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# FINANCIAL KPI ANALYSIS IN THE IMPLEMENTATION OF DMAIC IN A PHARMACEUTICAL ORGANIZATION – A CASE STUDY

***Abstract:*** *The present paper analyses the KPI's (Key Performance Indicators) of the financial area, based on the real project of the pharmaceutical company ABC in the Iberian affiliate. The process of outsourcing in the financial services, using shared resources is already a current practice in the organizations with multinational size.*

*With the definition of six sigma management strategy model, the choice has fallen on DMAIC methodology (Define-Measure-Analyze-Improve-Control).*

*Once the concept of quality is linked to this work presentation, was made a study about this issue. Was also performed in the literature review, a description was made to realize the relationship between the strategy and methodology, as well as itself concept. Outsourcing of services was recently, which allowed a very active participation and interaction between resources. The analysis was done step by step of this process, according to the chosen methodology.*

*Does the externalization of financial services (suppliers'area) have improved the key performance indicators (KPI) compared with the previous process?*

***Keywords:*** *Key performance indicators; Six Sigma; DMAIC; Transformational outsourcing.*

## 1. Introduction

The objective of the case study is to demonstrate, in the Portuguese company, the time reduction in the processing cycle of invoices and increase suppliers' satisfaction, through the timely processing of invoices, thereby increasing the proportion of the payments. By reducing the processing cycle time, the release of documents becomes faster, increasing the number of processed invoices and leading to the increase of the daily FTE (full-time equivalent).

Having set a model of Six Sigma management strategy, according to Mostafa et al., (2015) the objective of the project is to identify, through the DMAIC (Define, Measure, Analyse, Improve, Control) methodology, all stages of invoice processing, improving and reducing its full cycle. Additionally, the project aims to identify gaps in the work process and create a solution for the future, by reducing the time of the invoice processing cycle, by increasing the number of documents processed in a timely manner, and thus creating an opportunity to improve the treasury management. The reduction in processing time will be translated into savings in processing time and in the total time of the cycle, thereby increasing productivity and

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efficiency, while also enabling eliminating the risk of the Romanian company, provider of outsourced services to the Portuguese company, having to pay fines.

At the level of the business impact it is intended that this project results in improvements arising from the correct processing, thus enabling the reduction of overdue items, leading to improved cash flow and reducing the costs with the team. It is also intended to have greater control and perception of the costs involved in support activities, using the results of KPI (Key Performance Indicators) as a tool for cost control and the development of competitive strategies. According Chakraborty and Tan (2012), KPI show the actual data in certain results, as Six Sigma projects are generally required to be expressed in financial terms. According to Ferrari (2009), KPI try to translate the strategy into metrics that have greater meaning for the applications of the future implementation, developing reporting mechanisms that are able to present the vision of a good management practice, as well as a proactive management and the company's internal control. The project aims to answer the following research question:

Does the process of outsourcing financial services (suppliers' area) improve the key performance indicators (KPI) compared to previous processes?

After the introduction, this paper is organized in 4 additional parts. In the second part, a review of the relevant literature on the case study under analysis is done. In the third part, the research methodology used in the project is presented, which will serve as a guiding principle, so that in the fourth part a detailed description of the case study is presented, from the analysis to results. In the last part, findings, limitations and recommendations on the study performed are presented.

### 1.1. Literature Review

The use of the DMAIC methodology, which is based on the management strategy Six Sigma, was originated in industrial processes. In recent years, the methodology has led to a considerable amount of academic literature, and this literature review includes articles and books from a period of 20 years (1994-2014).

### 1.2. Research Methods

The literature review was focused in the research of scientific articles published in journals and books. The purpose of using these articles and books is to share ideas and the best practices used among the members of the communities. The research was done from bibliography, however only those considered the most appropriate and comprehensive to understand the research, were mentioned.

## 2. Framework – Article analysis

### 2.1. Quality Concept

Quality Management is a set of practices and tools, based on policies and rules internationally agreed in order to ensure the quality of products, processes and services. Rodrigues (2012), presents some quality definitions, referred to by the so-called promoters of quality. For example, to Deming quality is the ability to satisfy desires. As for Juran, quality is fitness for use, while for Ishikawa quality is to satisfy customers, internal or external, meeting or exceeding their expectations through a continuous process improvement.

The author presents the definition of quality adopted by himself: "Quality is what the customer perceives or understands by value, against his socially learned, the market, the society and the available technology" (Rodrigues, 2012:26), and it describes quality management as a methodology for the pursuit of business success, integrating the strategic, structural, behavioral and operational actions using techniques, tools and management models. On the other hand, for Pulido and Salazar (2013), quality has two meanings, which are the product characteristics, and the service that gives it its ability to satisfy stated or implicit needs.

The history of quality goes through the stages of pre- and post-industrialization, seeking to reach higher levels of excellence given the demands of the market. The quality assurance then starts to act preventively with controls along the production chain, resulting in the broader concept of Total Quality, which includes people in "fighting" errors and shortcomings in global actions. Currently, there is a set of techniques and tools that were added to all people and areas of companies to achieve the desired results.

Considering that the most important trends for the future are the increase of quality in companies providing services, due to the increasing weight of services in the current economy, a dynamic quality improvement, i.e. the development of quality dynamics and their integration into the global strategies of the different organizations, and the extent of quality operations to all functions and levels of an organization. Also, Freiesleben (2009) mentions that companies with superior quality products outperform their competitors and set new standards in their market segments, providing a quality evolution consciously guided to the development of the market economy.

### 2.2. Quality Errors

Some companies, when thinking of establishing their quality strategies incur in errors such as the lack of market research, excessive confidence in the quality, and the underestimation of the assessment made by consumers. On the other hand, there are companies who think that by having a certification they will increase their quality, mostly using ISO 9000. Martínez-Costa and Martinez-Lorente (2007) concluded that those who defend the ISO 9000 can claim an improvement in quality, and suggests that there are specific characteristics of each sector of activity, which may prove very significant in their performance, being more noticeable in companies with higher performance. Refering that the fact that quality management is often targeted and implemented in the production area, results in a slower implementation in other areas, but that cultural change can also influence implementation, since they have effects upon the learning curve.

### 2.3. Total Quality Management

Quality management has two aspects arising from the administration's trust that their products meet their customers' needs, and from the aspect of guarantee, resulting from customers' trust in the products. Following the idea of Basu (2011) and Kiran (2016), Total Quality Management (TQM) is not a system but a philosophy that encompasses the whole organization. Pires (2012) states that quality is what makes it possible for a consumer to have a passion for the product or service. On the other hand, and in an aspect more targeted to the market, according to Arauz et al. (2009), quality is seen as a competitive opportunity and can be a strong strategic weapon to attract customers from market competitors.

### 2.4. Quality Tools

According to Rodrigues (2012) and Liang (2010), Ishikawa (one of the promoters of the study of quality after the 2nd World War) was responsible for the beginning of the use of tools for the statistical control of quality, some of which are presented in Table 1.

**Table 1.** Tools for statistical control of quality, (Adapted from Rodrigues, 2012)

| | |
|---|---|
| Verification list (Simple and frequency) | The list of Frequency Verification is used to determine how often an event occurs over a given time period. To Pulido and Salazar (2013) it is a format built to collect data so that its record is sensitive and systematic, and so that the results can be analyzed. In this instrument, information on the events that are happening or on those that have already happened can be collected. |

**Table 1.** Tools for statistical control of quality, (Adapted from Rodrigues, 2012) (continued)

| | |
|---|---|
| Pareto Diagram | According Rodrigues (2012) it was Vilfredo Pareto, an Italian economist who lived in the XIX century, that in one of his studies found that 20% of the population had 80% of income, while 80% of the population had the remaining 20% of income, this being the origin of the 20/80 relationship. Following Rodrigues (2012), the Pareto diagram is important to explain the priority problems of a process by the ratio 20/80 (20% of the causes explain 80% of the problems). In Pulido and Salazar (2013), the idea is that when one wants to improve or solve the problems, one should not "fly blind", as one cannot solve all problems at once. |
| Ishikawa's Diagram | Ishikawa's diagram is a graphical form used as method of analysis for presenting influence factors (causes) about a issue (effect), according to Junior (2010). |
| Flowchart | According to Brilman (2000), the flowchart is for the description of processes, and a process is a certain combination of equipment, people, methods, tools and raw materials, which generates a product or service with certain characteristics. |
| Control chart | The control chart is a tool used to assess the stability of a process. According to Rodrigues (2012), the control chart is the way to explain the statistical control of the process. According to Teixeira (2005), in order to put a process under statistical control it is necessary to analyze all significant deviations that may occur in it, identify its causes and solve them as quickly as possible. |
| Scatter plot | According to Rodrigues (2012), the scatter plot is a tool to identify the existence and intensity of the relationship between two variables. According to Rodrigues (2012) the scatter plot lets you view the correlation between two variables. |
| 5S | The 5S tool is based on improving the quality of environments, making small changes in day-to-day to provide a great result, by aggregating the possible behavioral changes, since the environment is a preponderant factor in the process, into the satisfaction of the people and for total quality management. According to Junior, Vasconcelos, Neto, Andrade, Pontes, and Souza (2009), the 5S method was introduced in Japan in the 50s and 60s, when the country was living the so-called crisis of competitiveness. |
| Brainstorming | According to Chauvet (1998), brainstorming is characterized as a group meeting where new ideas are sought and therefore the free expression of the participants must be ensured. Brainstorming is a technique that involves the spontaneous contribution of all participants. |

## 3. Case Study – Analysis and presentations od results – DMAIC

### 3.1. Phase I – Define

The Six Sigma tool should be considered as a disciplined and highly measurable strategy (Oliveira et al., 2017). One of the main objectives is reducing costs and increasing or improving the organization's efficiency level. This objective is based in the optimization of products and processes, thus enabling an increasing customer satisfaction. However, this strategy can only result in a correct and successful way, if a methodology appropriate to the current reality regarding the desired vision is used. The methodology used in this project is called DMAIC.

This problem-solving methodology is a systematic and scientific method, based on facts that contribute to the improvement of processes, and is based on the logic of the PDCA (Plan, Do, Check, Act) cycle.

Typically, the DMAIC model is seen as the methodology to improve processes, which

follows processes in a linear manner. As in almost all processes, there are needs for adjustment and improvement that will be identified during the process, so that often the team that is in the measurement phase becomes aware that there must be an improvement in the definition of the process. On the other hand, when analyzing the causes of a given problem, one concludes that it is necessary to collect more data. The existence of a continuous need to step back, so that it is assured that each phase is performed in a complete and correct manner, is part of processes.

At this stage the Six Sigma projects to be developed in the company are identified. In the primary goal of satisfying customers, it is necessary to consider their expectations in terms of quality, price and deadlines. The first step of the phase is to identify the sponsor, usually the CEO, and those responsible for the project.

There should also be a full-time Black Belt (specially trained professionals who lead the implementation of methodologies and Six Sigma tools) to run the project, and it is necessary to clearly define the problem in which one is working. At this stage of work, it is very important to define the study that will be developed by the organization. The main aspect must be the understanding of the problem and, following this methodology, the Portuguese company identified as major problem the reduction in the time of counting invoices. Similarly, in this first phase the following sub steps were defined: identification of customers and project quality parameters, stakeholder analysis and communication of the project, and CEPES (client-exit-process-entry-supplier).

What are the reasons to carry out this study? One of the main activities that the Romanian company makes for the Portuguese company is related to the financial flow between the Portuguese company and its respective suppliers.

The Portuguese company is one of the largest companies in its field in Europe, and one of its main features is the satisfaction of their customers/suppliers, and in the case of suppliers, the fact that the deadline for payment is essential. At the time of project definition, this deadline for payment was being influenced by items pending in the workflow, with the project aiming benefiting the cash flow, triggering the possibility to get better discounts, better deals, better prices and supplier loyalty.

**Table 2.** DMAIC Definition Summary (Own elaboration)

| Measure Name | Description |
|---|---|
| Project CTQ's (Critical Quality Parameters) | |
| Stakeholders (s) | Customers – ABC<br>Function – Pharmaceuticals<br>Stakeholders – CFO ABC |
| CTQ's | Level 1: Cash Flow<br>Level 2: Timely payment<br>Level 3: RFI's (Request for Information) |
| Project Team:<br><br>Element 1<br>Element 2 and Element 3<br>Element 4<br>Element 5<br>Element 6<br>Element 7 and Element 8<br>Element 9<br>Element 10<br>Element 11 and Element 12 | <br><br>Project Defender<br>Project Sponsor<br>Project owner<br>Mentor Master Black Belt<br>Mentor Black Belt<br>Members project<br>Member of Project / Resource<br>Leader of project<br>Member of Project / Resource |

**Table 2.** DMAIC Definition Summary (Own elaboration) (continued)

| Milestones | Start Data | End Date | Actual Date |
|---|---|---|---|
| Definition | 17-05-2012 | 28-05-2012 | 28-05-2012 |
| Measurement | 29-05-2012 | 15-06-2012 | 15-06-2012 |
| Analysis | 16-06-2012 | 30-06-2012 | 30-06-2012 |
| Implementation | 01-07-2012 | 31-12-2012 | 31-03-2013 |
| Control | 01-01-2013 | 31-03-2013 | |
| Project Chart: | | | |
| Business case for doing this study | XPTO activity deals with suppliers to join Portuguese ABC. ABC is one of the largest pharmaceutical companies in Europe. | | |
| Essential characteristics of customer | One of the essential characteristics of customer satisfaction is the timely payment, which can be influenced by the outstanding items in the workflow. By reducing the RFI, reaches a high percentage of payments, ABC will benefit from increased cash flow triggered by an improvement in discounts, best deals and prices and increased supplier loyalty | | |
| Estimated project benefit | Reduction of RFI items (Request for Information) of 12.39% to 5%, implying greater satisfaction with the supplier timely payment of invoices. | | |
| Problem description | During the first four months of the year 2012 were received 11875 invoices, of which 1390 have the state of RFIQUE (requests sent to ABC by the need to obtain additional information), or RFIANS (requests awaiting response by ABC), ie 12%. This value is considered high, which leads to dissatisfaction suppliers, and on the other hand also involves the allocation of a time high by the ABC team to respond to RFI. | | |
| Determination of Target | Reduction of RFI from 125 to 55 in December 2012 | | |
| Scope of the project: | | | |
| Includes | All pending ABC's invoices in the workflow with the state RFIQUE and RFIANS | | |
| Excludes | Another subsidiaries ABC | | |
| Project start | Contact the AP team XPTO with the ABC team, in order to address issues related to the accounting records of invoices. | | |
| End of the project | When you made the registration of invoices. | | |
| Relevant Analysis Xs (5S) | | | |
| X1 – Missing Code | Each invoice has different requirements regarding the information to be displayed. Reason: There are cases in which the vendor description is not useful for the encoding process because the AP side has no knowledge about the GL accounts, cost centres and WBS - Work Breakdown Structure (breakdown structure) to account for some invoices, | | |
| X2 – Missing the number of Purchase Order (NE) | Reason: invoices are divided into invoices with and without NE. Suppliers tend to not mention the number of NE because the previous ones were not rejected | | |

**Table 2.** DMAIC Definition Summary (Own elaboration) (continued)

| | |
|---|---|
| X3 – NE not yet issued | Reason: there are invoices that are issued by the supplier before being issued the NE, this is because the purchasing department of the Portuguese company delayed the issue NE. |
| X4 – NE modified | Reason: the initial NE was changed after the issuance of the invoice; this is because the requester of the Portuguese company responded several times to the Romanian company's team always with the same answer, creating multiple RFI. This is because the requester of the Portuguese company is unaware of that can redirect the questions to the team AP-Romanian company speak directly with the purchase team - Romanian company, thus avoiding additional RFI. |
| X5 – NE complete | Reason: Because there are many cases of complete real NE, however, there are a number of RFI exchanges due to improper use of the system, again because the invoice for the NE is already accounted for, which may be because the supplier He mentioned a wrong number of NE, which led to the issuance of a new NE. However, the Portuguese company requester should have expected the internal resolution, which would decrease the number of RFI exchange. |

For all these aspects, although they are analysed and observed by employees who perform daily accounting of invoices task, there is the indispensable help of OCR validation module. This module detects pre-defined OCR words, and when scanning an invoice is prepared to detect mandatory fields such as NIF of the Portuguese company, NIF Supplier, purchase order number, address, amount, among others. Making a comparison of pre-defined fields, the algorithm will determine whether there are or not errors.

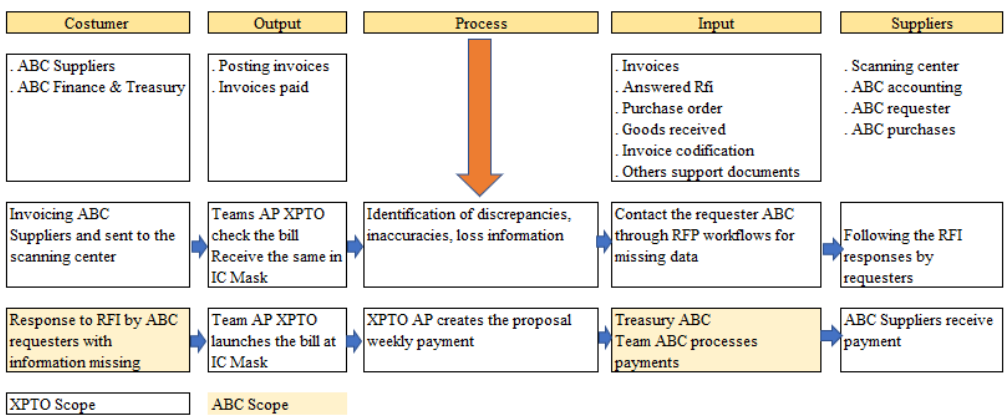


**Figure 1.** Maximum CEPES Level

### 3.2. Phase II – Measure

At this phase actions related to the measurement of process performance and quantification of process variability are covered. It is at this phase that, with the consent of all participants, the key process variables are identified, both input and output, and it is at this phase that should be checked how the process is running. Various types of measurement should also be developed, particularly concerning outputs and inputs. This measurement is considered of low level, as the high-level ones are collected at the critical points, to allow to know how the process is functioning.

**Table 3.** DMAIC Measurement Summary (Own elaboration)

| Measure Name | Description |
|---|---|
| CTQ Characteristic | Discrete – Percentage of all RFI items within the total number of invoices received in a month |
| Project Y Metric | Any item which has the workflow status RFIQUE or RFIANS |
| Performance Definition | |
| Operational Definitions: | |
| Unit | Each invoice received in the workflow |
| Opportunity | Any invoice received in the workflow |
| Opportunities per Unit | One |
| Defect | Any item which has the workflow status RFIQUE or RFIANS |
| RFIQUE | Any question query raised by XPTO AP team |
| RFIANS | Any answer provided to the raised questions |
| Potential Xs | Identified through brainstorming with project team |
| X1 | Coding missing |
| X2 | PO number missing |
| X3 | PO not issued yet |
| X4 | PO modified |
| X5 | Awaiting Credit Note |
| X6 | PO full |
| X7 | Approval required |
| X8 | PO Line unidentified |
| X9 | T&E issue |
| X10 | Budget exceeded |
| Measurement System | |
| Data Collection | Data set consists of all items received in the workflow as of 31st of March for the sites that are in scope of the project |
| MSA Results | To conduct MSA on Project Y |
| Method | Multiple Attribute Gage R&R performed with 2 operators on 30 randomly selected invoices to test repeatability, reproducibility and accuracy on Project Y. Audit results of SME used as Standard for verifying accuracy on Y. |
| Results | Initial MSA on Project Y Passed |
| Project Y: | |
| Accuracy | 100% |
| Repeatability | 100% |
| Reproducibility | 100% |

**Table 3.** DMAIC Measurement Summary (Own elaboration) (continued)

| Invoice | True RFIQUE (Audited) | Employee XPTO Nr1 | | | Employee XPTO Nr2 | | | Total Agreement | True Agreement RFIQUE | Total Number Agreement |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Test 1 | Test 2 | Agreement | Test 1 | Test 2 | Agreement | | | |
| 1 | S | S | S | S | S | S | S | S | S | 4 |
| 2 | N | N | N | S | N | N | S | S | S | 4 |
| 3 | N | N | N | S | N | N | S | S | S | 4 |
| 4 | N | N | N | S | N | N | S | S | S | 4 |
| 5 | S | S | S | S | S | S | S | S | S | 4 |
| 6 | S | S | S | S | S | S | S | S | S | 4 |
| 7 | S | S | S | S | S | S | S | S | S | 4 |
| 8 | S | S | S | S | S | S | S | S | S | 4 |
| 9 | N | N | N | S | N | N | S | S | S | 4 |
| 10 | S | S | S | S | S | S | S | S | S | 4 |
| 11 | N | N | N | S | N | N | S | S | S | 4 |
| 12 | N | N | N | S | N | N | S | S | S | 4 |
| 13 | N | N | N | S | N | N | S | S | S | 4 |
| 14 | S | S | S | S | S | S | S | S | S | 4 |
| 15 | S | S | S | S | S | S | S | S | S | 4 |
| 16 | S | S | S | S | S | S | S | S | S | 4 |
| 17 | S | S | S | S | S | S | S | S | S | 4 |
| 18 | S | S | S | S | S | S | S | S | S | 4 |
| 19 | S | S | S | S | S | S | S | S | S | 4 |
| Precision | 100% | 30 | 30 | 30 | 30 | 30 | 30 | 100% | 100% | 100% |
| Reproducibility | 100% | 30 | 30 | 30 | 30 | 30 | 30 | 100% | 100% | 100% |
| Repeatability | 100 | Employee Nr1 | | 30 | Employee Nr2 | | 30 | 100% | 100% | 100% |
| Method | A sample of 30 Items received in Workflow selected randomly from the reference period (March 2012). | | | | | | | | | |
| Accuracy | One person took sample of 30 items from the report and looked in SAP for the following: Whether it is RFIQUE/RFIANS or not (Yes or No);<br>30 samples * 4 measures = 120 opportunities – 120 matches à 120/120*100 = 100% | | | | | | | | | |
| Repeatability | 30 samples * 3 operators = 90 opportunities - 90/ matches à 90/90*100 = 100% | | | | | | | | | |
| Reproducibility | 30 samples = 30 opportunities – 30 matches à 30/30*100 = 100% | | | | | | | | | |
| The Operators were given the 30 items and were asked to identify if it's a RFIQUE/RFIANS two times each. | | | | | | | | | | |
| Measurement and Analysis of data collection | | | | | | | | | | |
| Date | 30 items randomly selected from the reference period | | | | | | | | | |
| Employees 1 | C1 and C2 | | | | | | | | | |
| Control Points | 1 SME (C3) | | | | | | | | | |
| Calculation | Minimum value accepted | | | | Result | | | Status | | |
| a) Repeatability | >90% | | | | 100% | | | OK | | |
| b) Reproducibility | >90% | | | | 100% | | | OK | | |

### 3.3. Phase III – Analysis

At this stage, all data related to the process are analyzed aiming to establish causal links and find out the reasons that can be a source of variability. It is here that one should, if necessary, make the appropriate changes, since there must be a visualization of the data, hypotheses testing, correlation, regression analysis and variance analysis. It is in this phase one may want to look at the areas where it is common to repeat work and where there are bottlenecks in the process, being equally necessary to quantify the opportunities, since the process should be expressed in numerical data that can be a true measurement of the improvements. In establishing the process capability, one has the goal to reduce the number of defects from 564 to 200 that is 35.5%, also changing the Six Sigma level from 2.6 to 3.2, as shown in Table 4. One can also check in Report 8B, the aim to get closer to the target for the average value of fulfilling the Six Sigma, that is, to keep the process in the control area.

**Table 4.** Meta statistics (Own elaboration)

| Statistic target | Opportunity | Defect | ST Sigma |
|---|---|---|---|
| Actual | 1 | 564 | 2,6 |
| Target | 1 | 200 | 3.2 |

DPU = Total number of defects / Total number of products units;
Total Opportunities: TO, with TO = Total number of product units x opportunities;
DPO = Total number of defects / Total Opportunities; DPMO = defects per million opportunities.
The DPMO can be converted into Sigma values using the Sigma conversion value given in Table 5.

**Table 5.** Six Sigma Conversion Table (Own elaboration)

| Yield | DPMO | Sigma |
|---|---|---|
| 30,90% | 690 | 1 |
| 62,90% | 308 | 2 |
| 93,30% | 68,8 | 3 |
| 99,40% | 6,21 | 4 |
| 99,98% | 320 | 5 |
| 100,00% | 3,4 | 6 |

Establish process capability: The project focuses on reducing RFI line items by 65% (reduction of DPMO from 123874 to 43927) by the 4th quarter of the year under study (October 2012). As can be seen in Figure 2, this allows increasing process capacity from 2.6 to 3.2 Sigma.

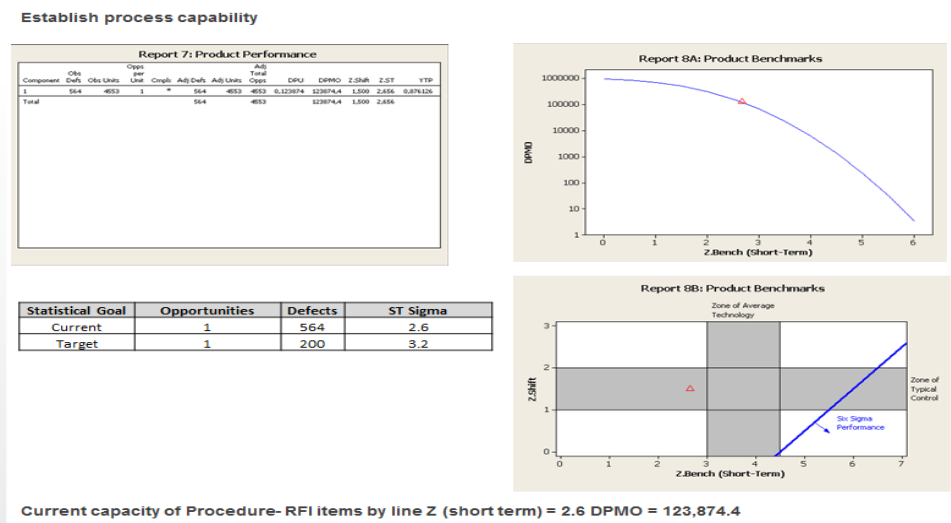


**Figure 2.** Process Capacity ( Own elaboration)

Identify evaluation sources: The diagram of cause and effect was built so that the relationship between the effects and the causes that may have contributed more to its occurrence could be made. In Figure 3 of all the causes/effects identified some aspects considered as priorities. In addition, Figure 4 serves to summarize the segmentation factors described above, and to help understand its importance.

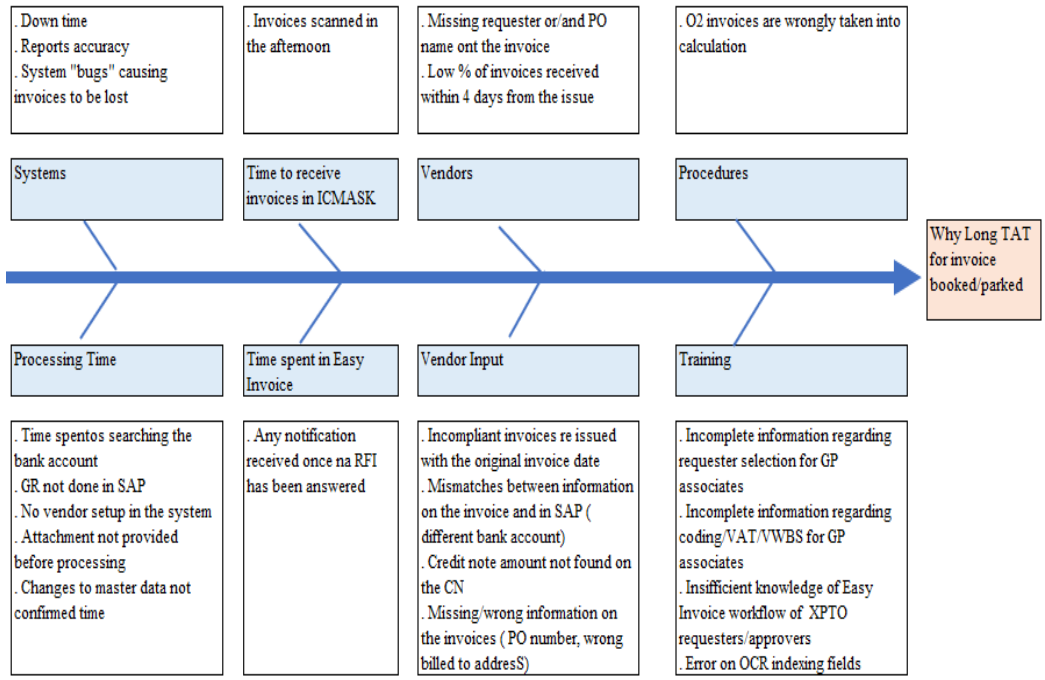


**Figure 3.** Identification sources of variation

| Measure Name | Missing Code | Missing PO Number | PO not issued yet | PO Modified | Awaiting CN | PO full |
|---|---|---|---|---|---|---|
| Measure TYPE (Y or X) | X1 | X2 | X3 | X4 | X5 | X6 |
| Data Type ( continuos or Discrete) | Discrete | Discrete | Discrete | Discrete | Discrete | Discrete |
| Operational Definition | Any invoice for which coding is not identified | Any invoice for wich PO number is not mentioned or unable to identify | Any invoice for wich the PO was not yet issued | Any invoice for which the PO was modified and is not matching anymore the invoice | Any invoice for which the vendor should send a Credit Note | |
| Range/Value | Range | Range | Range | Range | Range | Range |
| Significant/ Non-Significant | Significant | Significant | Significant | Significant | Significant | Significant |
| Validation method | Chi-Square | Chi-Square | Chi-Square | Chi-Square | Chi-Square | Chi-Square |

**Figure 4.** Segmentation factors – quantification XS

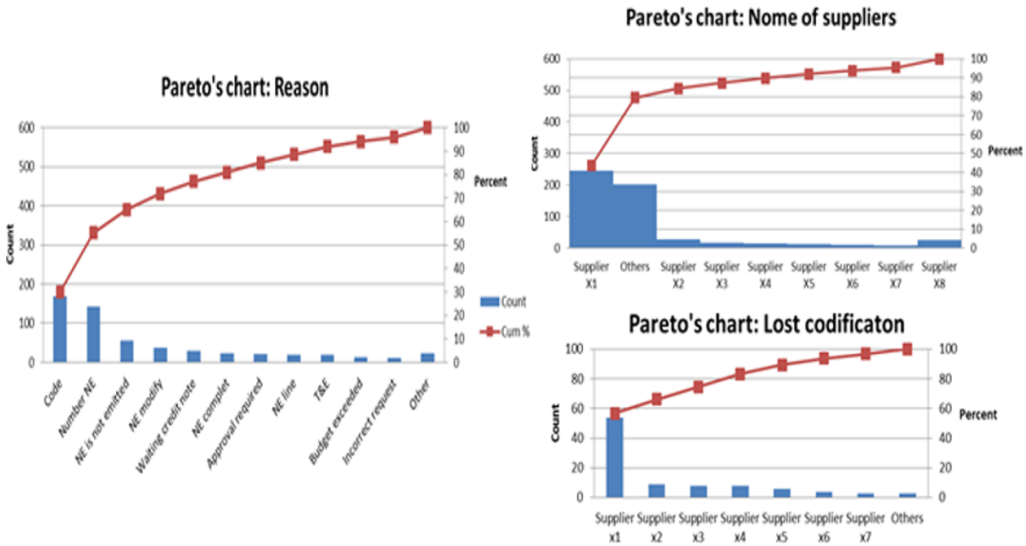


**Figure 5.** Pareto Diagram

Analysis of the cause of results: Suppliers who most contributed to the number of RFI lines were determined.

To determine if the encoding has statistic influence in the number of RFI items, the chi-square test was performed, with the results shown in table 6.

The analysis was done on all 4553 items (with or without defect), and the data were grouped based on the absence of encoding information for the analyzed items.

H0 - The Null hypothesis is that there is no significant influence on the number of RFI items generated by the lack of code.

H1 - The statistical value observed in the chi-square was 3067.593 and the p-value <0.05 (significance level) so that we can reject the null hypothesis and accept the hypothesis that there is a significant impact of the lack of coding on the number of RFI items.

The coefficient X2 is the value of dispersion for two nominal variables used in some statistical tests.

This coefficient reflects to what extent the observed values deviate from the expected value if the two variables are not related: $x^2 = \sum_i^r \frac{(Oi-Ei)^2}{Ei}$;

$x^2E \geq x^2T$, implies rejecting H0; $x^2E < x^2T$, implies not rejecting H0.

Note: Oi = observed frequency (values found throughout the study);

Ei = expected frequency (frequency concerning H0);

$x^2E$ = chi-square value found in the study;

$x^2T$= chi-square value found in the chi-square table.

Similarly, the same tests were made with the data relative to other sources of variation, with the results being presented in Table 6.

**Table 6.** Qui-Quadrado (Own elaboration)

| Lost codification | | | | Lost Nr. Purchase Order | | | |
|---|---|---|---|---|---|---|---|
| | Defect | Not defect | Total | | Defect | Not defect | Total |
| 1 | 396 | 0 | 396 | 1 | 421 | 0 | 421 |
| | 49,05 | 346,95 | | | 52,15 | 368,85 | |
| | 2453,841 | 346,946 | | | 2608,756 | 368,849 | |
| 2 | 168 | 3989 | 4157 | 2 | 143 | 3989 | 4132 |
| | 514,95 | 3642,05 | | | 511,85 | 3620,15 | |
| | 233,755 | 33,05 | | | 265,8 | 37,581 | |
| Total | 564 | 3989 | 4553 | Total | 564 | 3989 | 4553 |
| | | Freedom degree | | | | Freedom degree | |
| Qui-Quadrado= 3067,593 | | DF=1 | value-P= 0.000 | Qui-Quadrado= 3280,986 | | DF=1 | value-P= 0.000 |
| Purchase Order not issued yet | | | | Purchase Order modified | | | |
| | Defect | Not defect | Total | | Defect | Not defect | Total |
| 1 | 508 | 0 | 508 | 1 | 526 | 0 | 526 |
| | 62,93 | 445,07 | | | 65,16 | 460,84 | |
| | 3147,857 | 445,072 | | | 3259,396 | 460,842 | |
| 2 | 56 | 3989 | 4045 | 2 | 38 | 3989 | 4027 |
| | 501,07 | 3543,93 | | | 498,84 | 3528,16 | |
| | 395,33 | 55,895 | | | 425,737 | 60,194 | |
| Total | 564 | 3989 | 4553 | Total | 564 | 3989 | 4553 |
| | | Freedom degree | | | | Freedom degree | |
| Qui-Quadrado= 4044,155 | | DF=1 | value-P= 0.000 | Qui-Quadrado= 4206,169 | | DF=1 | value-P= 0.000 |
| Wait Credit Note | | | | Complete Purchase Order | | | |
| | Defect | Not defect | Total | | Defect | Not defect | Total |
| 1 | 535 | 0 | 535 | 1 | 541 | 0 | 541 |
| | 66,27 | 468,73 | | | 67,02 | 473,98 | |
| | 3315,165 | 468,727 | | | 3352,344 | 473,984 | |
| 2 | 29 | 3989 | 4018 | 2 | 23 | 3989 | 4012 |
| | 497,73 | 3520,27 | | | 496,98 | 3515,02 | |
| | 441,417 | 62,411 | | | 452,048 | 63,915 | |
| Total | 564 | 3989 | 4553 | Total | 564 | 3989 | 4553 |
| | | Freedom degree | | | | Freedom degree | |
| Qui-Quadrado= 4287,720 | | DF=1 | value-P= 0.000 | Qui-Quadrado= 4342,291 | | DF=1 | value-P= 0.000 |

### 3.4. Phase IV – Improve

At this stage it is necessary the development of small sub-projects in order to know the process in detail. Existing information should help identify possible adjustments, always with the goal of modify and optimize the process. At this phase of the process the planning and implementation should be carried out, and for the later be successful there must be a plan with the technical aspects, as well as a strategy to develop acceptance by customers.

Implementation of Xs solutions (5S): According to the aspects to improve, implementation processes were identified and actions to achieve the established goals were taken, (Kanamori et al., 2015).

X1 - Lost Code.

In this X an analysis of the reason why it is happening was made, and the conclusion was that the XPTO team lacks knowledge concerning the general accounts, cost centers, requesters, wbs, and other data necessary for the correct accounting of invoices.

What could improve this aspect?

1 - The AP team of Romania has created a list with the data of situations that happen for the reasons mentioned above, and the reasons why that happens, and sends it to the Portuguese company for approval. Action: The list was sent to the Portuguese company and feedback concerning it was given.

2 - Update of procedure manuals to reduce the number of clarifications made to the Portuguese company. Action: The Romania AP team updated the procedure manuals to reduce the number of clarifications to the Portuguese company.

3 – Training of the Romania AP team in the topics where they have greater difficulties. Action: The Portuguese company has trained the Romanian AP team.

4 - Adjust the number of backups (employees of Romania), to ensure the knowledge and execution of the tasks, in the holiday periods and during periods where there are jobs peaks. Action: the correct access and adequate training to backups were secured.

X2 – Loss of the Purchase Order number (NE).

Analysis: Suppliers do not mention the purchase order number on the invoice. Aspects to improve: Identify the suppliers that do not report the purchase order number. Request authorization to the Portuguese company to send information to suppliers. Action: Identify suppliers that do not mention the purchase order number and send to the Portuguese company, which analyzes and strengthens the request to the supplier, ommunicating afterwards in which cases it considers necessary to reject the invoices.

X3 - Purchase order not issued.

Analysis: purchase order created after the invoice been issued. Action: Increased awareness of the purchase team of the Portuguese company and strengthening of these issues to requesters. Mandatory authorization by the financial director, of the invoices falling in this category.

X4 - Modified purchase order

Analysis: purchase order modified after issuing the invoice. Aspects to improve: The requester of the Portuguese company directly informs Romania's purchasing team to make the changes, and the later then informs the AP Romania team, or the requester (Portuguese company) using the system option: "I need more time to answer" before responding to Romania. Action: Training of employees of the Portuguese company in the systems needed to resolve this aspect.

X5 - Complete purchase order

Analysis: although there are not many cases, there are some in which the process is not completed due to the existence of RFI that are not correctly completed in the system.

Aspects to improve: The requesters of the Portuguese company can modify the state of the RFI for "Awaiting internal solution."

Action: encouragement of the requesters of the Portuguese company to use the correct option, and training of requesters of the Portuguese company to recall the correct use of the systems. Deadlines for actions' completion were not considered, as this project is to be maintained over time and all situations are audited and evaluated monthly.

### 3.5 Phase V – Control

It is in this phase that several tools to constantly monitor the performance of the process are implemented.

Once implemented the expected gains can be confirmed, since it should be prevented that the same problems arise again, through a monitoring work, documentation (the whole process must be documented) and institutionalization.

Continuing with the DMAIC methodology, one of the tools used was the action plan. In figures 3 and 4 the previous process and the current process (as was intended to be) are defined, concerning the processing of invoices. In this project there are several types of control, which are made in different time periods, but given its high number, only some of them will be identified.

Daily management: there are daily records of the transactions made by each employee. Each operator must mandatorily register the operations performed and cannot ignore that the KPI themselves determine the level of performance of each one. As can be seen the workflows were automatized so that each

process can be recorded and a "case tracker" is automatically created, being only considered as complete when the operator "closes" the process.

Internal Audit: Because collaborators claim they follow the standards, it is mandatory to check if the process is done correctly. One of the internal audits done every week takes place when the payment proposal is initiated by the AP Romania team. It is the responsibility of the superior, to demonstrate. and reinforce the importance of compliance with the standards. Comply with these guidelines, not only is the responsibility of employees who perform the operations daily, but also of the entire organization. Human resources should participate in the quality mission because they want to, not because the leadership demands it. Identifying the problem, and the appropriate selection of techniques for its elimination, involves the mapping of the value chain of the current situation. With the identification of the existing problems, a classification is given, and in Figure 6 key areas where to act are identified as well as the origin of the causes.

| SL no. | Key areas/Kaizens | Source Causes |
|---|---|---|
| 1 | Scanning hours of Documents | Documents are scanned at the end of the night wich creates a delay since the documents are self recognized in OCR, to the validation stage |
| 2 | Steps Validation | The documents are validated even if it has 60% accurary in automatic invoice recognition step |
| 3 | Allocation of daily discripancies | SAP report (yfi 162) is not showing the actual delay of documents ( OCR received in time vs. Time received the Scannig Center) |
| 4 | Daily allocation tasks | Due to the fact that they are validated 18 different fields per day allocation is being made ≈ 1 hour |
| 5 | Response capacity RFI | RFIs are resolved in the next day, since they are allocated in the daily report |

**Figure 6.** Identification ok ket areas

Applying the VSM methodology (Cavdur et al., 2018), (Tezel et al., 2018), it can be seen the current processing cycle, and the time used in each cycle as well as other information. With the implementation of the improvement plan, presented in Figure 7, it can be seen the desired process improvement.

| Reference no. | Action provost's | Type Improvement | Responsible | Deadline | Status |
|---|---|---|---|---|---|
| 1 | Establish a new procedure for Scanning Center - scan documents between 7h00 - 10h00 | Process Flow | XPTO1 | 30-06-2012 | Not ececuted |
| 2 | Pass the OCR validation for suppilers that are fully recognized by the OCR automatic tool | System/Procedure | XPTO1/XPTO2 | 15-06-2012 | Not ececuted |
| 3 | Create a clear and precise report daily SPA (yfi162) | System | XPTO1 | 30-06-2012 | Conclude |
| 4 | Implement na automated solution for the allocation of daily tasks (macro) | System | XPTO1 | 30-06-2012 | In development |
| 5 | Receive notification email when na RFI is enswered | System | XPTO1 | 03-06-2012 | Conclude |
| 6 | Adequate training recycling with the term of submitters | Trainig | XPTO1/XPTO2 | 15-06-2012 | Open |
| 7 | Estabeblish a mandatory checklist for each invoice #, invoice date, NF, applicant's name, the total amount, bank account, (VAT exemption) | Procedure | XPTO1/XPTO2 | 30-06-2012 | Open |
| 8 | Review the accounting | System/Procedure | XPTO1/XPTO3 | 15-06-2012 | Conclude |

**Figure 7.** Improvement Plan

Figure 8 shows the mapping concerning what is intended in the future, including also the expected information from techniques. As can be seen, reducing the time allocated to the daily tasks from 60 min to 10 min (0,15FTE to 0,02FTE), will positively influence the performance of tasks in about 83%, thus allowing the collaborator to perform 6 cycles instead of just one.

Again, the motivating and active role of the management throughout the improvement process, from control tasks to resource support and allocation, leads to the achievement of the objectives. The cross training is also a constant way to motivate and make employees aware that this process should be improved over time, as in the short-term mistakes will be made for sure that will be minimized with experience.

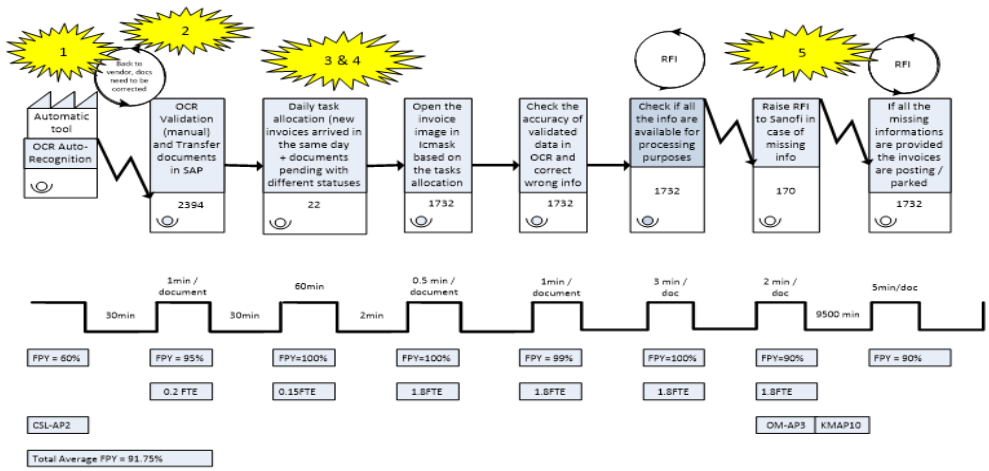


**Figure 8.** VSM previous accounting process

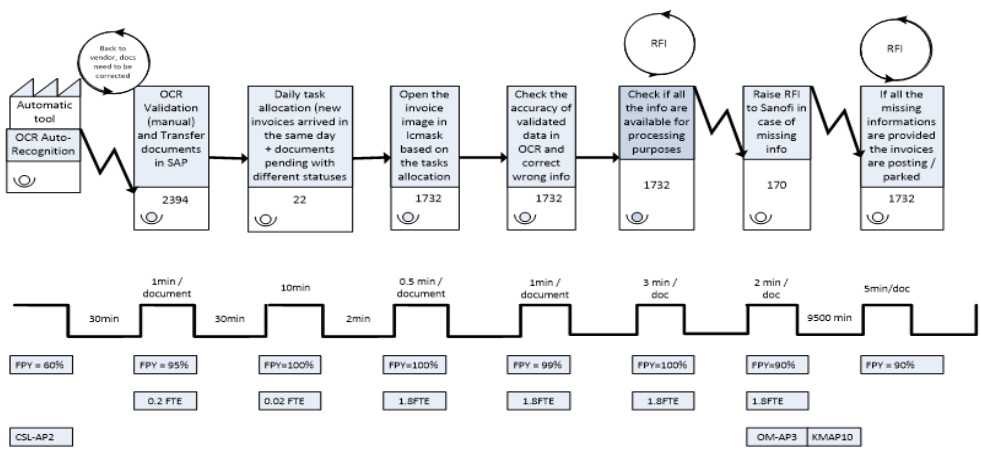


**Figure 9.** VSM current accounting process

As mentioned, the proposed approach is a powerful analysis tool to make the connection between the production and the improvement of opportunities. One objective was focused on identifying opportunities to improve the efficiency of tasks, thereby increasing the entire performance of the KPI. The analysis performed allowed to investigate and determine the causes of the low percentage presented in some KPI, leading to an improvement in confidence, and to the adoption of measures to prevent the recurrence of causes. Of the 13 KPI shown in Figure 10, joint analyzes were performed so that the results proposed in the project could be shown in a simpler manner.

| Metrics | Description of the metrics | 01-31 Dec | 01-31 Jan | 01-29 Feb | 01-31 Mar | 01-30 Apr | 01-31 May | 01-30 Jun | 01-31 Jul | 01-30 Ago | 01-30 Sep | 01-31 Out | 01-30 Nov | 01-31 Dec | Service level expected | Maximum level of service allowed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSL-AP1 a) | Check) | 96% | 100% | 95% | 98% | 96% | 96% | 96% | 95% | 96% | 99% | 99% | 98% | 99% | 98% | 95% |
| CSL-AP1 b) | Cheks) | 96% | 96% | 98% | 91% | 96% | 98% | 98% | 90% | 97% | 97% | 94% | 94% | 91% | 98% | 95% |
| CSL-AP2 | Good parking invoices (within 72hrs) | 70% | 62% | 61% | 52% | 57% | 73% | 89% | 86% | 83% | 94% | 91% | 96% | 90% | 95% | 85% |
| CSL-AP3 | Precision workflow (*%) Rejection by approvers) | 99% | 96% | 100% | 94% | 99% | 99% | 99% | 99% | 99% | 99% | 98% | 99% | 100% | 98% | 95% |
| CSL-AP4 | Timely response to requests from suppliers | 95% | 83% | 83% | 80% | 100% | 98% | 96% | 93% | 100% | 100% | 99% | 99% | 100% | 95% | 85% |
| KM-AP1 | By e-mail | 100% | 100% | 100% | 100% | 100% | 100% | 20% | 100% | 100% | 100% | 100% | 100% | 100% | 90% | 85% |
| KM-AP2 | Scan coding accurancy | 51% | 49% | 13% | 36% | 37% | 38% | 28% | 39% | 30% | 25% | 49% | 20% | 63% | 60% | 50% |
| KM-AP3 | Prompt payment | 59% | 42% | 27% | 31% | 46% | 42% | 45% | 36% | 57% | 29% | 43% | 45% | 49% | 95% | 85% |
| KM-AP4 | Resolution | 50% | 58% | 51% | 48% | 79% | 68% | 50% | 66% | 31% | 76% | 55% | 59% | 54% | 90% | 80% |
| KM-AP5 | Timely response to requests from suppliers | 83% | 76% | 100% | 100% | 90% | 91% | 100% | 100% | 89% | 92% | 94% | 94% | 100% | 90% | 80% |
| KM-AP6 | Trust approval circuit | 90% | 88% | 88% | 81% | 90% | 87% | 83% | 86% | 71% | 81% | 86% | 87% | 90% | 90% | 80% |
| KM-AP7 | Quick response to all queries doubts ABC | 50% | 67% | 100% | 100% | 92% | 100% | 86% | 100% | 100% | 100% | 100% | 100% | 100% | 95% | 85% |
| KM-AP8 | Correct time to perform the tasks | n/a | 68% | 88% | 74% | 83% | 83% | 20% | 100% | 96% | 91% | 100% | 98% | 100% | 95% | 85% |

**Figure 10.** KPI Analysis

Although the KM-AP1 to KM-AP8 are not subject to penalties, they can jeopardize the KPI (CSL-AP1 to CSL-AP4) considered critical. The KPI KM-AP1 and KM-AP2 lead to conclude that, despite the invoices that arrive to the scanning center are treated in time, there was a breach of the minimum level of service allowed over a long period. A more detailed analysis of the algorithm was necessary to determine why the OCR was not to identifying the fields correctly. After this analysis, it was concluded that the main problem was in reading the dates of the invoices. Example: the invoice was dated 09-05-2012 (May 09) and the OCR extracted the date to 05-09-2012 (September 5). Another conclusion can be drawn by analyzing the relationship between the KPI KM-AP3 (timely payments) and KM-AP5 (implementation of timely payment proposal). As shown in Figure 10, at the end of the period the execution of the payment proposal has almost always fulfilled the expected level of service. However, this did not happen at the beginning, it has improved with the implementation of the project. Making a relationship with the KPI KM-AP4 (confidence of the resolution of discrepancies), KM-AP6 (confidence of the approval circuit) and the KM-AP8 (correct time to redo tasks), we can see that the training given to employees of XPTO and of ABC allowed the increase of expertise in the use of tools, contributing to the improvement of service levels. This can be seen in the final quarter, which presented results in accordance to the established goals.

Following the KPI analysis it can be concluded that, starting in May 2012, service levels concerning the KPI CLS-AP1, CSL-AP2, CSL-AP3 and CSL-AP4 always maintained the established goals.

Concerning the research question of this project, it can be concluded that the process of externalization of financial services (supplier's area) really improved the KPI, compared to the previous KPI process.

## 4. Conclusions

### 4.1. Conclusion

This case study intended to demonstrate that the financial metrics of the Portuguese company improved, after the Romanian company implemented the project, and the latter assumed the tasks. Using the Lean Six Sigma strategy, it was described step by step the phases of the project, according to one of the methods of this strategy, the DMAIC. The interest and involvement of top management helped keep the team united and committed to the success of the project. The results presented in the KPI, show that the improvements were not immediate, but with the training of employees and the experience gained operating the tools, it can be concluded that the process has improved over time, with efforts to a continuous

improvement. The new system implemented becomes simpler, thus contributing to a better control and a faster support intervention, if needed. One limitation of this study was the need to hide the identity of the companies, and the most important was related to the secrecy required by companies concerning some data to display. Another limitation was that, despite the study consider the financial part, there was a wide area within the department covered by the study, and this work was directed only to suppliers' area.

### 4.2. Recommendations

To continue this study in other areas of the financial part but combine all areas in order to achieve the greatest possible synergy with the use of new tools.

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