Key Performance Indicators, Six Sigma, and Data Mining

Data Driven Decision Making for Financial Institutions
Table of Contents

Executive Summary .......................................................................................................................... 4

Key Performance Indicators: Frameworks for Action ................................................................. 6
   Productivity Improvement Drives Wealth Creation ................................................................. 6
   Metrics Matter ......................................................................................................................... 6
   What Gets Measured Gets Done ............................................................................................ 8
   Creating Relevant Metrics ..................................................................................................... 9
   Creating KPIs and Tracking Performance Against Them .................................................... 9
   KPIs As “Opportunity Areas”; Six Sigma Fit ........................................................................ 10
   Six Sigma Overview ............................................................................................................. 11
   Six Sigma Business Value Benefits and Methodology ....................................................... 11
   The Expanding Orbit of Six Sigma Related To KPIs ............................................................ 13
   DMAIC in the Expanding Six Sigma Environment ............................................................... 16
   Putting Business Processes Under The Six Sigma Microscope ........................................... 17
   Illustrative Business Processes Affected By Six Sigma (By Function) ............................... 17
   Illustrative Business Processes Affected By Six Sigma (By Industry) ............................... 19
   Integrating KPIs and Six Sigma ........................................................................................... 19
   Needs for Measurement Tools; Data Mining Fit ................................................................. 20

KPIs, Six Sigma and Data Mining: Process Optimization to The Power of Three .................. 20
   Data Mining Overview .......................................................................................................... 20
   The Data Mining Process ...................................................................................................... 21
   Using Data Mining Insight To Improve Corporate Performance ......................................... 22
   Data Mining Connections with KPI and 6 Sigma Based Management Systems ................ 24
   Leveraging Six Sigma and Data Mining Skill Sets ............................................................... 25
      Domain Knowledge .......................................................................................................... 25
      Project Management ......................................................................................................... 25
      Analysis Skills ................................................................................................................. 25
      IT and Data Competencies ............................................................................................... 26
   Leveraging Enterprise Systems ............................................................................................ 26
      Typical Corporate Environments ...................................................................................... 26
      G2500 Organization Environments .................................................................................. 28
Financial Services Organizations: Applying KPI, 6 Sigma and Data Mining Principles to Boost Productivity

Getting Specific On KPI Selection ........................................................................................................ 29
Applying the Six Sigma Treatment To KPIs To Eliminate Defects.............................................. 30
Using Data Mining to Accelerate Analysis and Results................................................................. 31

Conclusion...................................................................................................................................... 32
Executive Summary

Productivity gains through continuous process improvement can contribute to profitability by supporting both revenue growth and cost reduction. In this context, leading organizations increasingly emphasize continuous process improvement through “data driven decision-making” to achieve these benefits.

This white paper focuses on three specific management systems at the core of process optimization initiatives, each with their own jargon, methodologies and tools:

- **Key Performance Indicators (KPIs)** – with its emphasis on establishing and communicating targets for operating performance and benchmarking actual performance against them.¹
- **Six Sigma** – with its emphasis on identification of opportunities for eliminating defects as a means of achieving continuous improvement in core business processes².
- **Data Mining** – with its emphasis on learning from the past and predicting future performance with higher confidence through continuous analysis of operational data from diverse sources.³

KPIs, Six Sigma, and Data Mining management systems, methodologies and tools are closely related. An understanding of these relationships can help organizations accelerate productivity gains in their operations and thereby improve profitability.

This white paper summarizes these relationships and illustrates how these business value benefits are achieved. It provides a framework for discussion about (i) how KPIs are made relevant and actionable within organizations; (ii) how “6 Sigma” process optimization initiatives linked to KPIs are broadening to enable improved “data driven decision-making” well outside their traditional “quality assurance” boundaries; and (iii) how data mining processes support the variability in experience between performance achievements and target performance goals (from a KPI standpoint) and enable organizations to maximize “opportunities” for “defect reduction” (in 6 Sigma language).

This white paper illustrates how data mining is both logically and practically connected with KPI and Six Sigma based management systems and outlines a more systemic approach organizations can use to

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¹ Key Performance Indicators” or “Balanced Scorecards” incorporating both financial and non-financial measurement categories to achieve operational and strategic goals are a common “top down” management objective. These systems are typically based on Identifying financial, business process, customer satisfaction and internal development metrics that support corporate goals, selecting lagging (outcome) and leading (performance driver) measures that drive operational performance and achievement of these results, and establishing systems and procedures to track variations in performance and adjust performance metrics.

² Six Sigma has been traditionally used primarily in manufacturing industries, and with an orientation towards product defects, quality improvement and production optimization. Many organizations across numerous industry verticals have embraced these principles with their systemic emphasis on “Define, Measure, Analyze, Improve, and Control”.

³ Data mining involves the use of methodology and software tools to analyze data assets to identify patterns, causal relationships and anomalies that impact on business performance (to reduce fraud, reduce product defects, tighten credit rules etc) and to make this knowledge actionable within the enterprise to improve business rules that drive revenue growth, cost containment and risk reduction through model deployment in the form of “reports”, “scores” etc.
apply KPIs, Six Sigma principles and data mining tools in the context of process optimization initiatives. Key Performance Indicators define "opportunity areas" or focus areas for process improvements. Six Sigma initiatives incorporate a rigorous “DMAIC” based methodology of experimentation, analysis and assessment to reduce variability between target and actual performance outcomes. Data mining provides robust, efficient analytical tools and techniques that can be used to identify drivers of both success and failure in eliminating variability from expected performance.

The schematic below (Figure 1) summarizes the business process relationships between senior management (executives), line of business | business unit management (managers), and personnel (analysts and business teams) through which this integrated, systemic approach is implemented. This approach enables productivity gains through continuous evaluation of actual versus expected performance of KPI based metrics and continuous “root cause” analysis of variability in results and their causes applying Six Sigma principles and data mining tools.

These relationships can be viewed in terms of primary activities, players and roles as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>Primary Activity</th>
<th>Players</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPIs</td>
<td>Setting: Targets and Standards</td>
<td>Management leaders</td>
<td>Setting transparent goals; ensuring focus on improvement; communicating results; maintaining support</td>
</tr>
<tr>
<td>6 Sigma</td>
<td>Acting: Actual to Target Performance</td>
<td>Line of Business Personnel</td>
<td>Achieving improvements in performance; Measuring performance against goals; Identifying opportunities for defect reduction</td>
</tr>
<tr>
<td>Data Mining</td>
<td>Analyzing: Assessing for variability</td>
<td>Analysts</td>
<td>Identifying reasons for variability; assisting in the elimination of defects; monitoring and evaluating performance improvements</td>
</tr>
</tbody>
</table>
In this white paper we explore these relationships, personnel and roles. We move beyond traditional “quality assurance” centered applications of Six Sigma to a broader range of business processes across different industries. We also take business processes in one industry (financial services) as an illustrative example of activity areas where this integrated systemic approach can leverage data mining for real business value. We suggest that organizations integrating KPI, Six Sigma and Data Mining based initiatives more systemically are likely to outperform peer group companies over the medium to longer term from the perspectives of revenue growth, cost reduction and process optimization.

**Key Performance Indicators: Frameworks for Action**

**Productivity Improvement Drives Wealth Creation**

The production process for any good or service involves (i) the various inputs (capital, labor, raw materials, “know how” and technology etc) required by an organization to produce the output (the finished good or service); and (ii) the process of transforming and adding value to the inputs and delivering the outputs in desired form for current and future consumers. This production process creates chains of economic activity that are pervasive across the economy. Virtually all organizations are simultaneously producers and consumers. Reduced to essentials, businesses exist to generate wealth – most commonly measured as “return on investment”. Wealth gains are driven largely by productivity improvements. Productivity improvements specifically focus on applying management skills to eliminate inefficiency and maximize value adds through optimization of each phase of the production process reflected in these chains of economic activity.

**Metrics Matter**

In this context, data is the starting point. It is no surprise that in assessing productivity and identifying opportunities for process improvement, most organizations are driven by “key performance indicators”, whether or not they identify them as such. Obvious “macro” examples include revenue, cost or profit targets established under business plans, revenue forecasts, capital expense budgets, and the like. However, these macro indicators are largely driven by the “roll up” of a wide variety of internal “micro” business processes, objectives and activities that reflect the inputs to the organization’s production process and the process of transforming them. In addition, express or implied by any “key performance indicator” are directional goals or objectives reflecting the view that as part of its continuous process improvement, these indicators will (ideally) improve.
Examples include the following:

<table>
<thead>
<tr>
<th>Area</th>
<th>Illustrative KPI</th>
<th>Express / Implicit Goal or Objective</th>
</tr>
</thead>
</table>
| Financial Indicators | Revenues (or profits) / employee ($)  
Revenues (or profits) / assets (%)  
Revenues (or profits) / customer Profit margin  
Cash flow             | Grow revenues (profit) per employee  
Grow revenues (profits) per asset  
Grow revenues (profits) per employee Boost profit margin  
Improve cash flow       |
| Process Indicators | On time delivery (%)  
Inventory turnover (#)  
Productivity per employee (%)  
Administrative expense ($)  
Production lead time (Days)  
Production down time (Hours) | Improve on time delivery  
Accelerate turnover rate  
Improve productivity  
Reduce (absolute or relative to revenues)  
Reduce lead time  
Reduce down time        |
| Customer Indicators | Number of customers (#)  
Estimated Market share (%)  
Sales per customer ($)  
Sales closed versus opportunities tracked  
Number of customer interactions / sales rep  
Customer loyalty index  
Customer defection rate | Grow customer base  
Achieve target market share  
Grow sales per customer  
Improve close ratios  
Grow (Reduce) customer interactions  
Improve loyalty index  
Reduce customer defection rate |
| Personnel Indicators | Leadership Index  
Employee turnover  
Training programs effectiveness  
Employee satisfaction index  
Absenteism and Health Care | Grow leadership team  
Reduce employee turnover  
Improve training programs  
Improve employee satisfaction  
Reduce rates and costs |

Metrics such as these are useful management tools, providing benchmarks and frameworks for action across the organization designed to ensure business success through performance at or above the thresholds they provide. These key performance indicators drive everything from prestige and industry peer group assessment, to an organization’s internal compensation plans.
What Gets Measured Gets Done

Because KPIs are both directional and management led; they tend to focus corporate energy and activity towards achievement of the goals and objectives express or implied by the benchmarks that have been set. This indicates both the strengths and weaknesses of KPI based management systems. In general, within organizations personnel focus on business initiatives that are “visible”. If management of the organization is focused on a particular product, region, trend or issue this management focus tends to permeate the organization.

The notion that “what gets measured, gets done” summarizes this view. By focusing on KPIs, management can harness the support of personnel across the organization to achieve performance improvements (i.e. moving actual performance in the context of measured key performance indicators closer to target or desired performance). The most significant “key performance indicators” tend, in fact, to become a part of the organization’s mission statement and company culture. However, the focus on a “key performance indicator” says nothing about actual performance, expected performance or productivity gains that may result. Implicit in the concept of KPIs is the notion that organizations know what can or should be measured. This is often a much more complicated task then it seems, even in organizations which have good quality operational data (and many don’t).

Misplaced emphasis on KPIs can have a neutral to negative impact on productivity improvement, and lead to loss of support for the more fundamental process of continuous productivity improvement that drives KPIs through alienation of personnel and other stakeholders affected by the process. Moreover, since “what gets measured, tends to get done”, a flawed approach to performance management can have entirely the opposite of its intended effects. The process of establishing and monitoring “key performance indicators”, then, creates both opportunities and challenges for organizations intending to establish measures that can be used to gauge corporate performance.

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4 The focus of GE, Ford and other organizations on “6 Sigma initiatives” as a touchstone for productivity improvement and defect reduction, for example, are simple illustrations of how corporate leadership can direct this process; other examples would include Citigroup’s focus on “serving 1 billion customers by the year 2012”.

5 Criticisms of KPI based management systems include (a) a misplaced focus on what goes into the process (cost reduction) rather than what comes out (productivity); (b) poor understanding of the relationship among the combination of materials, labor, knowledge and capital inputs that provide the value the customer pays for in assessing efficiency issues; and (c) the failure to include operational and process factors such as system design, communications, information availability, accuracy and transparency, process time and issues such as safety, morale, housekeeping etc which impact on how the process actually works.
Creating Relevant Metrics

As many organizations have learned, KPI based management systems must be based on the selection of measures relevant to the people using them to be effective. Relevance comes by enabling personnel to participate in the creation of these measures, and by empowering them with real opportunities, tools and information in their business units and day-to-day working lives to assist in shaping process improvements around these measures.

Organizations that use “macro” measures (such as growth in consolidated sales and market share, net profit and return on assets, average cost per unit etc.) are selecting indicators that are irrelevant to the day to day work experience of virtually all personnel outside the executive suite. These measures, and the variability of the organization in achieving them, do little to empower personnel to identify areas requiring improvement and to identify the specific cost savings and quality improvements, which result from their efforts. Measures oriented to the actual needs, abilities and capabilities of personnel, as well as systems and processes that support and empower them to measure performance and progress against them, are likely to have more significant and lasting impact. Significant positive benefits can be realized by moving from overbroad or coarse measures of organizational performance to more granular approaches directly linked to the underlying business processes that impact on business success.

While a focus on “share price” or “top line revenue growth” is largely irrelevant to the day to day work processes, for example, the various shipping departments of a large organization with globally distributed manufacturing operations, within their respective geographic and functional areas of operation, can play a role in the improvement of “on time delivery” of the organization’s products, equipped with the right systems, processes and tools to assess and improve their operations.

Creating KPIs and Tracking Performance Against Them

Even assuming that the “correct” measures are selected, the notion of “Key Performance Indicators” implies that organizations have the means to ensure effective adoption and communication of these indicators and appropriate systems in place to monitor the actual performance of the organization against target in achieving them. While this requirement does not sound particularly difficult, it can prove to be daunting in organizations with complex business and support systems infrastructures, the lack of a “common vocabulary” for their business processes, heterogeneous business and systems environments and the like. The challenge becomes more significant for organizations seeking to adopt

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6 One commentator suggests the following fundamental requirements:

- A broad set of measures which describe the strategic objectives and key areas for improvement that everyone in the organization needs to understand. (Key Areas)
- Each work group should examine its own work processes to develop a set of measures which describe how the group influences productivity across the key areas. (Measures)
- The process which groups use to identify their measures is just as important as the measures themselves. Managers can assist in the development of measures, but measures should not be handed down to work groups. (Autonomy)
- Measures should be believable, tested and adjusted based on facts. The measurement system is a tool which does not replace the need for proper assessment and good management.
more granular approaches to performance management because more business processes are being captured within KPI based management systems.

It is for this reason (among many others) that a variety of management information systems have emerged over the past 20 years to support this more "scientific" or "empirical" approach to business management. These systems provide the infrastructure necessary to support the process of measuring, tracking and communicating the results of KPI based management initiatives. Such systems have included:

- Relational database applications (promoted since the early 1980s)
- Enterprise resource planning applications (promoted since the mid 1980s)
- Decision support applications (Q&R, OLAP) (promoted since the late 1980s)
- Data warehouses (promoted since the early 1990s)
- Operational and Analytic Data Marts (promoted since the mid 1990s)
- Customer Relationship Management applications (promoted since the mid 1990s)
- Supply Chain Management applications (promoted since the mid 1990s)
- “Balanced Scorecard” applications (promoted since the late 1990s)
- “Analytic applications” (promoted since the early 2000s)

In one fashion or another all of these “technology systems” assist in the process of capturing and managing relevant operational data that affects core business processes. Either directly or as a by-product of their core functionality, they enable improvements in business performance to be planned, executed and assessed. “KPIs” are most often numerically based with performance and achievement tracked in one or more enterprise systems environments (such as a database, spreadsheets, or for more complex organizational needs an “OLAP” or “Scorecard” system).

KPIs As “Opportunity Areas”; Six Sigma Fit

It is in the area of goal creation (i.e. target identification) and performance assessment (analysis and assessment of actual versus expected performance) that KPIs can play a vital role in helping organizations focus on and prioritize their business process optimization initiatives. Since “what gets measured, gets done”, the process of selecting appropriate targets for action creates a focus and motivation among affected personnel to focus on improving performance in these areas.

Moving from the general to the specific, however, presents its own issues. The critical issues most organizations face involve moving from the general to the specific and ensuring that process improvement initiatives are actionable and deliver demonstrable business value. Which metrics are relevant and why? Where can performance be improved? What are the relationships and factors that impact on success and achievement?

In this sense, as KPIs become less hierarchical and more oriented towards measurement of day to day improvements in operating performance that will drive value creation, we see the transition from a focus on “performance indicators” to the domain of Six Sigma with its emphasis on “opportunities” and “defects”. This is one very powerful way that KPIs can be productively integrated with six Sigma principles.
Six Sigma: Data Driven Decision-Making

Six Sigma Overview

“Sigma” is a statistical term for measuring how far a given process deviates from perfection. “Six Sigma” is a business management system based on the rigorous, focused and systematic implementation of proven quality assurance principles and techniques. Developed by Motorola in the mid 1980’s, it has been popularized by leading organizations such as General Electric, Allied Signal, Ford, Honeywell and others. Incorporating elements from the work of many quality pioneers, Six Sigma aims for virtually error free business performance. The central idea behind Six Sigma is that if an organization can measure how many “defects” it has in a business process, it can systematically determine how to eliminate them and get as close to “zero defects” as possible.

The main thrust of Six Sigma is the application of a well disciplined, easy to follow methodology to the optimization of discrete business activities that impact on corporate performance. Beyond this basic methodology, a system of leadership, support systems and technology tools has been evolving in many organizations. These organizational changes, which are central to Six Sigma success, reflect an increased emphasis on objective, data driven decision-making methodologies coupled with the disciplined application of methodologies and tools by empowered personnel to a broadening range of business operations.

“Critical mass” is achieved, in the jargon of Six Sigma, when Six Sigma practitioners within the organization reach levels of performance, results achievement and visibility that are sufficient to convert the balance of the personnel, at an organizational level, to the Six Sigma process.

Six Sigma Business Value Benefits and Methodology

Owing to its traditional grounding in manufacturing and quality assurance, Six Sigma remains primarily oriented towards issues of product quality, manufacturing production optimization and defect reduction. Its focus has been on isolating activity areas where outputs do not meet documented specifications (or where specifications are absent) and iterating through experimentation and analysis to identify, assess and reduce (and ideally eliminate) the causes of these failures. Concepts from Six Sigma jargon like “defects”, “DPPMs” (defective parts per million), “DPUs” (total defects observed / total units produced) illustrate this product-centric focus. Through the successive elimination of defects (unacceptable variances) in production processes, the costs of these production processes can be reduced, with increases in quality, predictability and certainty.

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7 See the list of identified organizations in the Appendices. From the GE website: “Six Sigma has changed the DNA of GE — it is now the way we work — in everything we do and in every product we design.”

8 The following resources may be helpful to understanding data mining applications in the 6 Sigma context:
   - Six Sigma Academy: http://www.6-sigma.com/
   - Benchmarking Group: http://www.sixsigmabenchmarking.com/
   - Industry Periodicals: http://www.qualitydigest.com/

9 The typical Six Sigma practitioner “hierarchy” includes “Master Black Belts” (individuals with quantitative skills and the ability to teach and mentor others within their organizations in Six Sigma methodologies), “Black Belts” (Team leaders responsible for measuring, analyzing, improving and controlling key processes that influence customer satisfaction and/or productivity growth) and “Green Belts” (Team members involved in Six Sigma projects).
This process is illustrated below:

Six Sigma initiatives have been credited with delivering substantial business value to adopting organizations in the form of:

- Reduced product defects and improved quality
- Reduced production cycle times
- Lower inventory levels
- Higher productive efficiency
- Lower production costs
These benefits are realized through a systematic approach to problem solving which enables organizations to identify activity areas for problem resolution, assess causal factors that impact on defects in business processes, formulate and execute modifications in business processes to reduce these defects, measure results, and operationalize findings where improvements are observed. The Six Sigma framework, with its system of disciplined problem solving around design, quality and continuous improvement of production processes to meet target objectives and reduce variance is illustrated by the following schematic:

![Six Sigma Process Diagram]

The Expanding Orbit of Six Sigma Related To KPIs
Many of the underlying principles of Six Sigma are also now being followed by manufacturing organizations in areas of operations outside the traditional quality assurance arena, and by organizations outside the manufacturing sector, for business processes generally. As GE and other organizations that have adopted the Six Sigma mantra know, the implications of Six Sigma drive substantial improvement in traditional manufacturing processes, but also go well beyond this to drive continuous improvement in all facets of business operations. Numerous examples exist of areas of operations both within and outside manufacturing industries where Six Sigma initiatives are moving beyond traditional product design and quality assurance activities to support a broader range of business process improvements.10

10 From Six Sigma consultant Thomas Pyzdek (in Quality Digest (2001) we see the following:

Accounts receivable—The Six Sigma team was tasked with improving the accounts receivable department’s collection process. The project sponsor was the CFO, and the top-level dashboard item that generated the project was improved cash flow. The team decided to use the average age of uncollected accounts on the last business day of the month as their metric. Using X-bar charts because the histogram showed a very non-normal pattern, the team determined that the process was in statistical control with a mean of 57 days. They made a flowchart of the as-is AR collection process and used it to guide an observational study. The team noted and corrected several discrepancies, and several obviously stupid things were changed. For example, a team member from billing asked why the term “Net 30 Days” was used. An experiment was conducted where the term was changed to “Due on Receipt” for a random sample of invoices. The results showed that the average time to collect for the experimental group was 45 days, vs. 57 for the control group. The difference was highly significant, both financially and statistically. Next, the team contacted randomly chosen customers who had paid late and asked why they had been late. Fully 70 percent of the reasons for late payment were factors under the company’s control (e.g., invoice errors or the bill being sent to wrong address). The team constructed a Pareto diagram and set about correcting the biggest problem areas. Within six months, the average age of uncollected invoices dropped to 37 days. The resulting savings were substantial.
Printed wiring board components—The Six Sigma team received its project from the material review board. The MRB identified the project as a significant and chronic contributor to the problem of failures at final product test. The assembly was a complicated piece of hardware and final test failures caused shipping delays, resulting in penalties and loss of customer goodwill. The team's project focused in the PWB assembly area. There were three major subprojects: errors at manual insertion, errors at automated insertion, and errors at semi-automated insertion. A few examples of the issues addressed include kitting errors, the layout of the manual insertion workstation, the positioning of axial lead parts on the automatic insertion machine's parts tape, and the speed at which semi-automated insertion was performed. Problems were prioritized and addressed, leading to dramatic reduction of test failures.

Cycle time—The team was chartered by a program manager to help the company introduce new programs more quickly. The company would often introduce a new design into manufacturing only to find that it couldn't be produced, which resulted in quality and schedule problems. The team's project—one of several—involved establishing the capability of complex numerically controlled machining equipment. This was important because the company manufactured a tremendous variety of complex parts in very low volume. Standard SPC was difficult because production runs were both short in duration and small in quantity. The Six Sigma team wanted to develop the ability to determine in advance if a particular engineering design could be produced at all and, if so, which CNC machine should produce it. To solve their problem team members designed a special test part that put each CNC machine through a complete series of tasks. The parts were then inspected and the results used to determine machine capability for each type of machine movement (e.g., drilling small holes, milling a surface or machining a groove). This data was used to evaluate proposed engineering designs for manufacturability, for make-by decisions and to select CNC machines to produce specific parts.

Injection molded parts—The Six Sigma team was chartered to evaluate a problem with field failures of molded plastic parts. Members began by replicating the problem with production parts. The problems were resolved within a few weeks when the team identified a new process as the cause of the core problem. The process mixed two different plastic components at the injection-molding machine, as opposed to the single hopper and pre-mixed material of the previous process. If not properly mixed, the carbon black component would stratify and the product would fracture at the stratification when exposed to low temperatures.

Wire bond—The Six Sigma team received its project from a senior executive who had received direct communication from an important customer who was upset about wire-bond failures of a particular critical part (a thick-film hybrid microcircuit). The project had two major areas of focus: the wire bonding process and the testing process. Problems addressed included the metallurgy of the gold wire; the preparation and set-up of the process; the dressing of the tip on the machine tool; pressure, time and other settings; the hook used to pull the wire; the angle of the pull; the rate at which force was applied.

Purchase order process—A Six Sigma team was chartered to streamline the process of obtaining a purchase order. The process took six weeks, creating delays and customer dissatisfaction. The Six Sigma team created a process map and used historical data to show the time taken by each step. By hand-carrying 10 PO requests through the process, the team was able to determine that, more than 99 percent of the time, a PO request spent in the system was nonvalue-added time—mostly waiting time. The team subdivided the project according to the type of PO being requested. Members were able to eliminate PO requests completely for a common type of PO and dramatically reduce processing time for the others.

Etched circuit boards—The Six Sigma team was directed by a senior executive to solve the problem of photoresist breakdown. This problem occurred at the very end of a long sequence of process steps, which produce a bare printed wiring board. The problem was sporadic, and when it occurred, it resulted in delays throughout the production process. This wreaked havoc with schedules and resulted in extensive overtime work, shipping delays, penalties and angry customers. Through data mining, the team was able to focus the project on work which took place in the “yellow room,” where the photoresist was applied. The project eventually focused on the settings of the lamination and the expose processes. The root causes of the problems were identified, and the problem was completely eliminated.
The core tenets of Six Sigma evolving at adopting organizations can be restated in a “non-quality assurance centric” framework as follows:

- **Benefits** - the business benefits realized through revenue growth and/or cost reduction by eliminating Defects that result in failures to meet Customer Expectations.

- **Customer Expectations** - Needs, as defined by customers, which meet their basic requirements and standards for products, services and interactions.

- **Defects** - Sources of customer irritation that results from the failure to meet Customer Expectations.

- **Control** - The state of stability, normal variation and predictability; the process of regulating and guiding operations and processes using quantitative data.

- **CTQ: Critical to Quality (Critical "Y")** - Element of a process or practice which has a direct impact on its perceived quality.

- **Variance** - A change in a process or business practice that may alter its expected outcome.

- **Six Sigma** - A vision of quality that strives for perfection and equates with only 3.4 defects per million opportunities for each product or service transaction.

- **Design for Six Sigma (DFSS)** - A systematic methodology utilizing tools, training and measurements to enable us to design products and processes that meet Customer Expectations and can be produced at Six Sigma quality levels.

- **Define, Measure, Analyze, Improve and Control (DMAIC)** - A process for continued improvement that is systematic, scientific and fact based. This closed-loop process eliminates unproductive steps, often focuses on new measurements, and applies technology for improvement.

Viewed from this broader perspective one can see how many of the business processes that form the sequence of production and delivery of products and services to clients can be viewed and analyzed through the Six Sigma filter with a view to learning upper and lower thresholds for variability and progressively eliminating the “defects” in those processes that are most likely to drive business value (in the form of revenue gains, cost reductions and productivity improvements).

It is also easy to see how the assessment of core business processes – in terms of their continuous improvement and elimination of defects – closely relates to organizational commitments to “key performance indicators” as measures of success.

In a rationally structured organizational environment, Six Sigma activities can be inextricably linked with Key Performance Indicators – adding to the KPI framework of priorities a systemic process and methodology for progressive productivity improvement through process optimization.
DMAIC in the Expanding Six Sigma Environment

As noted above, the Six Sigma “DMAIC” methodology comprises several steps: define, measure, analyze, improve and control. This process, its key components and the analytical tools used to support it are summarized as follows.

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Process Components</th>
<th>Process Key Analytical Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Identify Project, Champion and Project Owner, Determine Customer Requirements and CTQs, Define Problem, Objective, Goals and Benefits (FA), Define Resource/Stakeholder Analysis, Develop Project Plan, Map the Process</td>
<td>Process Mapping</td>
</tr>
<tr>
<td>Analyze</td>
<td>Benchmark the Process or Product, Establish Causal Relationships Using Data, Analyze the Process Map, Visualize the Problem, Determine Root Cause</td>
<td>Statistical Tests, Confidence Intervals Modeling, Root Cause Analysis</td>
</tr>
<tr>
<td>Improve</td>
<td>Design and Analysis of Experiments (optional), Develop Solution, Cost and Benefit Alternatives, Assess Risks of Solution Alternatives, Validate Solution Using a Pilot, Implement Solution, Determine Solution Effectiveness Using Data</td>
<td>Design of Experiments, Regression modeling, FMEA, Statistical Validation</td>
</tr>
<tr>
<td>Control</td>
<td>Statistical Process Control, Determine Needed Controls, Implement and Validate Controls, Develop Transfer Plan, Realize Benefits of Implementing Solution, Close Project and Communicate Results</td>
<td>Statistical Process Control</td>
</tr>
</tbody>
</table>
Putting Business Processes Under The Six Sigma Microscope

As outlined above, “defects” requiring elimination (or, more positively, business processes benefiting from optimization) can be seen as significantly broader than simply the process of designing and bringing to market higher quality physical goods that meet end using customer expectations at the lowest possible cost. Inherent in this formulation are a number of additional implications about Six Sigma principles.

Six Sigma principles can be usefully broadened as follows:

- They are applicable to both production and non-production related business processes by a business organization (e.g. the design and marketing of a product or service as well as the simple production process involved in creating it).
- They can be applied to both discrete and transaction oriented business processes (e.g. product design as a discrete process; management of the client acquisition, accounts receivable lifecycle or the credit approval process as a transactional process).
- They can be applied in both product and service organization types across different industries (e.g. by a financial services, telecom, or other organization that's business activities are exclusively devoted to digitized or “non-physical” product or service offerings).
- They can be applied to improve interactions and processes with all stakeholders that directly or indirectly impact on “customer expectations” (i.e. interactions with suppliers, personnel, distribution channels, customers and prospects can all be assessed and optimized where benefits that will lower cost and risk are identified for improvement)

As Six Sigma evolves to mean “continuous process improvement” to address stakeholder needs at the lowest possible cost, a much broader range of business processes can be made more effective through the application of Six Sigma methodologies (or data driven decision making) to drive process improvement.

Illustrative Business Processes Affected By Six Sigma (By Function)

With this more expansive view of Six Sigma, we can readily identify numerous business processes, both discrete and transacting, across any organization that can be optimized through a more systemic approach to “data driven decision-making” based on Six Sigma principles.

These functional business processes span all aspects of business operations -- from prospect activities and interactions (marketing, prospecting, sales funnel etc), through customer activities and interactions (acquisition, satisfaction, maximization, and retention), through product or service “manufacturing” (inputs, procurement, logistics, demand chain management, quality assurance and warranty claims), to finance (accounts payable, accounts receivable, financial reporting (external and internal), credit and risk management) etc.

Viewed in this context of process optimization illustrative functional business activity areas, goals, “defects” and impacts of favorable resolution include the following “non-traditional” areas of Six Sigma focus:
<table>
<thead>
<tr>
<th>Business Activity</th>
<th>Defect (Specific Example)</th>
<th>Process to be Optimized</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marketing</strong></td>
<td>Low yield per dollar expended (Response Rates of *% On Average to Our Marketing Campaigns)</td>
<td>Improve yield (response); change mix from “broadcast” to “narrowcast” offers</td>
<td>Neutral to positive (higher yield per dollar expended) Reduced marketing expenses for same impact; higher yield per dollar expended</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td>Revenue Shortfall (Group or Individual) (Sales personnel “forecast accuracy” ranges from 30% - 60% per field sales representative)</td>
<td>Sales cycle management and close ratios</td>
<td>Increased visibility and predictability of revenue funnel; improved sales skills Reduced discounting and more proactive (low cost) management of sales opportunities</td>
</tr>
<tr>
<td><strong>Customer Management</strong></td>
<td>Low share of wallet; High attrite rate; Low up-sell; cross-sell success; Slow migration to lower cost channels (Only % of our customers have migrated to our on-line banking service; we know we save $* per customer on it)</td>
<td>Customer interaction strategies; promotion of targeted</td>
<td>Higher revenues per quality customer; Lower costs per customer</td>
</tr>
<tr>
<td><strong>Product and Service Management</strong></td>
<td>Declining profitability (existing product or service); Low adoption rate (existing or new product or service) (We are showing a steady decline in profitability on this product line)</td>
<td>Product / Service mix; Product / Service terms and features;</td>
<td>Shed non-core business for maximum value to best buyer; re-launch a new product for a new audience Reduce costs associated with a non-core business; halt a failing program and recalibrate</td>
</tr>
<tr>
<td><strong>Credit Management</strong></td>
<td>Poor receivables management; poor receivables credit quality; high collection costs for defaults (our DSOs are at *%; and our success rate on collections is <em>% versus collection costs of $</em> per incident)</td>
<td>Awarding and monitoring credits to reduce defaults through proactive intervention</td>
<td>Accelerate collections (time value of money gains); improve quality of revenues Reduce collection costs and efforts</td>
</tr>
<tr>
<td><strong>HR</strong></td>
<td>High employee health and leaves of absence; High employee turnover rates</td>
<td>Employee wellness and job satisfaction</td>
<td>Improved productivity and higher revenues per employee Lower training and retention costs; Lower health care costs</td>
</tr>
</tbody>
</table>
Illustrative Business Processes Affected By Six Sigma (By Industry)

Similarly by reference to industry verticals key business activities (with their subsets of business processes) can be viewed through the Six Sigma prism in terms of data driven decision-making to support continuous process optimization.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Key Revenue Driver</th>
<th>Key Cost Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance</td>
<td>Growing profitability per quality customer in an environment of commoditized offerings</td>
<td>Infrastructure and transaction costs for supporting client base.</td>
</tr>
<tr>
<td>Telecom</td>
<td>Maintaining / growing market share and reducing client churn in an environment of commoditized offerings</td>
<td>Capital costs of network build out and maintenance in excess capacity environment</td>
</tr>
<tr>
<td>Health Care</td>
<td>Delivering value (quality care) in a manner that maximizes profitability (private sector) or “highest, best use” of available funds (public sector)</td>
<td>Reducing costs of service delivery (per payer, per provider, per patient etc) without compromising quality</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>Accelerate introduction of and market share growth for new offerings; retain market share versus competitive offerings</td>
<td>Costs of researching, developing and marketing new offerings.</td>
</tr>
<tr>
<td>Retailing</td>
<td>Growing “same store” sales in a competitive low margin environment</td>
<td>Input, inventory and logistics costs associated with supporting operations</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Ensuring the product mix enables maximization of value add, marginal revenues and profitability after all input costs.</td>
<td>Ensuring highest quality, lowest cost delivery to clients through optimization of input (demand side procurement), production (value-adding manufacture), and distribution (supply side logistics) costs.</td>
</tr>
</tbody>
</table>

Integrating KPIs and Six Sigma

As the discussion above suggests, KPIs and Six Sigma are logically interconnected. Through the process of creating Key Performance Indicators or metrics that are the focus of emphasis for improved corporate performance, managers assist in establishing an environment that helps prioritize areas of operation where improvements in productivity are desired or required.

This focus on creating visible and measurable areas for analysis assists personnel across the organization in taking their own initiatives to analyze and improve the business processes within their purview that impact on performance relative to those metrics. They can do this through continuous adoption and use of Six Sigma principles, systems and techniques to deconstruct and analyze all elements of the business processes within their area of operation.

It is also no coincidence that much of the management information systems infrastructure described above with respect to KPIs can be readily leveraged to provide the data “fuel” to support 6 Sigma based process optimization analysis and activities. Many organizations already have the technical foundations and personnel resources in place to support this. All that requires attention is more focus on leadership and addressing organizational issues on integrating a more holistic approach that leverages Six Sigma skill sets and methodologies in the cause of moving actual performance more closely to targeted (KPI driven) performance.
Needs for Measurement Tools; Data Mining Fit

At the core of Six Sigma, for any given business process, is a focus on learning (experimentation) the relationships and dependencies that determine “failures” (defect) and in reducing the likelihood of defects occurring through iterative analysis and assessment of the events giving rise to “defects”. In all companies, but particularly for complex organizations, this process must occur efficiently, so that business processes can be improved with minimal cost and time consequences.

A variety of measuring, management and analytical tools and skill sets are required to make Six Sigma initiatives successful. It is this area of analysis and assessment that the skill sets and tools of data miners become integrated with the emphasis of Six Sigma practitioners on creating opportunities from defects in the pursuit of performance at or above the target objectives outlined in corporate “key performance benchmarks” guidelines.

KPIs, Six Sigma and Data Mining: Process Optimization to The Power of Three

Data Mining Overview

By thinking holistically and systemically of KPIs and Six Sigma, organizations provide both a framework of business objectives and a system or prescribed methodology for process optimization. Data Mining analytic tools further extend this set of objectives and methodologies by providing an analytical context and related tools specifically designed to enable this process to occur rapidly and efficiently for maximum business value impact.

Data mining involves the application of pattern detection and analysis algorithms based on proven statistical techniques\(^\text{11}\) to data structures, to reveal relationships and pattern in data structures that are not self-evident from analysis. This activity is useful because:

- **It is automated**, enabling rapid exploration of data structures without user bias.
- **It is interactive**, accelerating knowledge discovery providing analysts with insight into unanticipated cause and effect relationships that impact on the business objectives (e.g. “process improvement) they are analyzing.
- **It delivers proven business value**, in the form of reports (that drive action by people) and models (that drive integration with technology systems) as follows:
  - First, by making “new knowledge” actionable in the form of analysis and reports that drive performance improvement; and
  - Second, by providing a framework of “new rules” (predictive models) that can be used to predict future performance based on the experience captured in existing data structures.

\(^\text{11}\) ANGOSS tools for example support decision tree, neural network, segmentation, regression and time series based analytical capabilities for analyzing data structures, conducting data exploration and profiling, as well as building and validating predictive models.
The data mining process, with its emphasis on business objective drive, project oriented, rigorous analysis and measurement of corporate data assets, can be illustrated as follows:

- **Business Objective Definition.** Establishing the target business objective for analysis (i.e. assessing the effectiveness of credit approval business rules, identifying a target customer population for a new product or service offering, or lowering the failure rate on a semiconductor production run). Illustrative objectives, for example, can be approached as a measurement creation or monitoring process (within the KPI jargon) or the exploration of an opportunity area for defect reduction (within the 6 Sigma jargon).

- **Sourcing Data.** Obtaining access to the data sources relevant to the defined business objective from the variety of internal and external data sources that may impact on the business objective (such as customer databases, transaction databases, production databases, external data sources etc)

- **Data Preparation.** Proceeding with the process of data preparation for data mining, including joining disparate data sources, creating derived attributes and measures from the underlying data (for example, days since last transaction, and average value of transactions, and number of transactions per week from a transactional database that captures only data (timestamp) of transaction and amount (value) of transaction.)
• **Data Mining.** Applying data mining software tools and related techniques to the resultant data to “model” the data and assess the underlying patterns, cause and effect relationships and hierarchies within the data at macro and micro levels with respect to the data and relevant sub-populations of it.

• **Validation.** Validation of the predictive models for purposes of reporting and applying the model to new data instances (through “scoring” of new data sets).

• **Measurement and Assessment.** Measuring and assessing the findings of the data mining process when applied in the operational domain (for example, through the use of a data mining based target mailing list for a new marketing initiative or a new scoring model for awarding or revocation of credit).

In this context “sample and extract methodologies”¹² on representative data accessed from operational data sources are employed to enable analysts to source, explore, iterate through and assess the results of the data mining process on the business objective(s) under study.

**Using Data Mining Insight To Improve Corporate Performance**

As a result of the relationships among Key Performance Indicators, six Sigma principles, and Data Mining Processes, it becomes possible to envisage how these techniques can be productively applied together.

In any industry context, we can move from the “focus area”, to the “KPI drivers” of the business process, to the creation of 6 Sigma initiatives to achieve the KPI benchmarks, and the use of data mining as a productive tool to measure, assess and modify the results of initiatives designed to focus on opportunity creation and defect reduction to enable achievement of KPI benchmarks.

¹² One common approach to this process, popularized by statistical tools vendor The SAS Institute, describes this process by the acronym SEMMA: sample, explore, modify, model, assess - which may be familiar to Six Sigma practitioners who apply the “DMAIC” approach to their Six Sigma initiatives. Beginning with a statistically representative sample of data, the SEMMA process makes it easy to apply exploratory statistical and visualization techniques, select and transform the most significant predictive variables, model the variables to predict outcomes, and confirm a model's accuracy using data mining software tools such as those offered by ANG OSS. The process can be described as follows:

- **Sample** the data by extracting a portion of a large data set big enough to contain the significant information, yet small enough to manipulate quickly.
- **Explore** the data by searching for unanticipated trends and anomalies in order to gain understanding and ideas.
- **Modify** the data where appropriate by creating, selecting, and transforming the variables to focus the model selection process.
- **Model** the data by allowing the software to search automatically for the data relationships that reliably predict the outcome under analysis (for example, modeling the root cause of a defective product component).
- **Assess** the data by evaluating the usefulness and reliability of the findings from the data mining process.

By assessing the results gained from each stage of the SEMMA process in an interactive fashion, users can determine how to model new questions raised by the previous results, and thus proceed back to the exploration phase for additional refinement of the data.
This relationship can be seen in the following illustrative matrix of KPI, Six Sigma and Data Mining intersections:

<table>
<thead>
<tr>
<th>Area</th>
<th>Illustrative KPI</th>
<th>Illustrative Six Sigma Focus</th>
<th>Illustrative Data Mining Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Revenues (profits) / customer</td>
<td>Grow revenues (profits) per customers</td>
<td>Which customers are we growing revenues (profits) with and why?</td>
</tr>
<tr>
<td>Indicators</td>
<td>Revenues (profits) / assets (%)</td>
<td>Grow revenues (profits) per asset</td>
<td>Which calls on assets drive revenues (profits) and why?</td>
</tr>
<tr>
<td></td>
<td>Revenues (profits) / employee ($)</td>
<td>Grow revenues (profit) per employee</td>
<td>Which employees drive revenues (profits) and why?</td>
</tr>
<tr>
<td></td>
<td>Improve Profit margin (Cash Flow)</td>
<td>Boost profit margin</td>
<td>Which business processes are impacting on improving (deteriorating) profit margin (or cash flow) and why?</td>
</tr>
<tr>
<td>Process</td>
<td>On time delivery (%)</td>
<td>Improve on time delivery</td>
<td>Which are not on time and why?</td>
</tr>
<tr>
<td>Indicators</td>
<td>Inventory turnover (#)</td>
<td>Accelerate turnover rate</td>
<td>What are the key factors that accelerate (slow) turnover and why?</td>
</tr>
<tr>
<td></td>
<td>Productivity per employee (%)</td>
<td>Improve productivity</td>
<td>Which employees are more (less) productive and why?</td>
</tr>
<tr>
<td></td>
<td>Production lead (down) time (Days / Hours)</td>
<td>Reduce lead time</td>
<td>Which factors most influence lead (down) time and why?</td>
</tr>
<tr>
<td>Customer</td>
<td>Number of customers (#)</td>
<td>Grow customer base</td>
<td>Which programs accelerate customer growth fastest and why?</td>
</tr>
<tr>
<td>Indicators</td>
<td>Estimated Market share (%)</td>
<td>Achieve target market share</td>
<td>Where are we growing share and why?</td>
</tr>
<tr>
<td></td>
<td>Sales per customer ($)</td>
<td>Grow sales per customer</td>
<td>Which customers are we growing relationships with any why?</td>
</tr>
<tr>
<td></td>
<td>Sales closed versus opportunities tracked</td>
<td>Improve close ratios</td>
<td>Which sales techniques are most effective and why?</td>
</tr>
<tr>
<td></td>
<td>Number of customer interactions / sales rep</td>
<td>Grow (Reduce) customer interactions</td>
<td>What impact to interactions (type and volume) have on sales</td>
</tr>
<tr>
<td></td>
<td>Customer loyalty index; defection rate</td>
<td>Improve loyalty index</td>
<td>Who are our most (least) loyal customers</td>
</tr>
<tr>
<td>Personnel</td>
<td>Leadership Index</td>
<td>Grow leadership team</td>
<td>What are the attributes of our most successful employees?</td>
</tr>
<tr>
<td>Indicators</td>
<td>Employee turnover</td>
<td>Reduce employee turnover</td>
<td>Why employees quit and why</td>
</tr>
<tr>
<td></td>
<td>Training programs effectiveness</td>
<td>Improve training programs</td>
<td>Which programs are most effective?</td>
</tr>
<tr>
<td></td>
<td>Employee satisfaction index</td>
<td>Improve employee satisfaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absenteeism and Health Care</td>
<td>Reduce rates and costs</td>
<td>Where are we losing productivity due to illness and absenteeism and why?</td>
</tr>
</tbody>
</table>
Data Mining Connections with KPI and 6 Sigma Based Management Systems

Obvious connections exist between KPI, 6 Sigma, and data mining based systems, processes and tools. These include the following:

- **KPI systems** are based on creating and tracking benchmarks. Data mining systems are useful in analyzing and measuring performance relative to benchmarks and in highlighting potential “root causes” of variability in performance.

- **Six Sigma based systems** are based on selecting “focus areas” of business processes for analysis, formulating experiments to establish parameters as well as exploring dependencies and other relationships that impact on outcomes, and conducting analysis and measurement on both existing business processes and proposed optimizations to evaluate improvements. Data mining methodology closely mirrors the six Sigma approach (a typical data mining project is in reality a subset of a business process type that would be subjected to Six Sigma study); Data mining tools provide required analysis and measurement decision support for Six Sigma practitioners.

- “**Data miners**” (i.e. knowledge workers who apply data mining methodology and tools to the analysis of corporate data assets) are, in effect, “Six Sigma practitioners”-- regardless of whether or not they consider themselves associated with this hierarchy, process or infrastructure within their organization.

These connections have not traditionally been obvious to date because data mining has been applied most often in isolation and in an ad hoc manner to support specific, project oriented, activities (such as response modeling to improve a database marketing initiative, or through risk scoring, to improve credit granting and flagging systems). However, these connections can be expected to become more obvious as predictive analytics become more pervasive within management decision support systems in organizations -- shifting from its “project centric” roots in database marketing (response modeling) and risk management (credit scoring) to be used in broader areas, as organizations adopt and expand more strategic analyses (e.g. integrated customer profitability, loyalty, best offer and risk models) in their sales, marketing, production and financial management areas.
Leveraging Six Sigma and Data Mining Skill Sets

KPIs are typically established by, and managed and measured for, senior management. To the extent that KPIs are “pushed down” as more granular measures or benchmarks to business units and line of business management, they in effect become transformed into Six Sigma opportunity areas for analysis and improvement. In this environment, the skill sets and expertise of both Six Sigma and data mining practitioners can be cross-leveraged to deliver process optimization improvements that will drive productivity improvements and profitability.

Individuals involved in Six Sigma projects bring a variety of skill sets and expertise to bear in implementing Six Sigma initiatives. As GE notes in its Six Sigma initiatives “people create results.” Involving all employees is essential to GE’s quality approach. GE is committed to providing opportunities and incentives for employees to focus their talents and energies on satisfying customers. In conjunction with this “top down” focus and motivation, GE employees are trained in the strategy, statistical tools and techniques of Six Sigma quality.

These Six Sigma skills, which are summarized below, can be readily mapped to the skill sets required to successfully implement data mining projects.

**Domain Knowledge**

Project members should have good knowledge of the business areas that are the target area of investigation and analysis. Ideally, these individuals have basic knowledge about the client’s business in key areas. These areas include: projects, products, customers, available information, company objectives and strategy, market trends, expected return on different business initiatives. In KPI jargon, all project members should have solid grounding in the key performance indicators that are being assessed, the business and process issues associated with them and their measurement, and the implications to the organization of their success or failure in executing initiatives to achieve improvements.

**Project Management**

Some of the team members should have some project management experience to provide needed support in the planning and execution of the data mining projects.

**Analysis Skills**

Data analysts are expected to be comfortable with performing simple statistical analysis tasks, such as summary reports, simple statistics (counts, averages, cross tables) and similar analysis tasks.

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13 Training courses are offered at various levels, including Quality Overview Seminars (basic Six Sigma awareness), Team Training (basic tool introduction to equip employees to participate on Six Sigma teams), Master Black Belt, Black Belt and Green Belt Training (in-depth quality training that includes high-level statistical tools, basic quality control tools, Change Acceleration Process and Flow technology tools), and Design for Six Sigma (DFSS) Training (prepares teams for the use of statistical tools to design it right the first time).
IT and Data Competencies
In many organizations, IT resources will be required to assist in the process since IT systems and related business rules and procedures govern and regulate access to operational data and the operational systems capturing these data assets. Project members should ideally have adequate IT skills in relation to obtaining the data from available sources, data aggregation and preparation software (such as database engines, SQL, DBA skills, ... etc). An essential competency is knowledge of the details of the data that would be available to the core team.

Leveraging Enterprise Systems

Typical Corporate Environments
The fit between KPIs, Six Sigma and Data Mining is not a technology solution; it is an organizational one. In addition to leveraging their human resources skills in Six Sigma and Data Mining activities, organizations can also leverage their existing enterprise systems to improve productivity and profitability by adopting a more systemic approach to their business process improvement initiatives.

As illustrated below, this occurs through the use of enterprise systems to establish:

- **KPI based management information systems** that roll-up to the executive level in the form of (a) macro performance benchmarks tracked for organizational (i.e. executive) MIS needs; and (b) business process related measures or metrics created and monitored by executives but designed as “focus areas” for process improvement by the line of business personnel most closely related to the items being measured;

- **Six Sigma based initiatives**, implemented at the mid-management | business team level by personnel who are focused on specific process improvement initiatives and who are empowered (including with access to systems, tools and personnel resources) to prioritize the business processes that can be assessed and to analyze, measure and adopt improvements where appropriate to realize productivity gains; and

- **Data Mining based initiatives**, at the analyst and project level, to enable more rapid and effective analysis and measurement by mid-management and business team personnel of the business processes under analysis for proposed improvement.

In this environment, the supporting technology and systems are likely to be:

- The databases supporting enterprise wide (smaller organizations) or divisional (larger organizations) business processes, including the customer, supplier, partner and financial data, that require access for analysis,

- Aggregated (rolled-up) internal and external data which incorporates KPIs and aggregated operational data for analysis and tracking (which may be stored in database tables, “OLAP cubes” or applications that track business processes under analysis, and

- The creation of “data mining views” to support the iterative analysis and measurement of current business processes and the outcomes of the modifications to them resulting from the continuous process improvement initiatives of the team.
Given that most organizations do not wish to impair the integrity or performance of their operational systems, some work may be required in smaller organizations in defining and implementing a rational extension of or extraction from existing systems (for example through the creation of separate schemas or an analytic data mart) and related procedures to support analysis and measurement with a minimum of overhead cost, in the form of data duplication, parallel systems or duplication of effort and resources. However, this work effort is a relatively trivial extension of and not a challenge to or substantial additional burden on existing systems and / or resources.

This systemic approach and allocation of responsibilities is illustrated by the following

![Diagram](image.png)

**Figure 1: KPIs, Six Sigma and Data Mining**

Global Business Unit or SME Corporate Business and IT Environment
**G2500 Organization Environments**

In larger organizational environments, the same underlying considerations apply. However, there is a higher likelihood that much of the “heavy lifting” will already have been done in the form of specially configured environments designed to support the analysis process. This would include the existence of data warehouse, data mart and OLAP type solutions that already provide “off line” sources of data that can be leveraged by Six Sigma practitioners and Data Mining analysts to support their analysis and measurement activities. Conversely, however, the “division of labor” associated with larger corporate environments necessitates a broader series of touch points for interaction among executives, managers, and analysts in the execution of process optimization initiatives.

An illustration of this framework, overlaid against the typical global corporate hierarchy, is outlined below:

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**Figure 2:** KPIs, Six Sigma and Data Mining
G2500 Corporate Business and IT Environment
Financial Services Organizations: Applying KPI, 6 Sigma and Data Mining Principles to Boost Productivity

The principles outlined in Sections 2, 3 and 4 are generally applicable – across numerous industries and with respect to all business process types in both product and service based organizations. In this section, we try to illustrate how one type of organization (a diversified financial services organization) can benefit from taking a more systemic and holistic approach to the integration of KPIs, Six Sigma and Data Mining systems and methodologies to improve the effectiveness of their operations.

Getting Specific On KPI Selection

In this organization, transparent key performance indicators relevant to business personnel are selected which reflect the focus of the organization on continuous process improvement. These indicators are selected in appropriate fashion across diversified business units with reference to the primary business challenges these business units face and with reference to both business generation and credit risk management issues they are experiencing.

Illustrative examples of KPIs that may be of interest might include the following:

<table>
<thead>
<tr>
<th>Line of Business</th>
<th>Current “Key” Issue</th>
<th>(Macro) KPI Focus</th>
<th>Target KPIs (Micro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Finance</td>
<td>Declining franchise; marginal profitability</td>
<td>Per customer profit</td>
<td>% of customers “on line” % of customers with more then X products % of customers with profit &gt; $Y</td>
</tr>
<tr>
<td>Lease Finance</td>
<td>Unprofitable lease finance operations</td>
<td>Profitability per lease (per customer)</td>
<td>% of clients buying out leases; $* disposal cost per vehicle reduction</td>
</tr>
<tr>
<td>Mortgages</td>
<td>Market share growth</td>
<td>Number of new mortgages issued</td>
<td># of new mortgages per month Average credit quality of *</td>
</tr>
<tr>
<td>Brokerage</td>
<td>Declining trading activity; high per customer new product distribution costs</td>
<td>Per client trading and distribution costs</td>
<td>Lower trading support costs by <em>% to $</em> Improve distribution speed by *%</td>
</tr>
<tr>
<td>Credit Cards</td>
<td>Profitable; slow growth rate; credit quality</td>
<td>New “good quality” customers</td>
<td>% growth rate; new clients above grade X % default rate; current clients</td>
</tr>
<tr>
<td>Small Business Finance</td>
<td>Larger then planned provisions</td>
<td>Reducing losses per credit dollar advanced; improving “early warning” systems</td>
<td>% of Provisions per Credit Dollar advanced; % of borrowers reporting monthly on line</td>
</tr>
</tbody>
</table>
## Applying the Six Sigma Treatment To KPIs To Eliminate Defects

<table>
<thead>
<tr>
<th>Line of Business</th>
<th>Current “Key” Issue</th>
<th>(Macro) KPI Focus</th>
<th>Target KPIs (Micro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Finance</td>
<td>% of customers “on line”</td>
<td>Accelerate on-line bankers; Accelerate % of business they do on-line</td>
<td>Remove barriers to on-line banking; Attract customers likely to be on-line bankers</td>
</tr>
<tr>
<td></td>
<td>% of customers with more then X products</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% of customers with profit &gt; $Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lease Finance</td>
<td>% of clients buying out leases; $* disposal cost per vehicle reduction</td>
<td>Save by having clients take ownership at end of lease</td>
<td>Remove barriers to end of lease ownership</td>
</tr>
<tr>
<td>Mortgages</td>
<td># of new mortgages per month</td>
<td>Accelerate mortgage market share</td>
<td>Mortgage approval process; product terms</td>
</tr>
<tr>
<td></td>
<td>Average credit quality of *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brokerage</td>
<td>Lower trading support costs by <em>% to $</em> Improve distribution speed by *%</td>
<td>Lower go forward cost of distribution channel</td>
<td>Barriers to use of channel; Online clients don’t take up our products</td>
</tr>
<tr>
<td>Credit Cards</td>
<td>% growth rate; new clients above grade X</td>
<td>Profitable; slow growth rate; credit quality</td>
<td>% growth rate; new clients above grade X</td>
</tr>
<tr>
<td></td>
<td>% default rate; current clients</td>
<td></td>
<td>% default rate; current clients</td>
</tr>
<tr>
<td>Small Business</td>
<td>% of Provisions per Credit Dollar advanced; % of borrowers reporting monthly on line</td>
<td>Unanticipated provisions from slowdown</td>
<td>% of Provisions per Credit Dollar advanced</td>
</tr>
<tr>
<td>Finance</td>
<td></td>
<td></td>
<td></td>
</tr>
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Using Data Mining to Accelerate Analysis and Results

<table>
<thead>
<tr>
<th>Six Sigma “Defect”</th>
<th>Data Mining Project</th>
<th>Actionable Results</th>
<th>Six Sigma Improvement</th>
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<tbody>
<tr>
<td>Remove barriers to on-line banking; Attract customers likely to be on-line bankers</td>
<td>Who are on-line bankers; who aren’t; why?</td>
<td>Report for management action and “score” showing propensity to use on-line banking</td>
<td>New process for promoting on-line banking gets % boost in usage at $ less than a traditional marketing campaign</td>
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<tr>
<td>Remove barriers to end of lease ownership</td>
<td>Profile lease portfolio and clients; who exercises put option and why?</td>
<td>Profile of all lease customers by all tracked dimensions with propensities</td>
<td>New program or option designed to offset cost of puts targeted to all customers / likely end of lease people</td>
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<td>Mortgage approval process; product terms</td>
<td>What types of mortgage products to we offer; who uses them?</td>
<td>Gaps analysis (who are we missing); Campaign modeling</td>
<td>Introduce new offers that accelerate origination at Z times historic origination rate</td>
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<tr>
<td>Barriers to use of channel; Online clients don’t take up our products</td>
<td>How does our distribution channel on the buy side compare to our overall customer portfolio; what cost components can we eliminate</td>
<td>Analysis of distribution channel and channel effectiveness by client; by product type, etc</td>
<td>New business opportunities for strategic partners</td>
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<tr>
<td>% growth rate; new clients above grade X % default rate; current clients</td>
<td>Where are we gaining and losing share; which clients are leaving or not using our cards?</td>
<td>Analysis of distributions for growth and cross-tabulation of growth (marketing and sales centric) versus credit (risk)</td>
<td>Improve growth rates for clients with improved understanding of all credit exposures; lower defaults and write-offs.</td>
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<tr>
<td>% of Provisions per Credit Dollar advanced</td>
<td>What do our defaulters look like compared to the population as a whole; what additional information and reporting systems can we implement</td>
<td>Analysis of provisions versus performing credits; assessment and verification of business rules and procedures for granting, restricting and provisioning credit exposures</td>
<td>Lower provision rate per dollar expended, with more insulation from business cycle fluctuations</td>
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Conclusion

In summary, logical and practical connections link KPI, Six Sigma and Data Mining based management tools and systems. Further understanding of these relationships can support better “data driven decision making” that enables improved enterprise performance, revenue growth and cost reduction. Organizations that understand the linkages between these systems and exploit these relationships are likely to:

- Select better key performance indicators, with opportunities for improvements that personnel can actually identify, implement “change management” initiatives around and achieve,

- Make more effective use of the analytical skill sets and methodologies of their personnel involved in “data driven decision making” and similar Six Sigma initiatives, and

- Successfully integrate their traditional “tactical” or project oriented use of data mining methodologies and tools with more integrated and strategic modeling activities oriented to achieving more permanent improvements in business operations.

The net effect of these initiatives are likely to be higher levels of revenue generation and profitability at lower cost relative to peer group companies that either do not use these techniques or fail to integrate them in a systematic fashion into their management systems.
About Angoss Software

As a global leader in predictive analytics, Angoss helps businesses increase sales and profitability, and reduce risk. Angoss helps businesses discover valuable insight and intelligence from their data while providing clear and detailed recommendations on the best and most profitable opportunities to pursue to improve sales, marketing and risk performance.

Our suite of desktop, client-server and in-database software products and Software-as-a-Service solutions make predictive analytics accessible and easy to use for technical and business users. Many of the world’s leading organizations use Angoss software products and solutions to grow revenue, increase sales productivity and improve marketing effectiveness while reducing risk and cost.

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