vital causes. This step completes the entire MASP planning process, which configures phase P of the PDCA cycle.

Question	Actions to minimize operator error
What should be done?	Make operators aware of the importance of avoiding paper waste in printouts by presenting a standard procedure for performing each print correctly.
Why is it necessary to do?	It is the most relevant cause.
Where should it be done?	In the department auditorium and the finance section.
Who are responsible?	Employees of the finance section.
When should it be done?	July 2018.
How will it be done?	Lectures and instructions for correct printing procedures.

Chart 6 - 5W1H to minimize operator error.

Source: Own elaboration

Question	Actions for Defective Printer Tray
What should be done?	Perform preventive and corrective maintenance on the printer within the specifications of the manual. Make the obligation on the printing contract stated by the contractor.
Why is it necessary to do?	Printing failures due to printer malfunctions affect the finance section's work, making the printer unavailable indefinitely.
Where should it be done?	In the printer of the finance section.
Who are responsible?	Contract supervisor and contractor.
When should it be done?	July 2018.
How will it be done?	Closer contact of the finance section with the contract supervisor who will request the presence of a company representative for proper maintenance, as well as assisting in drafting a future contract.

Chart 7 - 5W1H to minimize waste from the defective printer tray.

Source: Own elaboration

Question	Actions for the sudden change in the content of the documents.
What should be done?	Create standard templates for the documents that are most in the section, restricting changes to the document content only.
Why is it necessary to do?	Each operator makes documents individually, both in formatting and textual body.
Where should it be done?	Finance section
Who are responsible?	Employees of the finance section.
When should it be done?	July 2018
How will it be done?	Meeting to adjust and standardize all documents, as well as inform the other sections of the department about the new standards.

Chart 8 - 5W1H to minimize waste due to sudden change in document content.

Source: Own elaboration

5. Conclusion

The paper analyzes the reduction of A4 paper waste in the finance section of an Institution X department by applying the first four steps of the Problem Analysis and Solution Method (MASP) in conjunction with other basic quality tools.

When it comes to the relationship between MASP and PDCA, it is worth mentioning the importance of step P of this cycle, which is related to the first four stages of MASP developed in this study. This allows the identification of the problem in the study place and better clarity on the actions to be taken to solve it. The main causes of waste A4 paper used in printing were discovered through the Pareto chart since only with data collection it is not possible to identify the bottleneck. Using the 5W1H tool countermeasures have been developed to minimize the problem to eliminate the three vital causes: operator error, defective printer tray and sudden change of document content.

The application of this methodology will allow the execution of simple actions in the organization, reducing costs and providing a management process where problems are treated scientifically and effectively.

In addition to the measures presented in the action plan stage, the following are suggestions for improvements:

- The need for efficient paper consumption control by conducting a demand study to measure the real need of the finance section for the renewal or acquisition of a new printing contract;
- Replacing the printed version with the electronic equivalent will also reduce the amount of paper used, avoiding unnecessary printing;
- Disposal of discarded leaves for recycling;
- Extend improvement actions to the entire Institution X with the involvement of all employees, as it has 50 printers and this study was limited to only one. Reducing paper waste will bring environmental benefits and will reduce costs for the organization;

The limitations of the work are defined by the difficulty in measuring data since the institution did not have a structured data collection and due to the confidentiality of information, some data could not be plotted. Thus, the opinions of the employees involved through brainstorming meetings, questionnaire application and the use of check sheets were fundamental for this study.

For future works, it is recommended to develop the other stages of MASP regarding action follow-up, verification, standardization and conclusion, not seen in this study.

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