BUSINESS PROCESS BEST PRACTICES: PROJECT MANAGEMENT OR SIX SIGMA?

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Introduction

The aim of this paper is to evaluate the Six Sigma methodology using the tools and techniques as a proxy. The central problem will be defining usefulness in a measurable and valid way. A review of the literature on Six Sigma revealed seven major sources that articulated tool sets; all were incorporated into the study. For Project Management, *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*)—Third Edition was used as the primary source of tools (Project Management Institute, 2004).

The first step will be a literature review to identify what researchers have already learned about the Six Sigma methodology. Part of the literature review will be the identification of which tools are in use and in what phase they are used. As a second step, a comparison of the tools and techniques will be made – how many are used, how well accepted the tools are among various users of the Six Sigma methodology, and how the tools compare to a similar set of standardized tools, in this case, those employed in Project Management. The third and final step will be the comparison of the tools.

Limitations

The criteria for selecting Six Sigma tools were simple. The tools must be published. The American Society for Quality (ASQ) publishes descriptions of Six Sigma tools and quality tools. The authors conducted a literature review for other sources, and found seven critical sources for Six Sigma tools, all books published by commercial entities.

In comparing the sources for Six Sigma tools, it quickly became evident that each source tended to use unique nomenclature to define what seemed to be essentially the same tools. Efforts were made to overcome this by a tool-to-tool comparison, re-mapping where necessary. Another difficulty encountered was the singular/plural nature of the tools. If one author cites “Statistical” tools and another cites a specific listing of individual statistical tools (ANOVA, Regression, etc.) there is some difficulty in comparing the tool lists. This was managed on a case-by-case basis. Finally, one source for tools, Michalski (2003), had an extremely well documented but lengthy tool list. Michalski (2003) has 222 tools as compared to an average of 30 tools in the other six sources. One explanation of this is that Michalski’s tool list represents a “Quality” list as opposed to a Six Sigma list.

History of the Quality Movement

The roots of the quality movement in the twentieth century can be attributed to Walter Shewhart (1891-1967). His major work, published in 1931 under the title *Economic Control of Quality of Manufactured Product*, is considered the de-facto set of basic principles of quality control. His major accomplishment was the linking of statistics to managerial decision-making. W. Edwards Deming (1900-1993), a disciple of Shewhart, went further in securing the link between business and statistics. Deming's Fourteen Points defined the quality movement for the last half of the twentieth century and beyond. Deming also popularized one of the most well known tools in the quality movement, the Plan-Do-Check-Act cycle, originally contributed by Shewhart.

The tools used in quality differ from implementation to implementation, but generally they align with one of the categories shown in Figure 1. Figure 2 summarizes the history of the quality movement since 1950.

Seven Quality Control Tools	Seven Quality Management Tools
1. PDCA (plan, do, check, act)	1. The affinity diagram
2. Data collection and analysis	2. The interrelationship diagram
3. Graphs/charts	3. The tree diagram
4. Check/Tally sheets, and histograms	4. The matrix diagram
5. Pareto charts	5. The matrix data analysis plot
6. Cause-and-effect diagrams	6. The process-decision program
7. Control charts	7. The arrow diagram

Figure 1. Comparing Quality Control and Quality Management Tools (Adapted from Bhote, 2003)

Date	Methodology	Pros	Cons
1940–1950	Sampling Plans	Standardization of sampling methods	The sampling plans were viewed as end result
1960	Zero Defects	Employees pledged to produce no defects	No substance
1960	Deming Prize	Introduced statistical analysis of data	Limited focus on customers, suppliers, employees
1970	Quality Circles	Teams tracked daily issues	Lacked solid decision making
1980	Statistical Process Control (SPC)	Control Charts	Interpretation of validity is crucial
1985	Total Quality Management (TQM)	Systematic approach	Limited focus on customer
1987	ISO-9000	Standards defined, common to each industry	Considers defects "acceptable"
1987	Malcolm Baldridge Award	National (US) Quality Award (recognition)	Lacks focus on tools
1987	Six Sigma	Customer focused	Requires extensive training
1990	QS-9000	Improvement over ISO-9000 (automotive)	First tier supplier-oriented, not auto manufacturers
1993	European Quality Award	Patterned after " Malcom Baldridge Award"	Lacks focus on tools
1995	ISO-14000	Environmentally oriented	Lacks creativity

Figure 2. History of the Quality Movement (Adapted from Bhote, 2003)

Six Sigma

Six Sigma is defined, for purposes of this paper, as a business philosophy, one that attempts to analyze data as an enablement for improvement (Breyfogle, 2003; Pande, Neuman, & Cavanagh, 2002). It is, in fact, a business methodology. One should acknowledge, however, that Six Sigma is actually a trademark of Motorola, which first used the term to refer to the collection of tools and processes in the company's quality improvement practice.

In 1979, Motorola, under CEO Bob Galvin, commenced a renewal plan consisting of four key initiatives involving a) market/product competitiveness, b) participative management, c) quality improvement tied to executive compensation, and d) creation of Motorola University, a training and education center. An early training program of Motorola University was "Design for Manufacturability" (DFM). The DFM program included "Six Steps to Six Sigma." The program was required training for all worldwide Motorola employees. By 1985, the program was improved, based on the ideas of quality engineer Bill Smith. This eventually led to the Six Sigma methodology known as Define, Measure, Analyze, Improve, and Control (DMAIC). Subsequently, another Motorola University course was developed along the same philosophy, "Six Sigma Design Methodology." The course, designed by Craig Fullerton, eventually became what is now known as "Design for Six Sigma" (DFSS) (Barney & McCarty, 2003).

Many organizations have embraced the Six Sigma philosophy and have employed it widely as described by Anbari and Kwak (2004, 2005) and Kwak and Anbari (2006). Organizations such as Motorola, General Electric, 3M, DuPont, Boeing, Sun Microsystems, and Xerox are a few of the major adopters. The methods employed in Six Sigma are not exclusive to the discipline, but are common business practices originally developed under other disciplines and appended to existing tools in the quality movement. Some of the most common tool sets of Six Sigma are borrowed from both statistics and Project Management processes. The Six Sigma approach uses statistical analysis of data to measure and improve the organizations' operational performance. It accomplishes this task through the identification and elimination of defects. The Six Sigma method may be used for products or services, in manufacturing or service-related industries, in process industries, and in knowledge industries. Figure 3 is a sampling of tools in the DMAIC tool set.

Define	Measure	Analyze	Improve	Control
Business Case	Define Measures	Detailed Process Map	Generate Solutions	Process Chart
Charter	Critical Few	Multivariate Analysis	Cost-Benefit Analysis	Process Change Management
SIPOC	Data Collection Plan	Cause-and-Effect	Risk Assessment	Standardization
VOC	Gage R&R	Hypothesis Testing	Pilot	Process Documentation
Process Map	Trend Analysis	Regression	Implementation Plan	Control Charts
Yield Calculation	Process Capability	DOE		Process Capability
Customer Requirements				Document Key Learning
CTQ				

Figure 3. DMAIC Tools (Adapted from Bertels, 2003)

Six Sigma organizations have established roles and responsibilities. The key player is the Black Belt (Hoerl, 2001). This role is one of a trained leader and tool user, one who leads the project in identifying and developing the implementation of process improvements following a DMAIC or DFSS sub-method. Another player is the Green Belt; one who is trained in Six Sigma and works either under the direction of the Black Belt (on larger projects) or leads smaller projects. The Yellow Belt is a project participant who receives basic training in Six Sigma. Other roles often found in Six Sigma organizations are a) Sponsor/Champion – involved in project selection and senior management roles; Master Black Belt – a senior certified Black Belt functioning as a leader of a group of Black Belts or, in some organizations, a trainer of Black Belts.

One element of Six Sigma is Design of Experiments (DOE), which should not be confused with DMAIC or DFSS. DOE is a term for an experiment designed for simultaneous evaluation of two or more factors (parameters), measuring the effect of the variability of the process (characteristics). One approach to DOE segregates into three phases: planning, conducting and analyzing. Within DOE, there are twelve steps to be accomplished by Ross (1996).

1. State the problem or area of concern
2. State the objective of the experiment
3. Select the quality characteristics and measurement systems
4. Select the factors that may influence the selected quality characteristics
5. Identify control and noise factors
6. Select levels for each factor
7. Select the appropriate orthogonal (matrix) array (OA)
8. Select interactions that may influence the selected quality characteristics or go back to step four (iterative steps)
9. Align factors to OA and locate interactions
10. Conduct test described by trials in OA
11. Analyze and interpret results of the experimental trials
12. Conduct confirmation experiment.

Basic Concepts of Six Sigma

In understanding Six Sigma it is necessary to first understand its basic concepts. At the core, variation, types of data, and Six Sigma Quality must be appreciated.

1. Variation – the sum total of all the changes that occur when a process is run
    a. Special Cause – a specific assignable cause, something unusual that may be identified and reduced/eliminated
    b. Common Cause – chance or random cause, always present
    c. Statistical Control – only common cause is present
2. Types of data
    a. Continuous – variable can be measured in a smaller unit, may be represented graphically as a bell curve
    b. Discrete – variable is measured as count, list, etc., may be represented graphically as a histogram or Pareto chart
3. Six Sigma Quality – process defined as one in which the width of the distribution of values is 50% of the upper specification limit minus the lower specification limit (USL-LSL), subject to a 1.5σ shift. Simplified, a maximum of 3.4 defects per million opportunities (DPMO) is considered standard.

The two technical areas that distinguish Six Sigma are a) measurement of Voice of the Customer (VOC), and b) extensive use of statistical analysis to build new processes (Anbari & Kwak, 2004; Bertels, 2003).

The Six Sigma: Certification and Body of Knowledge

The American Society for Quality (ASQ) administers a Six Sigma Black Belt certification process and publishes a Body of Knowledge (BOK) (American Society for Quality, 2005). The certification process is rigorous, requiring proof of professionalism (experience, professional standing, and written confirmation by other professionals) and successful completion of a written exam to test knowledge of the BOK. The published BOK is a relatively simple listing of the concepts and tools that need to be understood in order to complete the written exam.

Most of the published material on the Six Sigma process is generated by the plethora of consultants offering their services for Six Sigma implementations. In the academic community, there is very little published material on the subject matter (ISix Sigma, 2005). Six Sigma is allowed to be defined and redefined by practitioners, many of whom are consultants or commercial organizations offering their version of Six Sigma. Of the material available for research, there seems to be wide variation in the interpretation of Six Sigma, its definitions, and which tools/techniques are utilized.

Project Management

For purposes related to this paper's scope, it is assumed that the reader understands the basics of Project Management methodology and thus it will not be covered in the discussion (Kerzner, 2005). Later, the tools used in Project Management will be compared to the tools used in Six Sigma. The *PMBOK® Guide*—Third Edition includes a total of 187 tools (Project Management Institute, 2004).

Understanding the Population of Six Sigma Tools

Our investigation has uncovered a total of 401 tools and techniques. Figure 4 presents the overall statistics of different tools and techniques from seven sources. Of the many sources reviewed, only seven contained listings of tools being used, and all are included. As a note, one of the challenges of this research is the use of different nomenclature for what is essentially the same tool. For example, one source may cite a tool name of "Five Whys" and another may cite a tool name of "Root Cause Analysis." Both of these tools are essentially the same (Michalski, 2003). As another example, a source may cite "statistics" as a tool and another may cite "regression," "ANOVA," and "correlation"; all may be considered a subset of statistics. The final tools list has been scrubbed, to the best of our ability, for these types of inconsistencies. The final count of tools has been adjusted from 401 tools to 293 unique tools after eliminating duplicate citations.

Source	Total	Unique to Source	% of Total
Michalski (2003)	222	175	44%
Stamatis (2004)	27	14	3%
Brue and Launsby (2003)	21	7	2%
Pande and Holpp (2002)	51	19	5%
Breyfolge (2003)	23	2	0%
Bertels (2003)	12	3	1%
George (2002)	45	17	4%
Total	**401**	**237**	**59%**

Figure 4. Summary of Six Sigma Tools

An analysis of the 293 tools was conducted and the number of citations was computed for each tool. Some tools were cited regularly and others were not cited frequently. The number of tools cited only by a single source is 237 (81%). This presented concerns for the researchers. If only one source cites the tool, it may not be sufficiently accepted by practitioners to include in the analysis. It may be assumed that a tool must be cited more than once to indicate acceptance, but a review of the excluded tools indicates this oversimplified argument to be faulty. Further analysis of this anomaly may be required.

Of the seven sources for tools use, one source stands out due to the sheer number of tools cited. Michalski (2003) cites 222 tools for Six Sigma. In comparison to the other sources, it was noted that 175 (44%) of the tools were cited *only in this source*. The rate of uniqueness of the other six sources averaged less than 3%. Therefore, an inference may be made that many of the tools cited in Michalski (2003) are not considered exclusive to the Six Sigma methodology by the other sources. With the lack of an independent institution to act as an arbitrator, the conclusion may be valid. A further check of the tools cited indicated that Michalski's tools list might be more generalized to the overall quality movement and not exclusive to Six Sigma.

Of the original list of 293 tools, we find a total of 56 tools cited by more than one source. The 56 (108 instances) multi-cited tools are considered stable for analysis and will be used as this research moves forward.

With the original list reduced and stabilized at 56 shared tools, the analysis continues. No single tool was cited by 100% of the sources. One tool was cited in six sources (less than 1%), four tools cited by five sources (1%), eleven tools cited by four sources (4%), fifteen tools cited by three sources (5%), and twenty-five tools were cited by at least two sources (9%). The population of 56 tools has an average of slightly less than 2 citations per tool and represents 19% of the initial tool set. Based on earlier assumptions, this average of 2 demonstrates the significance of the tools under analysis.

Comparisons of Various Six Sigma Tools and Techniques

In this section, we begin our analysis by comparing and contrasting three interesting relationships:

- *PMBOK® Guide* compared to Six Sigma Tools
- *PMBOK® Guide* compared to Six Sigma – Abbreviated Tools
- Statistical Tools Included in Six Sigma Tools

At the end of each section, a complete listing of the subset of tools-compared is included.

Comparison of the *PMBOK® Guide* to Six Sigma Tools

The *PMBOK® Guide*—Third Edition (2004) contains 187 tools as compared to the 293 tools found in Six Sigma. To compare the tools sets accurately, each tool was compared individually. Figure 5 shows that 33 *PMBOK® Guide* tools map to 37 Six Sigma tools. The reason for the lack of one-to-one correlation is inconsistency in naming conventions between the sources. For example, in the *PMBOK® Guide*—Third Edition, "Flowcharting" is listed as a single tool. In Six Sigma, "Cycle Time Flowchart" and "Decision Process Flowchart" are listed separately. The authors considered this as one *PMBOK® Guide* tool that maps to two Six Sigma tools. There are three instances of multiple mapping in the data set: two instances of one *PMBOK® Guide* tools mapping to two Six Sigma tools and one instance of one *PMBOK® Guide* tool mapping to three Six Sigma tools.

Of the 187 *PMBOK® Guide* tools, 33 (18%) can be mapped to Six Sigma tools. This roughly one-in-five ratio would indicate that the *PMBOK® Guide* tools are significantly correlated to Six Sigma tools. This relationship suggests a shared dependency between Project Management and Six Sigma methodologies. It may also suggest a common source of benchmarking between the methods. Of the 293 Six Sigma tools, 37 (13%) can be mapped to *PMBOK® Guide* tools. This indicates less of a role of Project Management in the Six Sigma methodology.

PMBOK® Guide—Third Edition				Six Sigma (SS)	
Knowledge Area	**Process**	**Code**	**Tools and Techniques**	**SS Ref.**	**Six Sigma Tools**
Integration	Charter	4.1.2.1	Project Selection Methods	154	Project Prioritization Matrix
Integration	Charter	4.1.2.2	Project Management Methodology (Charter)	249	Charter
Integration	Preliminary Scope	4.2.2.1	Project Management Methodology (Preliminary Scope)	252	Output Requirements
Integration	PM Plan	4.3.2.1	Project Management Methodology (PM Plan)	225	Project Management
Scope Management	Scope Planning	5.1.2.2	Templates, forms, standards	240	Customer Requirements
Scope Management	Scope Definition	5.2.2.4	Stakeholder Analysis	251	Stakeholder Analysis
Scope Management	WBS	5.3.2.1	WBS Templates	87	Gantt Chart
Scope Management	WBS	5.3.2.2	Decomposition (WBS)	220	Work Breakdown Structure (WBS)
Time Management	Activity Definition	6.1.2.1	Decomposition (WBS)	5	Activity Analysis
				6	Activity Cost Matrix
Time Management	Activity Definition	6.1.2.2	Templates (Activity Definition)	196	Task Analysis
Time Management	Activity Sequencing	6.2.2.1	Precedence Diagramming Method (PDM)	7	Activity Network Diagram
Time Management	Resource Estimate	6.3.2.1	Expert Judgment (Resource Estimate)	163	Resource Requirements Matrix
Time Management	Schedule Development	6.5.2.2	Critical Path Method	152	Program Evaluation and Review Technique (PERT)
Time Management	Schedule Development	6.5.2.4	What-if Scenario Analysis	215	What-If Analysis
Time Management	Schedule Control	6.6.2.3	Performance Measurement	199	Team Process Assessment
Time Management	Schedule Control	6.6.2.4	PM Software (Schedule Control)	109	Milestones Chart
Cost Management	Cost Estimating	7.1.2.8	Cost of Quality (Cost Estimating)	44	Cost of Quality
Quality Management	Quality Planning	8.1.2.1	Cost-benefit Analysis	45	Cost-Benefit Analysis
Quality Management	Quality Planning	8.1.2.2	Benchmarking	17	Benchmarking

PMBOK® Guide—Third Edition				Six Sigma (SS)	
Knowledge Area	**Process**	**Code**	**Tools and Techniques**	**SS Ref.**	**Six Sigma Tools**
Quality Management	Quality Assurance	8.2.2.3	Process Analysis	146	Process Analysis
Quality Management	Quality Control	8.3.2.1	Cause and Effect Diagram	25	Cause and Effect Diagram CED
Quality Management	Quality Control	8.3.2.2	Control Charts	222	Yield Chart
Quality Management	Quality Control	8.3.2.3	Flowcharting	56	Cycle Time Flowchart
				58	Decision Process Flowchart
Quality Management	Quality Control	8.3.2.4	Histogram	90	Histogram
Quality Management	Quality Control	8.3.2.5	Pareto Charts	101	Line Chart
Quality Management	Quality Control	8.3.2.6	Run Charts	171	Run Chart
Quality Management	Quality Control	8.3.2.7	Scatter Diagrams	175	Scatter Diagram
Quality Management	Quality Control	8.3.2.8	Statistical Sampling	173	Sampling Method
Human Resource Management	HR Planning	9.1.2.1	Organization Charts - Position Descriptions	124	Organization Chart
Communications Management	Performance Reporting	10.3.2.1	Information Presentation Tools	130	Pareto Chart
				262	Dashboards
				274	Scorecards
Risk Management	Risk Identification	11.2.2.5	Diagramming Techniques	168	Risk Space Analysis
Risk Management	Risk Response Planning	11.5.2.4	Contingent Response Strategy	261	Response Plan
Risk Management	Risk Monitor/Control	11.6.2.3	Variance and Trend Analysis	205	Trend Analysis

Figure 5. *PMBOK® Guide* Tools Compared to Six Sigma Tools

Comparison of PMBOK® Guide to Six Sigma – Abbreviated Tools

In this comparison, we use the abbreviated Six Sigma tool set – only those tools cited two or more times. The *PMBOK® Guide*, Third Edition contains 187 tools as compared to the now-56 tools found in Six Sigma – Abbreviated tool set, as shown in Figure 6.

Of the 187 *PMBOK® Guide* tools, 16 (12%) can be mapped to Six Sigma tools. This roughly one-in-nine ratio would indicate that *PMBOK® Guide* tools are not as significantly related to Six Sigma tools as the previous comparison. This relationship continues to suggest a shared dependency between Project Management and Six Sigma methodologies, but at a lower level. Of the 56 Six Sigma tools, 16 (29%) can be mapped to *PMBOK® Guide* tools. This indicates a very significant role of Project Management in the Six Sigma methodology.

Six Sigma – Abbreviated Version
Includes Tools with Two or More Citations

No.	SS No.	Six Sigma Tool Name	Michalski (2003)	Stamatis DMAIC (2004)	Stamatis DFSS (2004)	Brue and Launsby (2003)	Pande and Holpp (2002)	Breyfogle (2003)	Bertels DFSS (2003)	George (2002)	Number of Occurrences	PMBOK® Guide Reference Number
1	74	Failure Mode Effect Analysis (FMEA)	x	x	x	x	x			x	6	
2	17	Benchmarking	x	x		x		x		x	5	8.1.2.2
3	40	Control Chart - c (Attribute)	x				x	x	x	x	5	
4	41	Control Chart - *p* (Attribute)	x				x	x	x	x	5	
5	42	Control Chart - *X-R* (Variable)	x				x	x	x	x	5	
6	8	Affinity Diagram	x			x		x		x	4	
7	10	Analysis of Variance	x				x			x	4	
8	25	Cause and Effect Diagram CED	x				x	x		x	4	8.3.2.1
9	26	Cause and Effect Diagram Adding Cards CEDAC	x				x	x		x	4	
10	29	Check sheet	x				x	x		x	4	
11	91	House of Quality	x			x	x		x		4	
12	107	Measurement Matrix	x	x		x	x				4	
13	130	Pareto Chart	x				x	x		x	4	10.3.2.1
14	171	Run Chart	x				x	x		x	4	8.3.2.6
15	175	Scatter Diagram	x				x	x		x	4	8.3.2.7
16	204	Tree Diagram	x				x	x		x	4	

Six Sigma – Abbreviated Version
Includes Tools with Two or More Citations

No.	SS No.	Six Sigma Tool Name	Michalski (2003)	Stamatis DMAIC (2004)	Stamatis DFSS (2004)	Brue and Launsby (2003)	Pande and Holpp (2002)	Breyfogle (2003)	Bertels DFSS (2003)	George (2002)	Number of Occurrences	PMBOK® Guide Reference Number
17	231	DOE			x	x	x			x	4	
18	20	Brainstorming	x					x		x	3	
19	28	Checklist	x				x	x			3	
20	38	Conjoint Analysis	x		x				x		3	
21	43	Correlation Analysis	x			x	x				3	
22	44	Cost of Quality	x	x			x				3	7.1.2.8
23	58	Decision Process Flowchart	x				x	x			3	8.3.2.3
24	66	Descriptive Statistics	x	x				x			3	
25	80	Force Field Analysis (FFA)	x				x	x			3	
26	90	Histogram	x				x			x	3	8.3.2.4
27	147	Process Capability Ratios	x			x				x	3	
28	150	Process Mapping	x				x			x	3	
29	224	Poka-Yoke (mistake proofing)		x		x				x	3	
30	227	Regression			x		x			x	3	
31	234	Tolerance Design			x	x			x		3	
32	7	Activity Network Diagram	x					x			2	6.2.2.1
33	19	Box Plot	x							x	2	
34	53	Customer Needs Table	x			x					2	
35	77	Five Whys	x					x			2	
36	85	Functional Map	x		x						2	
37	87	Gantt Chart	x				x			x	2	5.3.2.1
38	92	Hypothesis Testing (Chi-Square)	x							x	2	
39	99	Interrelationship Digraph (I.D.)	x					x			2	
40	114	Multivariable Chart	x							x	2	
41	117	Nominal Group Technique (NGT)	x					x			2	
42	125	Organization Mapping	x				x				2	

Six Sigma – Abbreviated Version
Includes Tools with Two or More Citations

No.	SS No.	Six Sigma Tool Name	Michalski (2003)	Stamatis DMAIC (2004)	Stamatis DFSS (2004)	Brue and Launsby (2003)	Pande and Holpp (2002)	Breyfogle (2003)	Bertels DFSS (2003)	George (2002)	Number of Occurrences	PMBOK® Guide Reference Number
43	135	Point-Scoring Evaluation	x			x					2	
44	143	Problem Analysis	x				x				2	
45	146	Process Analysis	x				x				2	8.2.2.3
46	173	Sampling Method	x				x				2	8.3.2.8
47	192	Surveying	x			x					2	
48	199	Team Process Assessment	x	x							2	6.6.2.3
49	205	Trend Analysis	x				x				2	11.6.2.3
50	210	Value Analysis	x							x	2	
51	222	Yield Chart	x				x				2	8.3.2.2
52	226	Kano Model			x		x				2	
53	236	Gage R&R			x					x	2	
54	243	Pugh Concept Selection Technique (alternative evaluation)				x			x		2	
55	262	Dashboards					x				2	10.3.2.1
56	266	Creativity Techniques					x		x		2	

Figure 6. Six Sigma – Abbreviated Compared to *PMBOK® Guide* Tools

Illustration of Statistical Tools Included in Six Sigma Tools

In the entire Six Sigma tool set, there are twenty-one distinct statistical tools, representing more than 7% (21/293) of the total tool set, as shown in Figure 7. While this may show that statistics are a firm basis of Six Sigma methods, the statistical tool set represents only a small fraction of entire Six Sigma tools set.

Six Sigma Statistical Tools			
No.	Six Sigma Reference	Tool Name	Common Alternate Name
1	10	Analysis of Variance	ANOVA, Hypothesis Testing
2	14	Bar Chart	Bar Graph
3	19	Box Plot	Box and Whiskers Plot
4	35	Cluster Analysis	
5	40	Control Chart - c (Attribute)	
6	41	Control Chart - *p* (Attribute)	
7	42	Control Chart - *X-R* (Variable)	
8	43	Correlation Analysis	Hypothesis Testing (Correlation)
9	66	Descriptive Statistics	
10	73	Factor Analysis	
11	83	Frequency Distribution (FD)	Frequency Table
12	92	Hypothesis Testing (Chi-Square)	
13	114	Multivariable Chart	
14	119	Normal Probability Distribution	
15	171	Run Chart	
16	173	Sampling Method	Random Sampling
17	184	Standard Deviation	
18	227	Regression	
19	259	Sigma Calculation	
20	276	Statistical Tolerance	
21	281	SSPI Toolkit	

Figure 7. Statistical Tools included in Six Sigma tools

Summary of Comparisons

The key findings of the above comparisons are as follows:

- Using the *PMBOK® Guide* Third Edition as a base, 18% (33) of its tools (187) are mapped to Six Sigma. In reverse, using Six Sigma as a base, 13% (37) of its tools are found in the *PMBOK® Guide*. This indicates a high relationship between both methodologies.
- Using the *PMBOK® Guide* Third Edition as a base and comparing to the Six Sigma – Abbreviated tools (containing two or more citations), 9% (16) of the *PMBOK® Guide* tools (187) are mapped to

Six Sigma. Alternately, using Six Sigma – Abbreviated as a base, 29% (16) of its tools (56) are found in the *PMBOK® Guide*. This lessens the influence of Six Sigma on the *PMBOK® Guide*, but greatly increases the influence of the *PMBOK® Guide* on Six Sigma tools and techniques. This almost one-to-three relationship may suggest that the *PMBOK® Guide* Third Edition is an integral part of the Six Sigma methodology.

- The Six Sigma tool set (293) is comprised of 13% (37) *PMBOK® Guide* tools, and 7% (21) Statistical tools. The balance of Six Sigma tools (80%) may represent legacy "Quality Movement tool sets" or other sources.

Conclusions and Directions for Future Research

The tools used in Six Sigma are a collection of "Quality Movement" tools (80%), Project Management tools (13%), and Statistical tools (7%). Six Sigma seems to be more deeply based on the Project Management discipline when using multi-cited tools.

Earlier, we defined Six Sigma as a "business philosophy, one that attempts to analyze data as an enablement for improvement." The first observation arising out of this comparison is that Six Sigma and Project Management are relatively related; 13% or 18% of the tools map to each other, depending on the perspective used. Both methodologies seem ready to adopt new tools as the need arises, and neither methodology attempts to limit the use of different/new tools.

Is the number of tools used indicative of success? Or is the maturity of the tool set more important? These are interesting questions. Based on the number of tools, Six Sigma employs far more tools than Project Management. However, when the tool set is inflated (as may be the case of Michalski), this observation may be off the mark. When the Six Sigma – Abbreviated (more than one citation) tool set is used, the 187 tools of Project Management far exceed the 56 Six Sigma tools. In this case, the maturity of Project Management, based on its tools, is far more than the maturity of Six Sigma. This is further supported by the relative age of each methodology; modern Project Management arose in the 1940's while Six Sigma traces its origin to the mid-1980's.

Analyzing Six Sigma from the perspective of its tools, it is evident that Six Sigma is attempting to manage projects in addition to conducting statistical analysis of business data. A review of published articles and books on Six Sigma seems to confirm this Project Management link (Breyfogle, 2003; Michalski, 2003; Pande & Holp, 2002). However, the Project Management link is not well articulated. In general, the articles cited discuss projects under Six Sigma, and use Six Sigma tools to achieve results within projects, but do not sufficiently discuss using Project Management as a methodology, whether as a separate methodology or combined with Six Sigma.

This implied use of Project Management tools may be acceptable to Six Sigma enthusiasts, but it raises questions for academic researchers. Concern stems from the unarticulated and extensive use of Project Management tools, yet the common definition of Six Sigma does not address the management of projects. It may be implied that "analyzing data" usually requires the use of statistics; but it is not implied that "analyzing data" must include Project Management tools and practices. This seems to be a subject requiring further study.

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