Improvement of Segment Business using DMAIC Methodology: A Case Study

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Abstract: Xerox uses Lean Six Sigma to uncover methods to manage the company’s document strategy. At Xerox, the DMAIC (define, measure, analyze, improve, control) methodology of Lean Six Sigma is critical to helping us run our business. We use the tools and processes – along with the fact-based data-driven information – to drive decisions through this Black Belt project. It’s a rigorous, results-oriented approach to process improvement. And, we are disciplined and dedicated to its delivery. In this paper, we will describe how a new solution developed by a Xerox team, could increase the revenue and win additional new business in the Subsidiary Business in a specific area of business – Printing Systems. The various tools that are utilized at each step of the process are highlighted to demonstrate the effectiveness of this approach.

Keywords: Lean six sigma, DMAIC, black belt.

1 Introduction

This project aims to improve Printing Systems Business Model within the Subsidiary Business to improve penetration rate and achieve a more stable revenue over time. Xerox Portugal operates with 33 Subsidiary Business in the whole country.

Between 2003-2004, Xerox Portugal created a special certification – “Premier Partners Certification”; for achieving this certification the Subsidiary Business should own very specific resources. They need to develop the ability to remain alive or continue to exist, this is survivability.

Back in 2005, Xerox Portugal decided to create individual certifications for Printing Systems and for Office.

In 2007, there were a lot of problems with the Printing Systems business model resulting in the following:

- Decrease of Sales Results in the Subsidiary Business
- Printing Systems territory overlapped with Office territory & models of equipments
- Subsidiary Business Certification was not credible
- Low Economic Sustainability
- Market Dimension & concentration
Return On Investment
Much of the business is supported by Subsidiary Business margins (Transfer Prices not competitive)
Analyst Certification (number)
Not enough control of Activity / Not enough territory coverage by the Business Development Executive
Selling Strategy should be through services & not price (Value Added)

Xerox Portugal mission was to help them develop innovative techniques and technologies for Performance Improvement, understand the entire lifecycle of activities developed in the partners with the associated cost of environmental preservation, and maximize their performance.

2 Define Stage

We decided to improve this business model through DMAIC (Define, Measure, Analyze, and Improve) model. This model is used to characterize and optimize both business and processes.

In the Define step, the team refined the problem statement and goal, identified the customers served by the process being studied, defined the Subsidiary Business (customers) requirements and wrote the plan of how to complete the project.

In this step four outputs were produced:
- Project charter and work Plan
- Measurable Subsidiary Business Requirements
- SIPOC (Suppliers, Input, Process, Output, Customer)

3 Project Charter:

The project charter is the first tool in the Six Sigma Methodology which defines the team’s mission and also provides a brief description of the opportunity. Since January 2005, we are not growing in Printing System business in the Subsidiary Business.

Founded on our recent learning of Lean Six Sigma methodology, we estimated we could help the Subsidiary Business improving their service quality, their reliability and their maintainability.

Evaluate business cases that articulate what improvements might be made, what the potential return on investments (ROI) might be. Target: grow PSG equipment sold by these partners.

The business impact is the third statement that should have a clear and common understanding of “why we should do the project” and a quantified, estimated value of the project in monetary terms.

The target is to achieve the 2007 Plan in PBT for indirect channel increasing Printing Systems revenue.

We believe we can grow 10% in PBT in the printing systems business area via indirect channel, that increase $100k in PBT in Printing Systems indirect channel (our partners)

The project charter also describes the scope, identify the roles and responsibilities of team members and time required to achieve these objectives.

4 Identify Subsidiary Business requirements

VOC – Voice of the customer and VOB – Voice of Business
During this phase, the "voice of the customer" was captured and a measurement system was put in place. The Voice of the Customer are the requirements from the Subsidiary Business to provide the customers with the best in class service/product quality. This process is all about being proactive and constantly innovative to capture the changing requirements of the Subsidiary Business in a timely manner. We captured the Voice of the Customer using an indirect method - a survey sent to Subsidiary Business.

The goal was to translate Voice of Customer input into Customer Requirements. After that we organized Voice of Customer input using Affinity Analysis. An affinity diagram is a good tool for this purpose since it organizes language data into related groups.

The Tree Diagram used helped organizing needs by level of detail in order to analyze and prioritize Subsidiary Business requirements.

![Customer Affinity Diagram](image1)

**Figure 1:** Customer Affinity Diagram

The Subsidiary Business (partners that only sell Xerox Products) have three types of customers for which the most important requirements are the print quality of the equipments that the Subsidiary Business sell them, know-how from the salesman, choosing the right solution for their needs, helping them to reduce costs.

![Subsidiary Business Affinity Diagram](image2)

**Figure 2:** Subsidiary Business Affinity Diagram

So, after this step, we were able to define the needs of Subsidiary Business, their requirements and which one were priorities.

Regarding the resources available in Subsidiary Business, they need more support from Xerox Portugal, and they need to change their structure to support a specialization.
They also mentioned the high investment required to be selected as certified Subsidiary Business since they need persons with skills to support them.

The final step in Define is developing a “picture” of the process involved in the project by creating a “high level” flowchart: the SIPOC.

5 SIPOC (Suppliers, Input, Process, Output, Customer)

A high-level SIPOC chart helps to identify the process outputs and the customers of that output so that the Voice of the Customer can be captured.

Figure 3: SIPOC

At this phase we were able to:
- define the major elements of our process,
- identify the process boundaries and
- create a process diagram.

Because the work performed by Lean Six Sigma teams is part of the strategic decisions made by the organizations, we had a formal review procedure at the end of each phase of DMAIC (Define, Measure, Analyze, Improve, Control). The purpose of that review was for the Sponsor to review the team’s progress and give a formal go-ahead for the next phase. We call these types of review tollgate reviews.
6 Measure Stage

The objective of the Measure phase is to determine the baseline and target performance of the process, define the input and output variables of the process and validate the measurement systems.

Our first step was to observe and talk to the people involved. This observational experience helped to decide what to measure in the process.

Also important is to understand the difference between “continuous” data and “discrete” data because the differences influence how we define the measures.

Measurement is a key transitional step in the Six Sigma road; one that helped the team refine the problem and starting the search for root causes – which will be the objective of the Analyze step in DMAIC model.

We found difficult to reach a decision on what measures to take. The process of data collection was difficult and time-consuming.

Our Measure activities were:

- Measuring the processes (stratification factors)
- Develop Operational Definitions & Data Collection Plan
- Data collection form
- Base line performance
- Validate the business opportunity

7 Measuring the Process:

We used stratification of information because it gave us clues about where to look for the causes of problems:
8 Develop Operational Definitions

Operational Definitions is a clear, understandable description of what will be observed and measured, in a way that different people taking or interpreting the data will do so consistently.

9 Prepare Data Collection and baseline performance

After that a Data Collection was prepared covering three mains issues:
- Identify or confirm the stratification factors
- Develop a sampling scheme
- Create Data collection forms
We started to measure since 2006.
Key Messages:

Control Charts show that 2006 had a better monthly revenue average (US$232K) than 2005 (US$156K).
Box plot shows that quarter activities between 2005 and 2006, had better revenue ranges except in Quarter 1.

10 Calculate baseline Sigma Level for the process as a Whole

Calculating baseline sigma for process is a simple four step process. We did some simple math and consulted the conversion table:
- Actual Equipment revenue Year To Date 9 2006: $2091K
- Plan Equipments Revenue Year To Date 9 2006: $6574K
We did 32% from Plan. There is a gap between the Plan and the Baseline.

The Sigma Quality Level: 1 σ

11 Validate Business Opportunities

We validated the Opportunity through the PBT calculations.
By the end of the measure phase of DMAIC, we had data on which our improvements decisions could be based, and a baseline against which our progress was measured.

The last steps for completing the Measure phase were:
- Revisit our problem statement
- Create a Plan for Analyze Phase
- Update our Storyboard
- Prepare our Tollgate Review with our Sponsor
- Decide “Go” or “Not Go”

12 Analyze Stage

The typical steps in the analysis phase are the identification of patterns through data analysis using statistical methods to analyze the root causes, and validate the root causes.

We needed to generate ideas that helped us determine where to focus improvement efforts related to the goal.

The major activities in the Analysis Phase are the following:
- Identify patterns through data analysis
- Conduct Root Cause Analysis on Critical X’s
- Estimate the Impact of Each X on Y
- Validate & Prioritize Root Causes
- Quantify the Opportunity

13 Identified patterns through data analysis

The focus in the analysis phase is to identify special causes and eliminate them. The patterns are identified by analyzing the data and thus this step is referred as data analysis. In this step we proposed possible hypothesis’ for the current state process performance using Brainstorming, that is a structured method of generating unconstrained ideas/solutions and gaining engagement/involvement in the improvement process.

These were the proposed Critical X’s (input variables from the process):
We don’t have a person dedicated to Subsidiary Business (supporting them)

- Review the transfer prices (are very high related with Achieved Prices for direct Sales)
- Tactical Actions with special offers
- Sales Coverage must be improved - we have territories not covered
- Subsidiary Business Certification must be reviewed
- Training/Skills
- Competition
- Show room for printing systems group
- Gain in Service Contract

Up to this point, my team has been collecting data about the process outputs (The Y’s).

Y1 (Grow revenue at Indirect Channel) X1, X2, X3,……Xn

We used the Cause and Effect Diagram, because it is a really structured brainstorming tool. It represents the relationship between the effects (problem) and its potential causes. We used it to identify the sources of variation (causes), which are influencing the problem.

![Image of Cause and Effect Diagram]

**Figure 7: Cause and Effect Diagram**

We used the Cause and Effect Diagram, because it is a really structured brainstorming tool. It represents the relationship between the effects (problem) and its potential causes. We used it to identify the sources of variation (causes), which are influencing the problem.

The resulting diagram is also a good way for the team to document which theories it has considered, which have been targeted for further investigation, and ultimately which have been verified.

This type of diagram is also known as Ishikawa diagram or Fishbone diagram. The Cause and effect diagram is used for:

- Cause & effect analysis
Improvement of Segment Business using DMAIC Methodology: A Case Study

- Root cause determination of the problem
- Providing a clear graphical display of sources of the variation
- Serving as an excellent tool from which process improvement action can be originated.

14 Prioritize Critical X’s

In the next step we used QFD tool (Quality Function Deployment) to Determine Critical Customer Requirements and Performance Targets. This is a structured methodology for translating Customer Needs (Voice of Customer) into Service or Process Specifications, in our process:

![Quality Function Deployment Diagram]

**Figure 8: Quality Function Deployment**

Assessment or final conclusions:
1. Xerox Support is the Critical Customer requirement process functions that are having highest impact on all CTC (Critical to Customer) wants.
2. Sales Coverage and Change the Service Rules also have impact on the CTC (Critical to Customer) wants.
3. Increase the Subsidiary Business profit and Service Profit have the biggest impact by the design metrics listed in the Critical Customers Requirements.
15 **Conduct a Root Cause Analysis on Critical X’s**

To identify the sources of variation (causes), that are influencing the problem we constructed a cause and effect diagram. The Root Causes of why this business area (Printing Systems) profit doesn’t increase:

- We don’t have a person with skills dedicated to Subsidiary Business for supporting their salesman and their customers (More support from Xerox)
- Review the transfer prices (are very high related with direct Achieved Prices ie. the prices for direct sales force)
- Tactical Actions with special offers (to be more competitive)
- Sales Coverage must be improved (we have territories not covered)
- Subsidiary Business Certification must be reviewed
- Training Plan for Subsidiary Business

16 **Validate Critical X’s**

We knew that when we take the average of a sample, it was probably not exactly the same as the average of the population. So we used the confidence intervals to help us determine the likely range of the population parameter.

For example, if my 95% confidence interval is 5 +/- 2, then I have 95% confidence that the average of the population is between 3 and 7.

Because these estimates vary from sample to sample, we quantified our uncertainty using statistically-based confidence intervals. Confidence intervals provide a range of plausible values for the population parameters ($\mu$ and $\sigma$).

Extending the concept of confidence intervals will allow us to set-up and interpret statistical tests.

17 **Estimate the Impact of Each X on Y**

In most cases, the basic power tools will be enough to allow the team to identify significant differences in the data and verify cause-and-effect relationships that will be at the heart of the solutions.

In this process we needed more powerful, rigorous tools – 2 factors ANOVA

![Figure 9: Two factors ANOVA](image)

The Key Messages were:
Having an expert in Printing System supporting the Subsidiary Business has a high impact on the results.

The GOLD Subsidiary Business are not performing as expected – something is wrong with them. We did some root causes analysis to the Gold and Standard Subsidiary Business.

We used Hypothesis Testing, that is a set of calculations for determining the degree to which two groups are different (in our case is Subsidiary Business Standard average revenue and Subsidiary Business gold average revenue)

- Allow us to determine statistically whether or not a value is cause for alarm (or is simply due to random variation)
- Tell us whether or not two sets of data are different
- Tell us whether or not a statistical parameter (mean, standard deviation, etc.) is statistically different from a test value of interest
- Allow us to assess the “strength” of our conclusion (our probability of being correct or wrong)

We are going to analyze the average revenue that the Standard and gold Subsidiary Business produce:

So is the difference between average revenue statistically significant?

Hypothesis testing:

- The average revenue for Subsidiary Business standard is €67,695
- The average revenue for Subsidiary Business Gold is €57,714
- Is the difference between average revenue statistically significant?

The first hypothesis test to be performed is to determine whether there is a statistically significant difference between the means of the two certifications - Gold and Standard. This is called a 2-Sample t.

![Figure 10: 2 Sample t](image)

Two-Sample T-Test and CI: Std; Gold
Two-sample T for Std vs Gold

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
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<td>Std</td>
<td>6</td>
<td>45130</td>
<td>40938</td>
<td>16713</td>
</tr>
<tr>
<td>Gold</td>
<td>6</td>
<td>76953</td>
<td>36866</td>
<td>15051</td>
</tr>
</tbody>
</table>
Difference = \mu (Std) - \mu (Gold)
Estimate for difference:  -31822.9
95% CI for difference:  (-82701.0; 19055.3)
T-Test of difference = 0  (vs. not =): T-Value = -1.41
P-Value = 0.191  DF = 9

The T-Test of difference = 0, means that the null hypothesis states that the difference between the two means is zero
The P-Value = 0.191, means that we are 80.9% (1 - 0.191) confident that the Gold partners are bringing in less revenue than the Standard partners.
Please note transfer price is less for the Gold and yet the revenue is lower than the standard partners, this is unacceptable.

What actions should we take? It will be important to spend some time on this analysis.

Through hypothesis testing, we were going to be able to reach conclusions about whether the differences we think we see were important for our team.

18 Quick Wins – We took some actions in Quarter 1 2007

We recruited a Printing System Group expert supporting all Subsidiary Business in the whole country (More support from Xerox)
Launched new transfer prices for some products (Copier Printers)- Decreased the transfer prices

Tactical Actions in a Printing System Group Mono: Offer prints to the customers (To be more competitive)

19 Quantify the Opportunity (Results 2006 – 2007)

The impact of having a Printing Systems Group expert to support Subsidiary Business and also the Lower transfer prices made available to them, Subsidiary Business grew 8% revenue vs. 2006. The Subsidiary Business became more competitive.

20 Preparing for a Designed of Experiment (DOE)

Design of experience helped our team verify cause and effect relationships. DOE is based on simultaneously testing multiple factors that affect the process. Sometimes the X’s are correlated (dependent). This condition is known as multicollinearity. This could cause problems with the model

Response Surface Regression: month vs revenue; gp

The analysis was done using coded units.

<table>
<thead>
<tr>
<th>Term</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
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<td>2227.20</td>
<td>0.807</td>
<td>0.436</td>
</tr>
</tbody>
</table>

S = 140.8  R-Sq = 28.7%  R-Sq(adj) = 0.0%

![Figure 12: Regression Coefficients](image)

Why do we use Design of Experiments?
Design of experiments is a powerful experimental approach that allowed our team to:
- Test many potential causes at the same time
- Identify complex interactions between potential causes
- Quantify the degree to which individual causes and their interaction affect the result or outcome we are interested in.

21 **Improve Stage**

Following are the major activities in the improve Phase:
- Generate creative design concepts
- Select the best design concepts
- Design the process
- Validate the results

It is a good direction to develop Pilot Plan & Pilot Solution – Pilot the best solutions Complete Improve Gate Review.

22 **For the solution generation techniques we used**

- Brainstorming
- Building on Ideas from the Subsidiary Business survey
- Sub-teams participation

23 **Prioritize Root Causes - Q2 Actions**

Sales & Operations Planning:
From the Production analysis so far the corrective measures identified vs. the errors, have generated the following list of actions:
- Launch a new Subsidiary Business only to cover Printing System Group - CNX
- Launch a Printing Systems program for Subsidiary Business – Action Plan Erasmus
- Tactical actions to trade in old machines
- Tactical Actions for Printing Systems Mono and color – on going

24 **Regression Analysis on revenue – Jan 06 – Apr 07**
Figure 13: Regression Analysis: revenue versus month

R-Sq is the amount of variation in the data explained by the model. R-Sq is the square of the Pearson correlation.

P is < 0.05 so there is a correlation between revenue and the months. So we are increasing revenue during 2007

Regression Analysis on Gross Profit – Jan 06 – Apr 07

We also did the regression analysis in Gross Profit. And we concluded that as the P is > 0.05 there is no correlation between GP and the months. In 2007 the increase in GP is more flat.

25. Two applications of Control Charts:

These types of charts are used for monitoring the process and many six sigma professionals are using control charts only in the control phase. However, they can be very good diagnostic tools as well.

Figure 14: Control Charts with stratified data, can be used to analyse the sources of variation
Improvement of Segment Business using DMAIC Methodology: A Case Study

Figure 15: Control Charts for revenue – 2006 vs 2007

K$667 GP, the highest value in GP. The GP mean is $164K.
The revenue average in 2006 was $274K- YTD12 2006. The revenue average in 2007 was $416K- YTD7 07.

Control Stage

The control phase has 4 parts:

- Discipline
- Documenting the improvement
- Keeping Score: establishing ongoing process measures
- Going to the next step: building a process management plan

There is no tool that can help us with discipline – that depends largely on how committed our organization is to continuously doing a better job of meeting customer needs. There are a lot of tools we could use to document the improvements - we could use process maps (flow charts), we could use data to monitor de performance. Being proactive in planning for potential problems, assigning specific responsibilities for performing the work, helps the most.

Control Metrics:

Total Xerox Business (equipment indirect revenue) of Xerox Printing System portfolio (except Xerox Wide Format)

These metrics will be controlled every month, at the Printing System Indirect Channel monthly Meeting (using a Control Plan defined)

Control Charts will be used to monitor the process for quick detection of abnormal variation.

Process Dashboard for helping us to monitor the most important indicators of quality, cost and effectiveness.
26. Conclusions

This paper has described a powerful DMAIC methodology for improve a Xerox business model. The process steps were described with a considerable detail within the context Printing Systems business area to illustrate the key concepts. We believe that this methodology is applicable to improve other processes inside an organization.

Our focus to help them was:

- Providing real-world value for commercial applications through succinct delivery of the latest techniques and business practices.
- How to succeed in today’s market place.
- Our governance model allows for the delivery of the latest and greatest information on how to ensure product success and mission assurance. Our focus is on helping them to identify risks and mitigate them in the most optimal manner.

References


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