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A Framework To Align Strategy, Improvement Performance, And Customer Satisfaction Using An Integration Of Six Sigma And Balanced

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A FRAMEWORK TO ALIGN STRATEGY, IMPROVEMENT PERFORMANCE, AND CUSTOMER SATISFACTION USING AN INTEGRATION OF SIX SIGMA AND BALANCED SCORECARD

by

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ABSTRACT

This dissertation investigated the development, implementation, and evaluation of a management methodology founded on the alignment among the strategy, performance, and customer to bring value to any organization. A case study/action research in a service organization, called Institution "Z," provided the opportunity to assess the effects of the proposed Six Sigma Scorecard (SSS) methodology in the productivity indicators (measured by cycle time, line capacity, and number of errors).

The Case study/action research was conducted in three phases: Model and Concepts Design, Data Collection, and Findings. During the research, validity was pursued by using triangulation and theory to help maintain the case under research control. The observation of the SSS methodology in a real organization allowed the researcher to describe the merging process between Balanced Scorecard and Six Sigma methodology and their relationships to each other.

The SSS methodology allowed identification of improvement projects that contribute to organizational strategy, implementation of strategies and provide feedback to the top level of management establishing alignment at three organizational levels – corporate, business, and functional. The results of the implementation of the SSS methodology in Institution Z showed a 40% improvement of the cycle time of the auto credit process, a 500% increase in the capacity of the process, and 65% decrease in the number of non-added value activities. During the same period of time, the BSC indicators showed a positive impact, specifically one financial indicator known as Level of Intermediation or GIC grew from 30% to 42% as it was expected by the end of the SSS implementation.

The demonstration of the SSS framework in a Case study justifies the need for a combined methodology that aligns strategy, performance improvement and organizational outputs in a feedback loop.

More research in this area is needed, especially investigations that include assessment studies where different management approaches are used alone and combined with strategic tools, and investigations that measure the relationship between level of coherence in the three merging points of the SSS and the results reached at the performance of the organization.

Dedication

This dissertation is dedicated to my husband Martin, my sons Martin and Bernardo, and my daughters Angela and Claudia. Thank you, all of you, for your support, and take it as my legacy of hard work and perseverance in life.

I also want to dedicate this dissertation to my parents, Ruben and Gladys, because they have encouraged me to set goals, and they firmly believe in my capacity to reach them.

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LIST OF ABBREVIATIONS AND DEFINITIONS

Balanced Scorecard (BSC)	A formalism, methodology, and framework that translates strategy to actionable and measurable objectives. Following four perspectives, BSC balances these objectives and finance, as example. This methodology allows for all parts of the organization to know and understand their contribution to strategy.
MM. Bs.	Millions of Bolivares. The **bolívar** (plural: bolívares, ISO 4217 code: VEB; locally abbreviated as *Bs.*) is the currency of Venezuela.
Cause and effect	The effect of recognizing the relationship among strategic themes and their impact on one another.
Core competency	The basic set of capabilities and habits a corporation has that is unique to its personality and skills.
Key performance indicators	Measures those are critical for strategic or tactical realization.
Lagging indicator	A measure(s) that is identified only after an event occurs.
Leading indicator	A measure(s) that can indicate the result of an event prior to it occurring.
Mission	Why an organization exists and what it is charged with.
Objective	A goal to be achieved that is specific, measurable, and actionable.
Measure	A quantifiable formula with variables that define what need to be measured and monitored in order to achieve a target.
Operational excellence	Doing an activity well.
Performance measure	The methods to align performance results to measures and management of this process.
SWOT	Strengths, weaknesses, opportunities, and threats
Strategic theme	Key strategic objectives for differentiation, focus, and market dominance.
Strategic variables	Key drivers and assumptions to strategy themes that, once changed or altered, can affect the validity of the strategy.
Strategy mapping	The process of linking all the strategic objectives within the four perspectives into a cause-and-effect map.
Target	A numeric or non-numeric value representing a desired result.
Value proposition	Usually associated with products and services, this is the emotional, symbolic, and practical residue after a customer envisions payment for a product or service.
Values	In contrast to a mission, which is *why* an organization exists, the values are about *how* an organization wishes to exist.
Vision	The sight of the mind. An organizational vision is the statement of what an organization sees as the state of the future.
Kaizen	Improving
DMAIC	Design, Measure, Analyze, Improve, Control
DPMO	Defects per millions opportunities
DPU	Defects Per Units
TQM	Total Quality Management
UK	United Kingdom
VOC	Voice of the Customer
USA	United States of America
TOC	Theory of Constraint
CMM	Capability Maturity Model
BU	Business Units of the organization

BSC support	The BSC created for the support units within Institution Z
Detail Agency	Institution Z's agency, which has direct contact with external customers
ACT	Answer Cycle time indicator
ROE	For the Spanish name, referring to the return on investment metric
IISO6	ISO norm from the Spanish name
PVME	A special type of customer or preferred customer created by the Venezuelan government
Credisur	Generic Spanish name created by Institution Z to refer to all kinds of credit products they offer to their customers.
Microcredit, creditauto, creditcash	Different types of credit products that Institution Z offers to its customers. Their names are in Spanish.
SUDEBAN	Institution depending on the Venezuelan Fiscal Organization, with the objective of controlling and supervising all banking and financial organizations according to the National Banks' law.
Datanalisis	Private market research recognized for its excellent work in all economic and social areas in Venezuela. It was founded in 1985 and is known as one of the most reliable sources of information in Venezuela.
ABV	Venezuelan Bank Association. It is formed from 54 Venezuelan banking organizations with the objective of defending their interests in the changed marked.

CHAPTER 1: INTRODUCTION

1.1. Six Sigma Scorecard

This dissertation investigates the development, implementation, and effectiveness of a combination of two recognized management methodologies and tools – Six Sigma and Balanced Scorecard (BSC) – to align strategy and performance improvement in order to translate it to customer satisfaction. The researcher has named this combined methodology Six Sigma Scorecard (SSS).

Six Sigma is a quality management philosophy and methodology that focuses on reducing variation, measuring defects, and improving the quality of products, processes, and services. Popularized by Motorola in the 1980's, Six Sigma has garnered a significant amount of credibility based on the savings that the organization, along with General Electric (GE) and Allied Signal, made public. During the first few years of Six Sigma implementation in GE, the company obtained savings of about US$150 million. From 1996 to 1997, GE increased the number of Six Sigma projects from 3,000 to 6,000 and achieved US$320 million in productivity gains and profits. In 1999, GE reported US$2 billion in savings that it attributed to Six Sigma, and in its 2001 annual report, GE discussed the completion of over 6,000 Six Sigma projects, yielding more than US$3 billion in savings according to conservative estimates (Evans and Lindsay, 2005; Hayes, 2006).

On the other hand, the Balanced Scorecard is a strategic management tool and performance measurement system designed to directly translate an organization's strategies into action-oriented plans. The BSC was created by Robert Kaplan and David Norton in 1992 and has rapidly gained popularity because it offers the opportunity to control organizational performance

with a measurement system based on organizational perspectives rather than traditional accounting perspectives. Intensive research has been done to assess the benefits associated with the applications of the BSC in industry. The more recent research efforts will be highlighted in the literature review (Davis, 2000; Sierra, 2003; Andersen H. V, 2004; Phillips, 2004; Shu-Hsin Huang, 2004; Paladino, 2005).

The changing environments, forces, and threats that organizations are facing in translating strategies into action-oriented plans to be executed have, however, introduced some failures. Gupta (2004) made a point about certain realities in the applications of BSC when he explained that the design measurement process could be so long and bothersome that it could result in an immense amount of performance indicators that are not actually related to the organization's goals. "Fewer than 10 percent of the strategies outlined on the Balanced Scorecard were successfully implemented… the measurement strategy must be simplified for a successful execution" (Gupta, 2004).

Likewise, not all the Six Sigma projects have resulted in significant savings. Bruce Hayes, in the magazine Six Sigma, recognizes that many Six Sigma project savings were in the range of 0.5% to 1.0%, and some projects have been canceled after significant investment due to low returns (Hayes, 2006). Most of the research has concluded that the cause of failure lies in the deployment of the framework and not in the concepts and philosophies that support this framework (Jiju and Banuelas, 2002; Jiju, 2004; Pfeifer, Reissiger et al., 2004; Hayes, 2006). The problem of translating organization strategies to performance improvement processes that finally results in desirable organization outputs is present for today managers.

As pointed out by Anderson (2004), new gaps in the research are apparent, and new approaches and research are needed in order to adapt and integrate the new tools available (Forrest, 2003; Kubiak, 2003; Andersen H. V., 2004; Pfeifer, 2004; Schultz, 2006).

The BSC and the Six Sigma have been demonstrated to be strong management methodologies. The lesson learned from the failures in the implementation in both methodologies offer opportunities to build new strategies. The synergy of these two approaches may provide capabilities to:

1. Allow performance improvement as opposed to traditional symptom analysis
2. Provide a holistic view of the company
3. Work upon the lessons learned of both approaches
4. Establishes accountability for leadership and commitment

Some of the few applications of Six Sigma Balanced Scorecard include the following: in 2004, a theoretical framework was designed to apply the Six Sigma Balanced Scorecard in the healthcare sector (Schultz, 2006). A case study in 2002 reported the use of the Balanced Scorecard to measure their Six Sigma system's efficiency and effectiveness to find the causes for Six Sigma project failure (Starbird, 2002). In 2004, three case studies were studied to demonstrate that third generation Balanced Scorecards can support different management initiatives such as Six Sigma (Andersen H. V., 2004). These studies and others are evaluated in the literature review in the next chapter.

Research or studies that address specific aspects of this emerging trend in explicit sectors were not found by the author. The literature does not provide a holistic framework for implementing the proposed merger between Six Sigma and BSC methodology. New roadmaps

concerning improvement performance, along with new strategy and the need to satisfy customers, may benefit companies and provide a contribution to the management body of knowledge.

Empirical findings from the implementation of the proposed merger methodology may offer opportunities for managers to align strategy, performance and customer satisfaction in any organization, and evaluating performance and quality initiatives based on four BSC dimensions.

From the lessons learned and the gaps left in the most recent studies, it appears that there is a potential for extension of these works. This research will utilize scientific methods to produce a management approach that will help to close the gaps between strategy, performance, and organizational output in an attempt to tap into that potential.

1.2. Research Objectives

The objectives of this research are:

- Rationalize that the Six Sigma quality approach and the Balanced Scorecard can be effectively combined.
- Build a holistic framework that allows for the alignment of strategy, organizational performance indicators, and customer satisfaction using an integration of the Balanced Scorecard methodology and Six Sigma approach. The research will provide a framework so that organizations can implement Six Sigma Scorecard (SSS) and design a measurement system that connects performance (improving processes) and customer satisfaction back to BSC targets.
- Demonstrate the holistic framework via a Case Study

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Six Sigma Scorecard (SSS) is a combination of two proven methodologies focused on providing a holistic view of the entire organization's strategy and its improvement performance rate to satisfy customer expectation. This combined methodology aligns strategy, operational performance, and final organizational output.

This trend is novel in today's quality management application. Very little research has been done regarding this approach. In order to understand its scope, limitations and possibilities, Chapter 2 is divided into five sections. Sections 2.2 and 2.3 provide a brief explanation of the two parent philosophies: Six Sigma and Balanced Scorecard. Section 2.4 presents a literature review of research in each of the two areas, first, the Six Sigma literature review and then the Balanced Scorecard literature review. Section 2.4.3 presents the literature review on Six Sigma Balanced Scorecard. Finally, section 2.5 provides an overview of different classifications of research strategies, along with a description of some trends in the area of research in management, emphasizing case study and action research strategies.

2.2. Six Sigma Concept

Six Sigma is a management and quality philosophy that focuses on leading the organization through a continuous improvement process that seeks to find and eliminate causes of defects and errors in manufacturing and service processes. As a philosophy, Six Sigma rests on the same principles contained in the 14 points of Deming, Juran, Crosby, and other quality gurus' philosophies, but Six Sigma incorporates the use of rigorous statistical tools and the

DMAIC implementation cycle, which provides the infrastructure to obtain virtually error-free business performance (Mohan, 2004; Evans J. R., 2005).

The Six Sigma approach to problem solving is completed in five phases:

1. Define "D": Define the Six Sigma project and identify its scope and deliverables to resolve operational issues
2. Measure "M": Measure the performance status of the defined project
3. Analyze "A": Analyze project performance against the target
4. Improve "I": Improve Six Sigma project management system
5. Control "C": Control retroactively and monitor the improvements

The Six Sigma standard of 3.4 problems per million opportunities increases the traditional standards for quality as a response to the increasing expectations of customers and the increased complexity of modern products and processes. To ensure that these key aspects are implemented successfully, measurements are needed to monitor progress. Typical measurements include the following:

Defects per unit (DPU): a defect or nonconformance, any mistake that is passed on to the customer.

$$DPU = \frac{Ndd}{UP} \quad \text{..... Equation 1}$$

Defects per unit (DPU): Defects detected per units produced

Ndd = number of defects discovered

UP = Number of units produced

$$DPMO = DPU \times 1{,}000{,}000 \quad \text{..... Equation 2}$$

DPMO = Defects per million opportunities of errors

A Six Sigma quality level corresponds to a process variation equal to half of the design tolerance while allowing the mean to shift as much as 1.5 standard deviations from the target. The area under the shifted curve beyond the Six Sigma range is only 3.4 parts per million. A *K*-sigma quality level satisfies the equation:

K * process standard deviation = tolerance/2……. **Equation 3**

(Gupta, 2004; Mohan, 2004; Praveen, 2004; Evans J. R., 2005)

Six Sigma activities focus on the few things that matter most to three key constituencies: Customers, shareholders, and employees. Six Sigma narrows the tails of the normal distribution.

A set of tools used in each step of the DMAIC cycle is shown in Table 1.

Table 1. Six Sigma Toolkits

DMAIC cycle	Six Sigma's toolkit
Define	VOC tool: survey, focus group, letter SIPOC Benchmarking Process Map
Measure	Measurement system analysis Process Capability Exploratory data analysis Statistical chart Pareto chart Data mining
Analyze	Affinity Diagrams ANOVA Cause and effect Brainstorming Tree diagrams Process behaviors charts Process map DOE Inferential Statistics Simulation
Improve	Force Field diagram Project Planning and management tool Prototype and Pilot studies
Control	SPC FMEA ISO 9000 Models and Systems

Current measurement systems tend to focus on operations that limit measurements for the strategic aspects of the business. A heuristic measurement of organizational performance is missed. This may leave leadership unable to relate to the overall performance of the business.

2.3. Balanced Scorecard Concepts

The Balanced Scorecard is a management tool used to translate the corporate strategic mission and vision into a set of quantifiable indicators of performance. In other words, it is intended to explain what to do and how to do it. The real contribution of a Balanced Scorecard program is to link the objectives in each of four perspectives: financial, processes, customers, and growth and learning (Kaplan R. S. and D. P. Norton, 2001).

BSC focuses on four basic concepts: Performance at the Business Units (BU) level, cause-and-effect relationships, both non-financial and financial measurements, and dissemination of corporate strategies to employees.

The Balanced Scorecard is best deployed at the strategic level and trickled down through the organization. Work groups can devise their own Balanced Scorecards and their corresponding BUs that show their contribution to the strategy of the organization. Action plans and resource allocation can be determined according to the work groups' contributions to the corporate Balanced Scorecard objectives. The BSC approach recognizes the fact that goals can vary from BU to BU, so performance measurement should be adapted to a specific environment.

While implementing a Balanced Scorecard, managers articulate their strategy for the organization. Department personnel go through training and attend sessions to develop the vision, strategy, and measurements that will lead to a Balanced Scorecard. Departments develop objectives and targets as well as action plans. Weaknesses in the organization can be identified

through the reporting process and corrected through the learning process. The BSC is a performance measurement system designated to direct employee efforts into actions aligned with corporate strategy. (Mohan, 2004)

All the BUs are aligned through the cause-effect relationship. What causes the measures of success to improve are the drivers, which are called "lead indicators." The effects or outcomes are called "lagging measures." A good Balanced Scorecard contains both leading and lagging measures and indicators. (Evans and Lindsay, 2005)

The BSC visualizes the organization as a group of equally balanced components, each of which must be taken into account to understand how the organization as a whole is performing. BSC recognizes that organizational performance cannot be evaluated solely from the financial point of view.

The BSC is a performance measurement system that measures the performance of both individuals and BUs by using a combination of financial and non-financial measures. An objective of the BSC is to shift the focus of the performance measurement system from the short-term to the long-term.

Because the BSC requires knowledge of all levels of the organization, the process of developing a BSC emphasizes communication. A BSC communicates long-term strategic initiatives to the BUs and then tracks their performance.

The traditional perspectives in the BSC are the Financial Perspective, the Customer Perspective, the Internal Process Perspective, and the Learning and Growth Perspective. New trends in the BSC allow an adaptation of these perspectives to specific internal and external

environments and among different organizational sectors (Davis, 2000; Kaplan and Norton, 2001; Mohan, 2004).

A common cause of failure of BSC implementation is the delayed timeframe and the effort needed for its development. By the time the Balanced Scorecard gets to work groups, the strategy has become unrelated to employees, and too much effort is required to maintain the system. (Mohan, 2004)

2.4. Six Sigma and Balanced Scorecard Literature Review

The idea of combining Six Sigma and Balanced Scorecards as a method to improve performance in customer satisfaction is a very recent development. Very few articles combining the two ideas have been found. Specifically, the contributions of Andersen, Schultz, Gupta, and Pfifer will be explained in detail in section 2.4.3 of this chapter. Because this research sets a precedent for using Six Sigma tools and a Balanced Scorecard together to develop a framework that could align strategy, performance improvement, and customer satisfaction, separate literature reviews have also been developed for both Six Sigma and the Balanced Scorecard.

2.4.1. Six Sigma Literature Review

The application of Six Sigma concepts and methodology has been extended in the last few years; multiple articles and case studies can be found in the literature. In this research, we focus on the most recent works, especially those that combine Six Sigma with other applications.

In the manufacturing sector, Hoehn (1995)used a Six Sigma approach to translate customer needs to the early phases of product design. This paper shows a need to broaden the Six Sigma concept from the manufacturing process to the product design process. In other words, it

showed that quality is not only a matter of manufacturing but should also be linked directly with customer satisfaction. The objective during design is to predict design sensitivity and link it to process variability. Using Six Sigma tools and concentrating on opportunities and DPU, it was possible to determine the overall variability of the product. During the design process, product sigma level was tracked through the use of sigmacards and worksheets. Sigmacards provide the metrics for assessing product quality based on Six Sigma concepts. This paper presents an approach to effectively link Six Sigma with Robust Design processes. It was clear that the two processes must be linked effectively to ensure that customers will receive products that work well in the field and also have high first-time yields during manufacture. The key to the process was finding methods to determine customer requirements and then designing products that meet those requirements while remaining cost effective and capable of being manufactured. This early paper exposes the importance of variability and high sensitivity of product design, but a specific relationship was not determined, nor was the impact of those variables on the product and process design cost. How to reduce variability, and how this variability may affect the sensitivity of the product design, among other questions regarding cost and extension of non-production activities were not addressed (Hoehn, 1995).

In 1995, the Six Sigma approach was used to assess customer satisfaction in a high-tech manufacturing industry. A case study was presented to illustrate how the concept of zero defects, measured by Six Sigma, can be applied to customer satisfaction measurements. The case study also examined the impact of customer expectations on the company's strategies for improving satisfaction. This paper pointed out the fact that customer satisfaction is a multi-stage process, which makes it difficult to assess. Four hundred survey responses were analyzed, identifying the

attributes with high customer expectations. Then, by using customer expectations as a guide for targeting improvement areas, the client company could possibly satisfy its customers even more. There was a perceived need to attain higher sigma levels for these attributes. Higher sigma levels were generally perceived by customers as improved performance by assigning a correspondingly higher satisfaction score. The use of Six Sigma analysis allowed for the comparison of products and services of varying complexity on a common basis. This analysis identified two important issues; first, it revealed that higher sigma levels for certain attributes did not translate to correspondingly higher customer satisfaction scores and, second, indicated that some attributes with a higher satisfaction score did not necessarily have to be at a very high sigma level. This investigation used many indicators of customer satisfaction, including customer defections, customer expectation, customer dissatisfaction, and so on, but the investigation failed to identify the dimension of those variables and which ones were considered critical to quality "CTQ" from the customer point of view. The lack of established correlation among those performance improvement programs and the CTQ services features calls for more research in this area. Likewise, further research must investigate how the customer expectation, performance sigma levels, and the customer satisfaction scores for the different services attributes can be analyzed to develop a strategy for focused improvements. The paper concluded by emphasizing the Six Sigma capability to assess error across an organization, whether in production or in customer satisfaction (Behara, Fontenot et al., 1995).

During a quality conference, Six Sigma impacts on quality engineering were discussed. Snee (2000) opened the discussion about why Six Sigma can be considered an effective methodology. Snee indicated that "Six Sigma should be a strategic approach that works across

all processes, products, company functions, and industries." According to Snee, there are three aspects of Six Sigma that are not properly emphasized and differentiate Six Sigma from other qualitative initiatives. They are:

- Integration of the human and process elements of improvement
- Clear focus on getting bottom-line results ($)
- A method that sequences and links improvement tools into an overall approach

Snee (2000) called for quality approaches that integrate all aspects of the organization as it can be done using Six Sigma, "…instead of making strides in fragmented parts in the organization. It is the integration that's needed to produce breakthrough results." (Snee, 2000)

Fulenwider et al. (2000) pointed out that an organization's information technology (IT) system infrastructure needs to support some combination of management strategies such as Six Sigma and the Balanced Scorecard. The underlying infrastructure that supports effective decision making in an organization is the IT system. According to Fulenwider Kendall et al., in order to sustain a Six Sigma program, black belts, green belts, and organizational people, in general, need to have access to relevant data. An organization must be collaborative and connected through the use of its information infrastructure. It is essential to link the Six Sigma program to the IT infrastructure since the early phases of the program require context sensitive searches for relevant information. An information infrastructure promoting collaboration will "connect the disconnects" in the organization.

Similarly, Harrington and McNellis (2001) developed a model and illustrated it through a case study with the objective to merge an Internet development life cycle and a Six Sigma program to reduce cost, improve the delivery success rate, and increase service quality. The use

of this model enables the IT organization to infuse Six Sigma into the Internet development life cycle from the define phase of the project. In this case study, Internet value is evaluated as the sum of business process integration plus the satisfaction level attained from customer services, which can be reached through structured team efforts supported by the Six Sigma infrastructure. Some of the benefits derived from the project were: the reduction of customer complaint by 75%, increase in the reliability rate by 88%, reduction in the cycle time by 28%, and a decrease of 82% in rework on the virtual environment.

This project visualizes most of the gain that may be obtained using the Six Sigma tools and methodology in the design and development phases of an Internet project. However, this case study was developed in a project-based organization, which implies a particular set of conditions; investigations in more generalized organization environments are needed. In the same way, this investigation emphasized the technical needs of this merged process. However, some questions must be answered, including why and what is important to tie the Six Sigma improvement process with customer satisfaction and how the measurement of customer satisfaction is related with the internal improvement program and vice versa.

An empirical study, conducted in the UK, identifies the key ingredients for a successful implementation of Six Sigma. The pilot study identified 12 critical elements for a successful six sigma implementation: management commitment, methodology, tools and techniques, linking Six Sigma to business strategy, linking Six Sigma to customers, project selection and tracking, organizational infrastructure, cultural change, project management skills, linking to suppliers, training, and linking Six Sigma to employees. The first four elements held priority over the rest. It is worth noting that three of these four elements considered crucial in the pilot study –

management commitment, linking Six Sigma to business strategy, and linking Six Sigma to customers – can be addressed with the combination of Six Sigma and BSC. (Jiju and Banuelas, 2002)

Using the Taiwan automobile industry as an example, this study aimed to define the problems that require improvement and analyze the causes of these problems using customer opinions and by applying Six Sigma to a performance matrix. In this paper, customer satisfaction can be achieved by promoting high-quality design, manufacturing, and services. The authors used a countermeasure, which points out the causes and helps to make improvements in order to achieve customer satisfaction. In order to build a questionnaire that gets the voice of customers, the author used an approach that combines Kano's five quality mechanisms, Maslow's hierarchy of human requirements, and Herzberg's dual factor theory with the concept of dual machine system. In this case, they found the customer requirement and the key quality mechanisms and used these to identify the key quality specifications. (Chen, Chen et al., 2005)

Wiklund and Wiklund (2002) studied the correlation between the Six Sigma program and the learning curve in a manufacturing organization. The research question was how an improvement program should be designed to support changed attitudes and result in changed behavior and learning. Based on the fact that most of the quality programs imply analysis of process, which is part of the learning cycle, the author looked for a relationship between the continuous performance improvement program and the learning curve in the organization. Six Sigma relies heavily on training for its implementation as infrastructure for improving organizational performance. This paper presents how Six Sigma can be extended to gain even more. The presented approach has been implemented at Solectron Corporation (formerly

Ericsson Network Core Products AB) and has shown positive results in terms of improved organizational learning and, thus, a faster implementation of Six Sigma.

A case study conducted within BAE systems, a British defense contractor, combined the Six Sigma statistical tools with the Lean ideas of kaizen, talk-time-drive, kanban pull, lean production cell, mistake proofing, and a multi-skilled workforce, which are Japanese terms that connect manufacturing output to customer demand through a gradually continuous improvements process to reduce variation within the processes. BAE systems' control implementation plan improved the productivity by 97% and customer lead time by 90%. The synergy between Six Sigma and Lean Enterprise can be seen in the early kaizen events when the black belts were called to do data driven analysis, while reducing the completion time of the improvement project time frame to a week. In addition, Six Sigma techniques can generate the data needed to justify major changes in the kaizen events. Some of the results obtained were: Order-to-shipment lead time slashed 90%; floor space compressed from 6,000 square feet to 1,200 square feet; value added productivity soared 112% in five years; and work in progress reduced by 70% (Sheridan, 2000).

A new approach of Six Sigma, called customer-centric Six Sigma quality, was presented as a way to extend its capabilities by introducing strategic variables that were considered essential to achieving Six Sigma. The research recognized the need of evaluation and assessed the current organizational state from the customers' perspectives and service providers to conclude with the adoption of organizational cultural change. The proposed framework is a continuous cycle where customer-centered Six Sigma is always the selling and defining point, and the organization operates as a open system that receives feedback from its external

environment, namely its stakeholders. The framework is based on the DMAIC (Define, Measure, Analyze, Improve, and Control) cycle, considering critical the degree of cultural acceptance, the level of system capabilities, and the status of employee fulfillment.

Although this approach considers strategic variables and certainly offers a wider view of Six Sigma programs, the financial strategic perspectives are not evaluated, and they do not explain what needs to be considered when some critical indicators, such as employee fulfillment, were not offering good results. In addition, they do not address questions as to how Six Sigma targets could be established to meet stakeholders' needs, how the success of the program can be evaluated, or how one strategic variable can affect other variables or/and customer satisfaction (Kuei and Madu, 2003).

Sierra combined Six Sigma theory with the Theory of Constraints (TOC), offering a new approach to constraint management by including quality as a priority criterion during any manufacturing constrained decisions. This approach makes use of the Six Sigma statistical tool to augment the benefit of the Theory of Constraints (TOC) (Sierra, 2003).

Murugappan presented a new approach by combining Six Sigma concepts and various software capability maturity models (CMMs) for the purpose of aligning process improvement with customer satisfaction. Six Sigma was used to strengthen the difficult-to-link customer satisfaction with the identified organizational areas that need to reach some level of maturity. Some of the benefits gained from blending Six Sigma and CMM included the improvement of the process capability for product quality from 96% in 1999 to 100% in September 2000, the improvement of process capability for time delivery from 2.85 in October 1999 to 4.5 in October

2001, and savings in the order of US $700,000 over a three-year period (Murugappan and Keeni, 2003).

In the services sector, the contribution of Appelbaum (2004) looked to determine the critical success factors of a management consultant organization from the employee's point of view, and based on that, build a model. The research project defined the perceived customer satisfaction as a critical step to lead the organization to success. Appelbaum developed a questionnaire and, from the responses, listed the significant variables in a client-consultant relationship. The three most significant variables were taking into account the client state of readiness, prototyping, and clear visualization of deliveries (Appelbaum S., 2004).

A common point in the literature on Six Sigma application was the need to hear the voice of the customers and expand the quality initiatives beyond the manufacturing frontiers. A key measure of success is a company's ability to ensure customer satisfaction, but it is usually not accomplished with a specific organizational tool, as it was pointed out by Jiju Antony. Taking into account most of the limitations of the Six Sigma programs, such as the challenge of having quality data available, the right selection and prioritization of projects, the need for adapting the CTQ to the markets dynamics, the optimization of CTQ, and the need to simplify project deployment, this research pursues building a roadmap where the voice of the customers and the organization's strategy walk together in an improvement program. (Jiju, 2004)

In the services sector, one of the best known Six Sigma applications is in the city of Fort Wayne, Indiana. Fort Wayne implemented Six Sigma to improve customer service and increase the effectiveness of city government. Internet-based decision-making and empowerment of

employees are key components to the success of the program. Important bottom-line savings have been reached by the city, including the following:

- 5% savings in labor
- 50% reduction in late trash pick-up
- 5% savings equivalent to around US $11,476,976
- Decrease in the cycle time of Building Permits from 47 days to 12 days

Furterer (2004) combined Six Sigma and Lean Enterprise with the objective of developing a framework for implementing "Lean Six Sigma" in the city government. The Finance Department was able to significantly reduce the time of all of its processes, payrolls, purchasing, receivables, and reconciliation, with a major impact in accounts receivables, which reduces cycle time by 90%. The results support her statement that the application of Six Sigma is a powerful program to successfully improve the processes, reduce variation, and eliminate waste.

What to measure, how to measure, and why to measure have been key questions of many research efforts linked with the Six Sigma methodological approach. Regarding what to measure, the Six Sigma approach uses the CTQ criteria during its measure phase. Using an individual set of metrics and a cause-effect relationship, Pyzdek (2003) addresses the "how" concerns. The purpose is improvement of performance. These approaches have been argued in multiple papers. Some of them have indicated that aggregate measures can be preferred to individual measures because they increase the sample size, while others defend the idea of using individual measures in specific clusters of data because they think that global indicators may lose most of their meaning (Arya et al., 2004; Gafen and Ragowsky, 2005).

Questions that arise include the following: Is it possible to aggregate some sigma indicators to have a global sigma indicator of the organizational performance? How can the operational indicators be linked to strategy and organizational goals? (Jensen and Sage, 2000; Arya and Schroeder, 2004; Robson, 2004)

Jensen and Sage (2000) summarized a checklist of criteria for designing, developing, and implementing successful measurement systems and metrics:

1. Communicate to staff what will be measured and how it will be measured.
2. Communicate to staff the individual contribution of its sets of metrics.
3. Communicate to the entire organization the current performance level as a baseline.
4. Provide historical documentation of organizational performance.
5. Align business activities with organizational goals and objectives.
6. Provide information and resources to set goals based on current performance
7. Provide information needed to identify performance problems and risk.
8. Provide a means of determining if performance improvement interventions are successful and have the desired impact on organizational performance.
9. Provide a description of internal and external environments in which it states what interacts.
10. Standardize and formalize the way organizational performance information is collected and reported.
11. Provide information required for strategic decisions, capital investment, and other decisions.

Robson (2004) used psychology and managerial theory to demonstrate that many traditional methods of identifying performance measurements do not result in improvements to overall performance. From the mechanical point of view, the measurement system needs a

control structure and basic rules that link the assessment to actions or steps to remedy the problem. From the psychology theory, the measurement system should allow people for sensing, assessing, selecting, and acting at the same time. Another important conclusion came out of complex behavioral theory. This theory stipulates that most effective monitoring processes occur when the groups of people involved in a process are monitoring a small number of measurements that are critical to the success of the process. Robson states that too many, too few, or inappropriate process performance measures can easily create a deterioration in overall performance. The overall performance of a process needs, at least, to take into account the capability of the process to provide the predicted level of services and the cost of providing those services. The author recommended identifying a minimum set of measurements that indicate when the overall process performance was unacceptable. In regard to the supply chain, the paper promulgated the need for setting service-level agreements between internal business processes. In order to align the measurement system with organizational objectives, the set-up process should start with the customer inputs.

Pfeifer et al. (2004) presented a paper that emphasized the limitations of a Six Sigma program. The authors point out that there are some limitations when evaluating the current quality of the organization. The fact that Six Sigma focuses on a determined quality strategy and that customer satisfaction is a long-term developing project make it difficult to measure with maintainable efforts. The operational process limitations and the different maturity and objectives of the organization call for an effective adaptation of Six Sigma and Quality Management System (QMS). Specifically, the authors make a point about the difference between reaching optimal levels of quality or higher quality levels, and they ask for combined approaches

that targeted specific needs. Balanced Scorecards may support this kind of issue. In the same way, BSCs can play an important role in developing the QMS.

A novel comparison approach was presented by Jeroen de Mast (2004) by evaluating Taguchi's methods, the Shainin system, and the Six Sigma Program. These quality improvement strategies were compared based on seven elements: explanatory networks and their structure, type of influence factors, phases in improvement projects, rules for operational definition of the problem, heuristic for the discovery of potential influence factors, iterative nature of improvement projects, and improvement patterns. The results of this evaluation placed Six Sigma as the most complete statistical improvement strategy, but it pointed out weakness too such as the lack of a heuristic view of influential factors. In the Six Sigma program, the needs of the customer are translated into critical-to-satisfaction (CTS) characteristics and to critical-to-quality (CTQs) characteristics, which are made operational in the measurement phase.

Pfeifer's theoretical evaluation and de Mast's methodological comparison laid the foundation for further research to test Six Sigma possibilities in the global market. Empirical studies are needed to improve current quality strategies or to develop new approaches that address detected Six Sigma weakness from the literature, such as, the lack of a heuristic view of influential factors, limitations to the quality dimensions, the short-term results measures, and the possibility of setting up infeasible improvement rates.

2.4.2. Balanced Scorecard Literature Review

The success and failure in the design and implementation of BSC has been the subject of research for many years. Starting in the manufacturing sectors, researchers like Stephen Letza pointed out the critical success factor in BSC applications. The need for finding appropriate

performance measures is highly significant because they may affect commercial success. In the same way, the BSC may be adaptable to each particular business situation. The culture within each organization has to be of prime consideration in the construction of every BSC (Letza, 1996).

A clear picture of the current state of the BSC in the U.S. was presented by Bernard Marr (2005). This research showed that the BSC is the most common measurement system in practice in the U.S. Thirty-five percent (35%) of companies experienced some level of practices using this methodology. The aim of this study was to understand the current state of use in the 5,000 largest U.S. companies. The first fact that was pointed out is the incomplete application of the BSC methodology. Only 22% of respondents included the learning and growth perspective in their BSC. Only 14% of respondents reported relying solely on the BSC as their performance measurement tool. Many firms combined it with other methodologies –the most common combinations were BSC with TQM or Baldrige, or BSC and economic value added (EVA). This study found that the primary reason for having a performing measurement system, such as the BSC, was controlling the current activities. Thirty percent (30%) of the respondents stated that the purpose of the BSC is to control the performance of the organization, and 19% used BSC for strategic planning. Regarding the communication capabilities of the BSC, 51 percent of the respondents with a formal business process measurement (BPM) approach have experienced positive impacts on communication effectiveness, collaboration, and valuable insights. However, most organizations seem to spend the majority of their time and effort collecting and reporting data, and they have not spent enough time extracting valuable and actionable insights. Among

other important findings, this survey supported the idea that organizations with a formal BPM approach outperformed those firms with no formal approach to BPM.

Walsh (2005) pointed out the trend of repeatedly substituting measures of achievement with less and less relevant surrogate measures until what remains is an activity, not a measure of an outcome achieved. These practices send a signal that qualifies measurements as numeric values to report, rather than measurements that may help the business change and improve. In order to mitigate the effects of these measures in the BSC, the author recommended classifying the types of measures in terms of objectives, completeness, and responsiveness. Next, when organizations made use of less-than-perfect measures, they should add exact, proxy, process, and initiative indicators, to open the discussion to a better interpretation. Third, he recommended making a report by strategic theme, reducing the number of measures, and providing the direction a firm wishes. Finally, he recommended the use of a decision tree for less-than-perfect measures based on the trust and integrity condition.

The customer satisfaction index has played an important role as common cause of failure in most of the Balanced Scorecard implementation programs, as it has been observed in Six Sigma programs. Robin Lawton (2000) pointed out that most of the problems with Balanced Scorecards are based on their poor application of surveys to get the voice of the customer; although managers create scorecards, only 3 of 27 scorecard measures have anything to do with the customer.

Davis (2000) developed an investigation of the development, implementation, and effectiveness of the Balanced Scorecard. This dissertation extended this line of research by investigating the implementation of a performance measurement system that relies heavily on

Non-Financial factors (NFMs) by using a longitudinal approach and a BSC program implemented specifically to improve financial measures. The results from the repeated measure ANOVA indicated that the gain in performance experienced by BSC branches was not significantly greater than the improvement experienced by non-BSC branches (p-value = 0.346). One cause of these results could be the short period of time for this research. There is a need for further research in this area (Davis, 2000).

To fully explain the BSC, there must be the construction of linkages that should follow the organizational strategy. A study was developed to assess how individuals' evaluation of the performance of a business unit may depend on strategically linked performance measures of a BSC. The study showed that when participants were provided with strategic information of their SBU, they showed more reliance on strategic linkages measures in the corporate BSC than non-linked measurements. In this case, strategy linked unique measures also had a significantly greater impact on evaluation than common no-linked measures. These results supported their conclusion that when managers have an understanding of SBU strategy, linked measures dominate common measures in decision-making.(Banker et al., 2004)

The nature of the Balanced Scorecard measurements was addressed by Hua Tan at el. (2004) using a systemic approach, they classified measures in inputs, in process, and outputs with respect to the objective for managing and controlling a business. The input-process-output model utilizes the incremental calculus approach to aggregate measures based on complex cause-and-effect relationships. They said that the incremental calculus approach may add a predictable capability, allowing managers to quantitatively study how a minor change in an input or process

variable could affect output variables. This proposed framework had not yet been tested in companies.

A comparative study between the Balanced Scorecard and Total Quality Management (TQM) in the health industry illuminated the strengths and weaknesses of both approaches. Conclusions of this study support a common, modern belief that there is no better approach when dealing with all kinds of organizations. However, the specific environment, situation, and industry must all be considered. When developing a business strategy, an organization must consider multiple factors, including leadership, customers, business processes, and financial goals as well as the structure, culture, and size of the corporation. On the other hand, some shared points between BSC and TQM are needed to improve the communication in an organization. Organizations must communicate their mission and goals to their employees and customers. Other shared goals of the BSC and TQM are the reduction of costs, the improvement of services of an organization, and cross-functional involvement. One disadvantage of TQM versus BSC is the lack of measurement systems (Schwartz, 2005).

The increasing demand for customer satisfaction and market threats within the Taiwanese health system motivated the application of the Balanced Scorecard as a strategy tool to meet customer needs. Several quality approaches, including Six Sigma, had been applied in this organization, but the results had been limited. The methodology used to develop the BSC was adopted from Pink and colleagues and included choosing performance indicators, defining the parameters of a hospital, identifying data sources, and determining relative performance. In addition to selection of measurements, an educational process for the staff was applied to sustain a commitment to the objectives and to keep the focus on barriers and enablers that drive

performance. The pilot study lasted only three months, and diverse indicators in the four perspectives were found, indicating that a longer study is needed. Implementing a BSC in the emergency department improved the performance of the hospital both financially and non-financially. Indicators for all four perspectives of the BSC improved. (Huang et al., 2004)

Some research conducted in Europe and Canada described case studies where the search for excellence is the objective. A study conducted in Canada explained that adaptation of quality tools are needed to fit specific organizational needs. The objective of this research was to investigate the initiatives, challenges, and accomplishments of Business Excellence Programs (BEP). The study found that most organizations use ISO 9000 standards in combination with tools like Balanced Scorecards. Thirty percent (30%) of the surveyed organizations used a customizable program in their pursuit of excellence (Boys et al., 2005).

An important contribution is presented in Dickinson's paper. She described how the Australian Bureau of Statistics (Dickinson and Tam, 2004) used the Balanced Scorecard method to measure client servicing for its four client segments. The study includes how the Bureau delivered its services by Internet and by face-to-face encounters. This required some adaptation of the scorecard dimensions to suit the particular circumstances of this organization, although the four key areas of Balanced Scorecard measurement, namely financial, clients, staff, and process, were all retained. For this particular organization, the quality of services delivered to the customer was critical to its mission. To address the need for choosing appropriate indicators for the customer point of view, it used the causal model or value driver maps, which define the plausible cause-and-effect relationships that may exist between the chosen drivers of strategic

success and the outcomes. In other words, it made use of other available tools to reduce the effects of BSC's weakness in its process of choosing the critical performance indicators.

Their findings suggested that there is positive relationship between desirable outcomes and performance when the issue regarding choice of indicators is addressed. Their other contribution was to show that a positive relationship exists between servicing behaviors and performance indicators when the performance indicators are available to the client servicing staff (Dickinson and Tam, 2004).

Pushed by the need to report better indicators of performances, a case study was developed in the U.K. environmental agency where a third generation of a Balanced Scorecard was applied as a plan and control system in order to account for its performance. This "third generation of BSC" is an adaptation of the traditional perspective of the BSC to a particular mission and vision of the organization, allowing flexibility in the dimension of what one needs to measure. This system was called Corporate Performance Management (CPM) and was based on a third generation of Balanced Scorecard because it can be adapted to a complex flat organizational structure where there are no controls over individual units. An important contribution was the adoption of a particular scorecard for public sectors based on two basic dimensions – activities and outputs. The layout and design process delivered a mix of objectives allocated to just two perspectives – activities and outcomes.

In general, the results of the case study were positive because the new CPM was seen as a big step forward from the way the agency previously operated, as this new version called CPM was seen as less hostile than previous controlled measured systems. The new CPM increased the local autonomy and accountability, reduced the number of performance measurements, increased

the levels of ownership goals and the sense of clarity about local issues. In terms of the new approach used to control the organizational performance, the Modern Balanced Scorecard could be successfully introduced into large national public bodies. The simplification of the BSC perspective worked well in this public agency; the organization is more clearly focused on and accountable for progress toward key environmental outcomes (Gavin et al., 2004).

The limitations of the BSC to weigh relative importance of metrics and to manage the interactions and trade-offs among them inspired the research work of Youngblood and Collins (2003) by combining BSC with Multi-Attribute Utility Theory to address this problem. Developing a BSC utilizing MAUT to address trade-offs provided a better evaluation of alternatives for capital investments, resource allocation, or prioritization of interests, especially for organizations operating under different mission statements (Youngblood and Collins, 2003).

Y.K.. Ip and L.C Koo, in Hong Kong, presented a new strategic framework to make the process of formulating and transforming vague strategies into more user-friendly actions. The framework called BSQ is an acronym for the three tools combined in this approach. BSQ is a hybrid of the Balanced Scorecard, SWOT analysis, and Quality Function Deployment. Though the case study produced good results in terms of time and efforts needed to develop strategies, some issues were observed, which made the role of the moderator essential. (Ip and Koo 2004)

Ann Wu adopted a case study to illustrate the integration between the Balanced Scorecard with Intellectual Capital (IC) and to handle the significant issues of creation, formation, measurement, reporting, and management of Strategic Intellectual Capital (SIC), in a manufacturing organization in Taiwan. The principal contribution of this research was a framework that explains how BSC may direct the creation, formation, measurement, and

reporting of knowledge. The learning and growth perspective of the BSC was integrated with human capital, IT capital, and organizational capital by strategic jobs, strategic IT portfolios, and organizational culture. Based on the framework, the author concluded that the BSC can lead the creation, formation, and measurement of SIC, and the growth and learning perspective may strengthen the management of SIC (Wu, 2005).

Intangible assets may be the ultimate source of sustainable value creation, according to Robert Kaplan and David Norton, who stated that the alignment and integration among the BSC perspectives provide the conceptual building blocks for developing objectives for human capital. They proposed the utilization of Strategy Maps as a tool to facilitate discussions among executives about the linkages in the four Balanced Scorecard perspectives. A successful case study was developed by Paladino (2005) of Crown Castel, helping the company thrive in a market environment so punishing that two of its four competitors declared bankruptcy (Kaplan and Norton, 2004; Paladino, 2005).

The use of a Balanced Scorecard in combination with other management approaches has been successful and well-known in the literature. Approaches that look to individualize the BSC are encouraged. Heinz pointed out it is possible to find discrepancies between BSC traditional perspectives and strategic goals and mission. He suggested that methodological adaptation of the BSC perspectives derives from a company's mission. The normative goals can be used as a basis for deducing the BSC perspectives, whereas strategic goals can be used as basis for deducing BSC goals (Heinz, 2005).

Andersen made an important contribution in this trend with his new approach that he called the third-generation of Balanced Scorecard. In his research, he supported the combination

of the Balanced Scorecard with other quality tools to link strategy and operational initiatives in order to decrease the risk of failure of a qualitative program alone within the West Europe organization.

This paper suggests that a successful application of quality management tools, including Six Sigma, Malcolm Baldrige National Excellence Model, EFQM, and ISO standards, can be significantly strengthened when combined with a modern version of a corporate performance management tool (Andersen, 2004). In order to support their hypothesis that successful implementation of quality management tools relies on an effective approach to strategic control, the author conducted a case study of ISO 9000 combined with the third generation Balanced Scorecard, Six Sigma combined with the third generation Balanced Scorecard, and the business excellence model combined with the third generation Balanced Scorecard. Regarding the Six Sigma approach, progress in achieving the objectives in the strategic linkage model was influenced by data from specific Six Sigma measures and partly by more subjective measures focused on the implementation of the Six Sigma skills and the mindset in general. The paper illustrated how this third generation of Balanced Scorecard can embody best-practices strategic control characteristics and how it can offer an effective method of linking the most common quality management tools, thereby closing the gap between quality management and strategy. The paper does not offer a framework, nor does it offer specific information. (Andersen et al. 2004)

Discussing the areas of research related to BSC, Kaplan (2004) suggested the need for more research that addressed these following issues:

- Target setting: How do you set stretch targets for the indicators in the BSC?

- How do you get people to not only participate in setting these stretch targets but also strive to achieve them?
- Cause and effect: Further research in this area is needed to know how executive commitments and management systems can explain the success or failure of BSC implementations.
- Analytical and empirical research on alignment factors addressed the following: How does the alignment of people and organizational resources create performance breakthroughs?
- How does measurement create value through communication and coordination, not just through evaluation and control?
- How can incentive systems be better aligned with BSC measures? (DeWall, 2003)

2.4.3. Literature Review in Six Sigma Balanced Scorecard

It can be seen from this literature review that the possibility of the integration of BSC concepts with established quality concepts can be effectively used as a quality management system. The challenge is to combine aspects of selected approaches in order to reach a maximum benefit for a targeted application. Six Sigma must be adapted to the individual call for action. (Pfeifer et al., 2004)

Kubiak and Andersen each pointed out the need for combining a variety of approaches, such as quality circles, statistical process control (SPC), ISO 9000, Balanced Scorecard (BSC), and so on, in an integrated manner to build a high-performance organization. These quality approaches with BSC could be the missing gap to focus on both the performance and the health of an organization through the selection and use of metrics (Kubiak, 2003; Andersen et al., 2004).

Using a combination of literature review and case studies, Anderson supported the assumption that an explicit link between strategy and operational initiatives is a critical success factor in deriving long-term benefits from quality initiatives. Six Sigma and BSC were applied in a manufacturing industry. (Andersen et al., 2004)

Using as an example the U.S. healthcare environment, Schultz (2006) offered her view of the possible benefits of merging Six Sigma and BSC. This paper had the objective of building a solid infrastructure that aligns strategic goals and performance indicators that enable organizational change. Although the validity of this approach has not yet been proven, she made an enormous contribution through the visualization of what she called the ultimate "management cockpit." Following the seven steps based on the healthcare value chain, this approach may produce its expected results. The heavy foundation on the statistics of Six Sigma and the equilibrium across the enterprise of the BSC combined could focus the organization's improvement efforts and provide an organization with a solid foundation for change. The seven steps in her approach include the following:

Step 1 – Translating strategy imperatives into metrics

Step 2 – Align metrics in the value chain

Step 3 – Assess the organization's capabilities

Step 4 – Conduct a cause analysis

Step 5 – Deploy resources

Step 6 – Align systems and structures

Step 7 – Monitor progress and continually raise the bar

Some books and magazine articles review the latest application of these combined theories. It is important to mention the contribution of "Quality Beyond Six Sigma 2003" (Forrest, 2003) and "The Six Sigma Business Scorecard." Gupta (2004) made another interesting contribution when he wrote a book for managers and employees that called for further research based on his proposed model for a Six Sigma Business Scorecard. The book defines the Six Sigma Business Scorecard as "a complete corporate performance system that requires leadership to inspire, managers to improve, and employees to innovate to achieve the optimum level of profitability and growth." The author's experience as a CEO and as a Six Sigma consultant was an appropriate background to create a comprehensive corporate performance measurement system that would enable leadership to balance profitability and growth.

The Six Sigma Business Scorecard offered a new approach to establishing a corporate-wide measurement system that enables leadership to monitor a company's performance against expected performance using an indicator that was called The Business Performance Index (BPIn). The Business Performance Index is an aggregated indicator that allows an organization to determine the sigma level as a relative measure of performance. The Business Performance Index has been validated based on estimation, public information about the companies on the Dow Jones Industrial Average Index, and through discussions with professionals in industry and academia. The purpose of the Six Sigma Business Scorecard is twofold: (1) to identify measurements that relate key process measures to a company's profitability, making the opportunities so visible that they are difficult to ignore, and (2) to accelerate the improvement in business performance. Optimizing the profitability, cost, and revenue variables is a primary purpose of the Six Sigma Business Scorecard (Gupta, 2004).

With the objective of evaluating the effectiveness of the BPI, the work offers a framework, which is an important contribution to the body of research, but there are other questions as to the specific correlation with performance indicators and customer satisfaction indicators, the role of strategic measurements, performance measurements, and BPI measurements as leading and lagging indicators. The rigor of the scientific method could allow expand the BPI approach to other areas of interest as performance improvement and customer satisfaction in order to make generalizations.

2.5. Literature Review on Research Methods

There are multiple classifications of research methods, but there are currently two major paradigms within social and health sciences:

1. The Quantitative Paradigm, or the dominant paradigm or logical positivist, is usually associated with the so-called scientific method.
2. The Naturalistic Paradigm, or Constructivist approach, is usually associated with a qualitative approach to research (Gilner and Morgan, 2000). A summary of different types of research paradigms is presented in Table 2. Based on the advantages, disadvantages, and the qualitative nature of the integrated Six Sigma Scorecard management frameworks, a combination of a case study and action research was used for this research.

The following table was built with the contributions of many researchers, including Gilner and Morgan (2000), Hernandez Sampieri, Fernandez Collado (2001), Donald T. and Stanley (1963), Yin (2004), Lamnek (2006), Kazdin (1982), Ray, Ravizza (1988), Marczyk (2005), and Cunningham (1993).

Table 2. Advantages/Disadvantages of Research Designs

Approach	Design	Advantages	Disadvantages
Quantitative Approach	True Experiment Design	The principal advantage of this design is that it controls the potential effects of the pretest on posttest outcomes. True Experiment Design enables us to empirically examine the effects of more than one independent variable, both individually and in combination, on the dependent variable.	The most obvious limitation is its logistical difficulty. Randomized designs are often not feasible. True Experiment Design faces some validity issues, including being exposed to intervention in the control group, the substantial differences in the implementation of the experimental and control conditions, and the differences causes by participant mortality or dropout.
	Quasi-Experimental Design	This type of design allows us to examine real-world phenomena and begin to establish causal inferences, while it keeps its validity by using control groups.	Unfortunately, despite their often elegant structure, Quasi-Experimental Designs cannot automatically rule out threats to internal validity with the same degree of certainty as True Experimental Designs.
Qualitative Approach	Case Studies	A Case Study can expand the knowledge about contemporary phenomena within its real-life context when boundaries between the phenomena and its context are not clear.	A Case Study has lack of rigor due to the investigator's bias, and it provides little basis for statistical generalization. Case study may consume a long time period to complete
	Action Research	Action Research is a reflective process of progressive problem solving led by individuals working with others in teams, which improves the way researchers address issues and solve problems.	It is a process that lacks control. It calls for mechanisms to assemble evidence to illustrate that the conclusion is verifiable.
	Naturalistic Observation	Naturalistic Observation expands the knowledge by observation of a phenomenon in its natural environment without other variable interventions.	Naturalistic observations suffer from lack of rigor and control over experimental settings.
	Survey Studies	Survey Studies expand the knowledge about the effect of specific variables on a system by responding what, how many, and how much among similar research questions (frequencies and/or incidence).	It allows for external and internal validity and confidence. It also allows for statistical generalizations.

Tables 3 and 4 summarize the literature review with respect to both parent methodologies, Six Sigma and Balanced Scorecard. The tables present the information

categorized according to the purpose of the investigation, the combination of tools used on the methodological approach, and the area of application if there is any. (The symbol N/A is used if no area of application is cited.) The research gap tables show the combination of the two methodologies and the proposed Six Sigma Scorecard methodology.

Table 3. Six Sigma Literature Review

	Study Objective								Approach/Method					
Researcher/Study	Integration Approach	Conceptualization	Six Sigma Roadmap	Process Performance	Customer Satisfaction	Learning	Theory of Constraints	TQM	Robust Design	Process Capability	Technology	Management System	Lean Enterprises	Application
Hoehn (1995) Behara Ravi (1995)				x	x				x	x				Manufacturing
Snee(2000) Kendall (2000)		x x			x						x			N/A
Jiji Antony(2000)	x	x		x										Empirical
S.C. Chen(2000) H. Sheridan(2002)	x			x	x								x	Manufacturing
Hakan Wiklund (2002)	x					x								Manufacturing
Kuei and Madu (2003)		x		x	x									N/A
Sierra(2003)	x		x	x	x		x							Manufacturing
Murugappan(2003)	x			x	x						x			Services/IT
City of Fort Wayne(2002) City of Kingsport(2002)		x				x								Services/Empirical
Appelbaum (2004)					x									Services/Empirical
J.Mast (2004) Pfeifer (2004)		x	x	x	x									N/A
(Furterer 2004)		x		x	x	x							x	Services

Table 4. Balanced Scorecard Literature Review

Researcher/Study	Study Objective							Approach/Method				
	Combine with others tools	Measurements	Plan and control	Intangibles Assets	Effectiveness	Link strategy-operational	Customer Satisfaction	Qualities Methodologies	Input-Process-Output	Causal Models/Value Maps	MAUT	Application
Stephen Letza Bernard Marr(2005)	x	x	x	x	x	x	x	x				Theoretical
Paul Walsh Schwartz(2000)	x	x	x		x			x				Theoretical
Lauton (2000) Davis(2000)		x		x	x		x					Services
Banker Shu-Hsin Huang(2000)	x	x		x		x	x					Services
Kim Hua Tan Dickinson(2000)		x			x	x	x		x	x		Services
Boys Gavin Laurie(2004)		x	x		x			x				Manufactured
Youngblood(2004) Y.K. Ip(2004)	x	x				x		x	x		x	Manufacturing
An Wu Andersen (2004)	x			x		x		x		x		Manufacturing
Heinz Kaplan Norton	x		x		x	x				x		N/A

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

From the lessons learned in Balanced Scorecard and Six Sigma deployment, it is clear that managers and researchers are calling for integrating all management tools to connect strategy, improvement efforts, and organization's output. The output of this dissertation is a novel approach that combines elements from Six Sigma and Balanced Scorecard in three merging points that generate a measurement system that assesses the performance of the organization from a heuristic point. The fundamentals behind the proposed framework can be adapted to any quality or strategy approach by using similar tools and principals. This chapter presents the research gap and the rationale for research, following a detailed description of the proposed framework.

3.2. The Research Gap

Many authors made important contributions in each of the areas of Balanced Scorecard and Six Sigma. Most recently, the strengthened conditions of the market have pushed researchers and consultants to work on new approaches for facing organizational challenges. One of these approaches has been the combination of the well-known strategic management tool "Business Scorecard" and process improvement methodology "Six Sigma."

Two tendencies are observed:

1. Use of Six Sigma and Balanced Scorecard to link strategy and quality initiatives as a mechanism for the executive team to monitor the success of Six Sigma implementation.

2. Conceptual analysis to demonstrate how quality and corporate performance management tools can be combined to strengthen strategic control and successful quality management.

A systematic and holistic approach that shows and demonstrates how effectively the concept of Six Sigma, combined with BSC to align strategy, performance improvement, and customer satisfaction, was not found in the Literature Review. The theoretical approach developed by Schultz on the health sector was short of empirical findings to support conclusions (Schultz, 2006). Accordingly, Gupta (2004) used the merging approach with the objective of offering general performance indicators of the BSC, but it did not offer a roadmap that brings strategy to performance improvement and customers.

This investigation proposes a framework that aims at:

- Tying strategy to process improvement. One of the reasons for Six Sigma failure is the lack of alignment with organizational strategy. The misalignments between corporate and business strategies has produced several improvement programs run in isolation, looking for continuous improvement processes that may not be of strategic interest to the company. The combination of Six Sigma and Balanced Scorecard may allow for determination of numerical improvement projects based on strategic objectives.
- Tying critical to quality (CTQ) metrics to Strategy. One of the limitations of CTQ metrics is skipping the why and what of measurement. The Six Sigma Balanced Scorecard will allow connection between what organizations want and need, stated in the strategy with what the customer wants and needs, expressed in the "CTQ" metrics.
- Aligning customer satisfaction via CTQ to process improvement and to organizational strategy. Most organizations stated that their principal priority is customer satisfaction, but

most of them have measured internal processes in their Balanced Scorecard. Few indicators measure process performance in terms that customers care about. In addition, these efforts are not aligned with the organization's strategy. The Six Sigma Balanced Scorecard may allow using organizational strategy to trigger process improvements that pursue customer satisfaction, connecting corporate, business and functional levels. The CTQ measurements determine the few critical outcomes whose improvement would enhance the customer satisfaction and balance them with the organizational outcomes established in the organizational strategy.

This proposed research will add integration and communication abilities by the use of Six Sigma merged with Balanced Scorecard. The measurement system will show quantitative evidence of the effects of the alignment in the performance improvement efforts.

The purpose of this investigation is to evaluate the pragmatic evidence of the integration of Six Sigma and the Balanced Scorecard. The problems and opportunities that arise during the implementation of the proposed methodology will be considered as well. The proposed Six Sigma Scorecard will be designed for specific targets and will be illustrated through a Case study/action research.

This research proposes an extension of the theoretical approach discussed in the literature review by providing a step-by-step process to create the Six Sigma Scorecard, which is then tested experimentally in a Case study/action research. Questions to be answered include:

- How can managers move from the strategy to the improvement performance program to delivering value to the customers, using SSS?

- How can managers evaluate performance and the quality program from a heuristic perspective?

3.3. Rationale For Research

The goal of this research is to develop and implement a framework using Six Sigma principles and a methodology blended with the Balanced Scorecard strategy tool so that any kind of organization can effectively link strategy-performance and customer satisfaction. The proposed methodology would support the premise that a Balanced Scorecard can successfully be used as a management control instrument as claimed by Lawrie et al. (2004) and would support what is called "the third generation of Balanced Scorecard" to the successful implementation of a quality management tool. (Andersen et al., 2004)

On the other hand, Six Sigma practitioners and researchers suggest that new approaches may widen the benefits already using this approach and close the gap among improvement programs, strategies, and outputs.(Breyfogle 2003; Pfeifer et al., 2004; Gupta, 2004; Chen et al., 2005; Schultz, 2006). These characteristics explain why this research focuses on the integration of the Six Sigma quality initiative and BSC strategic management tool.

The Six Sigma Scorecard may offer an opportunity to:

1. Align the strategic and tactical levels with organizational outputs.
2. Identify and focus on activities that directly affect organizational performance and CTQ from the customer point of view.
3. Open the quality function beyond manufacturing by its application in the service industry with the purpose of going beyond efficiency and effective operational levels

to connect "what" an organization can reach, with "how" they plan to accomplish its mission and the outputs.

The research method offers the design and demonstration of a management tool that may integrate optimal improvement efforts with organizational strategy to satisfy customers' needs based on CTQ indicators.

The next section presents a description of the proposed methodology known as Six Sigma Scorecard (SSS).

3.4. Proposed Model: Six Sigma Scorecard (SSS)

The alignment among the strategy level, the performance, and the customer was considered the key element to integrate Six Sigma Scorecard. The concept of alignment has been studied in the field of Strategy Management. Venkatraman (1989), Joshi et al. (2002), Sun and Hong (2002), among others have provided theoretical and empirical evidence of the effects of the alignment in the business performance level.

In this dissertation, alignment is considered at three hierarchical levels, corporate, business and functional. The consistencies between strategies, expressed in the BSC, and business units' objectives are reached by the prioritization of the improvement projects. In the same way, consistencies between improvement projects objectives and BSC objectives and between critical-to-customer features (CTQ) and Strategies, allow alignment between business and functional levels of the organization.

The Six Sigma Scorecard Model proposes vertical alignment as the degree of internal consistency between strategies (BSC), improvement performance and CTQ (Six Sigma). The measure of fit at those three levels can be assessed by assigning scores according to the proposed

methodology that is explained in detail in section 3.4. It is expected that maximum levels of fit has significant effect on performance. (See Figure 1)

The independent variables include factors related to the strategy-performance-customer link. The variables could include:

1. The linkage between the strategic initiatives and the prioritization of the Six Sigma projects related to the strategic initiatives.
2. The linkage between strategies goals and project objectives, and then to functional levels translated to day-to-day actions plans.
3. The linkage to the Balanced Scorecard measures (strategies formulation) related to process, financial, and customer satisfaction. (Open feedback loop)

The dependent variables include productivity indicators, process, financial, and customer satisfaction indicators. The model posits that if strategy, performance, and customer satisfaction are aligned, the organization will gain benefits from the enhanced linkage between process performance, and strategic initiatives. These changes can be measured by process and productivity metrics such as cycle time, production rates, production efficiencies, and rework percentages. It is proposed that these process productivity changes will be achieved by the application of the SSS methodology, and they will impact the established BSC metrics by meeting strategic objectives and goals.

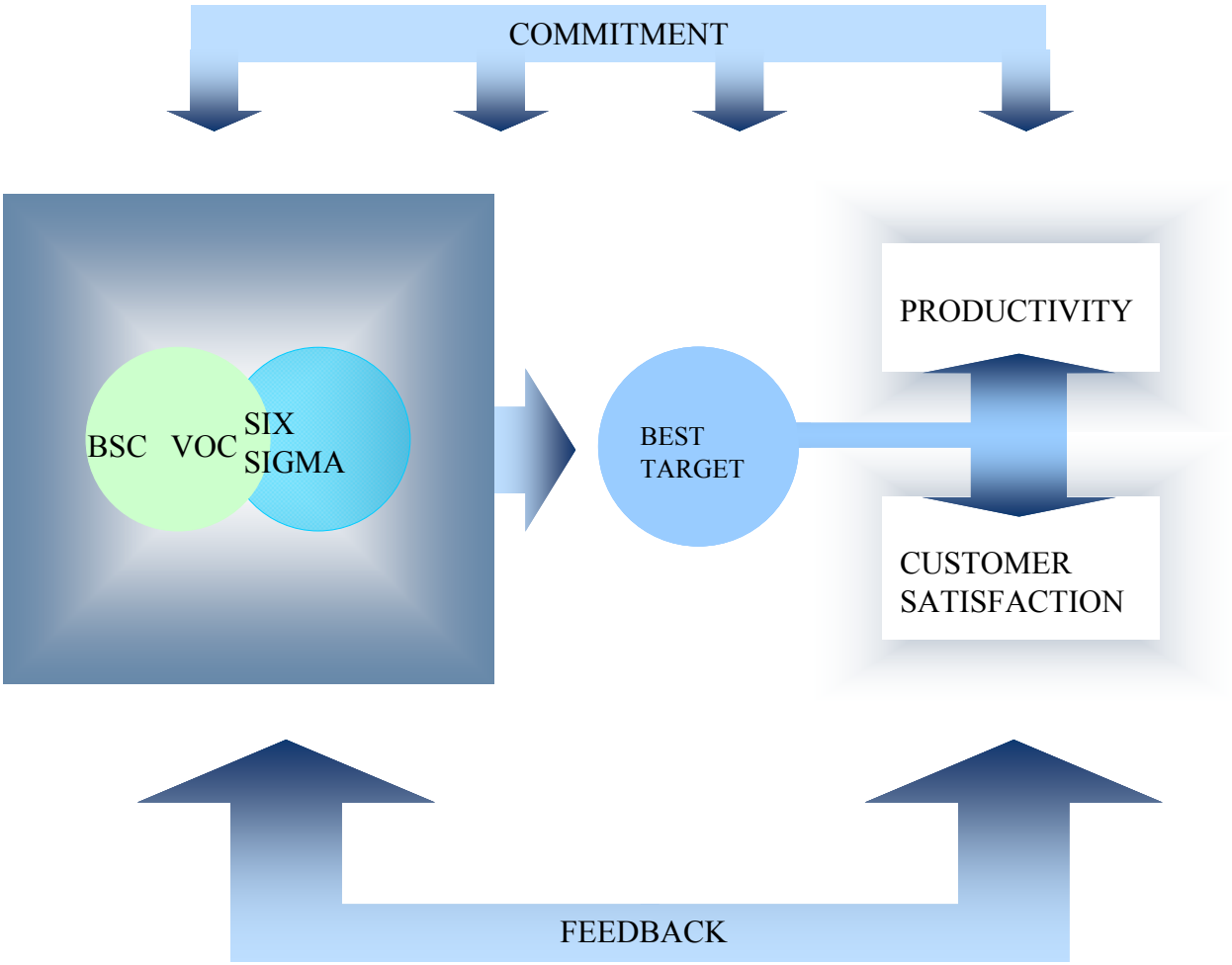


Figure 1. Six Sigma Scorecard Model

According to Venkatraman's (1989) classifications of fit and its methods and assumptions to analyze them, the model defines a Covariation Alignment as the internal consistency among a set of underlying theoretically related variables (independent variables). The covariance perspective can be analyzed using second order factor analysis.

Table 5 shows the initial relationship among the dimensions, constructs, possible variables, and some specific indicators at the productivity level that assess the alignment effects in the performance.

Table 5. Table Construct-Variables-Indicators

DIMENSION	ALIGNMENT VALUE PERCEPTION "USEFULNESS"
POSSIBLE CONSTRUCT	PRODUCTIVITY; MANAGEMENT PREFERENCEES; CUSTOMER SATISFACTION
VARIABLES	% Improvements; Projects Completed; # of Targets reached; External Customer Satisfaction Index
INDICATORS	Cycle Time; Frequency of Error per Application; Correlations BSC vs. Six Sigma; Frequencies; Survey

3.5. Hypothesis Development

In order to refine the research, a set of initial hypotheses are developed. These initial hypotheses allow focusing the research, determining the research strategy to be implemented and defining objectives for the data collection step.

The main research hypotheses of this dissertation are:

Hypothesis No. 1: The appropriate combination of Six Sigma and Balanced Scorecard into one tool tie strategy and critical to customer requirements to trigger performance improvement efforts.

Hypothesis No. 2: The implementation of the Six Sigma Scorecard (SSS) produces a better assessment of the performance indicators than the ones obtained in the same period of time at the same company when BSC alone is applied.

3.6. Proposed Six Sigma Scorecard Framework "SSS"

The proposed methodology is founded on strategic and tactical alignments, which have indicated the need to create strategies and implement those strategies by consensus among key systems, processes, and decisions within the firm, including reward systems, and corporate culture (Joshi et al., 2003). The Six Sigma Scorecard framework was built upon the success and failure stories of the Balanced Scorecard and Six Sigma implementation methodologies that can be found in the literature review. Merging these two methodologies, Balanced Scorecard and Six Sigma, proposes an increase in the performance of the organization, assessed in productivity, management value perception and customer's satisfaction indicators of an organization.

The implementation of the proposed methodology starts with an assembled Balanced Scorecard and is structured on three primary merging points, which are represented by Figure 2. The three merging points in the framework take the theoretical prepositions or three linkages established by the SSS model and operationalize fit at the corporate-business-functional levels.

3.6.1. First Merging Point: Selection of the Improvement Initiatives Projects

The objective of this step is to shift the organization's strategy to the tactical level. This step requires a deep understanding of the organization's background. Important elements to be considered are the vision, mission, objectives, culture leadership, and internal and external drivers of the organization. The Balanced Scorecard, which is prepared by the executive and managers of the organization, needs to be studied in order to get the most out of it. This step is an evaluation process, when it is possible and desirable for the information to go back and forth between all levels of the organization.

During this step, the team that will be working on the project is not completely formed. At this point, there are three or four people involved in these activities. The top executive level of the organization serves as the sponsor of the project. An executive of the organization serves as the second member of the initial team and will be the project champion. The third and fourth members of the team are quality experts, probably a Six Sigma Black Belt or Green Belt, and they can be either part of the organization or outside experts who will be working on the project. It is recommended to use an open-ended interview that later will be transformed into structured reports for data categorization and analysis.

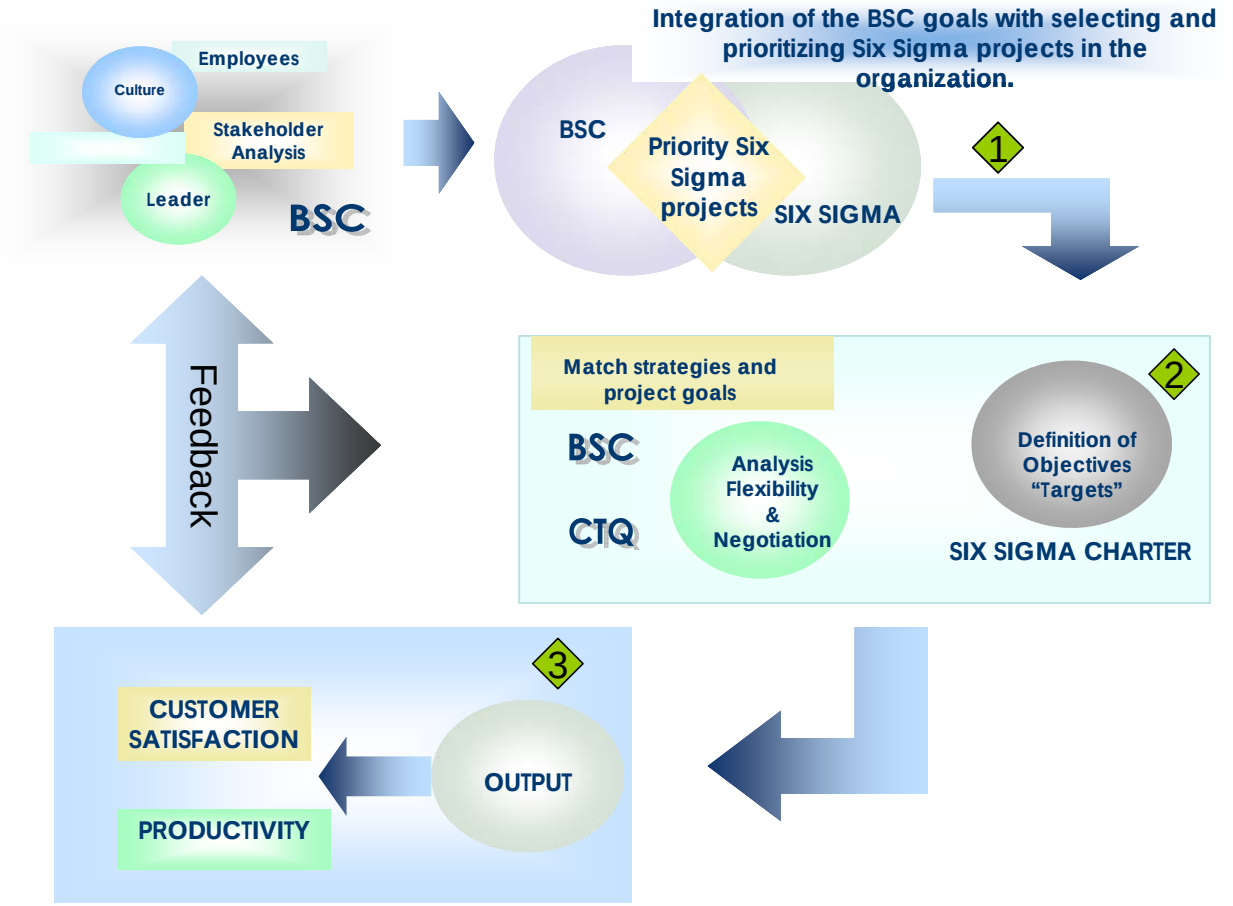


Figure 2. SS and BSC Merging Process

Once the BSC is understood, the researcher requests a list of the principal improvement initiatives from each one of the Business Units involved in the SSS improvement methodology. Each alternative is evaluated and assessed by using the following prioritization matrix. (See Table 6)

Table 6. Prioritization Matrix

			Initiative #1		Initiative #2		Initiative #3	
Criteria	Weight	Description	Points	Score	Points	Score	Points	Score
Linkage to Strategy (BSC)		Ability of the initiative to positively impact strategic objectives						
Impact on Customers		Ability of the initiative to positively impact critical aspects of the services from the customer point of view						
Bottom Line Results		Ability to achieve dramatic improvement results						
Cost/Resources Allocation		Total dollar cost and key personnel needed						
Time to Complete		Total anticipated time to complete the initiative						
Dependencies		Impact of other initiatives on the successful outcomes anticipated with this initiative						
Current State		Level of control and measurements system						

On the Prioritization Matrix, the first column corresponds to the criteria for the selection process. These criteria come from the literature review, where multiple authors have studied the principal causes of failure and success of the Six Sigma projects, and from the recommendation for the implementation of the Balanced Scorecard. The second column corresponds to the weight of each criterion. The weight assigned to each criterion can be developed through brainstorming in the organization with management knowledgeable of the strategic initiatives as well as potential Six Sigma team members. The weight has the purpose of indicating the specific importance of each criterion in the prioritization of the improvement projects. The lessons

learned and consulting books in the field of study provide the foundation for selecting the criteria. The third column is the description of each criterion, where participants find an explanation of what is considered in each criterion.

Initiatives are selected by the assignment of points. This assignment process is performed individually by top managers and executives. When each manager and executive has assigned points to each improvement initiative, a new table is built with the average of those points in order to get one prioritization matrix for the organization. Alternatively, selecting the Six Sigma projects can be completed by assigning points by consensus during a workshop between executives and managers.

The procedure to fill out the table involves assigning points to each improvement initiative. This action is performed by the manager and executive levels of the organization. Then, these points will be multiplied by the weight of the points. The results determine the score for each criterion on each improvement initiative. The summation of the criterion scores for each improvement initiative represents the total score for each initiative. An executive decision determines the number of initiatives in which the SSS will be implemented during a period of time.

The initiatives that have obtained more points will be counted as Six Sigma projects. Depending on the number of initiatives and the business units involved in the improvement processes, a number of Six Sigma teams will be formed. The team must include the sponsor and project champion from the executive level of the organization, at least two Six Sigma specialists, and organization personnel involved in the day-to-day activities of the process selected for improvement.

The next steps follow the activities that need to be performed during the Define phase of any Six Sigma project. The SSS team will start defining the project goals and objectives in order to prepare a charter, which represents the commitment of the organization and people involved with the improvement project. At this moment, the use of some quality and management tools, such as Supplier-Imput-Proccess-Output-Customer diagram, shareholder analysis, stakeholder commitment, and flow charts, play an important role because they help the team to visualize the scope of the project as well as barriers and opportunities and to plan appropriately.

At this point, the researcher has the opportunity to collect all of the background information for the process and the organization, make some explorative interviews, and try to involve and motivate stakeholders.

The researcher needs to receive training about advantages and disadvantages of the collection of data gathering techniques. In parallel, organization employees, especially members of the improvement team, must receive training in the foundation and tools used in Six Sigma projects. Education and reinforced information processes about organization strategy, mission, and vision have an opportunity to be disseminated here.

3.6.2. Second Merging Point: Complement Business Opportunities and Strategic Priorities

The identification of the project's objectives is an integral part of the Define phase for any Six Sigma project. These project objectives can be varied and may or may not be in accordance with the BSC objectives. The purpose of this second merging point assures that all Six Sigma project objectives target, directly or indirectly, the BSC objectives. In order to achieve that, a Matching Matrix needs to be created, with the BSC objectives in the first row and the Six Sigma project objectives in the first column. (See Table 7)

Table 7. Matching Matrix

6 SIGMA / BSC	Objective # 1	Objective # 2	Objective # 3	Objective # 4	Objective # 5	Objective # 6	Total Score (1 to 10)
Objective # 1	√	√	√	√			
Objective # 2			√	√	√	√	
Objective # 3	√	√	√	√	√	√	
Objective # 4				√	√	√	

Ideally, all of the SSS project objectives should match the BSC objectives. However, this is not always possible, and if not, the analysis and evaluation of both objectives must adhere to a strategy that avoids conflicts and maximizes benefits. According to degree of matching between the project opportunities and the formulated BSC, the improvement team, and the executive management level of the organization are asked to rank this link, using a scale from 1 at the lowest link level to 10 at the upper link level.

Most of the project objectives can be manipulated to some degree. Flexibility and adaptation are critical elements for the implementation of the methodology. Deep understandings of the organization's background and situations that may affect the success of the projects need to be studied in order to negotiate the most favorable context for the project. Adaptation to the real business world and the flow of information are essential to sustain the project during the Measure and Analyze phases of the Six Sigma Project.

During these phases, the strategic thinking and data-driven thinking must be integrated. It is important because the improvement team or SSS team must identify the causes and effects of problems avoiding jumping to early solutions during these stages. The team should look for facts and data that allow for the identification of problems objectively.

3.6.3. Third Merging Point: Relate Six Sigma Indicators and BSC Measures

The third merging point occurs during the Improvement phase of the SSS project. This point is the result of the two previous phases – Measure and Analyze. In the Measure phase, the Critical to Quality (CTQ) characteristics are defined. During the Analyze phase, the root causes are identified as the factors that cause the problems. Finally, during the improvement phase, once the recommendations are implemented, changes on the productivity and customer satisfaction indicators, represented as cycle time, number of errors, and customer satisfaction index, should be compared to the changes on the BSC indicators. Then, the productivity (process) improvements from the Six Sigma project should be compared with the BSC measurements in order to see if the BSC measurements improve after implementing the Six Sigma recommendations.

The team must identify and define the customer of the SSS project and list the characteristics of the services that are important, or CTQ, for them. The team may choose from a variety of techniques depending on the particular situation they may be facing. Some of the techniques include surveys, interviews, focus groups, questionnaires, and so on. Alternately, the SSS team may use secondary sources of information, archival records, or generic data when other techniques are not available.

The CTQ and the strategic objectives of the organization are analyzed by the use of tools such as the House of Quality, which is a Six Sigma tool, or by the use of the Matching Matrix as the next figure illustrates. The purpose of this evaluation process is to balance the CTQ objectives and the strategic objectives expressed on the BSC (See Table 8).

Table 8. Evaluating CTQ

CTQ LIST	BSC Objectives					
	Objective # 1	Objective # 2	Objective # 3	Objective # 4	Objective # 5	Objective # 6
CTQ # 1	√	√	√	√		
CTQ # 2			√	√	√	√
CTQ # 3	√	√	√	√	√	√
CTQ # 4				√	√	√
CTQ # 5	√	√√	√	√	√	√
CTQ # 6	√	√	√	√	√	
CTQ # 7	√	√	√	√	√	√
CTQ # 8						

Other important elements of the model include the commitment and feedback that must be incorporated and sustained throughout the process. Although commitment rests on the shoulders of each team member and the organization as a whole, the role of the sponsor and champion of the team, who are part of the executive level of the organization, is vital. The information needs to go back and forth between all levels of the organization during the methodology cycle time. The results of the Six Sigma methodology should produce actionable feedback for the BSC updated process when positive, negative, or neutral effects are observed.

Part of this feedback is the design of key performance indicators. In order for performance measurements to contribute effectively to the management of the organization and

offer opportunities for increasing the overall effectiveness of the business processes, it was necessary that these measures provide feedback and had predictability capabilities.(Hua et al., 2004; Robson, 2004)

The procedure for the design of the key performance indicators starts with a review of the process flow after all changes are implemented. When the new flow chart is built, a prioritization process starts with the objective of setting the performance requirements for the improvement process. First, a set of stakeholders are identified to assign them a relative weight according to the relative importance that they have within the organization. Stakeholder needs and expectations are determined and then translated into more specific performance requirements. These performance requirements are ranked in terms of relative importance using values from 1 to 10, with 1 being of little importance and 10 of the utmost importance. The last filtration tool used is to take the half of the performance requirements that got more points and go back to the Strategy level, adding 0, 5, or 10 points to them if they aligned with the BSC objectives. This point's assignation is executed by managers and CEOs during a brainstorming session with SSS team members.

The general purpose of this process is to come up with a reasonable number of key performance indicators, which represent the interests of all the stakeholders and keep the strategy as a compass to focus the actions. Figure 3 shows the matrixes used to define the key performance indicators.

Stakeholder ranking session		
Stakeholder	Importance	Rationale for ranking

Stakeholder:	
Expectation/Need	Performance Requirement

BSC Objective Alignment				
Performance Requirement	Lack of Alignment 0	Medium Alignment 5	High Alignment 10	Total Points

Figure 3. A Sequence of Stakeholder and Performance Requirement Prioritization

The third merging point is assessed by CEO and managers according to:

1. Number of BSC indicators affected after improvement performance project implementation.
2. Number of dependencies or organizational changes after the SSS implementation.
3. Level of actions executed to redefine strategies related to process, financial, management and customer satisfaction.
4. Level of Commitment
5. Design of key performance indicators based on ranked performance requirements.

The next section describes the goals and activities for each phase of the DMAIC problem-solving process within the Six Sigma Framework. These activities are followed during the implementation of the SSS when the improvement projects start and are considered Six Sigma projects. In general, it provides an overview of what needs to be done when the project

with higher priority rates are determined. As stated earlier, it is anticipated that this is iterative, and modifications occur during all phases.

DEFINE

- Create links among Business Unit A, Business Unit B, Business Unit C, Business Unit D, and the corporate level.
- List projects by Business Units A & B and map improvement projects against BSC
- Prioritize improvement projects
- Select improvement projects to be worked as Six Sigma projects
- Align Six Sigma business opportunities and BSC objectives.

MEASURE

- Profile current state using BSC indicators
- Design lagging and leading indicators where they are needed
- Identify problems and root causes
- Estimate current state in the Six Sigma projects using organization documentation, indicators, and surveys if they are needed.

ANALYZE

- Analyze gaps among BSC indicators and Six Sigma targets
- Perform statistical analysis
- Plan improvement benefits
- Identify dependent and independent variables

IMPROVEMENT

- Implement solutions

- Measure impact and cause-effect relationships on the BSC
- Identify the gap among BSC metrics and Six Sigma improvement targets
- Document

  CONTROL

- Track performance measures indicators
- Evaluate Six Sigma results and verify changes in the BSC relate to performance

3.7. Critical Success Factors

The literature review identified the critical success factors to be considered during the SSS implementation. These critical success factors are:

- Alignment and linkage: The alignment factors give meaning to the objectives of each business unit within the four dimensions of the BSC and connect the performance improvement efforts and cause-effect relationships among the individual BSC in relation to the corporate BSC. Building the prioritization project matrix provides the skeleton to move the organization as a whole to the organization's goal.
- Communication: Communication is a critical component for an effective use of organizational resources.
- Flexibility: Flexibility is essential in today's business environment. Breaking down a strategy into useful measures and linking it to improvement projects is a continuous, dynamic, and complicated process**.** The SSS capability of adaptation to an organization is essential. Again, the idea is not only to generate numbers, but to generate indicators of

performance that can be used and evaluated in the dynamic strategy and productivity environment.

- CEO and Employee Commitment: The upper level's support and involvement is a motivational and tactical component to put the organization to work for the same interest.
- Analytical and Data Driven Thinking: The analytical capabilities developed by the organization's members allows for the understanding of the organizational perspective's interlinks and strategic themes. Tools and techniques, such as benchmarking analysis, trend analysis deviation, and so on, facilitate the comprehension of the cause-and-effect relationships and determine the improvement opportunities that may exist in the organization (Coowar and Champney 2006).
- A good combination of these skills and strategies may offer more opportunities to make good decisions, to translate objectives into action plans, and to produce the desirable outcomes from the improvement programs.
- Fast Implementation: Keep organizational focus on the short-term results chain and the long-term strategic goals.
- Voice of the Customer (VOC): A key element of the success of a Six Sigma program is its ability to link to the customer. Any SSS project should start with the determination of the customer requirements, which is known through the voice of the customers tools (VOC), which imply (1) identifying the core processes, defining the key outputs of these processes, and defining the key customers that they serve and (2) identifying and defining the customer needs and requirements. An important issue here is the selection of critical-to-quality characteristics (CTQs). These CTQs must be identified quantitatively in the start phase of the

six sigma methodology. Quality function deployment is a powerful technique to understand the needs and expectations of customers and translate them into design or engineering requirements (Antony and Banuelas, 2002).

3.8. Significance of the Research

The contributions of this research include:

- Developing a step-by-step roadmap that can describe how to integrate the strategy to performance improvement efforts with a robust management tool that can be used in any organization.
- Providing integration of Six Sigma and the Balanced Scorecard methodologies that include the alignment of organizational strategy and process improvement programs, connecting BSC metrics with critical to quality (CTQ) metrics and connecting customer satisfaction and performance improvement and strategy.
- Developing a case study that illustrates the value of the proposed framework.
- Placing quality initiatives at the strategic level, reducing the gap between the strategic level, operational level, and organizational output.
- Maximizing the benefits of the measurement system by adding prediction capabilities that translate into better customer satisfaction. Determining the optimal performance level to satisfy customers' needs based on CTQs.

In this research, the researcher chose Six Sigma and Balanced Scorecard based on two principal criteria. First, both methodologies conceptually should be able to enhance the organizational performance. Second, both methodologies could be applied to existing

organizations that need to grow, gauging both the performance and health of an organization and its processes.

CHAPTER 4: RESEARCH DESIGN

4.1. Introduction

The research design to be applied in the study of the development and application of the Six Sigma Scorecard was a convergence of the case study and action research methodologies.

The phenomenon to be studied was based on the alignment management theory that promises growth and wealth to any organization (Kathuria et al., 2007). The alignment management theory needs to be studied in its natural setting, which calls for applied research in order to obtain a set of empirical findings. Three conditions of this investigation point to the use of a case study as a research strategy. These conditions were the essence of the research questions—the fact that the theory refers to future conditions and lacks control over events. In addition, the exploratory nature of this Case Study implies a continuous involvement between researchers, the elements of the phenomenon to be studied, and its embedded system. This constant feedback that places the researcher and phenomenon in a learning cycle is known as action research. (Barton, 1993; Yin, 1994; Yin, 2003)

The research design was conducted in three major phases, which are discussed as follows.

4.2. Phase I: Model and Concepts Design

In Phase I, this research combines elements from the conceptual domain and the methodological domain applied at a substantive level to demonstrate the value of the SSS methodology.

As explained in the literature review, the domain was determined by the nature of the phenomenon to be studied and the relationship among its elements and the system where it was embedded. The domain refers to the content of interest, the ideas that give meaning to that content, and the techniques by which those ideas can be studied.

The content of interest was the implementation of the management methodology, named the Six Sigma Scorecard (SSS) in a generic organization. The theoretical foundation that sustains the proposed conceptual model and framework comes from the quality and management body of knowledge. The methodologies that allow for the study of these quality and management theories were Six Sigma and Balanced Scorecard (BSC).

A case study protocol was developed to guide the SSS implementation process during Phase II of the research. The Case Study protocol's objective is to maintain the study within the research's parameters and to maximize the quality of the research (Yin, 1994). The critical components of the Case study/action research are presented below.

1. The Study Question

- Can the Six Sigma methodology and the Balanced Scorecard be successfully integrated to address the specific organizational needs?
- Does the implementation of the Six Sigma Scorecard allow alignment between the strategies, performance, and customer satisfaction levels within an organization?

2. The Study Proposal

- The proposed Six Sigma Scorecard methodology permits alignment of goals and objectives with improved performance and customer satisfaction. These elements can increase the

perceived value for the customers and management as well as the productivity levels (See Table 5).

3. The Unit of Analysis

- The unit of analysis will be represented by Institution Z, which is a financial institution located in Venezuela. Institution Z has a clear mission and vision that is expressed in a corporate Balanced Scorecard. This BSC needed to be tied to the Six Sigma performance improvement projects in order to maintain Institution Z's strength.

4. The Logic Linking the Data to Proposals

- Data sources will be explained in detail in the next section of this document.

4.3. Phase II: Case Study

The case study takes place during Phase II. The main activity during this phase is the collection of data. This investigation follows the experimental path, which involves combining elements and relations from the conceptual domain (SSS model) and the methodological domain (such as Six Sigma and BSC), and then applying them to some elements and relations from the substantive domain.

The following hypothesis assesses the research questions.

Hypothesis 1: The appropriate combination of Six Sigma and Balanced Scorecard in one methodology allows tying strategy to Critical to Quality to trigger performance improvement efforts.

In order to support the hypothesis, multiple sources of data and information will be used. Some of the instruments are described below:

- **Open-ended interviews**: Open-ended interviews provided a rich assortment of information, but the information was often presented in ways that were difficult to interpret or generalize. To increase the reliability of the data, the research scientist will use triangulation to increase the reliability in judging the problem under investigation as well as some statistical proof that measurements were accurate and statistically valid. Basic descriptive statistics were calculated to determine the level of improvement reached. Information collected from third party sources of information, such as newspapers, financial magazines and outside experts, offered a better picture about the market's behavior (Barton, 1993).
- The information obtained through interviews will be enhanced by combining it with measurable performance and productivity indicators, analytical reports from the business involved in the projects, information about the past, and academic information. In addition, the information obtained through interviews is stored and classified in predefined formats.
- **Problem-Solving Interview**: The problem-solving interview responded to the mutual interest of the researcher and client and encouraged individual problem solving or goal setting. This technique was one of the improvement process' tools that were used during the implementation of SSS framework. The researcher's purpose was to develop a climate where there were mutual interests in sharing ideas, exploring, and problem solving.
- The term "experimental effect" was important. The process of inquiry itself may act as a change agent. The researcher will take action in the improvement projects by encouraging managers and employees to formulate their own solutions to the detected problems. This process might be called haphazard interviewing to distinguish it from formal interviewing. Decisions and actions were based upon quick self-analysis, which was superseded by the

slow and pedantic formal action theorizing process, when researchers have to take time to compile the gathered data and feed it back to the client group. The interviews were a catalyst and crystallizer of ideas and events. (Barton, 1993)

- **Self-report instrument**: Dealing with the interview data consisted of transcribing, summarizing, or categorizing it and developing some system to reference and store it as raw interview data and subsequently sorting it into common categories. Some of the self-report instruments used during this case study included the project charter, BSC charter, matrixes, flow diagrams, and analytical tools used for improvement projects.
- **Observations and unobtrusive measures**: Observational and unobtrusive measures are ways of developing information about a setting, its history, processes, personalities, and events. During the first steps of the Case Study, historic data, strategies, mission, vision, and employee background of Institution Z allowed for an understanding of the events and situations being studied and led to appropriate analytical analysis. Types of unobtrusive information included available records, legal and tax information, operational and budgeting information, and personnel documents. (Donald T. and Stanley, 1963; Barton Cunningham, 1993)
- **Survey**: The proposed SSS methodology allows ranking the fit at the three merging points. These ordinal measures are provided by CEO and management level at Institution Z. In order to assess the impact of the proposed framework, a comparison survey was planned to be used. An initial list of construct's definitions, variables, and measurable items are proposed to be evaluated by a panel of experts (See Appendix D). The criteria used by the comparison (set of nonequivalent dependent variables) were based on the literature review in Six Sigma,

Balanced Scorecard, and researcher knowledge. If all of the outcomes favor the SSS framework, a strong indication may be extracted about the effects of the SSS scorecard in any organization (Donald and Stanley, 1963; Brinberg and Joseph, 1985).

Finally, researchers can expect to find three types of systematic errors when they attempt to use qualitative data collection. First, composition and conceptualization represent certain relevant variables that might not be included as well as irrelevant variables that were included. Implementation errors include the lack of a uniform relationship between the intervention and field setting; this type of systematic error was usually environmentally generated. Finally, researchers can also find errors in the measuring and recording mechanisms, specifically in Internet-based system communications.

4.4. Phase III: Findings

During this phase, the set of empirical findings are compared before and after SSS implementation. Because the SSS framework was a novel methodology, analytical generalization was needed to determine the boundaries, conditions, and limits associated with the findings. During this phase, researchers performed convergence analysis and boundary search. These processes were parallel processes and reflected opposite sets of expectations by the investigator, who looked to examine the scope and limits of the research findings.

The development of a formal Case Study protocol provides the reliability that is required for all research (Yin 1994; Tellis 1997). Although an identical replication was not possible, the use of the case study protocol as a guide during the research process provided evidence that a similar set of findings can likely be reproduced when the same pathway and the same set of elements, relations, and embedding system from each domain are used again.

Some techniques that were used in this research were as follows:

- Making matrices of categories and placing the evidence within such categories. Some of these matrices were prioritization matrix, matching matrix, and the comparison criteria survey.
- Creating data displays, flowcharts, SIPOC, and other devices
- Examining productivity indicators and their relationships with strategy indicators
- Creating a timeline that shows the events, changes, and conditions in Institution Z

The strategy used in this phase of the investigation relied on the theoretical proposition and the case study protocol. This strategy was called theoretical orientation (Brinberg and Joseph E., 1985; Yin, 1994).

4.5 Demonstration of SSS Methodology

To demonstrate the value of the combined methodology, the investigation will follow the combined case study and action research by using triangulation in all levels and also by using some unobtrusive data.

Yin (1994) cited the classification of Patton regarding the types of triangulations as follows:

1. Data sources (Data Triangulation)
2. Among several evaluators (investigator triangulation)
3. Perspectives on the same data set (theory of triangulation) and
4. Methods (methodological triangulation)

Data source triangulation occurs when the researcher looks for the data to remain the same in different contexts; investigator triangulation occurs when several investigators examine

the same phenomenon; theory triangulation takes place when investigators with different viewpoints interpret the same results; and methodological triangulation occurs when one approach is followed by another to increase confidence in the interpretation.

Investigator triangulation means that the researcher considers not only the voice and perspective of the actors but also of the relevant groups of actors. In case studies, this could be completed by using multiple sources of data. Triangulation in the proposed model, because it was a novelty theme, may be focused on data triangulation and investigator triangulation.

Generalization can be achieved in a case study/action research design by incrementing the level at which the concept and relationship of the research interest are represented in a broader scope. In order to increment the level at which this case study in today's business environment is represented, the researchers pointed out the multiple common points in organizations that fight to get success in today's business environment, even if it was true that each organization was an individual system, and there were not universal frameworks that can be considered and applied equally for all organizations.

Some of these common points were as follows:

- The need to reduce waste and efforts applied in performance improvement projects
- The need to coordinate and focus organizational efforts toward one common goal
- The need to translate strategy into actionable plans in all levels of the organization
- The need to satisfy customers and shareholders

A summary of the validities, constraints, and their corresponding mitigation plans used during the deployment of the case study/action research is shown in the following table (See Table 9).

Table 9. Validities Risk Summary

Criteria	*Case Study/Action Research Constraint*	*Mitigation Plan Control*
Construct Validity	Lack of control and precision	Multiple sources of evidence
Internal Validity	Lack of pure replication	Triangulation
External Validity	Lack of statistics generalization	Analytical Generalization
Reliability	Lack of replication	Case Study Protocol

4.6. Research Limitations

Strong limitations to collect reliable data were present during this case study/action research. The level of alignment was scored in the selected improve project, but neither information, nor alignment scores could be obtained related to other improvement initiatives running at Institution Z during the same timeframe. The lack of resources and the geographical distance between Institution Z and the researcher constantly avoid conducting surveys to get data.

The changes in the productivity indicators before and after SSS implementation were planned to be compared to changes in the productivity indicators of different improvement projects that used BSC during the same period of time, in order to provide congruent evidence. In the same way, a survey was designed to assess the perceived value of the SSS methodology against the BSC methodology at the management level, but it could not be conducted. During the Case study/action research there was no access to different projects' information. Most of those projects were lacking of hard measures and comparisons could not be completed. The selected SSS project was the only one that provided a formal measurement system and proved changes in BSC indicators.

External environmental situations (e.g., political) produced factors that were out of the control of the researcher making it impossible to conduct some comparisons and further statistical analysis. These potential limitations were identified based on the researcher's knowledge, the PhD committee's experience, and the knowledge of the Vice President of Institution Z. The identified limitations were factored into the final analysis.

4.7. Research Plan Summary

In summary, the research plan completed the following tasks.

- Performed a literature review of Six Sigma and Balanced Scorecard individually and then reviewed the literature that combined both management methodologies.
- Created a model and conceptual relationships that guided the Case Study.
- Developed a step-by-step roadmap that showed how Six Sigma and Balanced Scorecard can be combined in a unique roadmap.
- Developed a research design: A Case Study was used that illustrated the benefits and significance of the proposed methodology.
- Planned a series of exploratory interviews to find out the real context that fits the theoretical and methodological elements of the study.
- Selected an organization where the Case Study was applied.
- Interviewed selected organization's executive and management personnel.
- Prepared the research and training sections to conduct the Case Study.
- Selected the improvement projects that were utilized as a sample for the research purpose.

- Evaluated any relationships among BSC metrics, CTQ metrics, and performance improvement metrics (Six Sigma metrics).
- Established conclusions and proposed future research.

Table 10 provides a summary of the research plan with the activities that were performed within the research, and the following table shows the research's milestones.

Table 10. Six Sigma Scorecard project milestones

Milestone	Six Sigma Projects	Dates
Find an Organization where the Case Study can be conducted. Negotiate. Set agreements.		August 2006
Proposal Preparation	Define: Links BSCs Map BSC and Performance improvement initiatives Understand which opportunities to address Define objectives and goals Define stakeholders Develop and approve project charter Develop work plan Communication plan	September – October 2006
Data Collection	Measure: Document current process (SIPOC, Flow charts, Pareto chart, etc.) Measure current performance Identify and select process metrics Data collection Data analysis Voice of the customer Benchmarking Best practices	December 2006 – February 2007
	Analyze: Perform statistical analysis Gap analysis Identify cost of poor quality Quality Function Deployment	March- April 2007
	Improve: Improvement plans Recommendations for improvement Metrics and performance targets	April - June 2007
Investigation Results	Control: Proposed control mechanisms Evaluate BSC targets Assess impact at productivity levels	July 2007
Conclusions	Prepare data Assess SSS methodology effects vs. BSC methodology effects Statistical tests	August 2007
Complete		September/Nov 2007

CHAPTER 5: CASE STUDY IN INSTITUTION Z

5.1. Introduction

In order to evaluate the proposed merger of BSC and Six Sigma, this case study/action research designed and implemented the Six Sigma Scorecard (SSS) methodology and model parameters to determine the indicators that assessed the impact of the implementation of the methodology within Institution Z (Yin, 2003).

Institution Z had some experience using the Balanced Scorecard (BSC) as a strategic tool; however, it had experienced some difficulties in translating its BSC objectives and goals into day-to-day business activities. The institution was interested in the concept proposed herein of merging the BSC and Six Sigma processes to help assess the performance of the organization and the real contributions of each business unit to the strategic priorities of the organization.

The proposed SSS framework implementation provided evidence of alignment based on the scores from the prioritization matrix, the objectives matching matrix, and from the feedback loop which assesses the linkages to the BSC measures related to process, financial and customer satisfaction indicators. The effect of the fit can be assessed by the changes on the productivity indicators, and the perceived value of the proposed methodology against the BSC.

5.2. Unit of Analysis: Institution Z Background

A case study/action research was conducted in a financial institution located in Venezuela. This financial institution was identified as Institution Z during the case study/action research design and deployment. Institution Z was founded in March 1978, in the state of Bolivar, Venezuela with the mission of being the most solid and competitive financial institution

that satisfies its different market segments supported by an investment in human resources and technology that add value to its processes.

Institution Z has experienced growth and development in the Eastern, Central, and Western regions of Venezuela. Currently, Institution Z has 84 banking centers and ATMs strategically located in most of the states within Venezuela. The organization has built strategic alliances with corporations, the construction sector, universities, national and regional governments, and the health sector. Institution Z helps the alliances to strengthen their human resource processes, including payroll, hiring and staff management practices, management of investments and wealth, insurance policies, and other functions of the organizations.

In accordance with the business plan for the period from 1999-2001, Institution Z completed two mergers that increased its assets by 66.70%. Institution Z also acquired an insurance company in order to offer a wide range of services. This acquisition and merger allowed the transformation of Institution Z into a universal banking institution.

Institution Z, supported by 25 years of experience and modern banking technology, wants to offer a variety of services that satisfy their customers. Institution Z had provided archival records that identified the performance results of the utilization of the BSC Methodology during the past eight years. These records include financial, performance (i.e., cycle times of the processes) and customer response information. For research purposes, it must be noted that Institution Z re-evaluates and updates its BSC targets every six months. This Case study/action research employed the data collected during the second half of 2006 (June through December) and the data generated from January through July 2007.

The geographical limitation between Institution Z and the researcher was controlled by the use of Internet communication, including web-conferences with the Strategic and Planning Vice-President (VP) of Institution Z and Six Sigma team members.

Institution Z had been deploying a variety of improvement programs in different branches within the institution, but these initiatives had not been assessed nor had they been properly linked with their BSCs. Six Sigma was one methodology that Institution Z had not attempted to implement. Therefore, the researcher set up and led a Six Sigma project for Institution Z. The selected Six Sigma project was sponsored by the Planning and Strategy VP. The Six Sigma Project was prioritized based on the previously established BSC indicators provided by Institution Z and then it was evaluated by the relationship to the voice of the customer expressed via Critical to Quality (CTQ) and obtained for standard customer information measured by statistical research organizations of the industry sector of Venezuela.

To measure the benefits at the production level, the researcher used selected data provided by Institution Z. Institution Z had provided its corporate BSCs, the BSCs of the business units involved, and a list of the improvement initiatives that were currently in place.

A qualitative source of evidence and probably the one that demanded more skill to obtain information without bias was the continuous interviews with Institution Z members. Most of these interviews were conducted at the manager level of the institution because there were few opportunities to get direct contact with Institution Z staff members. A structured set of questions served as a guide to obtain important information about the problems, their causes, and how they should be resolved, but there were opportunities for deviations to explore areas of interest that came out of the interview itself. The fact that most of the interviews had to be done through

Internet communication was an advantage because it allowed the information to be saved and stored for further analysis.

5.3. Framework Six Sigma Scorecard (SSS) Development

A framework that applies the Six Sigma DMAIC processes integrated with BSC as a tool to align Strategy-Performance and Customer Satisfaction has been developed and applied to Institution Z.

To achieve alignment among the improvement initiatives, performance measures and the long-term strategic goals, the BSC objectives were used to define the course of direction for improved performance at all levels within the organization.

In order to limit the scope of the Case study/action research, some business units were selected. The Corporate BSC was linked to the BSCs of four of the sixty-seven business units: the Credit Product Unit, the Banking Center Unit, the Risk Support Unit, and the Electronic Banking Unit. These business units were linked by establishing cause-effect relationships among them.

The business units to be included in this study were selected based on the quality of the data provided by Institution Z. The defined indicators selected for research purposes were: cycle time, the number of credit product sales, the type of products, and the number of credit products approved and declined. The method for obtaining these indicators was referenced in the BSC.

In order to select the BSCs and their corresponding BUs involved in this research project, the researcher and top executives in Institution Z participated in a series of brainstorming sessions. The purposes of these brainstorming sessions were to understand the objectives and

linkages expressed on the BSCs, evaluate the quality of the indicators as a source of quantitative and objective data, and determine the impact of the strategic objectives within Institution Z.

Within each of the four perspectives of the BSC (growth and learning, financial, internal processes, and customer perspectives), the metrics were determined to be the common denominator of the four business units' BSCs. The tables below are some of the BSCs provided by Institution Z with the targets established for some support units during the last semester of 2006. As can be seen, some metrics were not properly created or could not be translated to a numerical value. Institution Z credit products were: credisur, credit-auto, microcredit, Cadivi customers, credit plus, and credit comercio. Some metrics, such as job requirement, were not easy to understand. For the case study/action research, the metrics were selected based on availability, comprehensiveness, and reliability. The boxes highlighted in the table show the metrics that were selected from the BSC as productivity indicators for the research purpose. The arrows on Tables 11, 12, and 13 give an idea about the selected indicators on the BSCs and how they were strategically linked among the four business units. Targets are expressed on the monetary currency of Venezuela, Bolivar, Bs, and for the amount set up by Institution Z.

Table 11. Corporate BSC

	COORPORATE BSC		
PERSPECTIVES	Objectives	Metrics	Target
GROWTH AND LEARNING	1. Decrease the gap between ideal skilled job functions and staff's competencies. 2. Evaluate organizational climate.	Graphic 1	
INTERNAL PROCESSES PERSPECTIVES	1. Increase the performance of the credit processes. 2. Increase efficiency of operating processes	Graphic 2	ACT= 2 days for credit approval (people). ACT <= 20 days for credit approval and cashing
CUSTOMERS	1. Target middle class, low class, and PVME class population sector. 2. Increase quality of services. 3. Identify the Institution (brand) market position. 4. Increase customer loyalty	1. Number of personal New accounts. 2. Answer Cycle time.	# personal New account=2,000 New complaint=50% old Complaint
FINANCIAL	1. Place ROE at 12% for IIS06 and 30% by 2007.	1. Number of new accounts	# of credit=164 Credit Intermediation=42% checking account=101,000Million

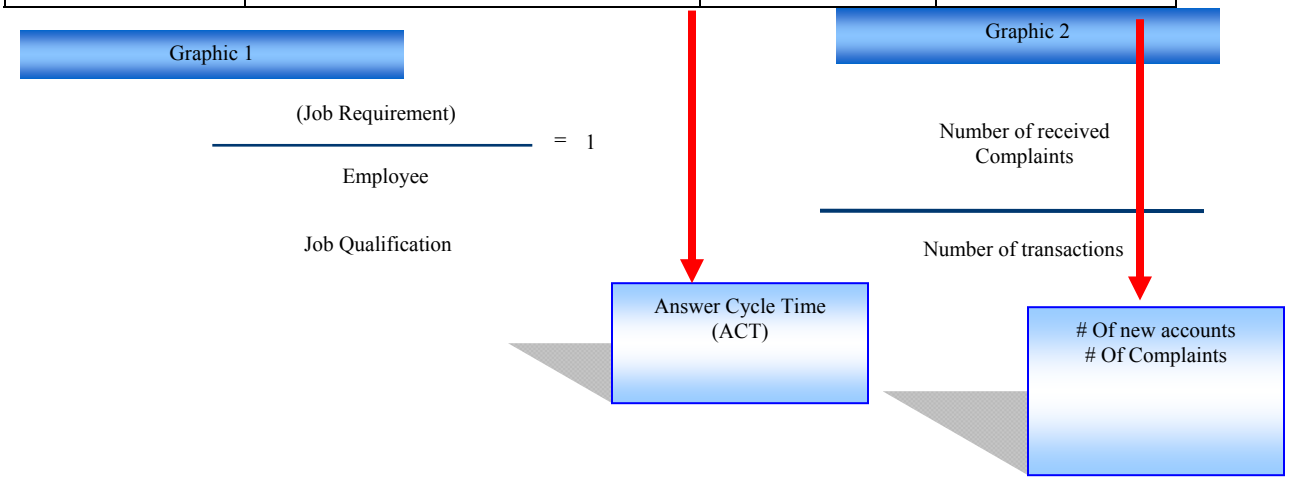


Table 12. BSC Banking Centers Credit Product

BANKING CENTERS "BSC"		CREDIT PRODUCT UNIT "BSC"	
Objectives	Metrics	Objectives	Metrics
1. Decrease the Gap between ideal skilled Job functions and staff's competencies	Graphic 1	1. Decrease the gap between ideal skilled job functions and staff's competencies. 2. Evaluate organizational climate.	Graphic 1
1. Increase quality of products. 2. Meet Capital clearances' requirements	1. Answer cycle time	1. End testing phase of the "Credisur" product	Answer cycle time
1. Increase Number of New Customers	1. Number new customer=33. 2. No of TDC= 10. 3. No Crediplus=3. 4. Number CreditCon=3. 5. NoCADIVI=	1. Decrease cycle time for approval and cashing of credit products	Answer cycle time.
1. Increase number of credit products	1. Number microcredit=20. 2. Number commercial=80, 3. Number creditAuto=25. 4. Number creditCash=5. 5. Number Credit Plus= 8. 6. Number Saving Account=100. 7. Number Checking Account=50	1. Decrease overhead Cost	

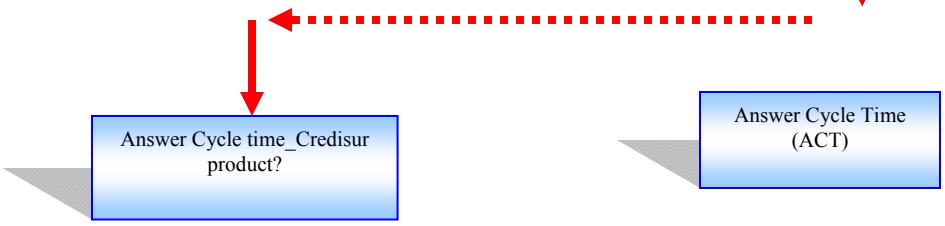
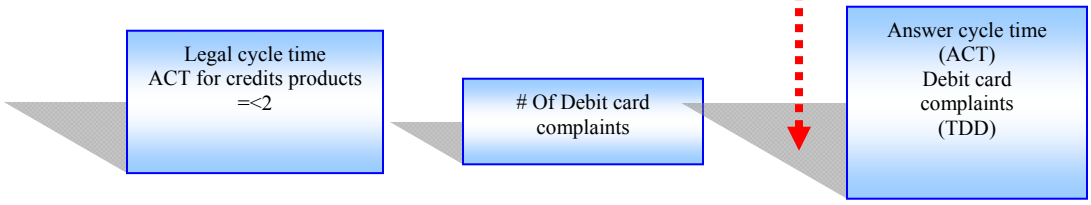


Table 13. BSC Risk Support and Electronic Bank

RISK SUPPORT UNIT"BSC"			ELECTRONIC BANK UNIT "BSC"		
Objectives	Metrics	Target	Objective	Metrics	Target
Evaluate Organization Structure			Decrease the gap between ideal skilled Job functions and staff's competencies.		
1. Prevent and Control process related to Capital clearances. 2. Evaluate delinquency payments	Cycle time to legal		Decrease cycle time of cashing	Cycle time	
1. Keep Answer Cycle time for credit products for people within 2 days	Cycle time	ACT=< 2 days	1. Decrease Answer time for Debit Card Complaints. 2. Decrease number of debit card Complaints	Answer cycle time	ACC = <5 days (TDD) ACC=<7 days (S7B)
1. Decrease overhead cost. 2. Meet budget	Budget deviations (BD)	BD= 0%	1. Meet budget of operating cost. 2. Decrease cost associated with delinquency complaints in debit card (TDD)		



5.3.1. First Merging Point

When the BSC for the participant business units was studied, the selection process started. A prioritization matrix was used in the selection of the Six Sigma projects from the list of initiatives provided by different BUs at Institution Z. The Six Sigma projects were selected from among those areas having complete data based on the projects that most strategically impacted Institution Z's organizational goals. At the time Institution Z was in this phase of the project, one of their principal strategies was to increase the level of financial intermediation or GIC. The financial intermediation measures the gap between what the bank pays savers and what the bank receives from borrowers (The net interest margin). Institution Z had a level of intermediation of 30% at the beginning of the SSS implementation. This level of GIC represented a high risk because at that level the Venezuelan Government had control over the financial stability of Institution Z. The level of control of the Government was originated in the regulations over the net interest margin or rate spread and in the amount of money in deposits the government had in Institution Z.

The procedure to get the total score for each one of the proposed initiatives started with a blank table provided by the researcher to the sponsor of the projects. As the previous chapter mentioned, the weight was an indicator of the importance that each criteria had on the decision-making process, and criteria came from the literature review and the researcher's experience. The assignation of points should be completed at manager and executives levels of the organization where the strategy is better understood. The points were assigned by Institution Z's CIO, using a 1 to 10 scale where 1 indicated the lowest priority and 10 marked the maximum priority for any considered project. The score for each criterion was the result of multiplying the

score by the weight, and the total score per improvement initiative was the result of the summation of each score for each improvement initiative.

The project that received more points was selected for the research purpose, and the define phase of the improvement project started. The automobile credit approval and cash disbursement was chosen. The prioritization table shows three of these improvement initiatives with the assigned points to each and the total score they got. (See Table 14)

In this phase of the project, a team was formed to collect direct information, assess process performance, and contribute to finding the best solutions to the problems. The commitment of the executive management level, middle level and employee levels to the Six Sigma Scorecard methodology was an advantage for this research effort.

Some techniques such as SIPOC, shareholder analysis, and some histogram tools were used within the Six Sigma projects.

Table 14. Prioritization Matrix w/assigned points by Projects

			Automobile credit		Credit card Complaint		Platinum Master Credit Card Program	
CRITERIA	**WEIGHT**	**DESCRIPTION**	**POINTS**	**SCORE**	**POINTS**	**SCORE**	**POINTS**	**SCORE**
Linkage to Strategy (BSC)	**30%**	Ability of the initiative to positively impact strategic objectives	10	3	10	3	5	1.5
Impact on Customers	**25%**	Ability of the initiative to positively impact critical aspects of the services from the customer point of view.	10	2.5	10	2.5	8	2
Bottom Line Results	**20%**	Ability to achieve dramatically improved results	10	2.0	8	1.6	3	0.6
Cost/Resources Allocation	**10%**	Total dollar cost and key personnel needed	10	1	5	0.5	8	0.8
Time to Complete	**5%**	Total anticipated time to complete the initiative	5	0.25	5	0.25	10	0.5
Dependencies	**5%**	Impact of other initiatives on the successful outcomes anticipated with this initiative	10	0.5	7	0.35	4	0.2
Current State	**5%**	Level of control and measurements system	1	0.05	1	0.05	10	0.5
TOTAL	**100%**			**9.3**		**8.25**		**6.1**

5.3.2. Second Merging Point

Once the Six Sigma project was started and the project charter was defined, a balance matrix was used to match the project's business opportunities against the BSC strategic goals.

(See project charters, Appendix A). The goal of all the activities during this phase was to ensure that internal and external conditions play in favor of the correct implementation of the proposed methodology. The fit score of the automobile credit project was 7.88. This score was obtained from the average of scores assigned in the business opportunities-BSC goal matching matrix by Six Sigma team members in consensus. These calculations were based on the scores assigned to each one of the business objectives on a 1 to 10 scale where 1 represents the lowest level of consensus between project objectives and strategic objectives and 10 the maximum level of consensus between project objectives and strategic objectives. This is an interactive process where negotiation is key to allow changes in the project objectives until the final scores of the project reached a minimum target. This minimum target is established by the improvement project team according to the Institution's CEO expectations. In this Case study/action research the minimum consensus target was set up at 70% or 7 points.

The improvement project was assessed following the DMAIC methodology as defined in the Six Sigma Scorecard framework. Before the SSS implementation, the automobile credit approval and funding was done manually, following the flow diagram on Figures 4 and 5.

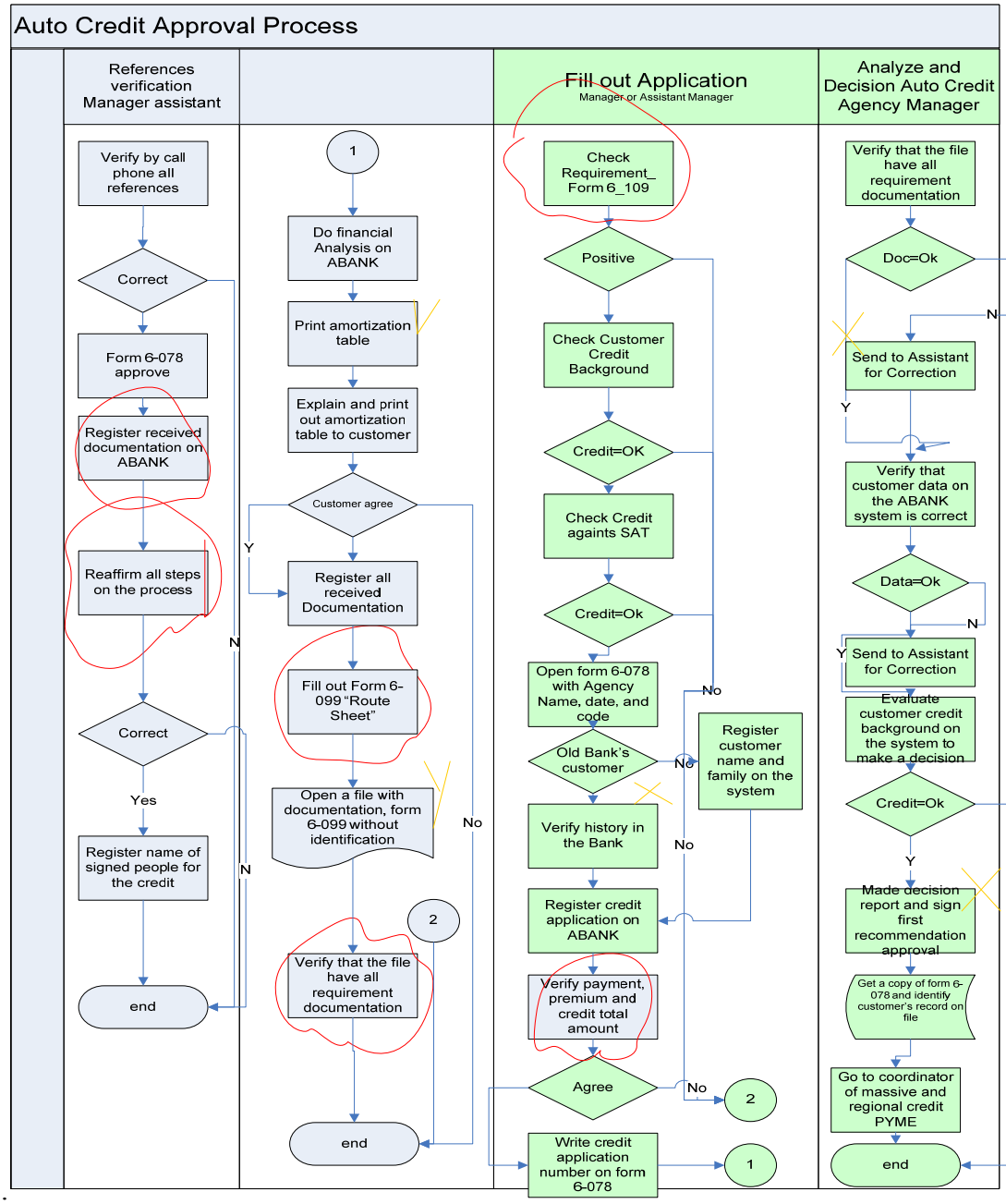


Figure 4. Auto Credit Flow Chart by January 2007

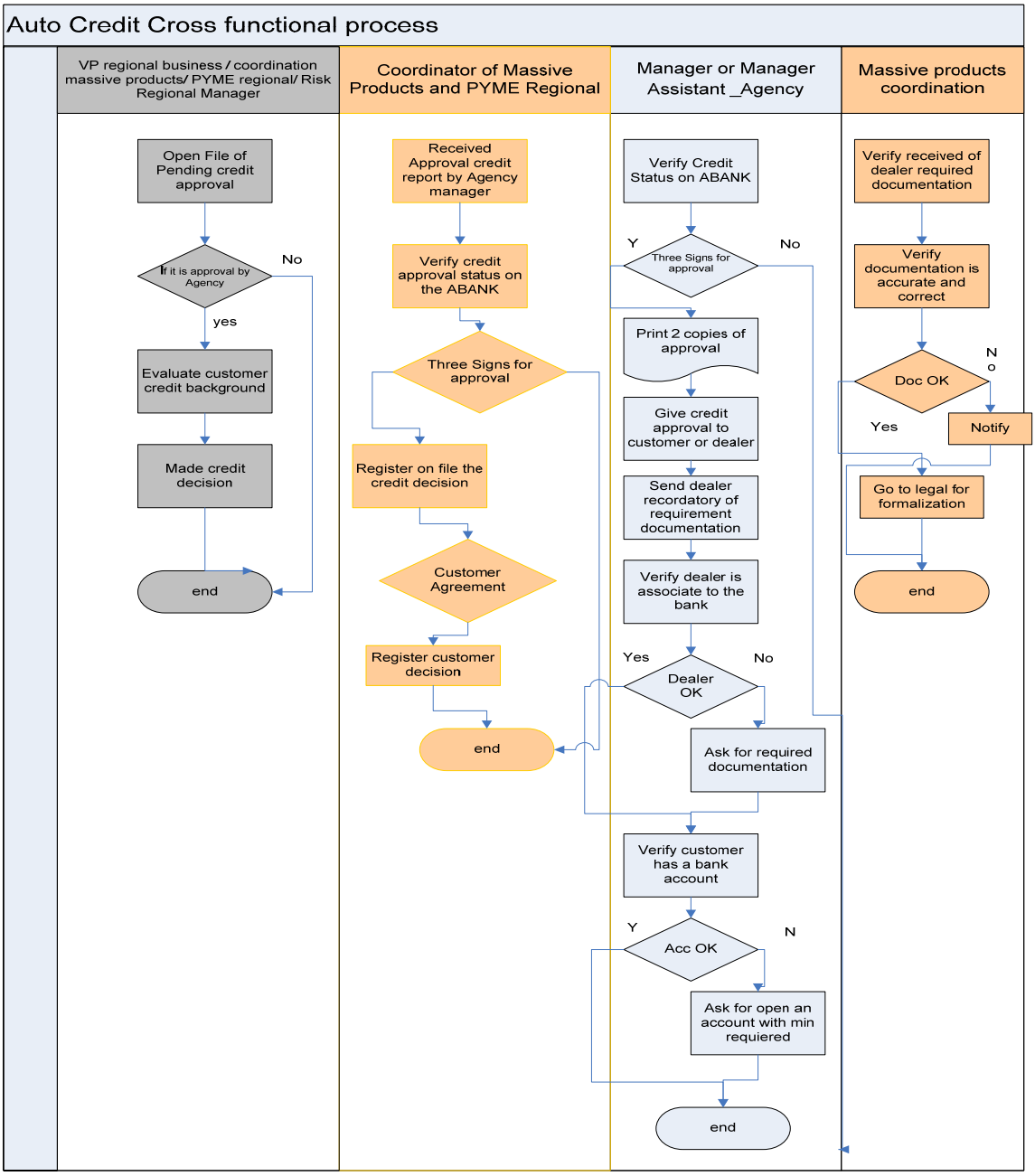


Figure 5. Auto Credit Flow Chart Jan-07. Continuation

Institution Z required a formalized measuring system that described the initial situation of the auto credit process. The baseline for this project was collected from a PowerPoint presentation of an internal project presented to the Institution Z's top executives with number of

auto credit loans and consumer loans processed and approved from January to July 2006. Information about sample size and confidence was not available. This information was confirmed in open-ended interviews conducted by the SSS team with Institution Z's middle managers and executives. Table 15 summarizes the average cycle time for the auto credit process in Institution Z during the first half of 2006.

Table 15. Auto Credit Cycle time in days January-06 to June-06

Regions	Application	Credit Analysis	Risk (verification and approval)	Legal (Document)	Reimbursement	Cycle time (working days)
Guayana	→	→	9-11	→	11	20
East	→	→	9-11	→	16	25
Central	→	→	9	→	15	24
West	→	→	12	→	20	32
Institution Z						26

Based on the indicators expressed in Institution Z's Balanced Scorecard, which set a target for all credit processes of six days for the whole process and 2 days for the approval part of the complete processes, the goal of the SSS project was to decrease the auto credit total cycle time by 70% by May 2007. (See project charter. Appendix A)

An important point was the benefits that were obtained from the Shareholder analysis. The Shareholder analysis tool was used to identify the impact of the Six Sigma project on the auto credit's shareholders within Institution Z. As a result of the analysis, the predetermined negative response some managers had to the Six Sigma methodology was identified as a potential weakness. For example, the Technology and Operations VP did not believe in the Six Sigma methodology and stated that Institution Z was not yet prepared for the application of the Six Sigma methodology. (See Shareholder Analysis, in Appendix A and tables 19 and 20.)

Some of the Six Sigma rejection came from the belief that Institution Z's processes were out of statistical control. After a concentrated analysis process, the Six Sigma team agreed that the principal problem within Institution Z was the lack of a standardized measuring system but not necessarily the lack of statistical control. The Six Sigma team realized that most of the improvement indicators can be obtained from the information system in place, but nobody had asked for them before.

Based on the analysis, the first strategy used was not to name the improvement project Six Sigma. Although the DMAIC methodology and Six Sigma tools were followed, the project was called Auto Credit Improvement Project. Then, it was decided to add some flexibility to the DMAIC methodology because of the necessary overlapping phases that occurred during the complete implementation of the proposed methodology. Specifically, the Measure and Analysis phases cycled back and forth until all of the indicators could be generated from the information system in place.

It is important to explain that, starting in October 2006, the SSS team was asked about the migration of the credit process to an automatic information system, known as ABANKS, designed for Institution Z. The migration to ABANKS was one critical improvement because it affected one of the detected causes of delays in the process. The migration to the ABANKS system was not directly related to the SSS but occurred during the SSS implementation. The SSS team supported the migration to the ABANKS system based on three points: first, the ABANKS deployment was a strategic priority expressed on the main BSC; second, the cause-effect diagram and the multiple interviews conducted with Institution Z's employees expressed

the waste of time and risk that a normal mail system creates for the auto credit process; and third, technology supported Institution Z's processes.

The migration of the auto credit process to the ABANKS system was made without redesigning the process, which cause duplication of manual and automatic tasks. Although the migration to ABANKS system seemed to short the cycle times, it increased the variability and most of the savings were losing by duplications of activities, lack of training, and lack of knowledge about what the system can do and can not do, etc. After ABANKS implementation, the SSS team started to value stream map the process in order to eliminate activities that did not add value.

During these phases, the researcher put much time and effort into assuring the proper implementation of the methodology and keeping the case study under control. Instructional study guides and interactive classes (e-learning) were some of the techniques used to explain the purpose of each tool. The proper planning assures that the job was done correctly. (See Appendix B)

5.3.3. Third Merging Point

During the measure phase, the Critical to Quality Characteristics, "CTQ," were defined. In order to define the CTQ characteristics, the researcher used two principal sources of information: a public report of the Venezuelan Bank Association (ABV) prepared by Datanalisis and a research paper from the Graduate division of the University of Zulia. (See Appendix H).

During the measure and analyze phases of the Six Sigma project, indicators such as cycle time, response time, and number of credit approvals were tracked in order to determine if the

processes were in statistical control. For those processes under statistical control, capability indices were calculated to determine at which performance level they were running.

The process capability index, Cp, is defined as the ratio of the specification with the natural tolerance of the process. Process capability is very important in Six Sigma performance studies because it allows one to quantitatively predict how well a process will meet specifications.

Based on the information collected, it was determined whether the process was under statistical control and capable of meeting specification (2 days for the approval process and 6 days for the total auto credit process). This analysis suggests that both the centering and the variation must be improved. Tables 16 and 17 describe the process capability analysis made on the auto credit process for the first half of 2006. The data used for the calculation were averages provided by Institution Z, with a sample size of around 50% of the auto credit loan applications processed during this period. There was not information about standard deviation and errors at that time. In addition, there were auto loan applications that may be not counted because some institution Z employees didn't follow the procedures and did not fill out the forms from institution Z but rather from where the information was collected. There was not enough evidence of the statistical state of the process, although this process was used during a long period of time. The constants D_3, D_4, and A_2 depend on the sample size and can be found in statistics tables.

It is evident that the auto credit process did not meet Six Sigma specifications of keeping process variation equal to half of the design tolerance of 2 days, while allowing the mean to shift as much as 1.5 standard deviations from the target of 6 days. The process had a low Cp and a

negative Cpu, which indicate that the process was not centered and did not meet the tolerance; in fact, the process average exceeded the upper control limit. The natural spread (6σ) was very large, (equal to 20.4) and exceeded the design specification. A summary of the calculations is presented on the following tables.

Table 16. Process Capability Auto Credit Process 2006

Process Capability Calculations						Six sigma	20.4
Upper specification	6					Cp	0.303
Lower specification	0					Cpu	-2.043
Average	26.25					Cpl	2.648
Standard Deviation	3.30					Cpk	-1.05

Table 17. Auto Credit Cycle time to August 2006

Grand Average	26.25				
		A2	D3	D4	d2
Avg. std. dev.	3.3099376	0.73	0	2.28	2.059

The Failure Mode Effect Analysis and Frequency Analysis were tools that were exploited to determine which causes of defects were critical and when and what type of key indicators should be used to prevent defects. (See table 18.)

The table below was modified by the researcher, and their objectives were explained through e-learning chats. The researcher allowed two weeks for practitioners to complete the tables and send them by e-mail. These tables were summarized and presented during a SSS team meeting to be verified.

Table 18. SIPOC-Failure Analysis Tool

PROCESS	INPUT	EXIT	CYCLE TIME	TYPE OF MISTAKE	FREQUENCY	MISTAKE SEVERITY
Customer First Contact	Product Sale	Customer Registration	10 Min.	None	None	Transitory
Application Process Start	Data Input	Print Application Out	10 Min.	Error On Data Input	Frequent	Transitory
Start And End Of Each Step Of The Process	Step 10,20 Y 30 Close	Go To Credit Coordination	30 Min.	Error On Data Input	Frequent	Transitory
Sending File To Credit Coordination	Approved Documentation On System	File Exit	1 Day	Requisites Incompletes	Less Frequent	Transitory
Credit Coordination Receives And Verifies Documentation On File	Credit Registration	File Goes To Risk Dept.	1 Day	Incomplete Requirement	Less Frequent	Transitory
Risk Department Receives File	System Information Must Match Customer Requirement	Credit Coordination	Same Day	Incomplete Requirement	Less Frequent	Transitory
File Goes Back To Credit Coordination	Credit Coordination Decision On File	File Goes To Credit Coordination	Same Day	None	None	None
Credit Coordination Receives File	Status Confirmation On System	File Must Contain Signed Document-Action By Credit Coord.	Same Day	None	None	None
Banking Center	Open Account	Open Account Notification To Credit Coordination	3 Days	No Money For Flat Commission	Less Frequent	Transitory
Credit Coordination	Step 40 Close (Warranty)	Go To Legal Department To Complete And Edit Documentation	3 Days	Incomplete Car Dealer Requirement	Frequent	Transitory
Reimbursement Receives Documentation	Verify Documentation	Complete File Goes To Credit Coordination	3 Days	Errors On Legal Document	Less Frequent	Transitory

PROCESS	INPUT	EXIT	CYCLE TIME	TYPE OF MISTAKE	FREQUENCY	MISTAKE SEVERITY
Credit Coordination Receives Reimbursement Documentation On File	Documentation Goes Back To Banking Center To Be Signed By Car Dealers	Loan Reimbursement	2 Days	Car Dealer Available	Less Frequent	Transitory

The improvement recommendations from the Six Sigma team were implemented progressively during the end of 2006 and at the beginning of 2007. The first recommendation that was implemented in Institution Z was the progressive use of an Information System called ABANKS, which allowed the cycle times to be shortened and to track the processes. Following, the SSS team streamlined the auto credit process, fostered structural change, and redesigned the process to allow outside suppliers to work suitably with Institution Z's member to satisfy customers' needs. The performance of these processes was assessed by the same indicators used at the beginning of the SSS project, plus the key indicators to evaluate the effect of the framework at the productivity level.

As part of the methodology, key performance indicators were determined as the result of the SSS methodology and tools. Some of those indicators were used to measure process performance, and they were tied to the current bonus of the Banking Centers Units of Institution Z during the second half of 2007. (Andersen and Fagerhaug, 2002) Inventories of possible metrics that can be used within Institution Z to measure its performance, which were extracted from literature review, are presented in the project charter (See Appendix A).

In order to develop a performance measurement system and relate it to the productivity indicator and the BSC objectives, the first step was the stakeholder prioritization process. The

next tables show the results of the assessment of stakeholders, performance requirements, and their importance. This assessment was made during a manager and executive meeting within Institution Z, and the results show the group's consensus.

Table 19 . Stakeholder Prioritization

Stakeholder ranking session		
Stakeholder	Importance	Rationale for ranking
PRESIDENT, VICE-PRESIDENT	10	They are highly interested in measure performance
MANAGERS	10	They are highly interested in measure performance
EMPLOYEE	8	They know the importance of measuring the performance, but they don't want to be controlled.
CUSTOMERS	0	In Venezuela there is no quality culture. Customers don't feel they are part of the process, and they don't feel they are important.

Table 20. Stakeholder Expectation

Stakeholder:	
Expectation/Need	Performance Requirement
Increase employee commitment to Institution Z	Decrease transformation and operating costs, reduce waste, increase number of credit products on the market, increase the number of auto credit loans placed on the market.
Decrease the effect of the active rate vs. passive rate spread on the operating cost. Increase performance control. Continued training and education	Eliminate waste, increase efficiency, and eliminate rework. Allow tracking capabilities. Increase employee performance.

Table 21. BSC Objective Alignment

BSC Objective Alignment				
Performance Requirement	Lack of Alignment 0	Medium Alignment 5	High Alignment 10	Total Points
President/ Vice President/ Managers			X	10
Employee		X		5
Customers	X			0

The results of the stakeholder prioritization process preferred that the president and manager levels be involved in the process. For the research purposes, it would have been ideal to set up some meetings with employees and customers, but it was not possible due to time and distance constraints.

Having completed the performance priorities, the SSS team set up meetings to evaluate the current performance measurement system, to analyze it as an effective tool, to assess the performance of the new auto credit process and its effects on the BSC targets, and to generate new performance indicators. It was pivotal to employ an evenhanded set of measures by stakeholders and BSC dimensions to understand the performance of the auto credit process and to be able to locate improvement areas.

The development of the measure system must include define measure purpose, assign name, assign owner, and provide calculation formula.

The indicators were classified by these dimensions:

- Hard versus soft measures. Hard measures are pure facts that can be measured directly; soft measures are intangible measures that have to be measured indirectly.
- According to the purpose, lagging measures assess outcomes and tell what has happened, while leading measures predict what will happen. The first ones are known as results measures, and the second ones as diagnostic measures.

The performance measurement system design process requires the collection of data, and that data must be accurate and timeless. The set of measures chosen for the final measurement system were those measures that meet stakeholder expectation performance; at least one indicator was chosen by the BSC dimension, hard indicators were favored over soft indicators; and indicators with available data collection mechanisms were used. Tables 22 to 27 show the final list.

Table 22. Performance Indicator

	STAKEHOLDERS	INDICATOR NAME	MEASURE PURPOSE	PERFORMANCE DIMENSION	DATA AVAILABILITY	DATA ACCURACY: Yes/No	PERFORMANCE INDICATOR'S PURPOSE	OWNER
1	Managers of each of the division: banking center, credit coordinator, reimbursement	Percentage of performed reviews conducted by deadline	Results and Competence	Hard	Yes	Yes	BSC: area growth. Determined how well managers and CIO of the organization are coaching processes	VP Technology
2	Employee	Percentage of rework	Results	Hard	Yes	Yes	BSC: Internal processes. Determine the percentage or saving that can be reaching by improving processes	Banking Center Coordinator
3	Banking Center Managers	Number of car dealer visits	results	hard	Yes	Yes	BSC: internal processes. boost face to face contact point in order to affiliate car dealer to the program	Banking Center Coordinator
4	Banking Center Managers	Number of applications per car dealer	results	hard	Yes	Yes	BSC: internal processes. boost car dealer's affiliations. increase credit portfolio	Banking Center Coordinator

	STAKEHOLDERS	INDICATOR NAME	MEASURE PURPOSE	PERFORMANCE DIMENSION	DATA AVAILABILITY	DATA ACCURACY: Yes/No	PERFORMANCE INDICATOR'S PURPOSE	OWNER
5	Employee, Car Dealer (supply Chain)	Number of applications with complete and accurate documentation	Results	Hard	Yes	Yes	BSC Internal Processes: Determine how well Car Dealer-Institution Z business is running	Banking Center Coordinator
6	President, Managers, Employee	Cycle time: open and close application (by phases); open and close application by banking center manager; open and close application by credit coordinator, requested documentation to car dealer vs. received documentation from car dealer, request cash check or transfer vs. car dealer payment.	Diagnosis, Results and Competence	Hard	Yes	Yes	BSC Internal Processes: determine the performance level by business unit (chain) involved in the process	Unit general Manager

Table 23. Continuation-Performance Indicators

	SOFT-WARE	Report Line	Indicator	FREQUENCY	SAMPLE	INDICATOR TARGET	CONTROL LIMIT, Max y Min
1	ABANKS	Business and Project Vice-President	No. of performed application reviews/ No. of application received	Months	100%	95%	MAX: 100%; MIN: 85%
2	ABANKS	Regional V.P and Business Executive V.P.	No of applications with errors	Months	100%	95%	MAX: 100%; MIN: 85%
3	EXCEL	Regional V.P. and Business Executive V.P.	# Car Dealer Affiliation / # Car Dealer visits	Months	100%	80%	MIN 30%- MAX 100%
4	EXCEL	Regional V.P. and Business Executive VP.	# applications per Car Dealer / Total approved car loan per dealer	Months	100%	80%	MIN 20%- MAX 100%
5	ABANKS	Regional V.P. and Business Executive V.P.	# of complete application/ Total number of applications received from Dealer	Months	100%	80%	MIN: 70%; MAX: 100%

	SOFT-WARE	Report Line	Indicator	FREQUENCY	SAMPLE	INDICATOR TARGET	CONTROL LIMIT, Max y Min
6	ABANKS	Regional V.P and Business Executive V.P.	Phase # Close Date - Phase # input Date	Months (count working days)	100%	Credit application =1 working day; Credit Review =2 work days; Car Dealer Requirement = 2 work days; Legal = 1 day; Reimbursement= 1 day	Max: +2 working days/ Min: -1 working day

Table 24. Continuation Performance Indicators

	STAKEHOLDERS	INDICATOR NAME	MEASURE PURPOSE	PERFORMANCE DIMENSION	DATA AVAILABILITY	DATA ACCURACY: Yes/No	PERFORMANCE INDICATOR'S PURPOSE	OWNER
7		Number of errors per application	Results and Competence	Hard	Yes	Yes	BSC Growth: Increase employees commitment and competence	Unit general Manager
8	CIO, President, Vice President	Actual-to-theoretical cycle time	Results and competence	Hard	Yes	Yes	BSC Growth: Determine BSC target met	VP Technology
9	Employee	Number of applications coming back for corrections	Results	Hard	Yes	Yes	BSC Internal Processes: Determine the level of waste on the process	Unit general Manager

	STAKEHOLDERS	INDICATOR NAME	MEASURE PURPOSE	PERFORMANCE DIMENSION	DATA AVAILABILITY	DATA ACCURACY: Yes/No	PERFORMANCE INDICATOR'S PURPOSE	OWNER
10	CIO, President, Vice President	Number of applications pending or "In Hold" for steps on the process	Diagnostic and Competence	Hard	Yes	Yes	BSC Growth: Determine special factor affecting the cycle time and performance on the process	VP Technology
11	Clients	Average complaints handled or solved at first contact	Diagnostic, results and Competence	Hard	Yes	Yes	BSC CUSTOMER: Determine answer capacity of Institution Z	Quality
12	Clients	Average resolution time for handling complaints	Competence	Hard	Yes	Yes	BSC CUSTOMER: Determine answer capacity of Institution Z	Quality

Table 25. Continuation - Performance Indicators

	SOFTWARE	Report Line	Indicator	FREQUENCY	SAMPLE	INDICA-TOR TARGET	CONTROL LIMIT, Max y Min
7	ABANKS	Regional V.P. and Business Executive V.P.	# error per each application	Months	100%	1	Max: 3; MIN: 0
8	ABANKS	Regional V.P. and Business Executive VP.		Months	100%		
9	ABANKS	Regional V.P. and Business Executive V.P.	Counter	Months	100%		

	SOFTWARE	Report Line	Indicator	FREQUENCY	SAMPLE	INDICA-TOR TARGET	CONTROL LIMIT, Max y Min
10	ABANKS	Business and Project Vice President	Number of application on wait	Months	100%	1	MAX= 3; MIN= 0
11	TBA	TBA	TBA	TBA	TBA	TBA	TBA
12	TBA	TBA	TBA	TBA	TBA	TBA	TBA

Table 26. Continuation- Performance Indicators

	STAKE-HOLDERS	INDICATOR NAME	MEASURE PURPOSE	PERFORMANCE DIMENSION	DATA AVAILABILITY	DATA ACCURACY: Yes/No	PERFORMANCE INDICATOR'S PURPOSE	OWNER
13	Clients, CIO, President, Vice President	Customer base growth	Diagnostic and Compe-tence	Hard	Yes	Yes	BSC GROWTH: Determine number of new client obtained by improved services	Quality
14	Clients, CIO, President, Vice President	Financial: GIC	Results	Hard	Yes	Yes	BSC: Financial: Determined car loan impact on financial institution Z strategy	VP Technology

Table 27. Performance Indicators

	SOFT-WARE	Report Line	Indicator Formula	FREQUENCY	SAMPLE	INDICATOR TARGET	CONTROL LIMIT, Max y Min
13				Months	100%		
14	ABANKS	Business and Project Vice President	Credit Portfolio / Total Deposit	Six months	100%	40%	MAX: 50%; MIN: 30%

5.4. Testing the Hypothesis

Statistical tests that would support the hypotheses were constrained by the inconsistencies of the data sources during the case study. There were not reliable data about the alignment scores of different projects running at Institution Z. There was not any reliable data about productivity results reached by those improvement projects that used BSC alone during the same period of time. The automobile credit project was the only one assessed during the case study in terms of the alignment and in terms of the productivity changes. The management preferences construct could not be assessed because the survey was not conducted. Only qualitative information regarding management preferences was collected from three people (Institution Z Vice President and some business units' managers). Although factor analysis could not be used to support Hypothesis 2, Hypothesis 1 is supported by the alignment scores of the three merging points, hard measures that are evidence of alignment and productivity changes in the automobile credit project.

Other sources of information that were helpful for this research purpose were: the public financial records of the Bank Association of Venezuela, financial magazines and financial white papers from consulting organizations in Venezuela, stationary automobile demand studies, and customer satisfaction studies. All of these sources of information were complementary to direct interviews with the Strategic and Planning Vice-President and personnel from the business units where the investigation was conducted. These interviews allow for a better understanding and mapping of business structure and processes, development of business process performance priorities, identification of improvement initiatives, understanding of the current performance

measurement system, identification of root causes of problems, and identification of key indicators.

Some of the documents and data that were created and provided by Institution Z to the researcher for further analysis were: SWOT table, Corporate BSC, and the BSC of the support units involved in the case study/action research. (See Appendix E)

Finally, quantitative and qualitative data obtained in Phase II of this Case study/action research were evaluated from different points of view. Investigator triangulations and using multiple sources of evidence produced data that allowed one to obtain measures of internal validity.

Additionally, the researcher used the case study protocols to evaluate how the set of empirical findings fit into the proposed SSS model. The effects that the implementation of the SSS framework on the productivity indicators of the improvement projects in Institution Z were compared to the construct defined during Phase I of the research. This was done to obtain construct validity. A summary table with data sources that finally were used, and the way in which these sources supported this investigation's hypotheses is provided at the end of the chapter.

5.5. Description of the Timeline with Institution Z

The next table lists the activities that were done during the development and implementation of the Six Sigma Scorecard for research purposes. The following table shows a visual image of the timeline.

Table 28. Case study/action research timeframe

Activities	Description	Dates
Make Negotiation with Institution Z	Find an Organization where the Case Study can be conducted. Make negotiations Set agreements	August 2006
Define Channel of communication Understand Institution Z background	Evaluate the Institution Z BSC, based on the quality of the indicators they had and on the possible cause effect linkages that can be established with respect to the Corporate BSC. Selection of 4 business units and their four BSCs to be used during the case study. These business units were: Credit Product Unit, Banking Center Unit, Risk Support Unit and Electronic banking Unit Links BSCs Understand which opportunities to address Communication plan	September – October 2006
Prioritization to select Six sigma project	Provide management consultation and enable prioritization of current institution Z improvement initiatives Map BSC and Performance improvement initiatives Provide consultation about Institution Z BSC weaknesses and how it could be strengthened by applying the proposed methodology Define objectives and goals Define stakeholders Develop and approve project charter Develop work plan	October 1 to October 15 -2006
ABANKS Migration	Document current process (SIPOC, Flow charts, Pareto chart, etc.) Measure current performance Identify and select process metrics Data collection Data analysis Voice of the customer Benchmarking Best practices	15/October 2006 – February 2007
Institution Z training session to enable six sigma methodology	Develop a study guide about six sigma methodology and tools Conduct on-line training session about six sigma methodology and tools Prepare and adapt some six sigma tools to the online interaction with Institution Z employees Provide theoretical feedback about six sigma tools. Stream map the process.	January- March 2007

Activities	Description	Dates
Data Collection	Perform statistical analysis Gap analysis	May - June 2007
Institution Z Improvement	As a result of the ABANKs migration and some improvements on the credit card process, one of the business units disappears and was absorbed by the Risk Business Unit of the bank. The Credit Product Unit was eliminated as a business Unit.	
Provide Recommendations to Institution Z	Improvement plans Recommendations for improvement Metrics and performance targets Proposed control mechanisms Evaluate BSC targets	June-July-Aug 2007
Investigation Results	Assess impact at productivity levels Evaluate comparisons	Sept 2007
Conclusions		October 07 /April 2008

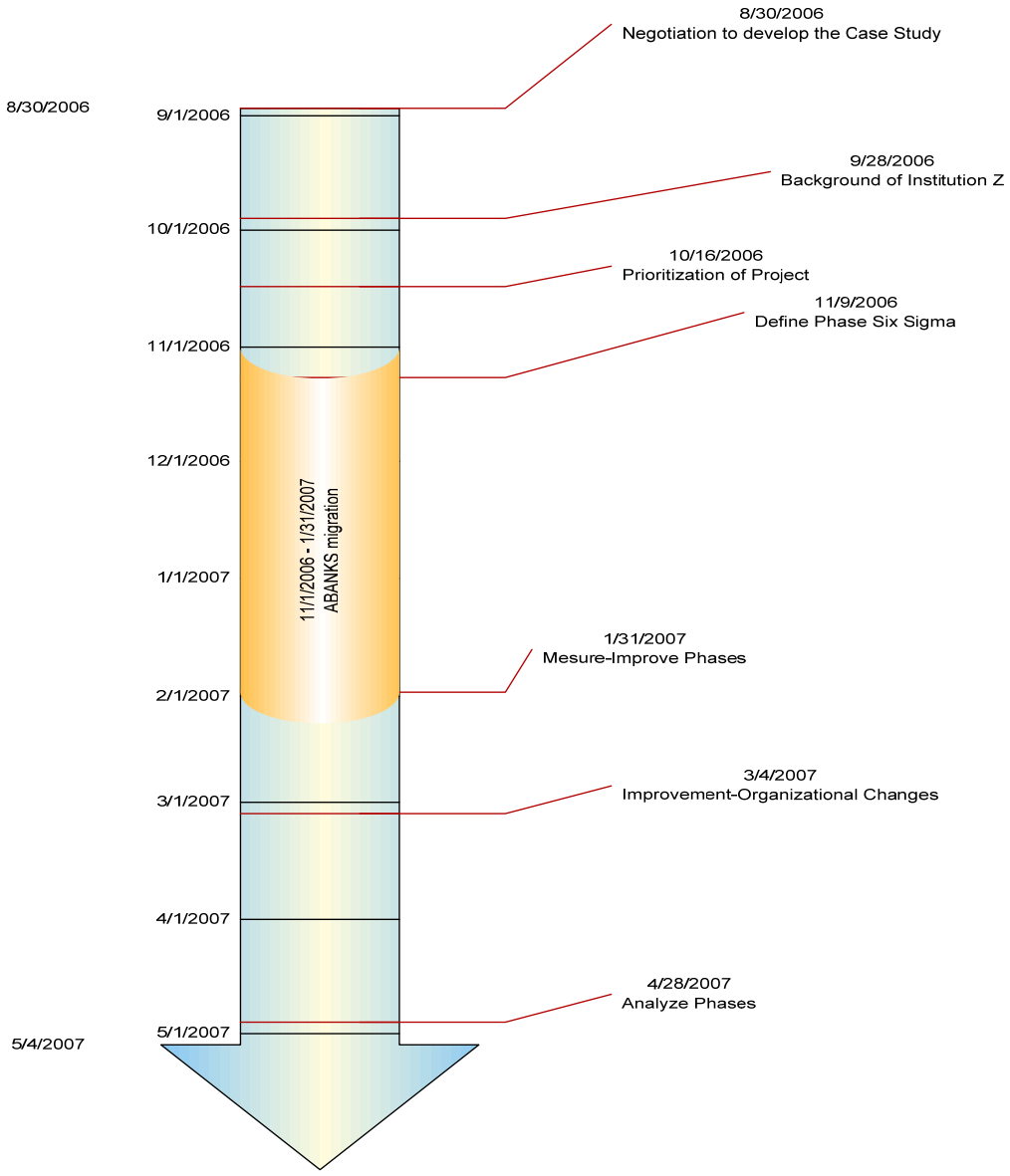


Figure 6. Case study/action research Timeline

Table 29. Available Data Sources

MEASURES	DATA SOURCES	SUPPORT HYPOTHESIS 1	SUPPORT HYPOTHESIS 2	DESCRIPTION
Hard Measures: From Improvement Project	Total cycle time: after and before SSS implementation	Δ Productivities indicators: 40% improvement. P-value:.002	Not provided for any project different from SSS project	Most of the projects were not well defined. There were no hard measures.
	No. applications: after and before SSS	From:20.25 to 116.5 . 500% improvement	Not provided for any project different from SSS project	
	No. of non-value activities eliminated: before SSS	From: 67 to 25. 65% improvement	Not provided for any project different from SSS project	
	Productivities Indicators from different projects at Institution Z	N/A		
From Strategic Objectives	Target established in the BSC: Answer cycle time for approval and cashing of credit products after SSS	After SSS implementation Cycle time reduction reached for all credit approval and reimbursement express: 80% Credit Unit 100% Risk Unit 100% Corporate	BSC project' results: 30% decrease answer time for credit card complaint, and 40% in the No. of complaint by TDD	There was no access to different projects' information. Partial information was provided regarding the Credit card complaint project which was completed by using the BSC approach alone.
	Global GIC	Δ Strategic financial indicators: from below 30% To 42%		
	Credit Car participation: GIC	2.8% to 7.31%. 261% improvement		
SSS Framework and tools: Prioritization Matrix, Relationship Matrix, measurement systems.	Number of BSC targets thought SSS approach	Reduction of cycle time of all credit processes	SSS: around 33% BSC projects 7%	Information based on Institution Z Vice president opinion and partial information collected in the BSC of Institution Z business units.
	Number of strategic changes after SSS implementation	Cost reduction, by eliminating one business units. Redefined cycle time target	N/A	
	Performance Assessment	Formal measurement system for auto credit.	SSS: Develop key quality indicators BSC: No indicators	
Methodology assessment tool: Survey	Customer Satisfaction Index	CTQ were obtained from private research company	Not provided	A survey to assess the usefulness of the SSS tool against the BSC was planned and built, but It couldn't be conducted due to Institution Z unexpectedly neglecting to proceed with the survey because they had an external constraint. The survey was used to conduct structured interviews with Institution Z vice president, and 2 Institution Z managers.
Survey	Management value assessment		Not provided	
Interviews and structured reports	Management value assessment	High impact in the strategic objectives. Board of Directors was amazed by the SSS results and approved the contract of external consulting firm to evaluate and apply similar improvements projects. Most of the changes on the auto credit process can be extended to	There are not hard measures or assessment progress for the projects. The auto credit project was the only one which provided a formal measurement system. SSS was the only project complete. The Debit card complaint project was not complete, although they said	Interviews were conducted by chat room, teleconference and video conference between the researcher and Institution Z members. Some of the Institution Z participants were: Vice-President (project sponsor), Legal Director (team member), Risk Vice-President (team member), Information System coordinator (team member), Regional Center Coordinator (team member), Marketing Manager and

MEASURES	DATA SOURCES	SUPPORT HYPOTHESIS 1	SUPPORT HYPOTHESIS 2	DESCRIPTION
		all credit products. The SSS project targeted the most important strategic objective which was the level of GIC.	they met the BSC target.	Business Intelligent Manager. Interviews were saved for future analysis. Most of the BSC targets were subjective and some were not real as the operating costs which were impossible to reach according to Institution Z VP, Risk Director, and most managers.
		Before the SSS project the auto credit process was done manually and according to Institution Z VP, and the director of marketing the process took around 30- 35 working days. Cycle time, line capacity and number of value added activities showed significant differences before and after SSS implementation	Results of the structured interviews with Institution Z Vice-President, Institutions Z Marketing and Business Managers and others managers by consensus revealed a tendency to value the SSS methodology and consider that this methodology can close the performance gap that they faced in the past when they couldn't translate the strategy objectives into day to day activities. They agreed that the SSS methodology allowed the generation of a holistic measurement system that goes back to BSC.	The selection of the project was oriented to select the one that allows good results easier because they are translated to a employee bonus plan, but not to the strategic interest of Institution Z Information published in newspapers and magazines in Venezuela were analyzed to understand the behavior of the process, for example to analyze the trend in the number of credit applications. It is important to know that in Venezuela the demand is bigger than the offer of cars. During Oct to Dec, when there was high demand for the auto credit products, it could have been possible that there were not sufficient vehicles available in the market causing a decrease in the number of auto credit applications. Along the same line, the political situation in Venezuela caused there to be only 15 working days during the month of Dec. which caused a decrease in the opportunities for credit applications.
		Savings can be expressed by the new organizational structure where one unit was eliminated		

CHAPTER 6: SSS APROACH RESULTS

6.1. Introduction

After the implementation of the SSS framework within Institution Z, the cycle time of the auto credit process was improved by 40% by May 2007 and by 80% by August 2007, and the BSC targets were impacted by reaching the strategic objectives of the organization. These outcomes demonstrate the benefits that can be reached by the implementation of the proposed methodology. The research results are presented by following the timeframe presented in the last chapter and following a chronological order of the improvement activities. Four major improvement changes affect the project:

1. Non-value-added activities detection and elimination. January-February 2007
2. Productivity Indicators improvements (total cycle time, number of applications, number of errors).
3. Organization Structure Change (March-April 2007)
4. Partnership with external supplier to smooth the process
5. Design for Quality and Measuring System (Jun-July 2007)

By the end of the research project, the Auto Loan Project was still running at Institution Z. The last SSS team's recommendations were implemented during the second half of 2007, and its effect may be reflected on the new Institution Z's BSC metrics. The evaluation of these results is beyond the scope of this research.

6.2. Improve Phases Results

According to the information provided by Institution Z, the auto credit process took approximately 25 to 30 working days to be completed before SSS team implementation. The BSC target used at the beginning of the SSS team was set as two days for the approval sub-process and six days for the total cycle time of the auto credit loan. Measurement of the approval cycle time before the SSS project was not found, so the baseline was set on the total cycle time of the auto credit process. The SSS project retained as a project goal to reduce the cycle's time by 70% by May 2007. Assuming a normal distribution of the auto credit's cycle time and using the averages provided by Institution Z, the process was not capable of meeting the BSC and SSS project requirements by August 2006.

A new process was implemented during January 2007 to March 2007 as a result of the analyze phase of the auto credit improvement project. Main improvements included the detection of the cause of delays, bottlenecks, and activities that did not add value to the process to be eliminated as well as the design and implementation of a first measurement system, which allowed getting data about the process performance since the initial migration to ABANKS in October 2006. As it can be observed on the cross-functional diagram a considerable number of activities were eliminated in order to smooth the process and be more efficient, some of these non-added value activities eliminated were: fill out manual form in parallel to ABANK system, registration and customer signatures in a pre-screening process, verification of calculations made by ABANKS like amortization tables and quotes, printing of unnecessary documents, duplication of activities as verification of documents, credit scores checking process to the same

customer by different people, and so on. Some of those activities are marked with red lines in Fig. 4. Results are shown on the next figure.

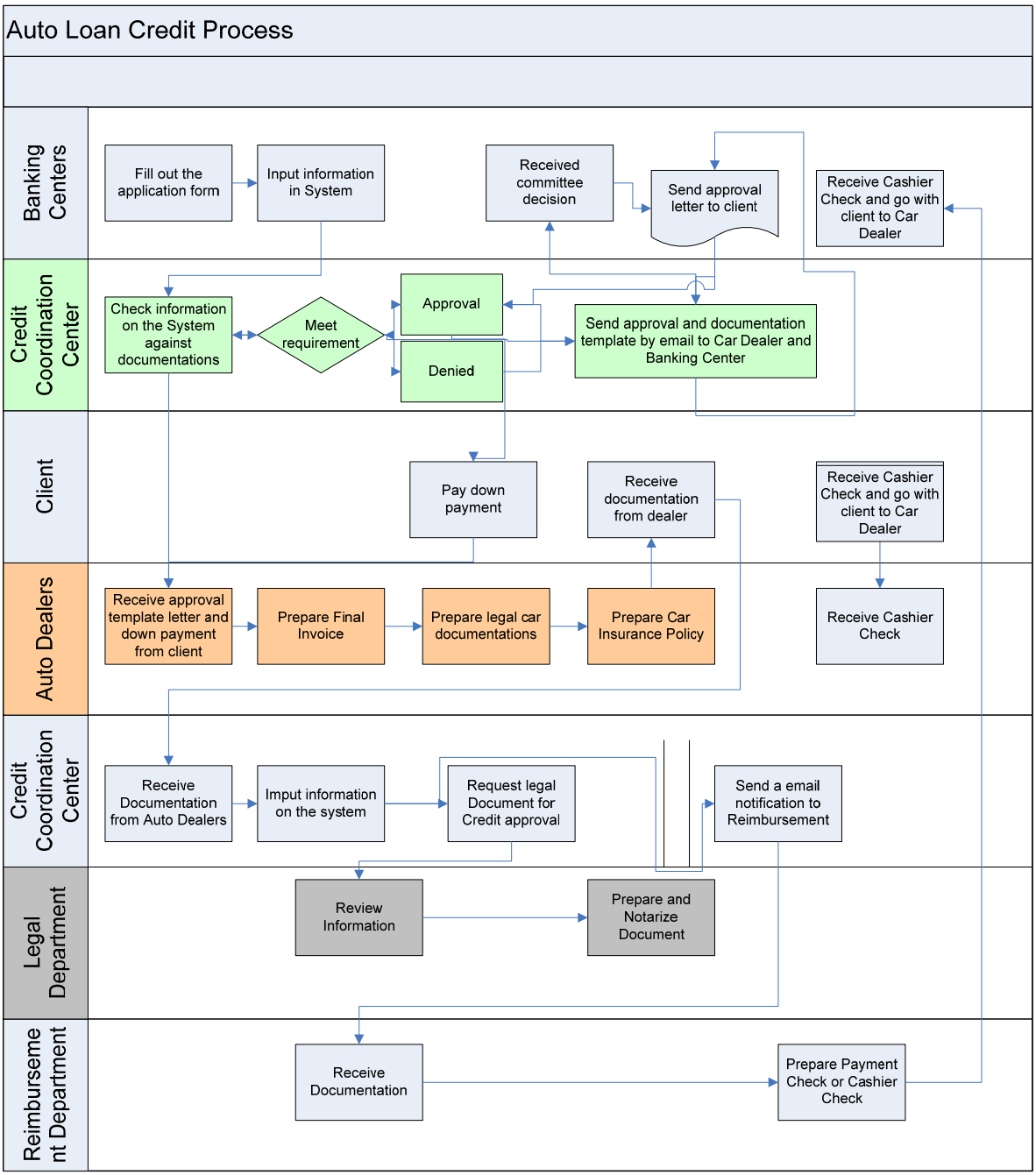


Figure 7. Auto Credit Process (Jan-07 to June-07)

The number of auto credit loans analyzed before ABANKS implementation was around 67 loans, but the total number of auto credit loans analyzed after ABANKS migration was an average of 132 credit loans. This number met one of the SSS project goals of increasing the number of auto credit applications processed in a fixed time period (See Project Charter, Appendix A).

Significant differences were detected and tested on the total number of auto credit applications processed; details can be observed in the statistics section 6.3. on pages 135-142.

The next figure shows the average number of auto loans processed after the SSS implementation during September 2006 to March 2007.

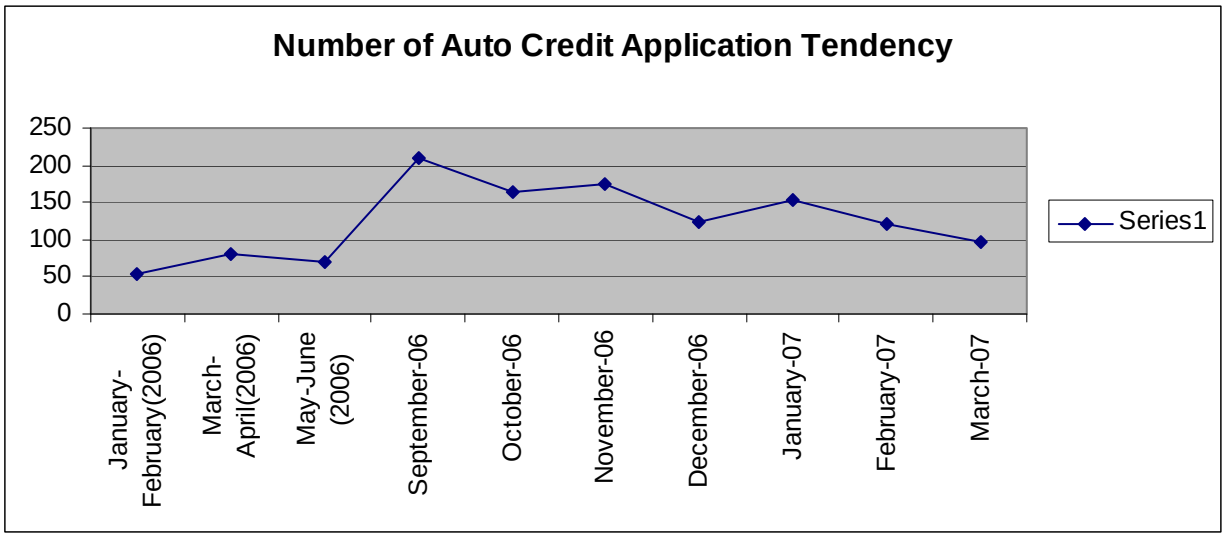


Figure 8. Number of credit applications

The statistical tests showed a shift of the population median between the cycle times of the auto credit process executed during January 2006 to August 2006 and the cycle from October 2006 to July 2007 (before and after ABANKS migration) (See statistics section on page 135).

Another indicator of the process's behavior is the number of errors after the ABANKS migration. A decreasing number of errors in auto credit applications were detected during this analysis (See Figure 9). During this time, a considerable number of applications seemed to be on hold for unknown reasons.

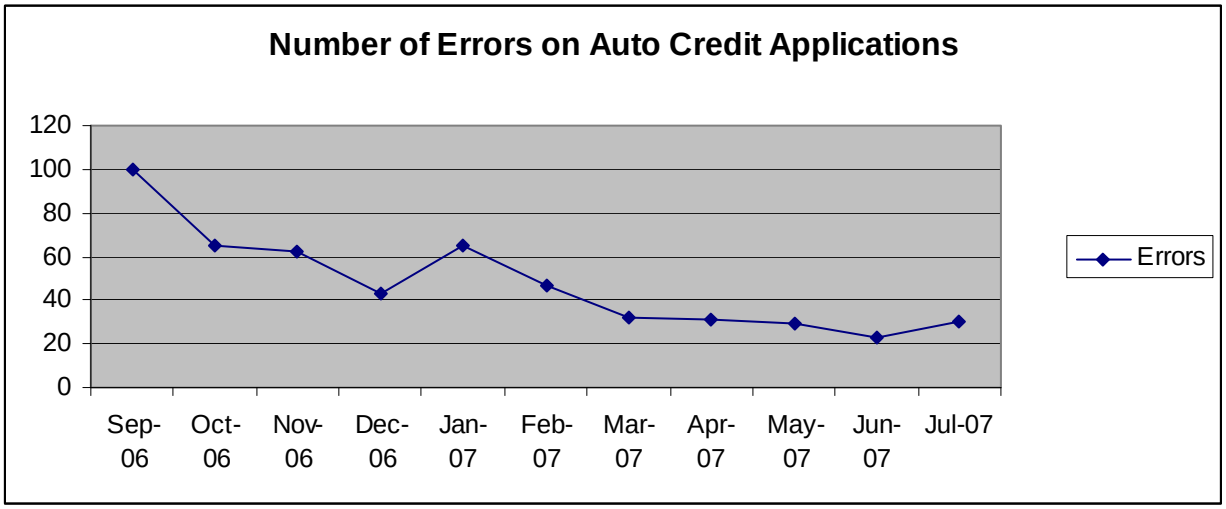


Figure 9 . Plot of number of Errors detected by Months Plot

The next tables show capability analysis from October 2006 to July 2007, under normality assumption.

Table 30 . Average Cycle time Data from Sep-06 to July-07

Number of Samples(<=50)	12				
Sample size (2- 10)	4				
Grand Average	15.113542				
		A2	D3	D4	D2
Avg. std. dev.	13.52333	0.73	0	2.282	2.06

Table 31. Process Capability Calculation for Cycle time from Sep-06 to July-07

Process Capability Calculations						Six sigma	39.4
Upper specification	6					Cp	0.15
Lower specification	0					Cpu	-0.5
						Cpl	0.77
						Cpk	-0.5

Although the capability analysis showed that the process was not capable of meeting specifications, and the Six Sigma levels seemed to decrease, it was explained by the higher variability of the process after the ABANKS migration. The Capability index, Cp, obtained was worse, but the Cpl was better. Again, the explanation came from the shift on the mean of the process from 26.25 days to 15.11, which was still on the top of the upper control limit but closer to specification, without meeting it.

During the improve phase, it was pointed out that a better assessment of the auto loan process performance can be obtained from the cycle time for the approval process. The approval process is done internally within Institution Z's boundaries, and the factors that affect this cycle time depend on Institution Z's performance. Specifically, on the total cycle time of the auto credit process, there are some activities that should be done by institutions different from Institution Z, for example, car dealers. Data were not collected related to the approval cycle time before the SSS methodology implementation, so this indicator can not be used to assess SSS, but it was utilized to detect causes of variations.

Table 32. Cycle time improvement rate in days

Timeframe	Application	Credit Analysis	Risk (verification and approval)	Legal (Document)	Reimbursement	Cycle Time (working days)	% Improvement
Before SSS implementation	→	→	9-11	→	16	25	0
After SSS implementation	→	→	→	→	9.13	15.11	40%

A series of brainstorming sessions were conducted in order to determine the special causes of variation that prevented the process from meeting the 6-day target for the total cycle time and the 2-day target for the approval cycle time. Some of the facts that were extracted from the data were the high number of errors during the application process and the high level of variability of the process. These facts explained that the process was not under control. The SSS team expected this kind of situation because the ABANKS migration was made without a redesign of the auto credit process and because of the natural consequences of the migration process itself.

One special cause of variation was that some banking center managers recommended that external customers use a different kind of credit product and substitute the auto credit with type II credit. This decision was not authorized by the credit committee and/or by the CIO of Institution Z.

Although most scoring of credit products considered both types of credit products the same, Institution Z differentiated those products because it considered that there were different kinds of risks associated to each one.

Using type II credit instead of the auto credit caused a decrease in the auto credit application tendency, but it was not realistic because most of the type II credits were approved to be used as auto loans, avoiding the legal requirements and rework on the auto credit process. Noises detected in the data were considered in the statistical section. (See statistics section.)

Managers who had approved type II credit instead of auto credit loans explained that the auto credit process was too complicated and bothersome because there were too many requirements, including the elaboration of legal documents, the auto dealer legal and commercial

requirements and their registration process, the setup process of the auto insurance policy, the lack of available cars on the market, car inspections, and so on. On the contrary, the type II credit did not need any kind of cosigner or legal documents, but it also did not have assets and/or warranties to support bankruptcy or any kind of bad payment records.

The SSS team gave two recommendations for Institution Z. First, this shift between the two types of credit products was prohibited at the banking center levels. Second, there were clear indicators of bottlenecks at the car dealers and within legal procedures of the auto credit process that need to be analyzed and solved.

Initial brainstorming and meetings demonstrated a high number of managers resisting change. Managers argued that the legal document requirements had to be met because they involved sensitive information, and it was too risky for Institution Z to leave the car vehicle/vessel identification number and title number with outside personnel. At this point, they didn't agree on using a template document to be filled out by the car dealer because it was used by competitors on the market.

In regard to the car dealer registration process, Institution Z managers and the SSS team agreed that they should provide its corporate records only when a transaction is first executed, and this information should be kept in a data warehouse or database. During the first months of the year, car dealers were asked to send all of their corporate records each time a transaction was made or each time they financed a car through Institution Z.

The number of auto loans approved during May decreased due to a misinterpretation of the new policy that said that the monthly payments cannot exceed more than 30% of each person's income. Most managers took the total of the personal income and multiplied it by 30%

and then subtracted the personal expenditure for each case. This result disqualified people who had previously qualified for this kind of loan.

If these special causes were taken into account, there was an increase in the number of auto loan applications, which decreased during December because there were only 15 working days due to government elections and Christmas holidays in Venezuela.

Finally, the auto credit process detected an artificial increase in cycle times, caused by the ABANKS system, which counted the number of times an application was open and not closed in the same timeframe. In other words, if an application is on hold for any reason, an agency consultant didn't open and close an auto credit application during the same day, or he/she opened a credit application for a customer one day but the customer didn't return to close or finish his/her application until one week later, the system started counting cycle time since the application was open. In simple words, every day from the time the application was first initiated (whether complete or not), the cycle time clock started ticking. In addition, when an application was on hold, managers and supervisors were not warned to take care of these kinds of situations.

In order to analyze and establish final recommendations for the auto credit loan, a new series of brainstorming sessions were conducted in order to detect failures and propose solutions. The following table reveals the failure analysis and the resulting actions.

Table 33 . Failure Analysis. May-07 to Jul-07

Process/Project:	Auto Credit Process		Process/Project/Product:		Auto Loan			
Process Owner:	Jose Luis Botomo	Location:	Venezuela		FMEA Date: (Original) August 22 (Revised) Sep 4			
Team Leader:	Adriana B. Rodriguez							
Team:	Auto Credit-SSS project Institution Z							
FMEA Process								
Item	Potential Fail Mode	Fail Effect	Severity	Potential Cause of Fails	Frequency	Current Controls	Detection	NPR
Application	Application is not setup in the same day	Increase Cycle time of credit approval process	10.00	Banking Offices fail	8.00	None	10.00	800.00
Banking Center-General Manager Revision	Pending applications	Increase Cycle time of credit approval process	10.00	Banking offices fail	8.00	None	10.00	800.00
Credit approval	Pending applications	Increase Cycle time of credit approval process	10.00	Credit Fails	7.00	None	7.00	490.00

Process/Project:	Auto Credit Process		Process/Project/Product:		Auto Loan			
Process Owner:	Jose Luis Botomo	Location:	Venezuela		FMEA Date: (Original) August 22 (Revised) Sep 4			
Team Leader:	Adriana B. Rodriguez							
Team:	Auto Credit-SSS project Institution Z							
FMEA Process								
Item	Potential Fail Mode	Fail Effect	Severity	Potential Cause of Fails	Frequency	Current Controls	Detection	NPR
Car Dealer Requirements	Deny to make a deal with Institution Z	Increase Cycle time of credit approval process	10.00	Supply Chain Fails	6.00	None	5.00	300.00
Car Dealer Requirements	Lack of available cars	Increase Cycle time of credit approval process	8.00	Supply Chain fails	6.00	None	8.00	384.00
Car Dealer Requirements	Fails and mistakes on legal documents	Increase Cycle time of credit approval process	10.00	Legal procedures	6.00	None	8.00	480.00

Process/Project:	Auto Credit Process		Process/Project/Product:		Auto Loan			
Process Owner:	Jose Luis Botomo	Location:	Venezuela	FMEA Date: (Original) August 22 (Revised) Sep 4				
Team Leader:	Adriana B. Rodriguez							
Team:	Auto Credit-SSS project Institution Z							
FMEA Process								
Item	Potential Fail Mode	Fail Effect	Severity	Potential Cause of Fails	Frequency	Current Controls	Detection	NPR
Car Dealer Requirements	Don't meet legal procedures	Increase Cycle time of credit approval process	10.00	Legal procedures	6.00	None	8.00	480.00
Application	Mistake	Increase Cycle time of credit approval process	7.00	Banking offices fail	7.00	None	5.00	245.00
Legal	Mistake	Increase Cycle time of credit approval process	5.00	Legal procedures	5.00	None	5.00	125.00
Net Priority Risk								3984.00

Table 34. Action Results. Jun-07 to July-07

Process/ Project:	Auto Credit Process	Process/Project/Product:	Auto Loan
Process Owner:	Jose Luis Botomo	Location : Venezuela	FMEA Date: (Original) August 22 (Revised) Sep 4
Team Leader:	Adriana B. Rodriguez		
Team:	Auto Credit-SSS project Institution Z		

Action Results			
Item	Recommended Action	Responsibility and deadline date	Action taken
Application	Set up System to record or save initial and finish date	TBA	Design performance indicator: cycle time: a. open and close application (by phases); open and close application by banking center manager; open and close application by credit coordinator, request documentation to car dealer vs. received documentation from car dealer, request cash check or transfer vs. car dealer payment
Banking center-general manager revision	Set up System to show manager's approval Date	TBA	Design performance indicator: number of applications pending or on hold for steps on the process
Credit approval	Set up a warning sign on the system	TBA	Design performance indicator: number of applications pending or “in hold” for steps on the process
Car dealer requirements	make face-to-face meeting and promotions marketing	TBA	Design performance indicator: number of applications with complete and accurate documentation, cycle time

Process/ Project:	Auto Credit Process	Process/Project/Product:		Auto Loan
Process Owner:	Jose Luis Botomo	Location :	Venezuela	FMEA Date: (Original) August 22 (Revised) Sep 4
Team Leader:	Adriana B. Rodriguez			
Team:	Auto Credit-SSS project Institution Z			

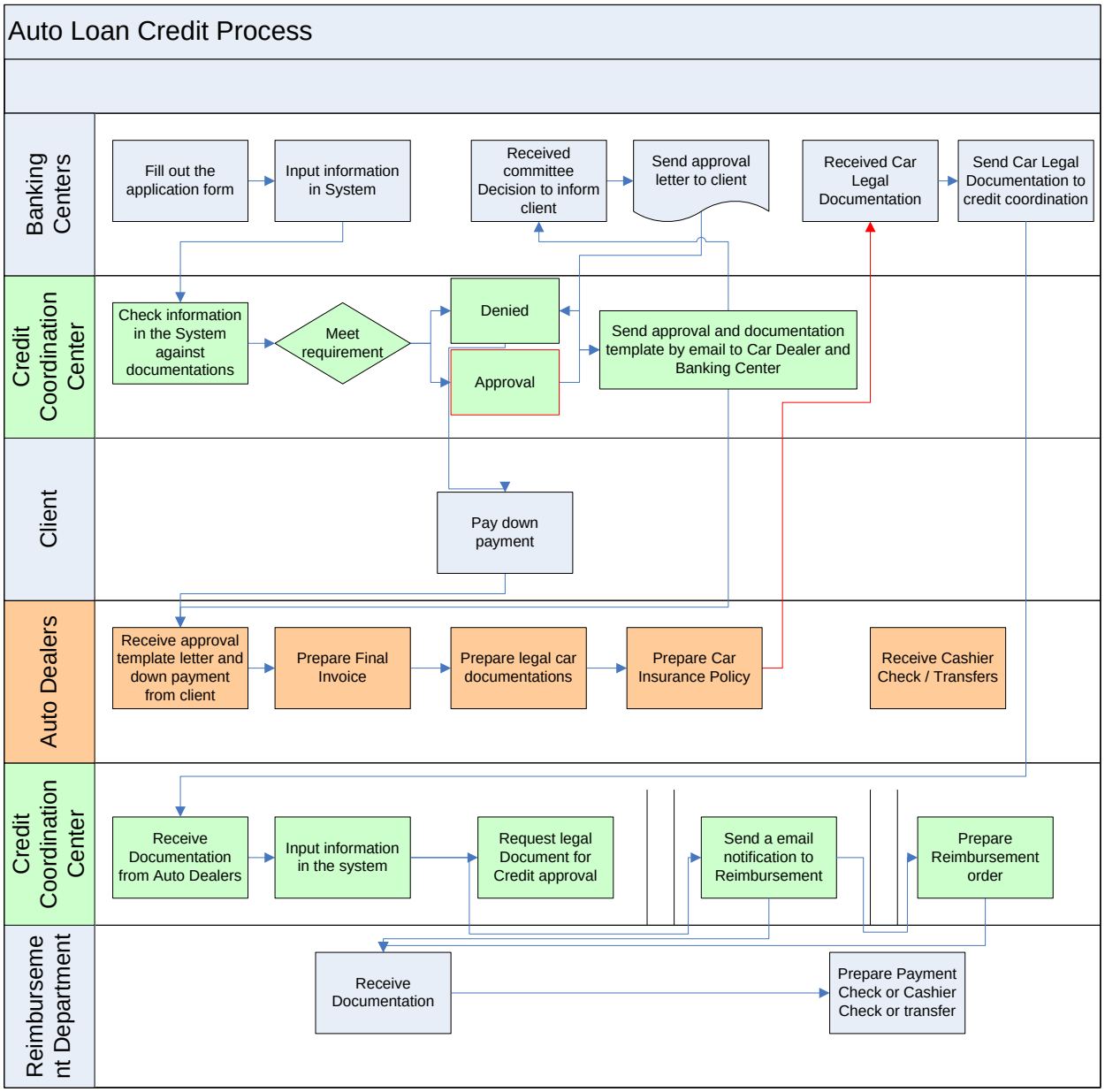
Action Results			
Item	Recommended Action	Responsibility and deadline date	Action taken
Car dealer requirements	No Controls	TBA	Out of the process measure. Measure this cycle independently.
Car dealer requirements	Design a legal document template to be complete by car dealer	Legal-Credit_(one week before final meeting)	Design a legal document template and use internet for communication
Car dealer requirements	Design a legal document template to be complete by car dealer	Legal- credit (one week before final meeting)	Design a legal document template and use internet for communication
Application		TBA	Design performance indicators: rework, average lead time for corrections, number of applications coming back for corrections

Process/ Project:	Auto Credit Process	Process/Project/Product:		Auto Loan
Process Owner:	Jose Luis Botomo	Location :	Venezuela	FMEA Date: (Original) August 22 (Revised) Sep 4
Team Leader:	Adriana B. Rodriguez			
Team:	Auto Credit-SSS project Institution Z			

Action Results			
Item	Recommended Action	Responsibility and deadline date	Action taken
Legal	Design a legal document Template to be complete by Car Dealer	TBA	Design a Legal Document Template and use Internet for communication

As a result of the analysis, the SSS team recommended a new auto credit product with most of the strengths that competitive products have on the market, plus an attractive promotional interest rate. Although there is not a customer satisfaction culture within Institution Z, the new product is based on critical quality features from the customer point of view. This new credit product reduces the approval and reimbursement cycle times and facilitate the dealer procedures by the use of a document template and Internet communication. Figure 10 shows the process as it was approved starting on August 2007.

Figure 10. Modified Auto Credit Loan



A summary table shows the improvement percentage reached and the expected improvement percentage with the new approved procedure. (See table 34)

Table 35. Improved Percentage Performance Expectation

Timeframe	Application	Credit analysis	Risk (verification and approval)	Legal (document)	Reimbursement	Cycle time (working days)	% Improvement
Before SSS Implementation	→	→	9-11	→	16	25	0
During SSS Implementation	→	→	→	→	9	15	40%
After SSS Implementation	→	→	→	→	→	7	80%

6.3. Statistics Test

6.3.1. Testing for Normality

The ABANKS migration allowed getting data about the auto credit process starting in October 2006. The first statistical test applied to Institution Z's collected data was the normality test.

In order to perform the test, the data were divided by point in time where major changes were implemented to the auto credit process. In other words, tests were applied to two sets of data. The first set of data corresponded to the cycle time of the auto credit process from January 2006 to August 2006 (before SSS implementation). The second set of data corresponded to the period from September 2006 to July 2007. During the first period of time, the SSS Project and methodology were not implemented, and the data were obtained from an average number of auto credit applications collected by hand by Institution Z personnel without any researcher's involvement. Sample size, confidence interval, and errors were not provided by Institution Z. According to the information collected through open-ended interviews, this set of data showed a

conservative picture of the auto credit loan cycle time. The sets of data collected from September 2006 to July 2007 were obtained from the ABANKS system and correspond to 100% of the applications processed by Institution Z. The indicators were developed to meet SSS team expectations.

For total cycle time before ABANKS migration, the hypothesis testing was:

Ho: The data follow a normal distribution

Ha: The data do not follow a normal distribution.

The data were plotted against a theoretical normal distribution in such a way that the points should form approximately a straight line. Departures from this straight line indicate departures from the normal distribution.

In this test, the p-value was 0.186, which was bigger than the significance level of 0.05, so we fail to reject the Null hypothesis and can assume a normal distribution of the data.

The normality test was applied to data obtained from the ABANKS system after the SSS project implementation. In this particular case, it was necessary to eliminate some outliners or noise from the data, which were presented during the months from December to February due to the irregular situation in the use of type II credit instead of the credit car loan.

The following plot shows the results obtained. The next probability plot looked approximately straight, and the p-value (p-value= 0.179) obtained was larger than the significance level, so we fail to reject the null hypothesis, and assumed a normal distribution of the data.

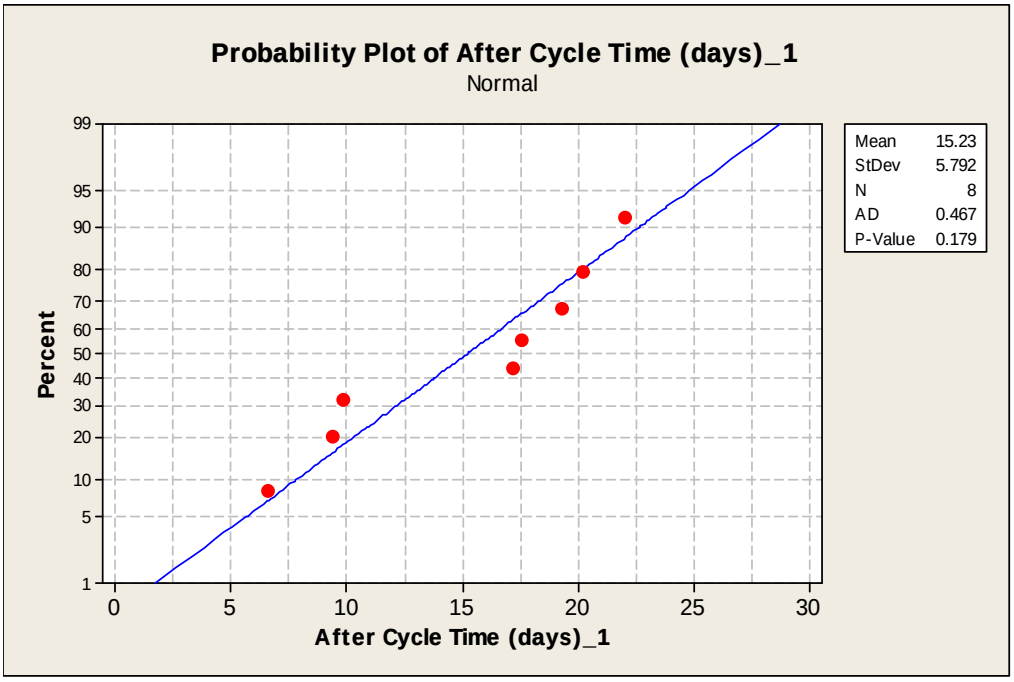


Figure 11. Probability Normal Plot of after cycle time. w/outliners

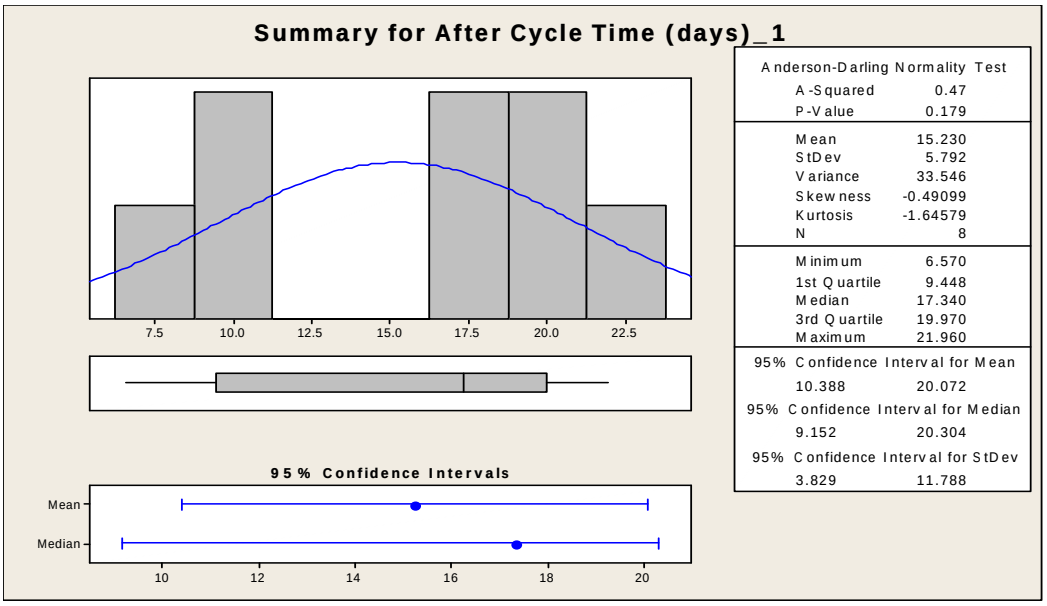
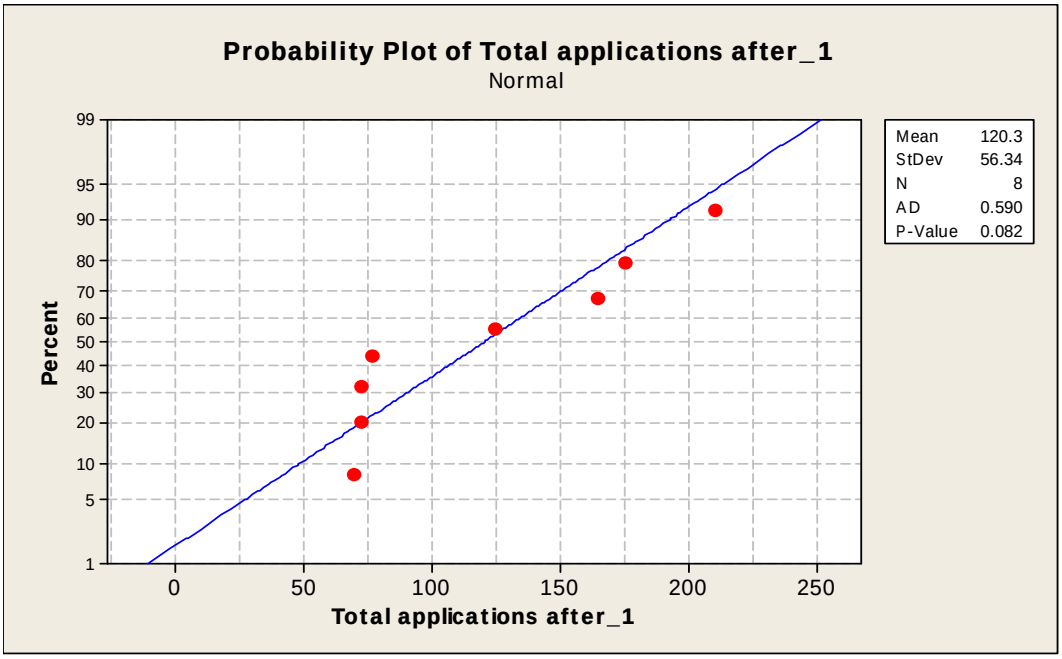


Figure 12. Summary of the Normality test for Cycle Time

The same test was applied to the total number of applications processed. In the case of the total number of applications before ABANKS migration, the sample size was too small to

perform this statistical test, and the p-value equal to 0.082 is very close to 0.05 and so extreme caution should be taken in using the normal distribution assumption. For this case it is appropriate to use a non-parametric test. (See next section)



6.3.2. Testing for Significant Difference

The second step was to test if there was a significant difference before and after the SSS project implementation on the total cycle time and on the number of applications processed. In this case, we were testing if the total cycle time before SSS implementation was bigger than the total cycle time before SSS implementation, showing an improvement on the total cycle time.

As it was explained at the beginning of this section, during this Case study/action research, we were unable to obtain exact values of the sample measurement during the period from January 2006 to August 2006. For this set of data, we computed just the median, and the sample size was too small to use a parametric test. This situation, together with the results of the normality test under the total number of applications, prevented us from performing a two-

sample wilcoxon rank sum test of the equality of these two population medians and from calculating the corresponding point estimate and confidence interval. (See Table 38.)

Ho: The two population medians are identical.

Ha: The population median 1 is bigger than the population median 2.

Table 36. Wilcoxon Rank Test for Cycle time

	N	Median	Achieved Confidence	Confidence Interval	
				Lower	Upper
Before Cycle Time (days)	4	25.00			
After Cycle Time (days)	12	17.186			
Point estimate for ETA1-ETA2	9.373				
95.5% C.I. for ETA1-ETA2				4.803	17.433
W	58	Test of ETA1= ETA2 vs. ETA1> ETA2		p-value = 0.002	0.002 Adjusted for ties
The test is significant at 0.0022 (Adjusted for ties)					

The above table shows a p-value close to zero which signals that the null hypothesis is false and typically that a difference is very likely to exist.

The observed p-value, adjusted for ties, presented in the table is 0.0022 and falls in the rejection region, indicating that the mean response of the cycle time before and after the SSS implementation was statistically different with high-achieved confidence.

The next box plot graph showed the median differences, and that the data were skewed. It can be observed that the median of the data before SSS project implementation was located above the median, while it was located below the median after the SSS implementation.

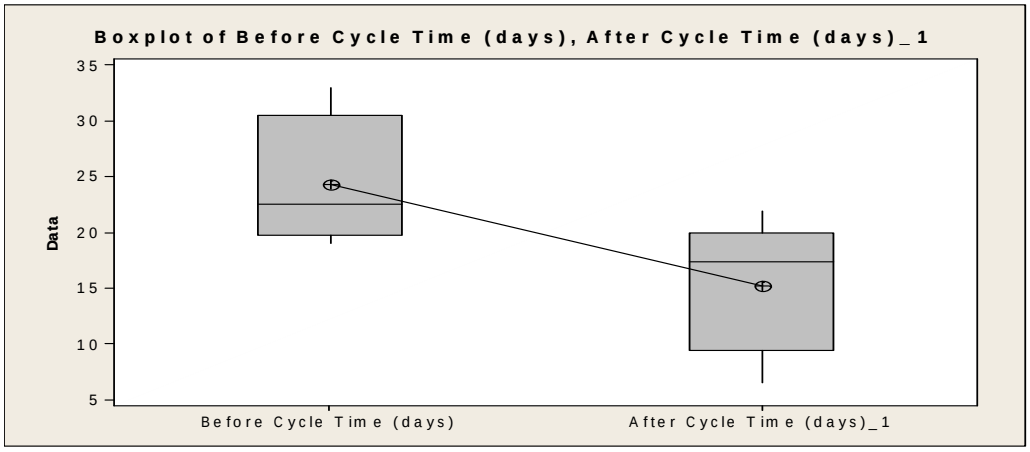


Figure 13: Box plot of before and after Total Cycle Time

The next table shows the two sample Wilcoxon rank sum test for the differences of the means of the total number of applications before and after the SSS project implementation. In this case, the p-value indicated significant difference, so the null hypothesis that there was not a difference in the means is false, and the difference is very likely to exist.

Table 37. Two Sample Wilcoxon rank sum test for total number of applications

Rank SumWilcoxon Test and CI: Total Applications Before, Total applications after						
	N	Median	Achieved Confidence	Confidence Interval		Position
				Lower	Upper	
Total Applications Before	4	19.00				
Total applications after	12	108.00				
Point estimate for ETA1-ETA2 is	-86.50					
95.5 Percent CI for ETA1-ETA2 is				-147.99	-51.00	
W = 10.0 Test of ETA1 = ETA2 vs ETA1 < ETA2 is significant at 0.0022 The test is significant at 0.0022 (adjusted for ties)						
The highest attainable confidence has been achieved.						

The box plot demonstrated graphically the differences between the medians for the total number of applications before and after SSS implementation. The median of the total number of applications increased after the SSS project implementation.

Figure 14 shows the box plot for number of applications before and after SSS implementation. Appendix A offers the control charts for the mean and for the ranges for the data before and after the SSS application, considering the cycle times in working days.

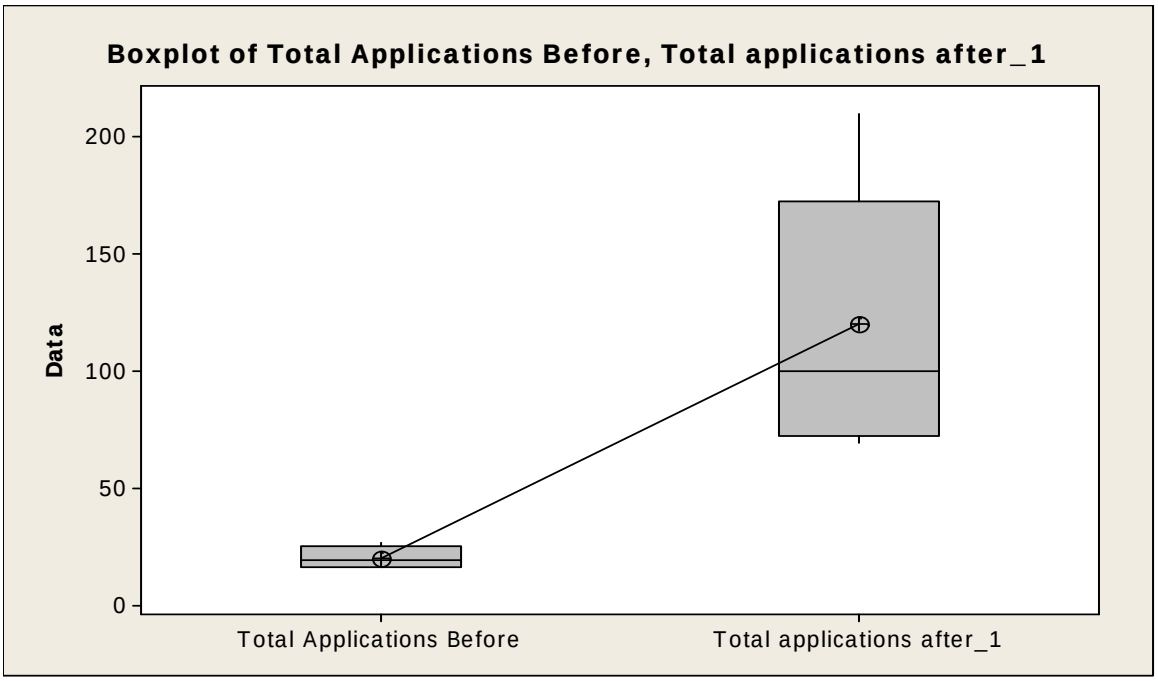


Figure 14: Box plot before and after for Total number of Applications processed

6.4. BSC Indicators

As part of the SSS methodology, it was necessary to evaluate the effect of productivity improvements on the auto credit process for the Business Units' BSC at the end of the first six months of the SSS running cycle (December 2006). In other words, the BSC needs to be re-

evaluated each six months with respect to the results of the improvement projects. On the following table, the Target Reached column shows the percentage reached at that time on each one of the objectives listed on the BSC. This evaluation was made by an Institution Z member without the researcher's intervention. The risk support unit was not evaluated because it was considered for a structural reorganization change. After the structural change, the risk unit was divided into two administrative areas and they responded to two command lines, to a Personal and Commercial Unit and to the banking center units. This change on the organizational structure of Institution Z was not designed by the SSS team, but it was related to the discussion and analysis of the auto credit product because it was evident a bottleneck and conflicting points existed among the Risk Unit, Credit Unit and Banking Center.

The banking center units determined that they reached the target of reducing the answer time for all credit processes by an average of 73%. Similarly, the risk center units evaluating their target of reducing answer cycle time, and they obtained an 85% of improvement. The numbers of new customer by credit products showed a level of achievement in the 80-100% in average.

Special explanation was given to the financial indicator because it had a direct influence on the Institution Z's strategic control. The financial indicator used at all levels within Institution Z was called GIC, Credit Intermediation Level, and it was an indicator of the participation of credit portfolios. When the strategy called for increasing the bank GIC, the financial performance of Institution Z, evaluated in its corporate BSC with the GIC indicator, showed a 100% level of achievement placed a 42%. The financial indicator for the credit portfolio showed

an improvement of 261%, placed on 7.31. For reference, the BSC tables are shown in Appendix E.

Additional insights were offered by Institution Z's strategic vice president who explained the high level of alignment between the improvement indicators on the auto credit process and the strategic objectives of Institution Z. According to the information collected through open-ended interviews, Institution Z's Vice-President considered achievement of a 100% alignment between the auto loan project and the strategic objectives of the bank. He indicated that the Venezuelan government regulated much of the banking activities by mandate and set the passive and active interest rates plus the banking commissions. Four years ago, the government cut off rates on security and government obligations as well as on the broker commission and management fee. These changes led to Institution Z's strategic shift as they tried to increase the intermediation and/or financial spread to support the transformation and operating costs. The credit car loan played an important role in the credit portfolio because most of the internal consumption is charged on auto loans and the level of competence on this segment is high.

Additional evidence of the go-back loop between the six sigma improvement indicators, and the BSC measures came from the reconsideration that Institution Z executives made on the BSC objective of 6 days for the auto credit process. After the SSS brainstorming sessions and SSS recommendations, the new BSC targets for credit cycle time were increased to 7 days for the total cycle time (if the cars were available) plus a flexible range of 1 to 3 days (if the cars were not available), and 3 days for the approval cycle time. The reasons for these changes were based on the consideration of the real system capabilities.

6.5. Comparison Criteria Questionnaire

A questionnaire was designed to measure the perceived value of the proposed SSS methodology against the BSC within Institution Z. The instrument was designed to measure the perceived value of these two methodologies on the following constructs: Production and Employee Engagement. The set of questions were planned to be evaluated for content validity by a panel of experts, and a pilot test was planned for the August-October 2007 period. Although the questionnaire was done according to the plan, an external factor dominated the situation within Institution Z, and all the resources, including human resources of the SSS team, were redirected to an Institution Z currency re-conversion project. This conversion process was a high-priority process, and it was to be a delicate process for Institution Z. The Board of Directors decided to move all resources to this conversion process and put other projects on hold.

Although the survey was not conducted, partial qualitative data was collected during two brainstorming sessions where it was only possible to collect averages from the groups. Similar situations occurred when the researcher asked for hard indicators of those projects where BSC alone was applied. They said they didn't have these kinds of indicators, and due to the lack of resources, they avoided trying to find them.

Each survey was analyzed as qualitative data to explore the results of a consensus reached during their brainstorming session where different members participated. During the first survey, some members of the Six Sigma team, including the business units' managers and Institution Z's vice president, participated. Two evaluation criteria were filled out by Institution Z Vice-President and Institution Z's risk vice president, independently. The third one was filled out by some business managers by consensus.

The size of the sample and the lack of control over the data collection process disqualified the instrument for statistical analysis. The sample size was too small to calculate the reliability and the validity of the instrument. Specifically, for the BSC methodology, the sample size was 3. For the SSS methodology, the sample size was 2, and no further analysis was possible. Next table shows SPSS output performed on the collected data.

Table 38. SPSS output on factor analysis for the proposed questionnaire

Notes		
Output Created		28-Nov-2007 16:38:47
Comments		
Input	Data	C:\Documents and Settings\Adriana beatriz\My Documents\QuestionarieBSC.sav
	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	3
	Matrix Input	C:\Documents and Settings\Adriana beatriz\My Documents\QuestionarieBSC.sav
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 /SCALE('ALL VARIABLES') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE /SUMMARY=TOTAL MEANS.
Resources	Processor Time	00:00:00.125
	Elapsed Time	00:00:00.156

6.6. Institution Z Organizational Structure Change

Institution Z's structural change of the auto credit process resulted in helping to avoid conflict between the Credit Business Units and the Risk Business Unit. There are two main branches, or divisions, in Institution Z's structure. One branch is related to administrative procedures, and the other branch serves as a Control unit that reports to the Board of Directors. The Business Units were divided into two branches. The Personal and Commercial Division consists of the Banking Centers. The second branch controls the industry relationships.

The Personal and Commercial Division has a Risk Unit below the authority line. This Risk Unit is in charge of the credit portfolio analysis and changed it to avoid the conflict between the business division (Banking Centers) and the Risk Unit. On the old structure these business units operated in a different command line, and worked independently with different goals and objectives that increase the conflict level and cut the flow of activities. This new organizational structure expedites the flow of the processes, making them more efficient. Appendix E shows figures that correspond to the new organizational structure.

A summary of the auto credit process flow with timeframes for each step is shown on the following figures. (See Figures 15,-17.)

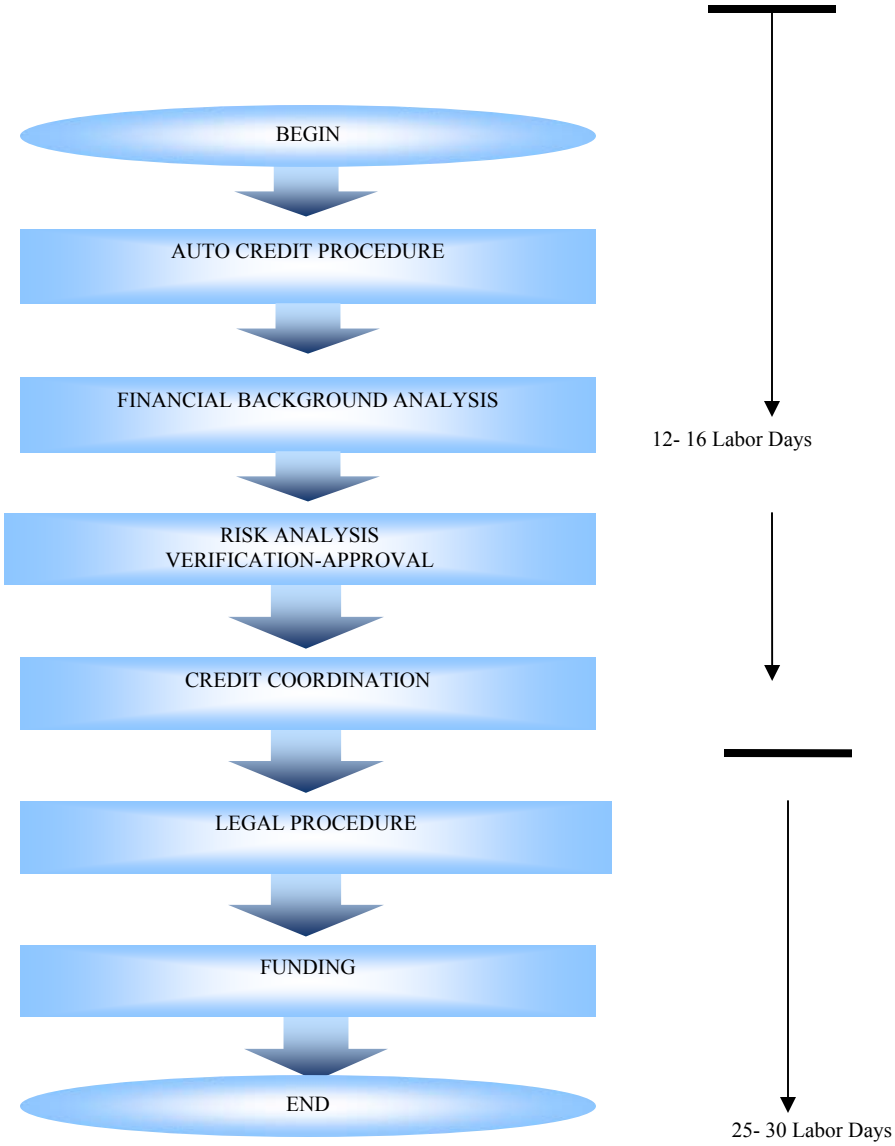


Figure 15. Process Map Auto credit before SSS

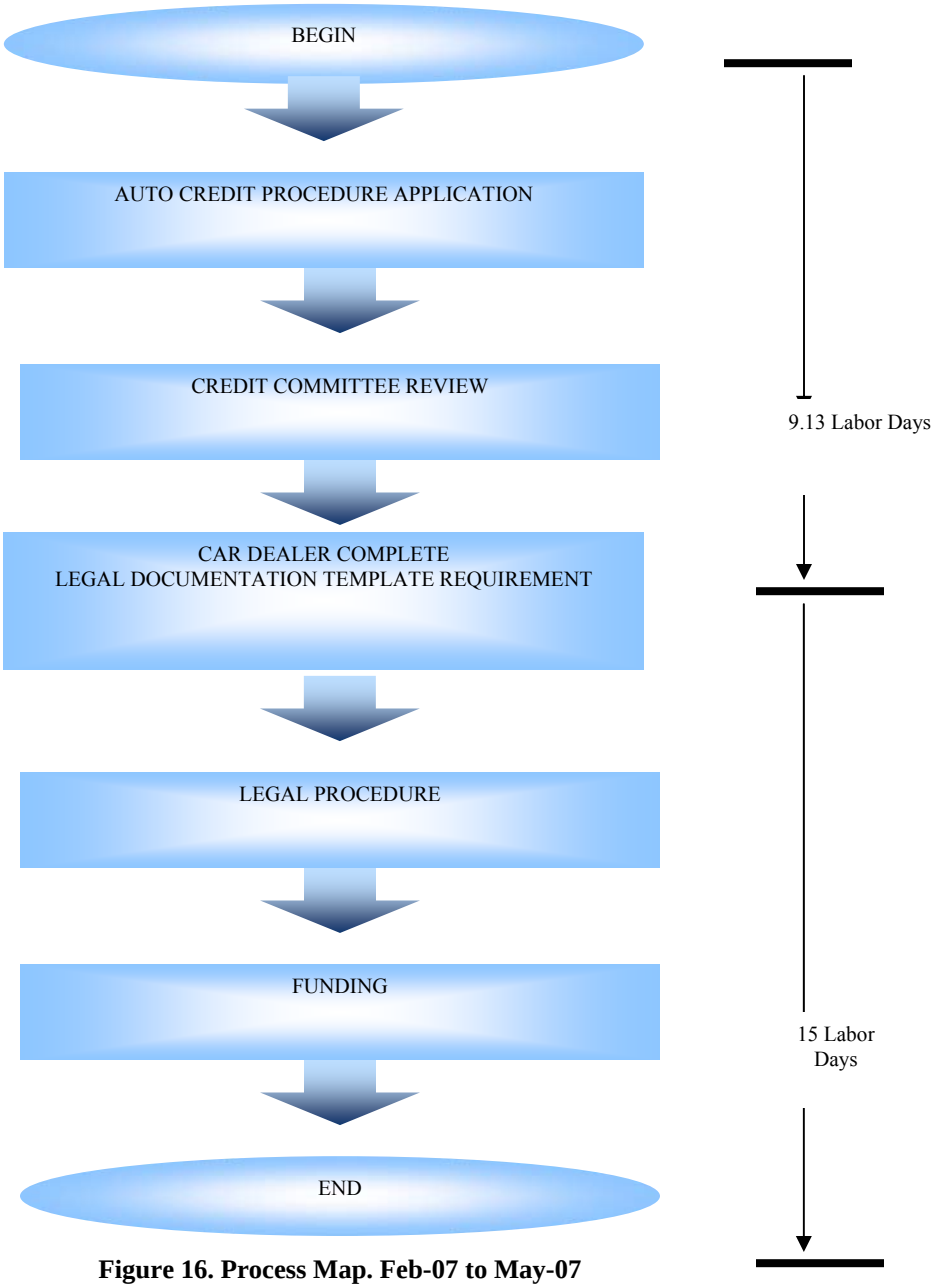


Figure 16. Process Map. Feb-07 to May-07

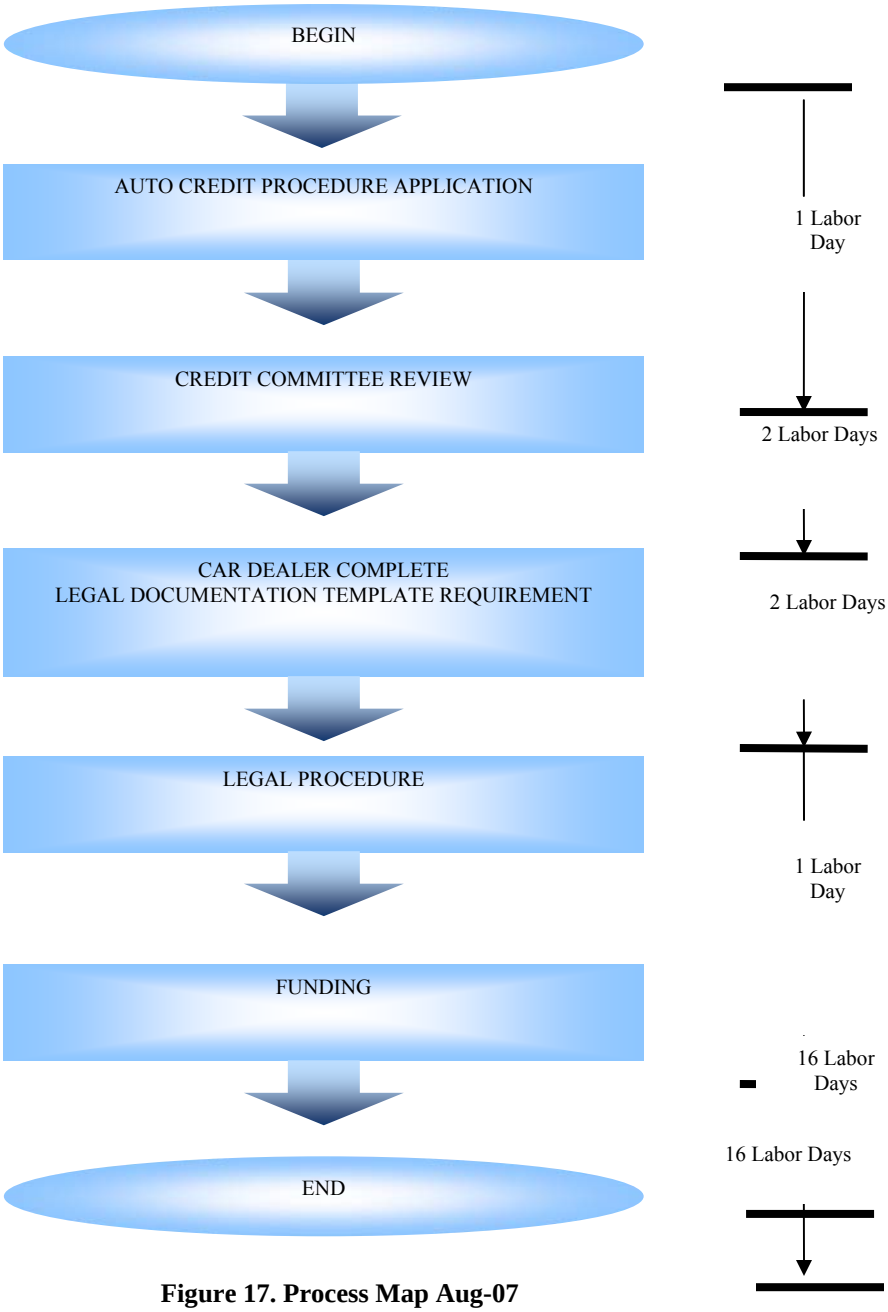


Figure 17. Process Map Aug-07

CHAPTER 7: CONCLUSIONS

7.1. Introduction

The Six Sigma Scorecard methodology has been demonstrated through Case study/action research developed in a financial organization. Chapter 6 presents the results of the analytical and statistical analysis reached during the 12 months of the Case study/action research.

7. 2. Demonstration of the Theoretical Propositions against the Results Reached

7.2.1. Study Question

The Six Sigma Scorecard methodology offered the opportunity to combine the Balanced Scorecard and Six Sigma methodologies into one approach to address an organization's specific needs. The new methodology was built from understanding both parent methodologies, BSC and Six Sigma, and from the failures and threats found in the literature review. Management and quality theory served as the strong foundation of the new Six Sigma Scorecard. The merging points explained in Chapter 3, showed the integration of both parent methodologies. In these points, activities and tools were used to develop one unique methodology. The successful implementation of the new methodology during 12 months as well as Institution Z results that indicated a perceived value of the SSS implementation reveal that it is likely that the Six Sigma and the Balanced Scorecard can be successfully integrated for all companies.

7.2.2. Hypotheses

Hypothesis No. 1: The appropriate combination of Six Sigma and Balanced Scorecard into one tool tie strategy and critical to customer requirements to trigger performance improvement efforts.

This Case study/action research allowed the demonstration of the proposed SSS methodology in a service organization, offering an appropriate merging methodology that can bring positive results and open the possibilities of applying it as management tool.

During the implementation of the SSS in Institution Z, the collected CTQ pointed to the cycle time of the auto credit process as the target to be reduced during the improvement phase. The cycle time was also used as a BSC indicator, which was established as a six-day timeframe for the answer time of any kind of credit within Institution Z. The selection of the auto credit project was based on strategic and customer priorities, as it was explained during the implementation of the first merging point of the proposed methodology.

The migration to the information technology system called ABANKS, the first improvement of the SSS project, allowed streamlined processes. During the first phase of the project, extensive information technology improvements were recommended through the project to further streamline the auto credit process. Unnecessary steps in the auto credit processes, such as printing applications, amortization calculations, reviews of automatic processes, review of no critical steps, were identified and eliminated. The numbers of activities were reduced from 67 to 23, which showed a 65% improvement. These improvements were translated to two critical indicators, cycle time and capacity of the line, measured by the number of auto loans processed. The processing time of the auto credit processes were reduced from an average of 24.25 days to 15.11 days, with a p-value: 0.001, and the number of auto credit applications processed increased from an average of 20.25 to 116.8, with a P-value = 0.0002. The results of the auto credit loan project indicate that the approval cycle time decreased by 67%, and the total cycle time was reduced by 40% by May, and by August it showed a 67% improvement.

The evaluation of the BSC provided by Institution Z indicated positive results as well. Institution Z managers and the CIO reinforced an 85% decreased rate on the BSC indicator for the approval and reimbursement of credit products. The BSC's indicators showed a 100% increase rate on the number of credit products (micro-credit, commercial credits, credit cash, credit plus, etc), which include the results reached by the auto loan processing.

Measures of success of the alignment between BSC and Six Sigma are the scores extracted from the three merging points. The selection of the project that got more points during the prioritization process is an indicator of corporate and business unit fit. The matching scores of the business objectives against BSC objectives and from CTQ against BSC objectives are evidence of corporate, business and functional strategies fit. Finally, the results reached by the BSC related to cycle time of the credit process, the structural organization change to transform Institution Z into a customer center organization, the changes in the future BSC target based on the performance improvement results by redefining the BSC target of cycle time of the credit process from 6 days to 8 days, and the level of commitment of the executives and staff member involved in the process established a feedback loop that shows functional-corporate fit.

In addition, the auto credit loan represents a high percentage of participation on the total credit consumption market, and Institution Z's GIC level was about 40%, as the BSC was established.

Other evidence of the level of alignment among CTQ, BSC objectives, and improvement efforts within Institution Z can be extracted from a second source of information. Specifically, the most recent market study of auto credit loans in Venezuela, presented in Chapter 5, explains why one competitive institution dominated the auto credit market. Customers identified the

critical features of auto credit loans, which included shortest approval and reimbursement cycle time. The new auto credit loan designed for Institution Z was customer centered, based on these CTQs, it was fully implemented starting in August 2007.

In this research, strategy is tied to process improvement by using a prioritization matrix to select the Six Sigma project. During the measure phase of the SSS project, the researcher collected customer information to prepare the CTQ characteristics that were used to target the SSS project. In that way, BSC objectives and CTQ were aligned to trigger the auto credit loan project.

7.2.3. Six Sigma Scorecard Demonstration

The literature provides critical success factors for implementing both parent methodologies—the Six Sigma and Balanced Scorecard. The literature review pointed out important contributions of the merging methodologies, which helps to build the theoretical foundation of this research. The author reviewed the literature to understand strengths and breakdowns of the merging methodology to ensure that the Six Sigma Scorecard roadmap was based on sound theory.

In order to demonstrate the framework, a case study/action research was conducted on a service organization, Institution Z, located in Venezuela. The proposed SSS methodology was implemented into the auto credit project. The framework described the three merging points identified in the methodology as well as activities and tools that were needed to conduct the project.

The changes on the productivity indicators and the results in the BSC targets during the same period of time, as well as the evidence of relationship that arrives from the methodology

applied and the analytical analysis of the open-ended interviews showed a high level of relationship between strategic objectives, performance improvement and customer satisfaction. This alignment allowed generating key performance indicators that connected improvement performance back to the strategy level and opened a feedback loop that transformed the cycle time of the organization. These sets of empirical findings were congruent with the initial theoretical propositions that explained an apparent relationship between strategic, customer, performance alignment and productivity gains.

Numerous insights were generated from the SSS implementation. Four critical factors were determined to be keys to the success of the project:

1. Flexibility: The project life cycle was not considered a series of rigorous steps; instead, it was necessary go back to the measure and define phases from the analyze phase in order to facilitate the interaction between project resources and Institution Z resources and allow adaptation to external factors, which affected the normal activities within Institution Z.
2. Executive and Management Commitment: During this project, the executive and management commitment to the SSS project was the main guarantee that all steps in the process would be completed. All negotiations between Institution Z executives and the researcher were made via Internet and by phone. The researcher sold the proposed SSS methodology as the solutions to some of the problems that Institution Z was experiencing.
3. Internet Communication: During the Case study/action research, the necessary interaction between the researcher and Institution Z employees took place by phone and Internet. Although this lack of direct interaction with front-desk employees as well as limited interaction with middle-level managers was a limitation, the researcher's knowledge in

technology education and the advantages of the Internet in terms of managing time and distance allowed for continuous feedback, support, and the development of a secure record of data during the project.

4. Cultural knowledge for negotiation/barriers: In an environment like Venezuela where government and/or political issues drastically change the economic and external conditions that organizations face, and where the social instability raises cultural barriers and causes resistance to change, it was necessary to use negotiation strategies in order to allow the project run to its end. One of these strategies was to present the project not as a quality methodology, but rather, as an improvement of the traditional BSC methodology applied at Institution Z which will allow design performance indicators that relate day to day efforts to Institution Z goals.

The SSS improvement recommendations produced a significant increase in the average number of auto credit applications processed, from 67 loans during the first half of 2006 to 132 loans by March 2007. After the application of the SSS methodology, the auto credit process reached a 40% improvement rate on the cycle time by the end of May, 67% by August, and expected an 80% improvement rate in the approval cycle time by October 2007. In addition to the productivity changes, major changes took place in order to eliminate rework and have savings that affected all of the organization such as the organizational change and the financial indicators of their BSC. The improvement in financial indicators used by Institution Z, called GIC (acronym in Spanish which meant Credit Intermediation Level), which measured the participation of the credit portfolio, served as an important sign of the level of alignment of the SSS target and the BSC indicators, together with the gains in the productivity targets reached by

the improvement project. Institution Z's financial strategy mandated an increase on the GIC rate because it reduced the government credit dependency.

In this context, the auto credit loans played an important role because the credit loans had a high percent of the credit market. At the beginning of the project, the GIC rate for the auto credits was low, below 2%; during March, there was an increase to 2.64%; and by August, it was at 3.51%. By the end of this research project, this BSC productivity indicator increased by approximately 80%. The auto credit percentage rate in the GIC increased from 2.8% to 5.87% at the end of the project, which contributed to elevating Institution Z GIC to 42% as it was mandated by the BSC.

The average value of the assessment of the Six Sigma Scorecard methodology against the BSC when it was applied alone showed an initial tendency in assigning a better assessment on its perceived value than the BSC alone. More data is necessary to validate the instrument, and access to individuals to conduct a survey that provides clear evidence of this evaluation is needed.

Analytical analysis made from the case study's interviews showed a high level of interest and enthusiasm about the extension of the Six Sigma Scorecard methodology to other processes within Institution Z.

7. 3. Value Proposition

The literature does not provide a framework for implementing the proposed merger of BSC and Six Sigma methodologies herein named Six Sigma Scorecard, but there was potential for the SSS methodology. The engineering management can use the results of this dissertation to:

- Managers can move from strategy to an improvement performance program that adds value for the customer. The new auto credit loan within institution Z is a customer-centered product, based on strategic objectives aimed at increasing the GIC rate and the credit portfolio, while decreasing the operating cost within Institution Z.
- Managers will be able to evaluate performance and quality programs from a heuristic perspective, and this evaluation tool is important. The measurement system is based on the four BSC dimensions and on the business prioritization of the stakeholders.
- There is evidence of alignment between strategy and improvement performance.
- There is evidence of alignment between performance and customer satisfaction.
- The use of the Six Sigma Scorecard improved performance levels.
- The use of the Six Sigma Scorecard produced a better assessment than the BSC alone based on analytic generalization.
- The use of SSS strengthens both the BSC and Six Sigma methodologies.

The application of a Case study/action research allowed an understanding of the phenomenon under study and its surrounding system. The multiple sources of evidence allowed hypothesizing the causal links of the Six Sigma Scorecard methodology and illustrated the basics of the three merging points between the two parent methodologies, which described the proposed SSS methodology.

7. 4. Scope And Limits Of The Research Finding

Although implementing the Six Sigma Scorecard provided stunning improvements in the cycle time of the approval process of the auto credit loan, substantially increased the number of

applications reviewed and approved by Institution Z, increased the perceived value of the methodology to bring strategy to day-to-day activities by comparing it to the BSC, added tracking capabilities to the Objectives traced by Institution Z, provided a better assessment of the participation of each BU to reach corporate strategies, and proved to influence BSC indicators, SSS cannot solve all the problems in any organization.

One of the issues not addressed by the SSS was the capacity to change strategy and deal with the political elements of special interest groups within and outside of Institution Z. Other issues that were not specifically addressed included how the SSS methodology may affect the lack of employees' commitment and some structural cultural problems that were observed within Institution Z. The social instability of Venezuela may increase the lack of commitment and may contribute to some cultural incongruence between organization goals and objectives and individuals' objectives. Some efforts and investment were not made because of lack of resources and forced changes mandate by governmental regulations, however this was not studied during the SSS Case study/action research.

One limitation during SSS implementation was that the researcher was not able to collect external customer data directly. Additionally, a customer-centered culture did not exist within Institution Z. The organization knew the importance of the quality of services, but they showed more interest for competitors and how to gain market share than for building a culture focused on quality of services.

Limitations to collecting data for questionnaires were presented during the entire research project. Information collected through a questionnaire which was designed to assess the value of the proposed methodology SSS against the BSC can only be used for analytical analysis but not

statistical analysis. Case studies that include the use of this instrument and its appropriate analysis are strongly recommended.

The lack of hard measures made it difficult for the researcher to make comparisons between SSS and BSC on the same variables, this kind of investigation is necessary for a better understanding of the scope of the proposed methodology.

7. 5. Future Research

The SSS model opened up many avenues for future research. Multiples case studies that investigate the effects of the SSS methodology in organizational settings are needed. One challenge would certainly be designing a measurement system that evaluates vertical and/or strategic fit and the output and value of the aligning methodology versus strategy and quality initiatives applied independently.

The application of the SSS was in a service organization, but there may be other factors that are different in a manufacturing organization which need to be explored. Other approaches may also prove helpful, such as merging BSC with other quality methodologies like TQM and ISO 9000.

Organizational change also needs to be explored. The entire area of culture and change management in implementing SSS and other combined methodologies needs additional research to understand how to best implement these types of programs in any organization.

Six Sigma Scorecard implementations' failures and problems is an interesting research area that still needs to be explored in detail.

Several other research questions that need to be addressed include the following:

- How should firms plan, implement, and measure goal-based quality programs such as TQM or ISO 9000 standards with other strategy tools?

The area of performance measures is fairly well developed, but there are still opportunities for a great deal of research that can augment the SSS framework in the area of process and performance measurement. Additional research is needed to validate the BSC process measures. The design of a measurement system that can be tested with forecasting capabilities is an important area of research that needs to be explored.

The suggested areas of future research outlined above are indeed rich and exciting and will provide many researchers with challenging and rewarding work.

7.6. Conclusions

A new management approach that aligns organizational strategy, performance improvements, and customer satisfaction was presented and evaluated in a real environment. This management approach, named Six Sigma Scorecard or SSS, closed the gap between strategy's design and strategy's implementation and between improvement initiatives, organizational output, and strategy.

Extensive research had proven the effectiveness of the BSC as a strategy tool (DeWall, 2003; Andersen , Lawrie et al., 2004; Banker, Chang et al., 2004; Heinz, 2005; Marr, 2005; Coowar and Champney, 2006), and the effectiveness of Six Sigma as a quality and management methodology (Behara, Fontenot et al. 1995; Antony and Banuelas, 2002; Starbird, 2002; Breyfogle III, 2003; Furterer, 2004; Jiju, 2004; Hayes, 2006), independently. Some research, however, has shown the failures in the ability of an organization to translate strategy into delivery activities and targets, and the failures in the Six Sigma project, mostly caused by the

lack of support and alignment of top management levels. SSS is based on the lessons learned of BSC and SS, supporting both methodologies and offering a wide variety of tools to identify improvement initiatives that affect organizational strategy, and design strategies that can transform cycle time.

Additionally, today, engineering managers face the need of designing strategies that can translate to day-to-day efforts and employee outputs and then reevaluate these strategies in shorter cycle time to keep organization growth and health in today's ever changing markets. This research offers an opportunity to close the gap between strategy design and its implementation and between improvement initiatives and its supported strategy.

In the same way, recent investigations in the engineering management areas have pointed out the critical roles of human factors and top level alignment in successful projects. The proposed SSS methodology offered an opportunity to satisfy these needs.(Hacker and Doolen 2007; Hirtz, Murray et al. 2007)

This Case study/action research allowed the design, implementation, and evaluation of the SSS approach in the natural organizational environment and contextual factors. The multiple sources of evidence allowed illustrating the basics of the three merging points between the two parent methodologies BSC and Six Sigma. The Case study/action research allowed the description of the SSS methodology and their three merging points: first "prioritization and selection of the six sigma project," second "complement business opportunities and strategic priorities, and third, "relate six sigma indicators and BSC measures."

The SSS methodology has proven successful in increasing the performance of the auto credit process measured by cycle time, process capacity, number of value added activities, and

percentages of BSC targets reached, during the same period of time. There was evidence of alignment among strategy and improvement performance. There was evidence of alignment between performance and customer satisfaction.

Additionally, information collected through direct interviews and other instruments showed a tendency for preferring the use of the proposed SSS methodology over the BSC, when it was applied alone. The demonstration of the SSS methodology through the Case study/action research allowed a deeper understanding of the phenomenon under study and its surrounding system, and proved that managers can move from strategy to an improvement performance program that adds value for the customer and evaluates performance and quality programs from a heuristic perspective.

The SSS approach has proved to be flexible and adaptable to organizational needs and can strengthen the advantages of the BSC and Six Sigma approaches. The demonstration of the SSS methodology offers a new roadmap that can be implemented by engineering managers in any organization to solve strategy, performance and output misalignments.

APPENDIX A: PROJECT CHARTER

Six Sigma Project: Automobile credit approval and Cash Disbursements
1. Project Charter

A Six Sigma team has been formed to decrease the cycle time of the automotive credit approval process within Institution Z. This project has been selected like a prototype project where a new methodology is applied with the purpose of directing the efforts of the personnel towards initiatives of strategic interest in Institution Z

In order to accomplish that, the first step was the selection of the Six sigma project. A list of possible improvement initiatives were evaluated according with the relationship that their project's outputs may have over the BSC objectives, for the same period.

A prioritization matrix allows the assignation of points to each one of the possible projects according to the objectives formulated by the Institution Z in its BSC, for the second period of 2006. Some of the projects that were considered for the selection process are: reduction of the checks orders delivery process, provide training to all the personnel, Measure the organizational climate in each department, reduce the cycle time of the auto-credit process, reduce the answer cycle time for the debit card complaints, make the migration to ABANKS system, Identification of processes that do not add value to the business, and so on.

Each one of these projects was evaluated in order to assign a score for each one. This assignment was made by the Institution Z Vice-President with the researcher's collaboration. As a result of this process, the auto credit project was selected as an opportunity to apply the Six Sigma philosophy and methodology.

Also, the opportunities of improvement of the auto credit project, together with the outputs that the project offers should be related directly and indirectly to the objectives formulated in the BSC, as it can be observed in the following matrix. By using this matrix, we are assuring that the automotive credit project's objectives are in agreement with the strategic goals of the BSC..

Table 39. Business Opportunity vs. BSC goals

6 SIGMA \ BSC	That each position is held by the personnel with the	To reduce to response time of Approval of Credits	To reduce response time of all the credit process in order to eliminate Credits in a lapse non greater to 20	To catch 2000 new clients Natural People To catch	To maintain a result average of 95% in Incognito Client	To diminish in a 50% the monthly average of Reclamations
To improve the Efficiency and productivity in the process of approval of credit to vehicular	√	√	√	√		
To identify the voice of the client and the characteristics of the service that are essential for their satisfaction (CTQ)			√	√	√	√
To diminish the time of approval and liquidation of the credit to vehicular	√	√	√	√	√	√
To diminish the number of activities that do not add value to the process				√	√	√
To identify the causes of greater impact in the retardation of the process of approval of credit to vehicular	√	√	√	√	√	√
To make statistical analysis with the data provided by Institution	√	√	√	√	√	

6 SIGMA \ BSC	That each position is held by the personnel with the	To reduce to response time of Approval of Credits	To reduce response time of all the credit process in order to eliminate Credits in a lapse non greater to 20	To catch 2000 new clients Natural People To catch	To maintain a result average of 95% in Incognito Client	To diminish in a 50% the monthly average of Reclamations
To identify the difference or gap between the performance of the process of approval of the credits and what it is desired to reach	√	√	√	√	√	√

1.1. Executive Summary

The table below provides a big picture of the automobile credit improvement project within Institution Z. The executive summary lists the project's characteristics in terms of time, human resources and scope by providing of project's name, project's champion, project sponsor, and project team. It also shows the business opportunities, objectives, goals, and outputs that the project offers to Institution Z.

Project Name Institution Z_Auto Credit Approval	Project Champion Planning and Strategic VP
Project Sponsor Institution Z President	Co-Leaders PhD Sandra Furterer Six Sigma Master Black Belt
Business Opportunity Institution Z has set up as its goal 25 approvals for the number of auto credit applications and funding. One opportunity of improvement that allows reaching this goal is the reduction of the cycle time of these processes. This improvement requires analysis of the problems. Potential impact of this goal's achievement will be analyzed before presenting recommendation for implementation	
Business Objectives DMAIC framework using Six Sigma tools and methodology. Improved efficiency and productivity of labor Less time spent on rework Minimize their non-value added production time. Identify the major cause of the leak. Evaluate the quality control of the manufacturing process Measure the impact of duration of the cycle time of the auto credit approval and funding processes Provide recommendations for improvement	
Scope The Six Sigma project involved two sub-processes the auto credit application and evaluation, and the funding process. It means that the auto credit process will be studied from external customer to external customer.	

Principal Project Objectives (See the Project Control Milestones for details):
Decrease the time of approval and funding of the auto credit process
Decrease the number of activities that do not add value to the process
Identifying primary targets of the project
Identify the critical causes of delaying on the auto credit approval process with greater impact on it.
Get performance indicators and conduct statistical analysis of the data provided by Institution Z at the moment
Identify the difference between the performance of the process of approval of the credits and what it is desired to reach. Gap Analysis.
Identify the best practices in the approval and funding processes of auto credits in Venezuela
Identify the voice of the customer.
Identify potential improvement.

Principal Project Deliverables/Outputs (See the Project Control Milestones for details)
Provide report and presentation for initial phases (Define, Measure, and Analyze).
Final report and presentation with recommendations for improvement.
Provide a comprehensive program analysis.
An assessment of how well the auto credit approval process is working
Key performance indicators for Auto credit approval process

Risk Analysis
Lack of data on specific areas at Institution Z
Fall 2006 timeframe constraint
Data Bias
Unpredictable team member absence or lack of commitment
Presidential elections in Venezuela
Reliance upon primary stakeholders' schedules and work load.

Benefits/Cost Savings
To improve the productivity and efficiency of the Auto Credit Process
Decrease the cost associated to rework and activities that do not add value to the service
Decrease the risks associated to the process benefits for the clients and community in general
Improve production
Improve Quality Assurance
Facilitate the cultural change that will allow improvement of the quality of services and products

Project Start Date: October 1, 2006
Project End Date: Jun 1, 2007

Goal	Objectives
To reduce by 70% the cycle time of the auto credit process by May, 2007.	Decrease the time of approval and liquidation of the auto credit process Decrease the number of activities that do not add value to the process Identifying primary targets of the project Identify the critical causes of delaying on the auto credit approval process with greater impact on it. §Get performance indicators and conduct statistical analysis of the data provided by Institution Z at the moment Identify the difference between the performance of the process of approval of the credits and what it is desired to reach. Gap Analysis. Identify the best practices in the approval and funding processes of auto credits in Venezuela Identify the voice of the customer. Identify potential improvement.

1.2. Critical Success Factors

In order to meet the project's goals and objectives, the critical success factors are identified, and the inputs that the projects will need during its development. On the other hand, the external factors that may limit the project progress and success are recognized, together with the assumption that the team made for the project development and its implementation.

Critical Success Factors	Inputs identified for the project
Clear understanding of the overall auto credit process. Clear understanding of the customer needs Clear and effective communication with internal and external customers. Statistical analysis and data driven thinking Well-defined process metrics. Stakeholders' cooperation.	Current Institution Z data collection. Manufacturing process document. Meetings with the Project Champion (Strategic and Planning Vice-President). Meetings with the project sponsor (Institution Z Manager). Interviews with dissertation committee and professionals.
External Time Constraints Semester period and breaks. Presidential elections in Venezuela Reliance upon primary stakeholders' schedules and work load. Reliance upon Institution Z strategic planning. Institution Z collected data. Dependencies of external factors that may affect the auto credit demand tendency as: political factors, government intervention, seasonal demand cycle, etc	Assumptions The reduction of the cycle time of the auto credit process will have a critical impact on the customer satisfaction index, and on the continuous improvement process of all credits services within Institution Z.

1.3. Six Sigma Team members

A Six Sigma team was formed with people from different business units which were involved with the auto credit process within Institution Z. The communication facilitator role is shared by the team leader and the project sponsor due to the geographic distance among the team members. In this project, the Six Sigma champion plays a critical role as communication facilitator and tasks coordinator of all the activities that Six Sigma team members meet within institution Z. The team member names, roles and a job description are listed below.

Name	Roles	Job Description
José Luís Botomo	Six Sigma Champion	Provide the resources during the Project development. Keep open the communication flow among all member of the six sigma team, the project leader and principal researcher. Task coordination.
Adriana Rodríguez	Team leader & researcher	Provide technical consulting to all members of the six sigma team. Prepare all Six Sigma documents and project charter. Conduct statistical analysis, diagram, and track the project progress. Plan all the activities for the Six Sigma team.
Rommel Barrera, (Coordinator Reg. Central)	Process Analyst. Detail Agency. Researcher.	Process Analyst, Detect cause of problems, and collect data.
Mervin (Credits)	Process Analyst. Credit Agency researcher	Process Analyst, Detect cause of problems, and collect data. Risk Analyst.
William Rojas (Risk Analyst)	Project Manager & Researcher	Process Analyst, Detect cause of problems, and collect data. Risk Analyst.
Mirna Gisela	Process Analyst. Edition	Process Analyst, Detect cause of problems, and collect data. Risk Analyst.
Legal	Process Analyst.	Process Analyst, Detect cause of problems, and collect data. Risk Analyst.

1.4. Six Sigma Planning

The table below shows the principal task grouped by six sigma phase, start and finish date and the predecessors.

PROJECT TASKS				
Auto Credit approval and funding DMAIC	AUG	START DATE	END DATE	
Define"DMAIC"	184 days	10/16/2006 8:00	11/27/2006	
Project Charter	31 days	10/16/2006 8:00	11/27/2006	
Stakeholder Analysis	31 days	10/30/2006 8:00	11/10/2006	
Work Plan	10 days	11/13/2006 8:00	11/16/2006	4
Responsibility Matrix	4 days	11/17/2006 8:00	11/23/2006	5
Measure	5 days	11/24/2006 8:00	5/2/2007	
SIPOC	55 days	11/24/2006 8:00	1/26/2007	6
Cause & Effect Diagram	30 days	11/24/2006 8:00	1/26/2007	6
Process Flow Chart	30 days	11/24/2006 8:00	1/26/2007	6
CTQ	30 days	11/24/2006 8:00	2/9/2007	6
Analyze	15 days	3/5/2007 8:00	5/6/2007	
Items for Resolution	25 days	3/5/2007 8:00	6/16/2007	7
Pareto Chart	10 days	3/19/2007 8:00	3/23/2007	14
Summary of Problems	5 days	3/26/2007 8:00	6/30/2007	15
Summary of Data Collected	5 days	4/2/2007 8:00	6/6/2007	16
Improve	5 days	4/9/2007 8:00	7/18/2007	
Revised Process Flow Chart	30 days	4/9/2007 8:00	7/13/2007	13
Metrics & Performance Targets	5 days	5/23/2007 8:00	7/4/2007	20
Recommendations for Improvement	10 days	5/7/2007 8:00	7/11/2007	21
Proposed Control Mechanisms	5 days	5/14/2007 8:00	7/18/2007	22
Control	5 days	5/21/2007 8:00	7/20/2007	
Teams Assessment	30 days	6/21/2007 8:00	8/1/2007	23
Project Assessment	10 days	7/2/2007 8:00	8/6/2007	
Final Report & Presentation	5 days	7/2/2007 8:00	8/20/2007 17:00	
Final Report & Presentation	2 days			

1.5. Six Sigma responsibility Matrix

The way how the Six Sigma team works is dependent of the physical distance that exists among all member of the team, in particular. Several training sessions lead by the team leader and coordinated by the project sponsor were necessary to meet the project objectives and assure the correct implementation of the Six Sigma tools. The team leader was in charge of teaching all members of the team about the Six Sigma tools, why it is necessary and how it should be used. When the team member felt comfortable with the tools, the team met via online conference to decide who would be in charge of executing each activity and what would be the best way to transmit the information. Some electronic forms were created to collect the necessary data.

AUTO-CREDIT PROJECT RESPONSIBILITY MATRIX							
	TEAM MEMBERS						
TASK	JLB	AR	MG	RB	WR	MH	SA
Project Charter	x	X					
Stakeholder Analysis	x						X
Work Plan	x	X					
Responsibility Matrix	x	X					
SIPOC		X	X				
Cause & Effect Diagram				X	x	x	X
Process Flow Chart			X			x	
CTQ		X					
Cost/Benefit to Quality Analysis							
Items for Resolution		X	X				
Pareto Chart	x		x	X	x	x	X
Summary of Problems		X					
Summary of Data Collected	X	X					
Revised Process Flow Chart	x						
Training Plans		X					
Metrics & Performance Targets	Team						
Recommendations for Improvement	Team						
Proposed Control Mechanisms	Team						
Verification of Improvements	Team						
Teams Assessment	Team						
Project Assessment	Team						
Final Report & Presentation	X	X					
Team Participation Log	X	X					

1.6. Stakeholders Analysis

	Stakeholders	Who are they?	Potential Impact
PRIMARY	President/ Vice-President	President, founder and principal owner of the Institution Z. Top level executive.	Reduce Production Cost (+) Profit (+) Recognition (+)
	Support Units Managers	Managers of different business units of the bank, professional with median level of experience within Institution Z.	Improve Performance(+) Measure Performance Cultural change and barriers (+)
	Employees	Front line employees of the different business units within Institution Z.	Reduce rework time. (+) Employee training. (+) Better understanding of the application process. (+) Change the culture and the way things have been done in the past. (-) Willingness to accept changes (-)
SECONDARY	Car Dealers	Organization that sells cars and truck to final customers and who need to establish credit relationship with Banks	Reduce the paper work. (+) Decrease the response time for financial approval (+) (-)
	Venezuelan Bank Association	Association that control and coordinate all banking activities and financial operations in Venezuela.	Increase the financial stability and strength of the financial Industry in Venezuela.
	External Customers	Society, people and organizations that need credit line and credit products.	Increase the quality of services Decrease uncooperative suppliers. Communication between dealers and Institution Z. (+)

1.7. SIPOC Analysis

1.7.1. Who is the Customer?

For this project, our customer is the end-user of the auto credit process.

1.7.2. Who are the Suppliers?

The suppliers for the project include: external customers, automobile dealers, electronic bank system, SAT system.

1.7.3. Who are the Stakeholders?

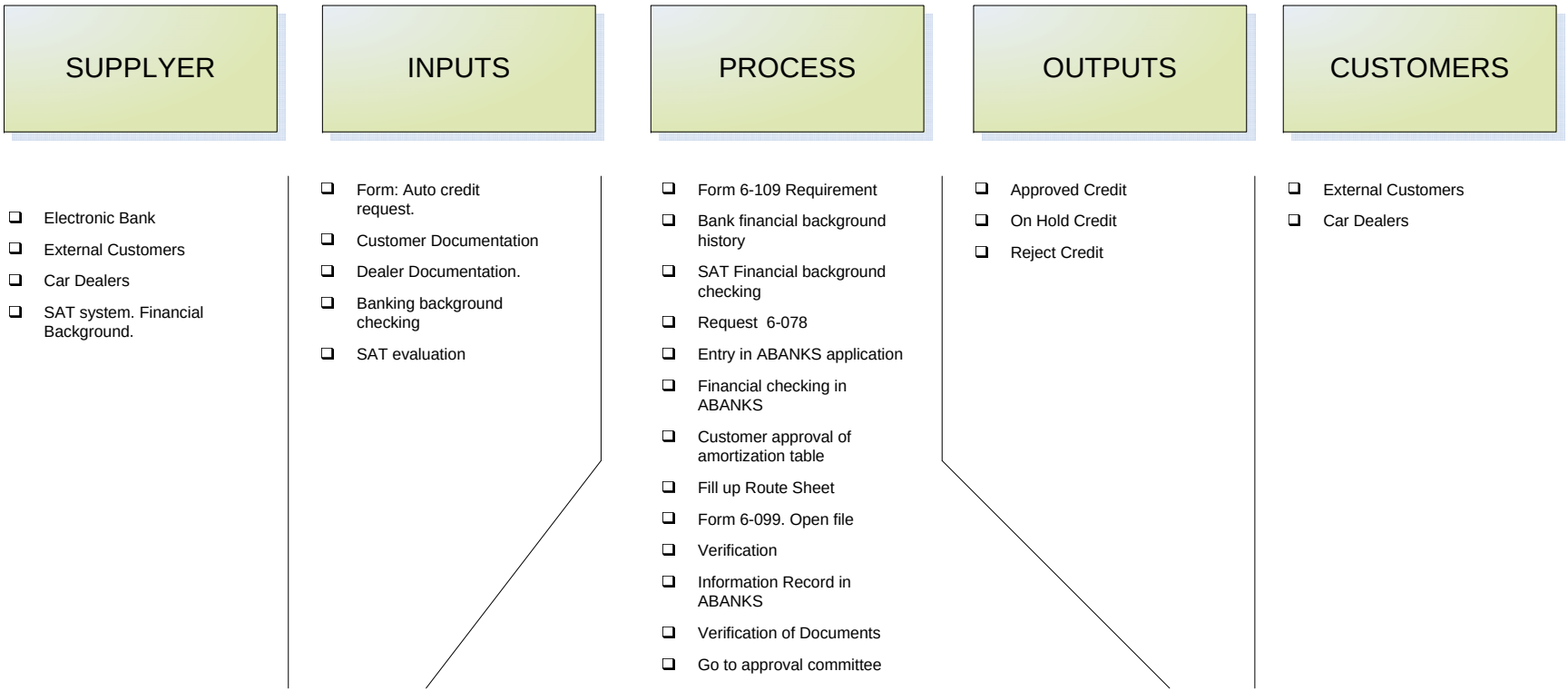
The major stakeholders of this project can be divided into primary and secondary stakeholders.
The primary stakeholders are:
President and Vice President of Institution Z
Managers of Support Units
Employees
Car Dealers
External Customers

The secondary stakeholders consist of
Venezuelan Bank Association

1.7.4. What are the Inputs and Outputs?

Inputs:
Auto Credit Procedures' Formats
External Customers' personal documentation
Auto Dealers Legal Documents
Financial background within Institution Z
Financial background provided by SAT system
Outputs:
Credits approved
Credits on Hold
Rejected Credits

SIPOC
A better overview of the respective inputs and outputs for the auto-credit process are shown in the SIPOC diagram on the following page


SUPPLYER
INPUTS
PROCESS
OUTPUTS
CUSTOMERS
Electronic Bank
External Customers
Car Dealers
SAT system. Financial Background.
Form: Auto credit request.
Customer Documentation
Dealer Documentation.
Banking background checking
SAT evaluation
Form 6-109 Requirement
Bank financial background history
SAT Financial background checking
Request 6-078
Entry in ABANKS application
Financial checking in ABANKS
Customer approval of amortization table
Fill up Route Sheet
Form 6-099. Open file
Verification
Information Record in ABANKS
Verification of Documents
Go to approval committee
Approved Credit
On Hold Credit
Reject Credit
External Customers
Car Dealers

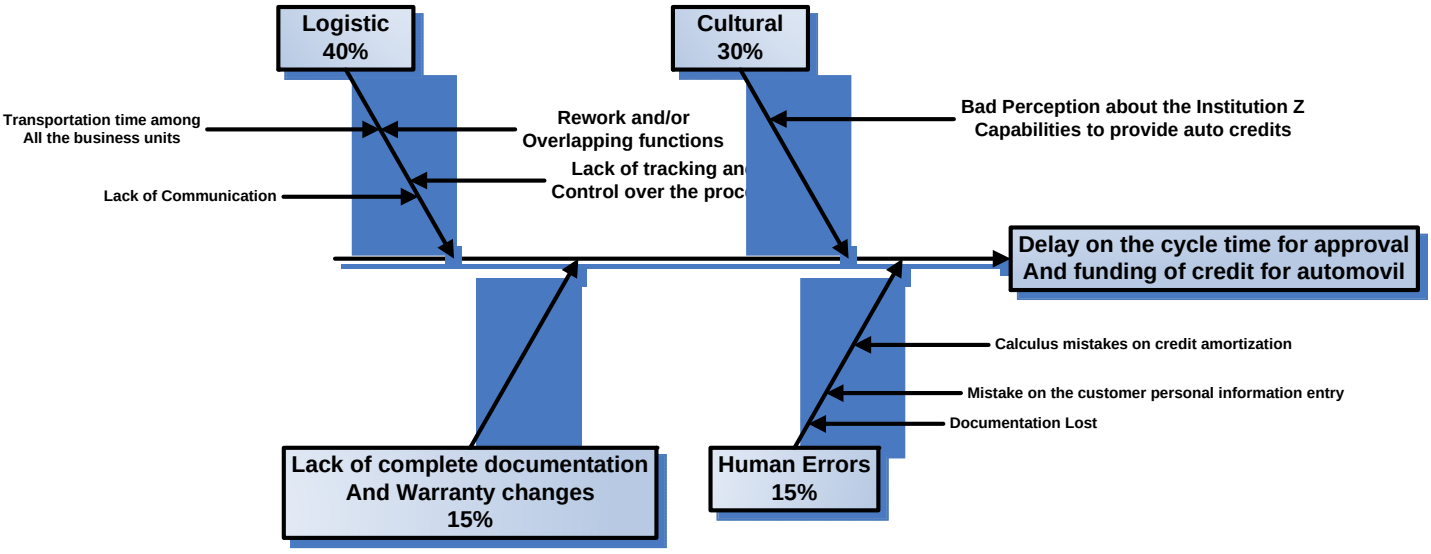
1.8. Obvious Problems

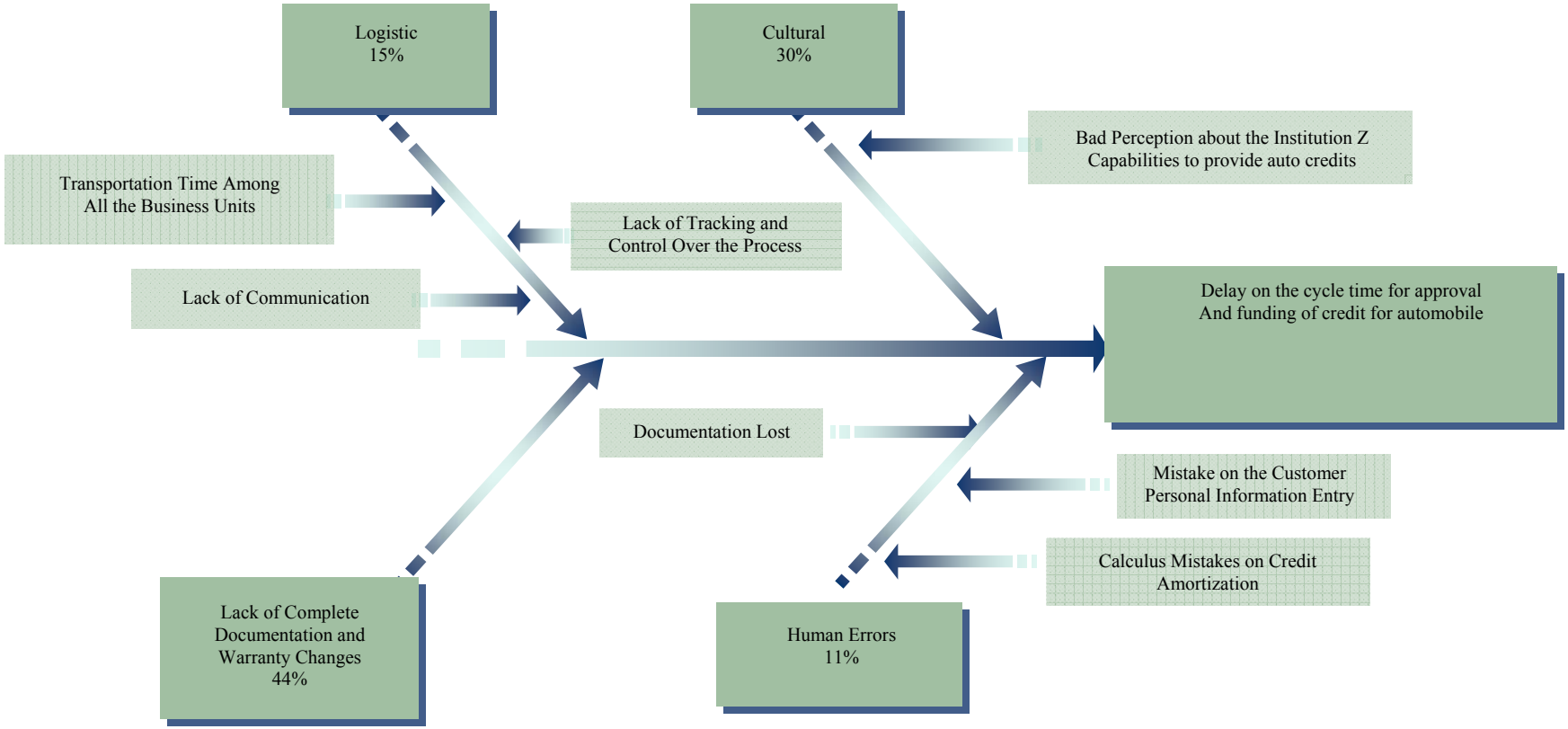
Major problems discovered during the data collection process were:
During the first semester of 2006 the auto credit process was done manually, hence format documents needed to be filled out by hand, and the background checking process was done individually and in a manual manner. In addition, the risk analysis verification and approval process was executed in Institution Z headquarters. The geographic distance between the agency and headquarters, together with the inefficiency in the mail system, caused delay in the process.
Cultural barriers. Managers and Institution Z workers believed that Institution Z would not approve any car loan. This negative presumption causes that most of the application were not processed and/or sent to Institution Z headquarter.
Lack of tracking and control of the process. Nobody owns the process, nor is anyone responsible for the process' output. Some records of frequency, types of requests and time-in-service are kept in the Institution Z data warehouse that might be helpful in determining proper staffing levels. However, these records are incomplete. Further, there appears to be no regular periodic monitoring by the agency managers.
Lack of performance indicator.
Lack of standard process.
No guidelines for service or targets for response times are established and published.
Lack of complete requirement documents provided by car dealers.

1.9. Problem Statement

The auto credit process is composed of several sub-processes that have lack of standardized procedures, communication gaps, and non-optimized workflow. Also, there is a cultural barrier in middle management levels that stop the process flows. Problems with the supply chain were detected; most of the problems are more visible at the car dealer level. The Six Sigma Team will work on providing recommendations to improve the cycle time of the auto credit approval and funding process within Institution Z.

Cause-Effect Diagram before ABANKS migration

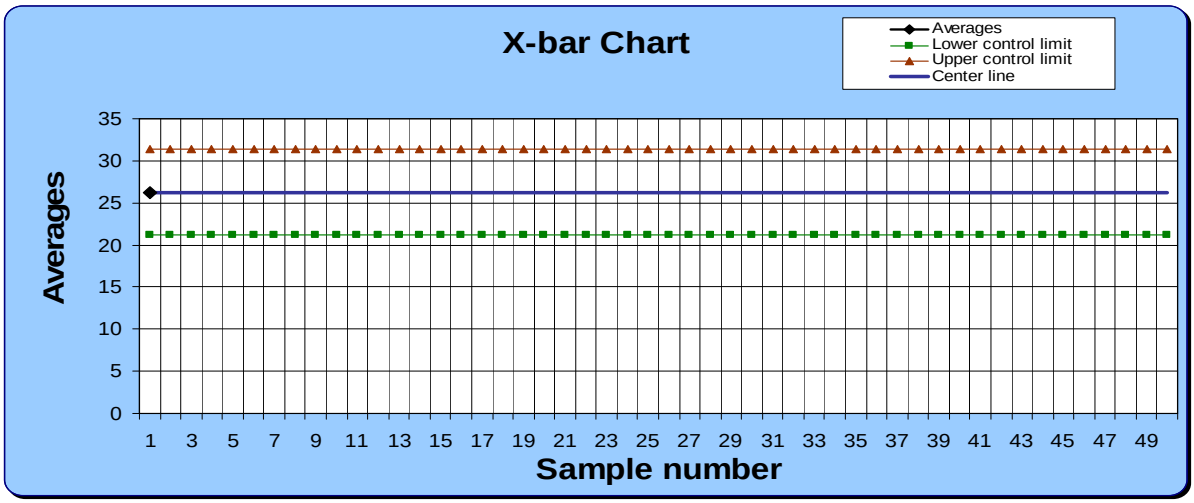



DELSUR
Banco Universal
Logistic
15%
Cultural
30%
Bad Perception about the Institution Z
Capabilities to provide auto credits
Transportation Time Among
All the Business Units
Lack of Tracking and
Control Over the Process
Lack of Communication
Delay on the cycle time for approval
And funding of credit for automobile
Documentation Lost
Mistake on the Customer
Personal Information Entry
Calculus Mistakes on Credit
Amortization
Lack of Complete
Documentation and
Warranty Changes
44%
Human Errors
11%

2. MEASURE PHASE

2.1 Statistic Graph Control (SPC)

In order to determine the behavior of the auto credit process, the SSS team collected data to construct the SPC diagram and calculate the process capability by August 2006.



2.2. Data Collection-After SSS implementation

Next tables show the results of data collected in excel worksheets for the number of auto credit applications denied, approved and funded, together with their cycle times by months.

Table 40. Cycle time and Number of Auto Credit Application Data

	Denied		No. of Mistakes		Approved		Total Number of Reimbursement				
	Number	Days	#	Days	#	Days	#	Days	Total Days	Analyzed	Hold
September-06	25	5.29	100	6.3	64	2.9	63	3.68	6.57	210	121
October-06	35	22.64	65	9.21	50	9.43	47	7.9	17.55	164	79
November-06	27	8	62	9.66	66	11.44	64	8.65	20.19	175	82
December-06	20	4.43	43	12.27	46	10.62	44	8.66	19.31	124	58
January-07	20	8.63	65	7.48	48	12.08	48	5.17	17.25	154	86
February-07	10	3.67	47	8.57	34	10.56	34	5.94	16.5	120	76
March-07	5	6.33	32	4.24	24	14.43	21	7.56	19.19	96	67
April-07	7	9.17	31	4.75	10	9.5	9	7.71	17.13	69	52
May-07	5	3.5	29	1.78	8	4.43	4	6.67	9.33	76	63

In order to evaluate the process behavior, controls charts for mean and range were calculate and prepare as follow.

Table 41. Total Cycle time for Auto Credit Process for Process Control Charts(Oct 06/Jul 07)

DATA	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07
1	7.07	16.67	26.4	7	16.33	9.25	19.5	22	6.67	21	5.33	2
2	4.57	19.08	17.23	20.63	25.3	21	10.38	14.33		25	11.5	9
3	12.38	24.95	23.59	15	24.61	19.64	37.5	13.67	12	20	11.33	11
4	2.25	9.5	13.55	34.62	2.75	16.13	9.4	18.5		21	11.17	5
Average	6.568	17.55	20.19	19.31	17.25	16.51	19.2	17.13	9.335	21.75	9.833	6.75
LCLx-bar	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255
Center	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11	15.11
UCLx-bar	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97
Range	10.13	15.45	12.85	27.62	22.55	11.75	28.1	8.33	5.33	5	6.17	9
LCLrange	0	0	0	0	0	0	0	0	0	0	0	0
Center	13.52	13.52	13.52	13.52	13.52	13.52	13.52	13.52	13.52	13.52	13.52	13.52
UCLrange	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86	30.86

Although the process seems to be within the natural control limits, the pattern shows an erratic pattern in the cycle time for auto credit process and high variability which means that its mean was placed beyond the 6-days specification limit. The graph explained that the mean and the range of the process need to be improved, by identifying and eliminating these normal causes of variation. The Control Charts and Capability Analysis were derived under the assumption of Normal distribution. The number of errors and the number of applications were evaluated in order to determine their possible impact on the cycle's times.

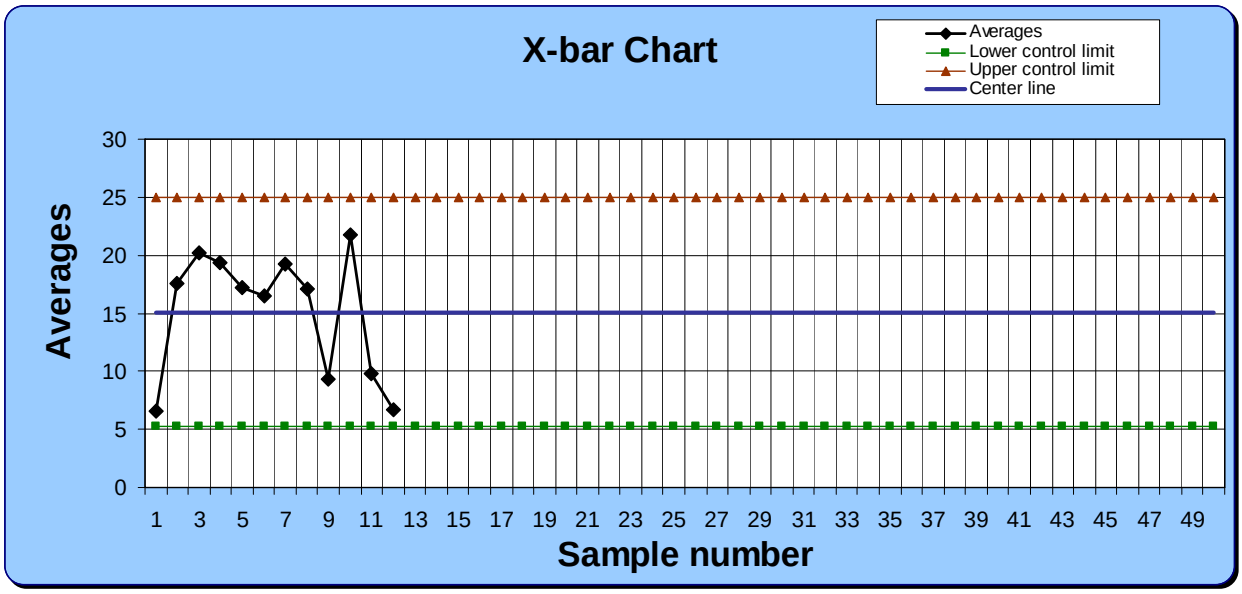


Figure 18. Auto Credit Process Average Chart

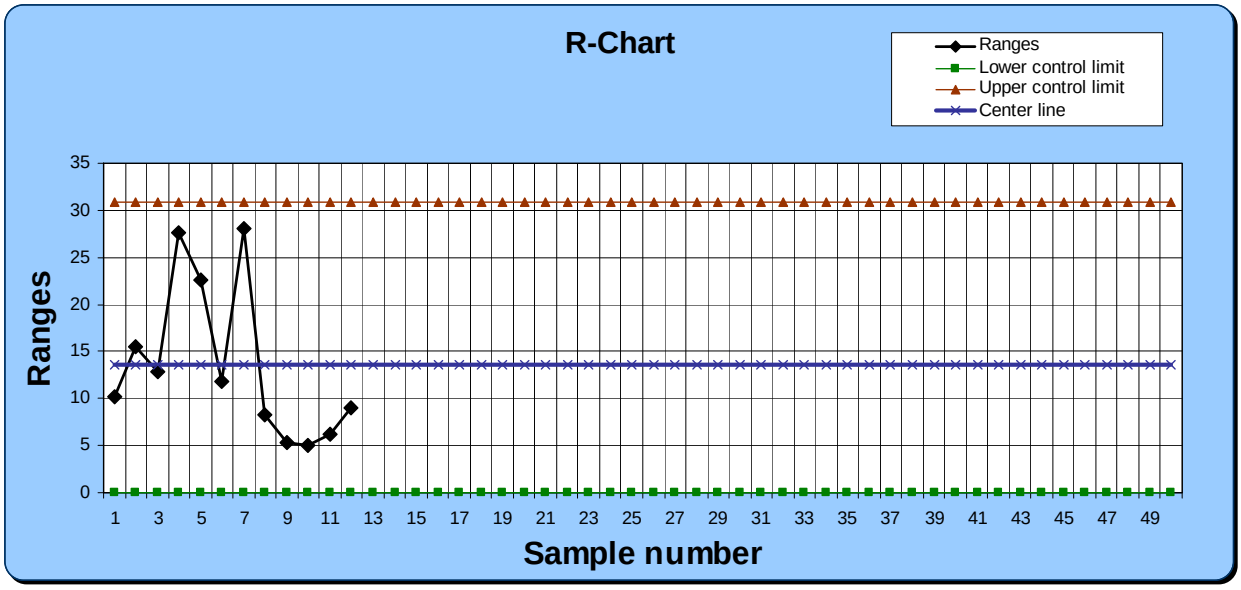


Figure 19. Auto Credit Range Chart

3. IMPROVE PHASE

The BSC goal was set at 2 days for the approval cycle time. The capability analysis and the statistical process graphs show a productivity improvement of 40% on the process cycle time for the approval and reimbursement phases of the auto credit (total cycle time) and a 100% increase rate on the number of auto loans analyzed. The next table describes the capability of the process for the approval cycle time during a timeframe from October 2006 to July 2007. Table 42, on page 178, is a summary of the improvements for the auto credit cycle time by July 2007.

Table 42. Process Capability Analysis of Approval CT from Oct-06 to Jul-07

Number of Samples(<=50)	12				
Sample size (2- 10)	4				
Grand Average	9.1359028				
		A2	D3	D4	d2
Avg. std. dev.	11.719167	0.73	0	2.28	2.06

Table 43. Process Capability (Oct 2006- to Jul 2007)

Process Capability Calculations						Six sigma	34.2
Upper specification	2					Cp	0.06
Lower specification	0					Cpu	-0.4
						Cpl	0.54
						Cpk	-0.4

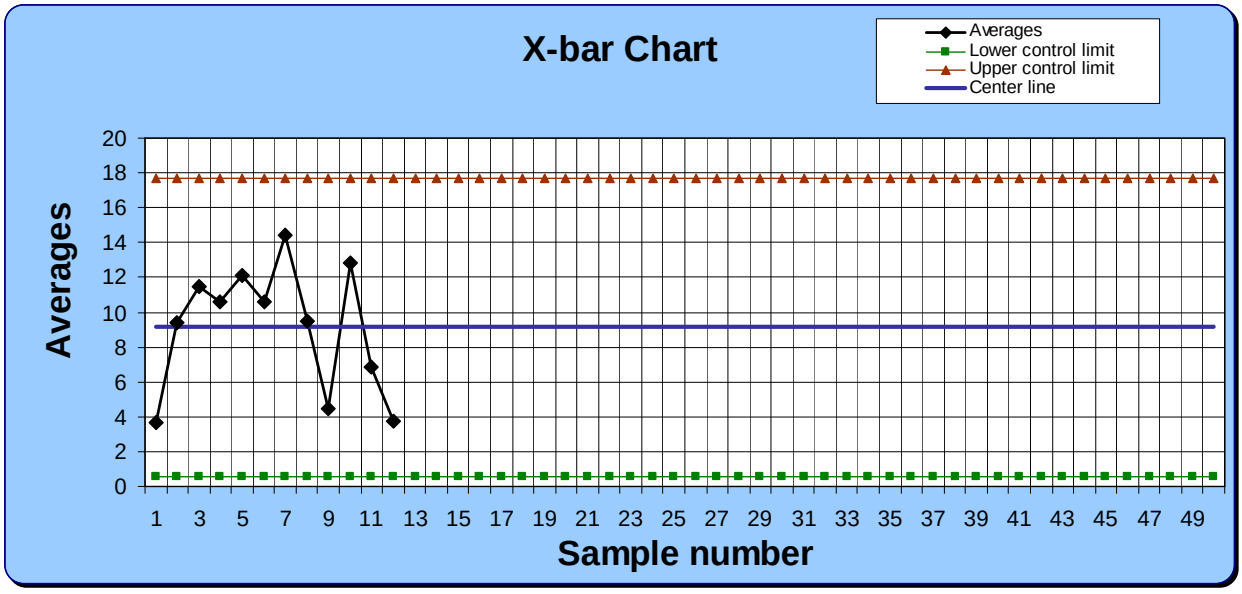


Figure 20. Approval Cycle Time-Average Control Chart (Oct 06-Jul 07)

The capability analysis requires the data fit the Normal distribution. The results of the test indicate the data fit the Normal distribution. But the process is not capable of meeting the 2 days specification for the approval process. The condition of the lack of control of the process and the high variability prevented for doing more capability analysis, since all the evidence indicates that first it is necessary for the process to be in statistical control, and then perform the capability analysis.

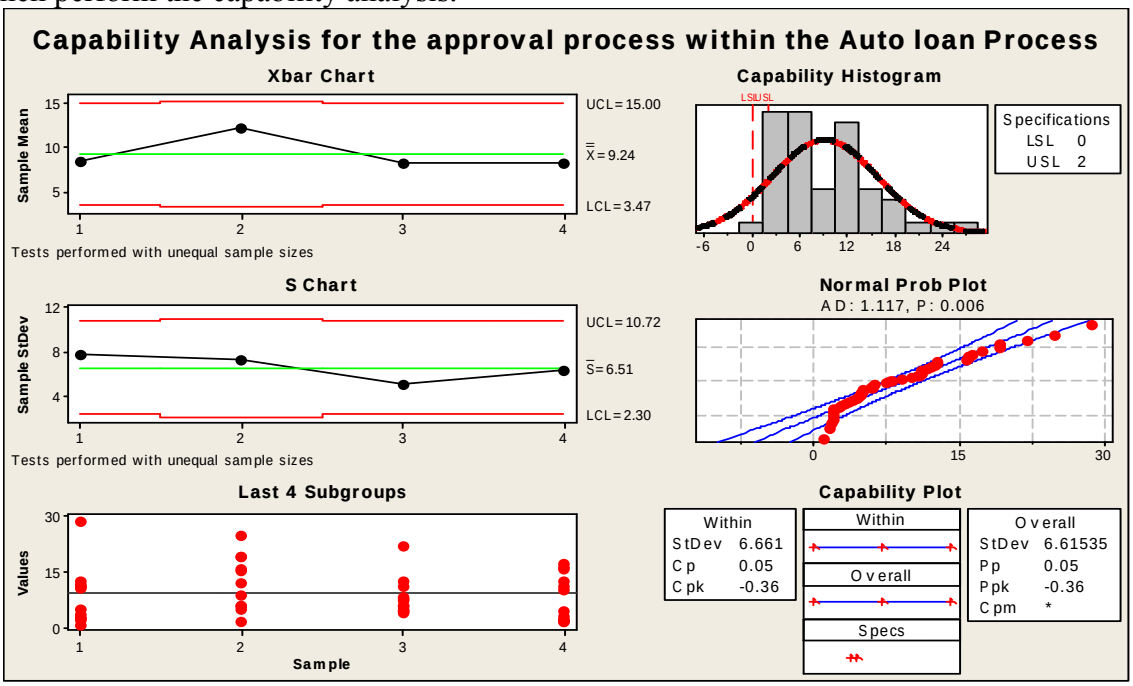


Figure 21. Capability Analysis for approval cycle time (sep/06-may/07)

In order to detect waste and cause of failure in the process a traditional failure analysis tool was combined with the SIPOC tool. By combining these two tools, it was possible to detect failures during the process flow for further analysis. See results on the next tables.

Table 44. SIPOC-Failure Analysis Tool

	ACTORS	PROCESS CAUSES OF PROBLEMS	EFFECTS
1	EXTERNAL CUSTOMER	LACK OF REQUIREMENT	DELAY ON THE PROCESS
2	ACCOUNT EXECUTIVE	MISTAKE ON ELECTRONIC APPLICATION SETUP	REWORK
3	AGENCY MANAGER	TRANSACTION REVIEW	DELAY ON DECISION
4	CREDIT ANALYST	MISTAKE ON GETTING APPLICATION FROM DETAL AGENCY	DELAY ON THE PROCESS/ REWORK
5	CREDIT COORDINATOR	LACK OF TRACKING AND COMMUNICATION CAPABILITIES	REWORK
6	RISK DEPARTMENT	MISTAKE ON THE APPLICATION SETUP ON THE SYSTEM	DELAY ON THE PROCESS
7	RISK DEPARTMENT	INCOMPLETE FILE FROM CREDIT COORDINATION	DELAY DUE TO REWORK ON THE PROCESS
8	CAR DEALER	CAR DEALER AFFILIATION PROCESS	DOCUMENT EDITION DELAYED

APPENDIX B: E-LEARNING, E-COMMUNICATIONS FORMS

Project #1. Decrease the cycle time for the
Approval and reimbursement of the auto credit product
at Institution Z.
Project Six Sigma No.1
STUDY GUIDE #1
SIX SIGMA FUNDAMENTAL AND
GENERAL METHDOLOGY

ACTIVITY OBJECTIVE:
At the end of the activity, participants will recognize the fundamentals of a Six Sigma project, providing their knowledge and enthusiasms to compleate a project.
The project will be made with the participation of all team members who through this activity will be able to use some six sigma tools.
At the end of this activity, the participants will be able to apply the 6 Sigma methodology and Green Belt tools to solve problems in the auto credit process at Institution Z

What is a Six Sigma project?

A Six Sigma project, as well as any project has an objective that need to be reached during a specific timeframe and with limited resources. Additionally, a six sigma project's objective is related to eliminate a defect, or a problem that is translated to the customer

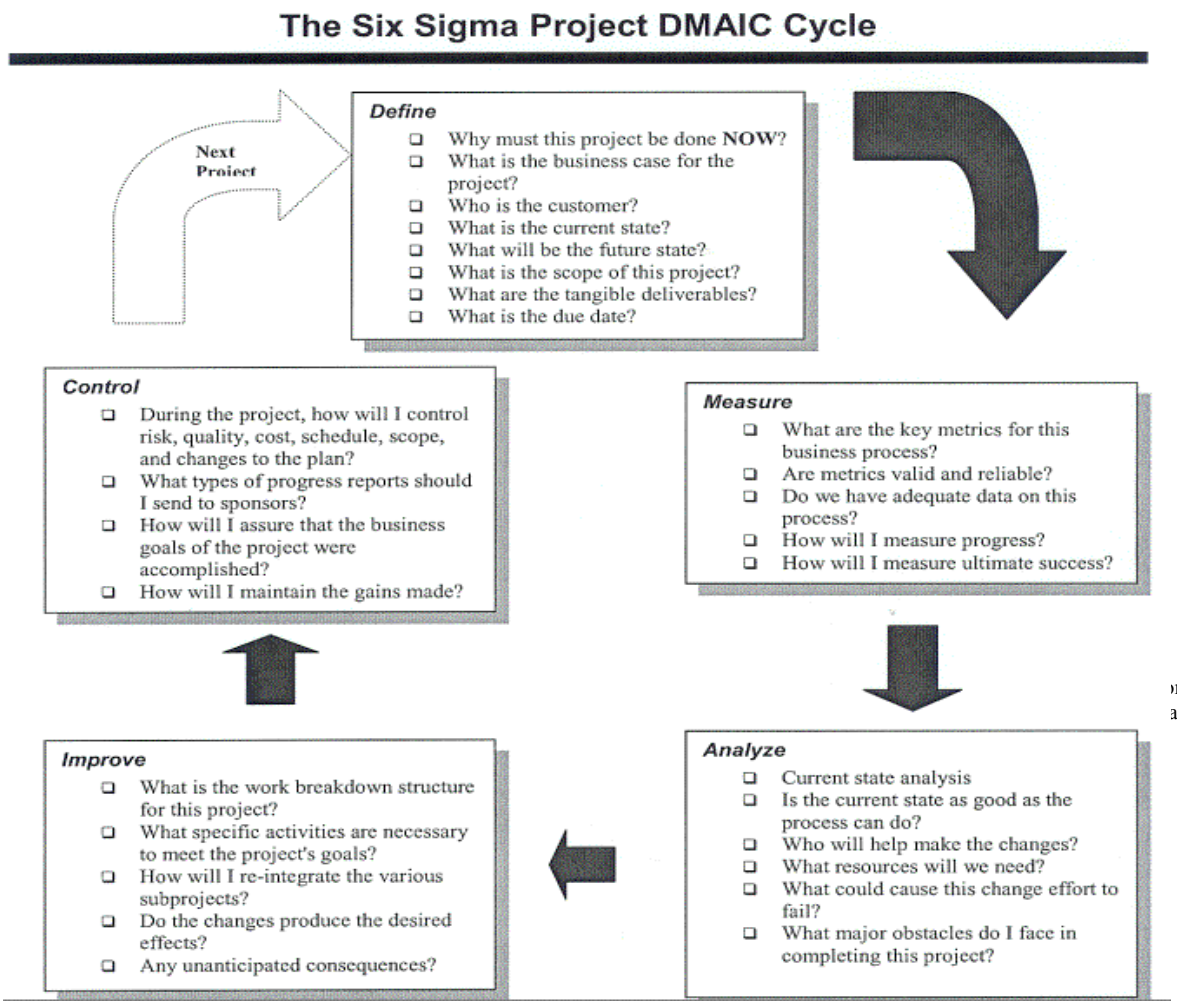
Six Sigma provides a Blueprint for implementation of a total quality management, the integration of human and process elements of improvements. The six sigma advantages is that it offers a methodology and statistical tools that guide in the problem solving paths and in finding sustainable solutions

Problem: any deviation between what "should be" and what "is" that is important enough to need correcting
Problem Solving: the activity associated with changing the state of what "is" to what "should be. In this project the problems is the delay of the approval and reimbursement for the auto credit process. It is "what is right now, around 25 working days"
The six sigma methodology is know as DMAIC; Define, Measure, Analyze, Improve and Control. A graph with explanations of each phases fallows.

METHODOLOGY TO BE APPLIED

The methodology to be applied during the auto credit project is based on the six sigma framework or DMAIC. Accordingly, the first step is the define phase, so the first study guide is the Define phase. During this phase the principal output is a project charter. At the beginning of each teleconference and/or by internet chat, we, as a team, will discuss some basic concepts, and start preparing the project charter.

In order to get a better understanding, each team member should have loaded on their computers, the template of each one of the six sigma tools facilitated by the team leader, the study guide and the data and information requested to each session.



HOW TO DESIGN PERFORMANCE INDICATORS
STUDY GUIDE #6

DESIGN PERFORMANCE INDICATORS PROCESS**.**
GENERAL OBJECTIVE

Design a performance indicator system that will be able to explain the current performance of the auto credit process and how it will be able to react to predictable future conditions.

GENERAL METHODOLOGY

During the process of design of the performance indicators you will be asked to fill out a template that guides you through getting the activity's objectives. Please be patient and fill out each cell one by one.

ACTIVITY: PRIORITIZAR PERFORMANCE INDICATORS

1. **ACTION #1**: Evaluate the new process from start to end, based on the new structure of the company.

Tools:

Process Flow Chart or Process Map:
Detail Description document: A detailed description of the process in a separate paragraph

2. ACTION **#2**: ASSIGN PERFORMANCE INDICATOR' NAMES
List the name of performance indicators and fill out next tables to determine the expectation of each management level. The objective of the activity is identified what need to be measured to satisfied shareholders' needs.
In order to complete this exercise you will be asked to determine and to assign a weight for each shareholder, which describes the importance of the performance indicator to each partner of the process.

Finally, you will be asked to add 0, 5 or 10 points to the weight of each performance according to its relation with the strategic goals of the BSC, that is to say:
1. Related and expressed in the BSC..... 10 points
2. Moderately related to the BSC..... 5 points
3. Not related to the BSC ..... 0 points

3. ACTION # 3: CLASSIFICATION OF INDICATORS
Three types of management indicators will be defined (see cell A1)
Measurement of results
Measurement of diagnose
Measurement of competition or capacity to respond to future conditions

Another Classification to take into account is: (see cell A2)
Direct quantitative indicator
Indirect indicator.

4. ACTION # 4: ESTABLISH DATA CHARACTERISTICS

Determine data availability for each one of the selected indicators (see cell A3)
Determine the degree of exactitude of the data and the objective of the indicator.
Assign responsibilities for data gathering and reporting problems. (See cell A4)

5. ACTION #5: ESTABLISH DATA SECURITY.
Decide where the data will be kept: Software and data backup. (See cell A5)

Six Sigma Meeting Agenda

Project Name Del Sur Banca Universal-Credito Vehicular	
Project Goal:	Date
	Time:
	Location

Team assistance		
Team' Member	Role	√
	Leader	√

Points to be discussed	Action	Assigned to	Time
Task to be done			
Task	Action	Assigned to	Due date

AUTO CREDIT
APPROVAL AND REIMBURSEMENT PROCESS

Process from February to August 2007

This document has the purpose of describing the present procedure for the approval and Reimbursement of these Vehicles credits as well as the description of the process to be defined for itself for its suitable implementation

Present process
Request/Approval/Reimbursement
Agency receives file with the request of auto credit by the client, then proceeds to registers it in the credit platform and sends file to the credit coordination.
(Time approx of a day 01)

Control and Approval
The Coordination of credit receive file from the agency and review the credit request on the credit platform against the received file, check certainties and references and prepare files for the respective committee.
Committee approves or denies the presented/displayed credits. (Time approx two days 02)

Notification to the client and concessionaire
Coordination of credit once received the answer of the committee notifies the respective agency, then agency completes the letter of approval with the data of the approval of the credit, and notifies the client and gives this letter to him.
Client brings to the concessionaire the approval letter, pays the initial or down payment, and receives from the concessionaire the invoice and legal vehicle's documents. If the concessionaire or dealer is not affiliated to the bank, then the documentation needs to be brought to the agency. Agency receives the documentation and she sends it to the credit coordination. (Time approx two days 02)

Constitution of the Legal Document
Coordination of credit receives the documentation of the agency, loads the data of the vehicle in system, elaborates the document writing request and sends it to the Legal department. (Time approx a day 01)
Legal reviews the received documentation, drafts the credit document and sends the notarized document to Reimbursement. (Process approx two days 02)

Process of Reimbursement of the credit
Reimbursement reviews the signatures and seals of the document and sends it to credit coordination. (Process approx a day 01)
Coordination of credit receives the document and informs to the corresponding agency, agency notifies the client and the concessionaire, then the client brings the Policy of the vehicle to the agency, and the agency notifies to the coordination the issued date of the policy. (Time approx a day 01)

When the coordination of credit receives the data of the policy, they send a mail with the data of the payment and policy of the vehicle to the concessionaire. (Time approx a day 01)
Reimbursement receives file, reviews that it contains: Policy, Companies, original Invoice, certificate of origin, and mode of payment, to prepare a check emission. (Process approx a day 01)

Concessionaire's payment process
Agency elaborates the checks and the borrower client goes to the concessionaire.
Concessionaire receives the payment and signs the document, client bring the down payment in cash to the bank in the amount corresponding to the established by the notary's office.
Total Cycle Time: nine 09 working days.

Process approved by August 2007

Request/Approval/Reimbursement
Agency receives file with the request of credit by the client, and then continue to registers it in the credit platform and sends file to the credit coordination.
(Time approx of a day 01)

Control and Approval
The Coordination of credit receive file from the agency and review the credit request on the credit platform against the received file, check certainties and references and prepare files for the respective committee.
Committee approves or denies the presented/displayed credits. (Time approx two days 02)

Notification of Approval
If the credit is approved by the coordination, they send the approval letter and the legal transaction's template via electronic file to the concessionaire. The Agency notifies the client.
The client makes the down payment to the concessionaire and receives from the concessionaire the invoice, legal vehicle documents and the legal transaction's template signed and sealed by the concessionaire. (Time approx two days 02)

Process of Reimbursement of the credit

The Credit Coordination receives the compleate transaction package, load data to the information system and send it to legal department. (Time approx of a day 01)

Legal Department reviews the transaction package and if all the documentation is correct, they send the approval and file to reimbursement.
Reimbursement receives file, reviews that it contains: Policy, Companies, original Invoice, certificate of origin, and mode of payment, to prepare a check emission. (Process approx a day 01)

Concessionaire’s payment process

Agency receives the payment order, and then prepares the money order and go with the client to the concessionaire to make payments and collect final signatures.

Target total Cycle time, after approval: 4 working days

PARTIAL TRANSLATION OF THE
LEGAL DOCUMENT TEMPLATE TO REQUEST AUTO CREDIT LOAN AND TO BE FILLED BY CAR DEALERS

Between, the Mercantile Society----------. , domiciled in the city of ----------, State----, registered in the Mercantile Registry ----------of the Judicial Circumscription of ----------, State Miranda, in date----------, under the N°----, Volume----------, modified later its Social Statutes, counting like last the enrolled seat before the Mercantile Registry ----------of the Judicial Circumscription of ---------- of the State -------in date-------, low in Nº-----, Volume-----, in ahead denominated indifferently the ASSIGNING SALESMAN AND/OR, represented in this act by his----------, Venezuelan, of legal age, married, domiciled in the city of----------, State ---------- and to title of the Identity card N° V----------, sufficiently authorized for this act by ----------, on the one hand, and by the other----------, Venezuelan, of legal age, unmarried, domiciled in the city of----------, State---------- and to title of the Identity card Nº V----------, in the successive thing denominated the BUYER; and Institution Z UNIVERSAL BANK, C.A. (before the SOUTH C.A, Investment bank.), Banking Institute domiciled in the city of Caracas, registered originally in the Mercantile Registry First of the Judicial Circumscription of the Federal District and State Miranda, in date 10 of January of 1973, under Nº 5, Volume 18-A, later modified its Social Statutes, according to consists of document enrolled in the Mercantile Registry First of the Judicial Circumscription of the Capital District and State Miranda, day 30 of March of 2001, under Nº 19, Volume 59-A, changed its social denomination the present one and modified totally their Social Statutes, summaries in a single and only text, according to consist of enrolled document before the mentioned Mercantile Registry First of the Judicial Circumscription of the Capital District and State Miranda, in date 23 of November of 2001, under Nº 26, 223-TO-Pro Volume., later modified and summaries again in a single text by before already mentioned Mercantile Registry First of the Judicial Circumscription of the Capital District and State Miranda, in day in date 23 of November of 2,001, under Nº 26, 223-TO-Pro Volume., and identified in the Fiscal Registry of Information Nº RIF. J-00079723-4, upon ahead denominated INSTITUTION Z, represented in this act by its Special Proxy GUILLERMO RUBEN CASTILLO, Venezuelan, of legal age, unmarried, of this address and holder of the Identity card N° V-6.000.590, representation that consists of power of Attorney by the Subordinate Office of Public Registry of the Chacao Municipality of the State Miranda, in date 28 of November of 2001, under Nº 8, Volume 4, Protocol Third, has been agreed upon on credit celebrating the present sales contract with Title, which will be governed by following the clause:

I. DEFINITIONS: To the aims of one better understanding of the terms used in the present document, the following definitions are settled down:

1. SALES CONTRACT AND TITLE: It is the convention by virtue of which the ASSIGNING SALESMAN grant to INSTITUTION Z, the amount of the credit and the title contained in this document.

2. THE ASSIGNING SALESMAN: It is the Mercantile Society----------, above identified.

3. THE CESIONARIO /CREDIT INSTITUTION: It is Institution Z UNIVERSAL BANK, C.A., already identified.
4. THE BUYER AND/OR BAROWER: It is----------, above identified.
II. ABOUT THE SALE BY CREDIT WITH TITLE: The ASSIGNING SALESMAN sells on credit and with Title to the BUYER, the vehicle that is specified next, in accordance with the Certificate of Origin N---------- , sent by the National Institute of transportation of the republic Bolivariana of Venezuela: plate number_____, brand_____, model_____, year_____, color_____, serial ID_____, motor ID_____, type_____, weight, capacity_____. This vehicle is under the custody of the buyer or borrower according to the article 1.193 of the civil code.
IIII. Regarding to the price and Title, and payments mode. The total cost of the operation, FOB, to the wholesale administrator is _____Bs_____of down payment and the difference will be paid by a loan approved by Institution Z.
IV. Regarding the Title and the loan. The car dealer gives in a simple, direct and unchanged way the Title to Institution Z.

APPENDIX C: AUTO CREDIT PROJECT AFFIDAVIT

ASQ SIX SIGMA BLACK BELT CERTIFICATION PROJECT AFFIDAVIT/VERIFICATION FORM

Please see the explanation of how to fill out this form on the reverse side

One of the requirements for application approval to take ASQ's Six Sigma Black Belt certification exam is the demonstration of experience. Six Sigma Black Belt affidavit(s) must be completed and submitted attesting to that fact. Provide **two** signed affidavits attesting to the completion of **two** Six Sigma projects, signed by the project champion(s). If two Six Sigma projects have not been completed, **one** completed project will be allowed providing you have at least **three** years of work experience covered by the Six Sigma Black Belt Body of Knowledge (BOK).

- ❑ Check here if **two** projects have been completed.
- ❑ Check here for **one** completed project **and three years' experience**.
  If you have not completed at least one Six Sigma project, you will not be allowed to sit for this examination.

Completed, signed affidavits can be faxed to Certification Offerings at 414-298-2500; or e-mailed to cert@asq.org. The signed Six Sigma affidavit(s) must be received at ASQ within one week of receiving your application. If not, your application will be cancelled and a partial refund (less the application fee) will be returned to you.

1. Six Sigma Project completed by Adriana B. Rodriguez 63410239
(applicant's name, please print) *(member number)*

2. Six Sigma project title Automobile credit approval and Cosch Disbursements

3. Provide a brief description of the purpose of the project, and how it related to the business objective:
During the project the Six Sigma methodology was aligned to the BSC, the goal of the project was reduce by 70% the cycle time of the auto credit process and it is an business opportunity to reduce the response time of approval of any credit product,

4. Six Sigma project's start and completion dates by month/year: Oct /2006 –to→ August 2007

5. Provide a brief description of applicant's hands-on performance in completing Six Sigma project. Please include specific examples of tools used, i.e., process maps, metrics (DPU, DPMO, RTY), procedures, charts, etc. Do not send documentation.
Adriana B Rodriguez was the team leader, provided trainning in Six Sigma fundamentals, supervicized all team activities, was the team editor Perform statistical analysis and design performance metrics.

6. Provide a brief statement on the benefits achieved by the successful completion of the project, including but not limited to financial savings, labor, material costs, cycle-time reduction, etc.
- Reduce the number of non value-added activities from 132 to 67 (65% imp.)
- Decrease approval cycle time by 67% and total cycle time by 40%
- 600% Increase on the number of auto credit application processed

7. Verification of completion by project champion:
Verification form completed by: [signature] 19/10/2007
(project champion's signature) *(date signed)*

Champion's name José Luis Botomo Job title Strategic and Planning V.P.
Company name DEL SUR Banco Universal
Address Avenida Fco de Miranda. Torre Delta. P. B. Urb. "Altamira". Miranda State. VENEZUELA.
Project champion's e-mail address Jose.botomo@delsur.com.ve
Project champion's telephone 58-212-208-7323 Fax number

APPENDIX D: INITIAL PROGRAMMED SURVEY

Survey to Determine the Value Perception Usefulness of BSC/SSS Methodology within Institution Z:

The purpose of this document is allowing an accurate determination of the value perception relating to the usefulness and satisfaction resulting from the deployment of the BSC/SSS methodology by employees and managers within Institution Zs.

I am a PhD Candidate at the University of Central Florida possessing over ten years expertise in the academic field.

This document is part of research for a dissertation to complete my Doctoral Study in Industrial Engineering and Management System focused in studying whether the alignment between Strategy, improvement performance and customer satisfaction, by merging BSC and Six Sigma methodology bring value at the Management, Employee, Customer and Productivity level of a service Organization.

The way you will be approached will either have been by email notifications, and by accessing a server from your work in Institution Z. In order for me to get full benefit from this study, I have no interest in your identity and feel that this should facilitate a more candid response.

In order to get most benefit, this survey should ideally be completed by all employees and managers at the Banking Unit, Electronic Banking unit, Risk Support unit, Credit Products units and at the VP level of the Institution.

The deadline for responses is Friday 10th August 2007.

My research will be completed by the start of December 2007 and I will be disseminating the finding of my research to those people who contributed to my surveys within the first two weeks of that month, through the channel by which you received notification of this survey.

I expect this research to be of value to the strategic and management functions, regardless of industry and/or geographic location.

I would like to thank you for your time and participation in this research, and hope that my research is of use to you.

Kind regards,

Adriana B. Rodriguez

CONSTRUCT	DEFINITION	VARIABLE CATEGORY	MEASUREMENT ITEMS
MANAGEMENT SATISFACTION AND USEFULNESS		Perceptual measures of net Benefit from "SSS" use	How would you rank the overall level of benefit derived by your organization from the current methodology (BSC/SSS) on a scale of: Using the current methodology enable you to accomplish manager-employees related task more quickly Using the current methodology enhances my effectiveness in coach daily employee activities Using the current methodology enhances my effectiveness in communicate the strategic goals of the Organization
		Ability to control and assess performance	How would you rank your actual methodology ability to measure the business units effort/ performance objectively?
		Ability to foster employee commitment to Strategic Goals	How would you rank the overall commitment level of your organization to reach BSC goals? How would you rank the current methodology capability to clearly communicate to employee the strategic goals of your organization? In which level do you believe employee involvement is important to set up measurable goals? A which level Do the methodology encourage employee participating to reach strategic Goals How would you rank your employee commitment level to reach Units' strategic Goals? Do you believe your actual bonus employee system tied to BSC goals increase the commitment level of your employees?
EMPLOYEE PERCEIVED USEFULNESS	It will measure the impact of the alignment model at the perceived employee levels	Perceptual measures of net Benefits from "BSC/SSS" use	In which level does the actual methodology BSC/SSS improve your job performance? In which level does the actual methodology BSC/SSS increase my productivity? In which level do the actual methodology BSC/SSS enhances my effectiveness on the Job? In which level does the actual methodology BSC/SSS make me easier to do my Job? In which level do the BSC targets are related to your daily efforts activities? In which level do the BSC corporative targets are well communicate through all level of the organization? In which level do the actual BSC/SSS goals are achievable with the current level of performance of your organization? Do you believe your efforts can be objectively measure? Do you believe your performance level is related with the department bonus your unit gained? Do you understand how do you contribute with your units and organization goals? Do you think the methodology allow you to help your unit reach their goals with your efforts? Do you believe you can meet your job requirements?
		Participation Involvement	How many times do you have participated on the set up process of your business unit goals and targets? In how many improvement teams have you be part of? How many activities of your daily work are related to team efforts? How many times have you meet with your supervisor/Managers to suggest improvement on the processes? How may times have you suggested improvement for the processes where you work? How many times do you formally have recommended changes on your business processes? How many times have you participated in formal meetings to evaluate the performance of your BUs? How many times have you participated in informal meetings to

CONSTRUCT	DEFINITION	VARIABLE CATEGORY	MEASUREMENT ITEMS
			evaluate the performance of your BUs? How many times have you discussed with your peers possible recommendations for process improvements? In which level the BSC/SSS methodology encourage you in participating in improvement initiatives?
		User Satisfaction	How would you rate your satisfaction with BSC/SSS methodology?

D1	What unit do you work in?	Select
	Banking Units	☐
	Electronic Banking Units	☐
	Risk Support Unit	☐
	Credit Product Unit	☐
		☐
	Other (Please Specify)	
	How many years have you been working with the Institution Z?	
	1 to 2 years	☐
	2 to 4 years	☐
	More than 5 years	☐
D2	Do you have direct contact with the customer:	Select
	Yes	☐
	No	☐
	N	☐
		☐
D3	What is your company's geographical area of operation?	Select
	West Regions	☐
	East Region	☐
	Central Region	☐
	All Regions	☐
		☐
		☐

Table 45. Survey of SSS Evaluation.

Name:					
Age:					
Gender:					
For each item identified below, circle the number to the right that best fits your judgment of how the implementation of the Six Sigma Scorecard accomplishes the target. Use the scale above to select the quality number.					
Description/Identification of Survey Item	Scale				
	Poor	Good			Excellent
CONNECT TO STRATEGY	1	2	3	4	5
CONNECT TO DAY TO DAY ACTIVITIES	1	2	3	4	5
TRACKING CAPABILITIES	1	2	3	4	5
FORECAST CAPABILITIES	1	2	3	4	5
MEASURES/CONTROL	1	2	3	4	5
TEAM EFFORT	1	2	3	4	5
MATRIX TEAM	1	2	3	4	5
COST/SAVINGS	1	2	3	4	5
PRODUCTIVITY TARGETS REACHED	1	2	3	4	5
PERFORMANCE TARGETS REACHED	1	2	3	4	5
EMPLOYEE ENGAGED, INVOLVEMENT, COMMITMENT	1	2	3	4	5
RESOLVES PRACTICAL PROBLEMS	1	2	3	4	5

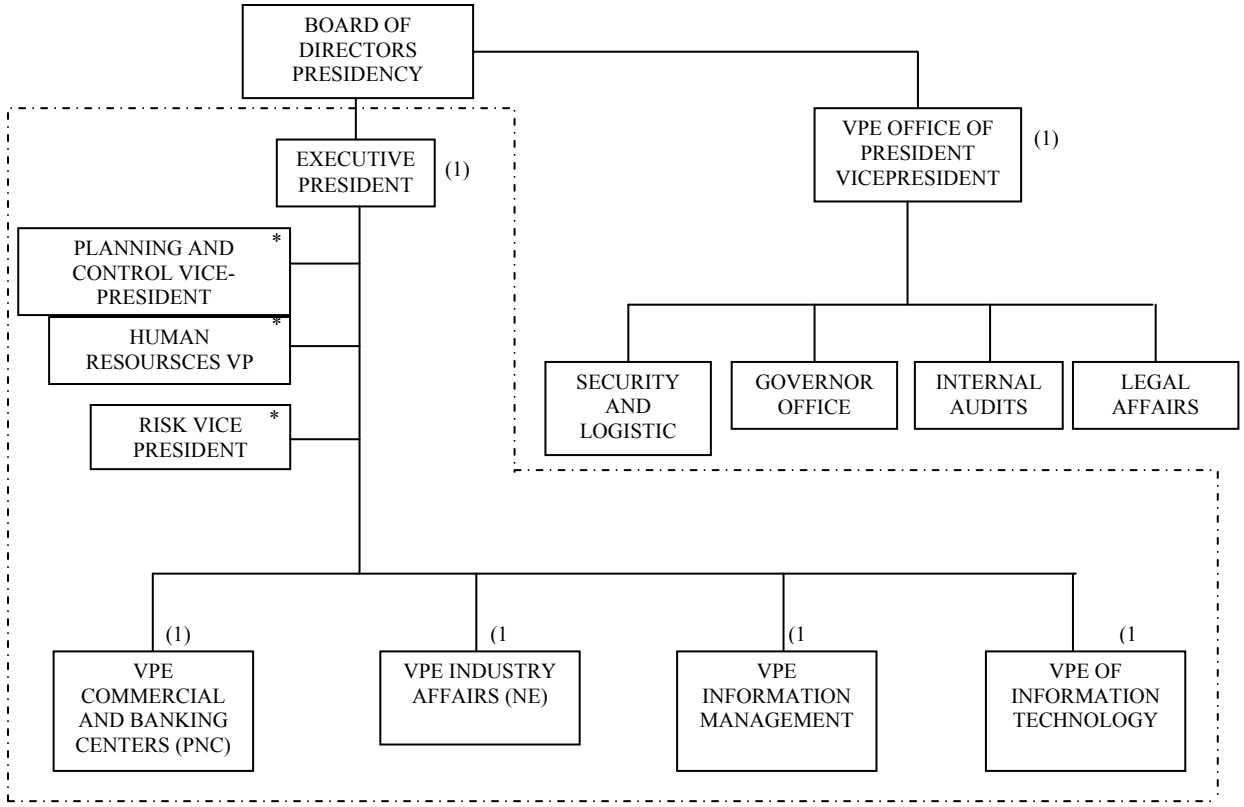
APPENDIX E: INSTITUTION Z ARCHIVAL RECORDS

BALANCED SCORECARDS BY BUSINESS UNITS:

BANKING CENTERS "BSC"		TARGET REACHED	RISK BANKING CENTER UNIT "BSC"		TARGET REACHED
Objectives	Metrics		Objectives	Metrics	
1. Decrease the gap between ideal skilled job functions and staff's competencies.	Graphic 1	74%	1. Decrease the gap between ideal skilled job functions and staff's competencies. 2. Evaluate organizational climate.	Graphic 1	100%
1. Increase quality of products. 2. Meet capital clearances' requirements.	1. Answer cycle Time= 6-7 days.	73%	1. End testing phase of the "Credisur" product	Answer cycle Time	Not provided
1. Increase number of new customers	1. Number new customer=33. 2. No of TDC= 10. 3. No Crediplus=3. 4. Number CreditCon=3. 5. NoCADIVI=	77%	1. Decrease cycle time for approval and cashing of credit products.	Answer cycle time.	85%
1. Increase number of Credit Products	1. Number microcredit=20. 2. Number commercial=80, 3. Number creditAuto=25. 4. Number creditCash=5. 5. Number Credit Plus= 8. 6. Number saving account=100. 7. Number checking account=50	100%	1. Decrease overhead cost.		100%

RISK SUPPORT UNIT"BSC"			ELECTRONIC BANK UNIT "BSC"			
Objectives	Metrics	Target	Objective	Metrics	Target	TARGET REACHED
Evaluate organization structure			Decrease the gap between ideal skilled job functions and staff's competencies.			7%
1. Prevent and Control process related to capital clearances. 2. Evaluate delinquency payments	Cycle time to legal		Decrease Cycle Time of Cashing	Cycle Time		53%
1. Keep answer cycle time for credit products for people within 2 days	Cycle time	ACT=< 2 days	1. Decrease Answer time for Debit Card Complaints. 2. Decrease number of debit card complaints	Answer cycle time	ACC = <5 days (TDD) ACC=<7 days (S7B)	19%
1. Decrease overhead cost. 2. Meet budget	Budget deviations (BD)	BD= 0%	1. Meet budget of operating Cost. 2. Decrease cost associated with delinquency complaints in debit card (TDD)			20%

INSTITUTION Z NEW ORGANIZATIONAL STRUCTURE-APPROVED ON MAY 2007



* Executive Staff Members

(1) Board of Director Members

APPENDIX F: INSTITUTIONAL REVIEW BOARD LETTER

University of Central Florida

Office of Research & Commercialization

To: Adriana Rodriguez
Graduate Student
From: UCF Institutional Review Board
Re: IRB Determination Letter
Date: 04/12/08

Dear Mrs. Rodriguez:

This letter is in reference to your Industrial Engineering and Management Systems dissertation, "A Framework to Align Strategy, Improvement Performance, and Customer Satisfaction Using an Integration of Six Sigma and Balanced Scorecard".

Thank you for submitting the information regarding your Doctoral dissertation, as requested by the IRB office. As you know, the IRB cannot approve your research because it was already completed prior to IRB review.

However, Dr. Ana Leon, IRB Vice-chair, reviewed the material and determined that if this proposal had been submitted to the IRB prior to conducting the research, it would have met the criteria for expedited review and likely would have been approved as being minimal risk to human subjects.

Much of the data collected did not meet the definition of human subjects research, but the audio-taped interviews with three company employees should have been reviewed and approved prior to data collection. You may not use the data collected for purposes other than for the submission of your dissertation at UCF. You cannot use the data for scholarly publications or presentations outside UCF.

If you have questions, please phone the IRB office at 407-823-2901.

Cordially,

Ana Leon

Ana Leon, Ph.D.
UCF IRB Vice-chair

Copy: IRB files – student permission
Linda Malone, Ph.D., Industrial Engineering & Management Systems
Waldemar Karwowski, Ph.D., Department Chair
Dean Neal Gallagher, College of Engineering & Computer Science

12201 Research Parkway • Suite 501 • Orlando, FL 32826-3246 • 407-823-3778 • Fax 407-823-3299

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