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ABSTRACT

The Six Sigma Black Belt (SSBB) certification is granted by many organizations including industry, academia, consultants and professional quality organizations. Each of these organizations has independently developed their own unique body of knowledge (BOK) by which their SSBB certification is granted. This inconsistency in the fundamentals of what a Black Belt (BB) should know, regardless of where he or she attained certification and works, has eroded the credibility of the training, certification, and ultimately the profession. Many Six Sigma leaders have made a call for action to establish a "common core" BOK that all certifying entities will adopt and may add to for their particular needs.

This article seeks to determine trainers' perceptions of the relative importance of the ten major topic areas defined in the American Society for Quality's Six Sigma Black Belt Body of Knowledge through survey research of independent Black Belt trainers. The quantitative results identified the rank order of importance of the American Society for Quality's (ASQ) SSBB BOK major topics. The qualitative results suggest that the top seven major topics of Measure Stage, Define Stage, Analyze Stage, Control Stage, Business Process Management, Project Management, and Improve Stage, be classified as problem solvers and the remaining three, Enterprise-wide Deployment, Lean Enterprise, and Design for Six Sigma be classified as problem preventers. The top seven major topics should be considered for every certifying organization's common core and the hierarchy importance should receive appropriate amount of emphasis in BB training.

INTRODUCTION

The American Society for Quality (ASQ) is regarded as the preeminent professional quality organization in the world and grants professional certification in 14 different areas, based almost exclusively on the respective Body of Knowledge (BOK). ASQ's certification is highly regarded by business and industry (Moran & La Londe, 2000; Hartman, 2002) and proven to be of significant financial value to quality professionals (ASQ, 2008). ASQ (2008) research showed that holding ASQ certification(s) earned quality professionals higher salaries, as much as $12,000 per year for a Certified Reliability Engineer. Of these certifications, the Six Sigma Black Belt (SSBB) certification may be one of the most sought after. Black Belts (BB) have risen to an elite status in business because of their ability to produce significant financial success for a company. Motivated by the promise of creating business improvement juggernauts or the opportunity to capitalize on the financial rewards of training Black Belts, many different organizations have devel-

oped their own Black Belt certification process independent of ASQ. But even in the midst of all its celebrated success, controversy surrounds the SSBB certification process due to the lack of an established common core BOK.

Most of the various certifying organizations such as Motorola, Rath & Strong, George Group, and ASQ require a Black Belt candidate to successfully complete a Six Sigma training course and project, but some also require the candidate to pass either their own internal certification exam or the examination sponsored by ASQ. Additionally, each of these organizations has developed its own proprietary Body of Knowledge (BOK) as the basis of their training and testing. This inconsistency in training/certification requirements has produced discourse among the quality profession (Stamatis, 2000; Ramberg, 2000; & Pyzdek, 2000) as individuals and organizations philosophize on what should be the most essential topics to be part of the BOK.

While no organization should have its Black Belt training methodologies mandated, there are at least two reasons why a consistent level of rigor to its content is vitally important to the quality profession. First, this level of rigor will protect and ensure the credibility of the Black Belt certification, and secondly, will promote the acceptance of Black Belts as a recognized profession. To achieve this consistent level of rigor, broad-reaching research needs to be conducted that will measure the perceived importance of the BOK major topics.

LITERATURE REVIEW

The issue of certification has drawn a significant amount of concern among Six Sigma practitioners because of the many different certifying organizations. Several quality professionals have refuted the legitimacy of certification since there is not just one certifying entity and because there is so much variation within the training and certification requirements (Ramberg, 2000; Hoerl, 2001; Cazar, 2006). Hoerl (2001) noted "there are no standardized criteria for certification, as there are with accountants, lawyers, and engineers, hence being a 'Certified BB' has little meaning without knowing the specific certification criteria" (p. 394). Hoerl further states "there is a need for a common 'core' Black Belt skill set, which is dynamic over time, can be tailored to specific application areas, and is derived from general business needs. The profession needs to reach consensus on what this common core is" (p. 432).

As part of ASQ's role as the authoritative source of quality, they have methodically developed a comprehensive BOK specifically for the BB certification (ASQ, 2006). The Black Belt BOK is comprised of 10 topic areas that serve as the foundation for developing the examination's questions (Moran & La Londe, 2000). According to ASQ (2007), the BOK is "the prescribed aggregation of knowledge in a particular area an individual is expected to have mastered to be considered or certified as a practitioner" (Section B, ¶12). This definition places a great importance on the BOK as a valid and reliable standard for performing an objective evaluation of BB learning and performance.

The methodology for the development of its certification adheres to the following phases (Hartman, 2002):

1) Job Analysis and Survey (the foundation for the examinations)
2) Advisory committee (identifies job responsibilities and knowledge of field)
3) Member input (who decides what will be in the body of knowledge)
4) The BOK committee (how does the content get organized in the BOK)
5) Question writing committee (how does it write questions)
6) Question review committee (verification and review)
7) Testing the test (the last check before the exam)
8) Exam statistics (post-exam question verification)

The certification development process serves the ASQ member population well; however, only about 20 percent of the Black Belt certifications have been granted by ASQ (DeRuntz, 2005).

The Need for a SSBB BOK

There are three primary purposes for developing and publishing a BOK. First is to aid the examinee in his or her preparation of the exam, second is to standardize the minimum common knowledge that each certificate holder will possess and third, direct the content and level of training. With this intent, the developers of ASQ's SSBB BOK have indicated the level of cognition for each of the major topic's subsections using Bloom's Taxonomy. While this classification is an indicator of the depth of knowledge that each ASQ examinee should possess for the sub-topics, it does not indicate relative importance of the major topics or subtopics. A hierarchy of importance needs to be established for the major topics and sub-topics so the examinee will have a comprehensive understanding of the relative importance of the topics in relationship to each other and hence improve their preparation.

A Universally Accepted Common Core

ASQ has made a tremendous contribution to the quality profession by making publicly available the SSBB BOK. This valuable work needs to be the foundation by which to establish a universally accepted common core BOK, but first the current information must be improved. The hierarchy of importance for ASQ's CSSBB BOK is unknown and thereby fails to direct the amount of training or project evaluation for each major topic. Second, ASQ's representative sample of survey participants only comes from their population and doesn't provide unbiased representation of the quality profession. Finally, the BOK is the foundation for the expert process of training, evaluating and certifying of a BB; greater validity can be given to ASQ's BOK if it was validated by the people who have greater experience at training and evaluating BB (e.g. MBB). ASQ can demonstrate its leadership among all quality professionals by having its SSBB BOK validated by outside membership. This validation

would begin the important process of developing a universally accepted common core of knowledge for six sigma professionals and elevate the recognition of the profession.

In response to this clear need, a study was conducted that could validate ASQ's SSBB BOK topics (DeRuntz, 2005). This study surveyed a broad sample of the BB trainers that were not directly associated with ASQ with the intent of assessing their perceptions of the relative importance of certification topics to be used as BB candidate training criteria.

The purpose of the study was to explore the perceptions of Black Belt trainers with respect to the criteria used to train and certify BB candidates. More specifically, it sought to understand trainers' perceptions of the relative importance of the ten certification topics identified by ASQ.

METHODOLOGY

The study sought to obtain a sample population that was a cross sectional representation of the quality profession and independent of any professional quality organization. The population for this study was identified through a Six Sigma consultant directory on the website isixsigma.com. This widely used website contains many resources for Six Sigma professionals and offers consultants the opportunity to list their business. As such, one limitation of this study is that only Six Sigma professionals registered on the isixsigma.com website were included in the studies sample.

The sample population was comprised of 120 Master Black Belts who have taught Black Belt training courses. The 120 consultants represented an international cross-section of the Six Sigma trainers who are leading this global transformation. Inferences made from this study were limited by this selective population that offers training commercially because there are many more Six Sigma trainers who work for corporations, educational institutions, etc. This cross-section of Six Sigma professionals was chosen because; they are not employed exclusively by one company, they are not associated with any particular professional quality organization, and they had the greatest variety of training experiences.

The study utilized a mixed-methodology of both quantitative and qualitative research methods. Using a mixed-methodology can create cross validation, which combines two or more theories or sources of data that study the same phenomenon in order to gain a more complete understanding of it (Denzin, 1970). Additionally, a mixed-methodology is used to achieve complementary results by using the strengths of one method to enhance the other (Morgan, 1998). This mixed-methodology was carried out in sequential phases (i.e. quantitative-qualitative) for complementary purposes.

In the quantitative phase, a survey instrument was developed from an extensive literature review and interviews with Six Sigma professionals. The instrument was pilot-tested to determine face validity, content validity and ease of use by a group of three Master Black Belts not included in the survey population.

Instrumentation.

The final version of the instrument consisted of 63 questions contained in four parts. In Part I of the survey, participants were asked to choose a descriptor on a Likert-type scale to indicate their perceived importance of the 10 major topics and respective subsections of the ASQ BOK. Each Likert descriptor corresponded to a value ranging from 1 to 5; a higher value would be used to indicate an essential topic (i.e., 5) followed in descending order to the least important topic (i.e., 1).

Part 2 asked their opinions regarding the need for a project evaluation instrument, and other data unrelated to this article. Part 3 collected basic demographic data regarding the trainers' experiences, and Part 4 solicited voluntary contact information if the respondent wished to participate in the qualitative portion of this study.

The survey achieved a response rate of 30.0%, and while a response rate of 30% may seem low, it is not unusual. Alreck and Settle (1995) noted that surveys with response rates of more than 30% are rare. In a study by Colombo (2000), the author stated that "typical response rates from surveys are about 20%" (p. 2). While research shows that 30% is an acceptable response rate, the author felt the study would be further validated through the use of complementary research in the form of follow-up interviews with a randomly selected cross-section of respondents.

Using a random number table, one subject was chosen from each of the representative organizations: ASQ, Education, Industry, and Consultant. The sample size of four was chosen based upon a projected return rate of 30%, or 40 responses. From the 36 respondents, a random sample of 10% (i.e., 4) respondents was chosen to participate in a follow-up interview.

Demographic data was collected in Part 3 of the survey to assess the qualifications and experience of each participant. Qualitative participants who had completed fewer than ten Black Belt projects were excluded from the data analysis for lack of experience. In the (2003) article, "What does it take to become a Master Black Belt?" Watson recommended that a Master Black Belt candidate should have completed at least ten BB projects with topics having both commercial and technical applications.

Table 1 presents the certification affiliation of SSBB trainers who responded to the survey. These data show where the respondents received their certification. Note that the response from trainers who received their certification from Industry comprised 41.7% of the respondent population.

Rigor and Validity

Establishing survey validity usually requires evidence from several sources. The internal validity or rigor with

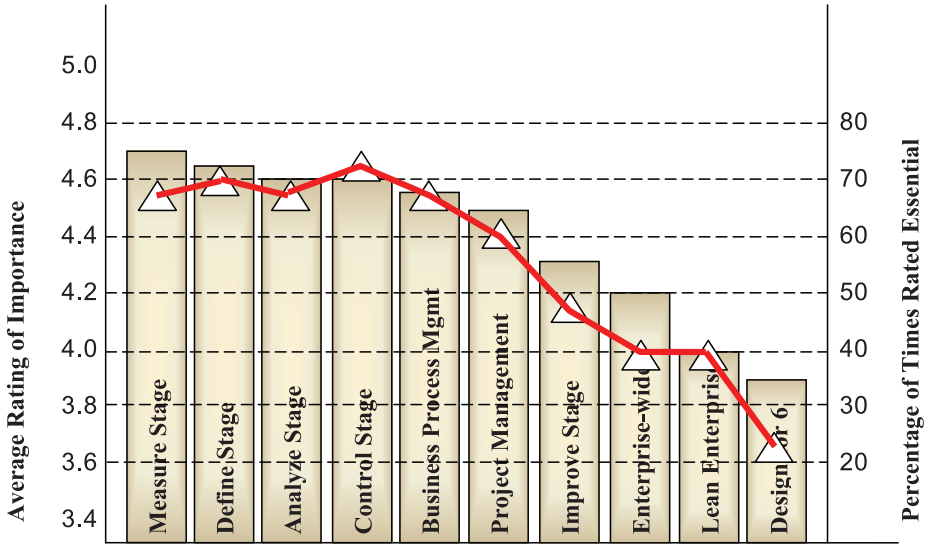
which this study was conducted (e.g., the study's design, the attention taken to conduct measurements, and decisions with reference to what was and wasn't measured) is offered through the extensive review of literature that was conducted. Four bodies of knowledge were reviewed in depth. These four bodies of knowledge included: (1) Motorola, (2) The George Group, (3) Rath & Strong, and (4) American Society for Quality. Upon careful review of these bodies of knowledge the authors chose to utilize the American Society for Quality Six Sigma Black Belt Body of Knowledge for this study. The rationale for selecting the ASQ Body of Knowledge as the focal point for this study was based upon the fact that ASQ is the only organization that uses all the other Six Sigma Bodies of Knowledge as references and for the development of their certification exam (ASQ, 2009). Additional secondary information sources were reviewed including a review of classic quality texts, quality journal articles, master black belt proceedings and the ASQ website.

To achieve survey validity from an external perspective it is important to have a high response rate. In order to have survey results that genuinely reflect the population, it is necessary to have a statistically valid sampling from the SSBB constituency. The higher the response rate the more valid the results. According to Bennekom (2003) a 30% (36/120) response rate yields a statistical accuracy of 95% ±15%. Ninety-five percent was chosen by convention. If the accuracy is ± 15% and the survey instrument utilizes questions with a measurement scale that ranges from 1 to 5, then there are 4 intervals on the scale. Plus or minus 15% on the scale is slightly more than one full interval point (25% of 4). Therefore, the authors are 95% certain that the average (population mean) would lie within a band of one point on the scale with the average score from a survey question (the sample mean) in the middle. Put a different way, if a particular survey question had a mean score of 3.5, and the authors conducted a census, 95% of the scores would lie in a band from 2.975 to 4.025.

Table 1. Number of Survey Respondents by the Organization Granting Certification

	Frequency	Percent Distribution
ASQ	7	19.4
Consultants	9	25.0
Educational Institution	3	8.3
Industry	15	41.7
Other	2	5.6
Total	36	100.0

Figure 1. SSBB BOK Factors Average Rating of Importance and Percentage of Times Rated Essential



The alpha level selected for this study was .05. Alpha is the likelihood of being wrong that the authors are willing to accept. Five percent or (.05) being wrong is the same as 95% certainty that the authors findings are correct. In this example, if the mean for a particular survey question was 3.5 on a 1 to 5 scale and the confidence was 0.15, then the authors are therefore 95% certain the true mean or population mean lies in a band defined by 3.5 ±0.15. Our accuracy is 0.15 as a percentage of the size of the scale, which is (5 - 1) = 4. Thus, our accuracy is ±0.15/4 or 3.75%. Therefore, 95% of the time the mean will fall in a range from 3.35 to 3.65.

QUANTITATIVE FINDINGS

The statistical descriptors of mean and frequency were chosen to assess two different aspects of the perceived importance of the major topics. A mean descriptor was used to illustrate the topics with the highest average level of importance. Essential is defined in the survey as having the highest importance when considering initial project evaluation criteria. Frequency was used to illustrate the number of times a topic received the highest ranking of Essential. The intent of this design was to understand both the average level of importance and how often each topic was considered to be Essential. Figure 1 illustrates the average rating of Importance and the percentage of time a factor was rated Essential.

Based on mean scores, the hierarchy of importance of the ASQ SSBB BOK topics is as follows: 1) Measure Stage, 2)Define Stage, 3) Analyze Stage, 4) Control Stage, 5) Business Process Management, 6) Project Management, 7) Improve Stage, 8) Enterprise-wide Deployment, 9) Lean Enterprise, and 10) Design for Six Sigma.

Confidence Intervals Calculations

The data was further analyzed by examining the confidence intervals for each of the 10 SSBB BOK topics or factors. The width of the confidence interval gives an idea about how uncertain the researchers are about the differences in the means. A very wide interval may indicate that more data needs to be collected before anything definite can be said. The confidence intervals were set at 95% by convention and thus can be interpreted as; the researchers are 95% confident that the interval contains the true difference between the two population means. In other words 95% of all confidence intervals formed in this manner (from different samples of the population) will include the true difference.

The formula for the confidence interval of a mean is: CI = $\overline{Y}$ ± (t * SE), Where "t" is a factor that depends on the confidence desired (95%) and the degrees of freedom generated for the estimate of error. It represents the number of standard deviations from the estimated mean ($\overline{Y}$). The 95% confidence interval represents approximately two standard deviations from the mean. The formula for the mean of each survey response (Y) is shown below, where "n" equals the sample size (36 for this study) and "i" is each respondent's individual ranking for the specific survey item.

$$\overline{Y} = \frac{\sum_{i}^{n} {}_{1} Y_i}{n}$$

The mean, or $\overline{Y}$ was calculated by adding up each of the individual respondents rankings and then dividing by the number of respondents. Variance (s^2) equals the sum of the squared deviations from the mean, divided by one less than the number of survey respondents.

Table 2. Perceived Importance of Major Topics within ASQ's BOK

Major Topic	Avg. Rating of Importance out of a possible 5	Percentage of Times Rated Essential	S.D.
Measure stage	4.67	67	0.48
Define stage	4.64	69	0.59
Analyze stage	4.61	67	0.60
Control stage	4.61	72	0.80
Business process mgt.	4.58	67	0.65
Project management	4.50	61	0.74
Improve stage	4.31	47	0.82
Enterprise-wide deployment	4.19	39	0.89
Lean enterprise	4.03	39	0.91
Design for six sigma	3.92	22	0.77

n=36, Note. S.D. = standard deviation.
1 = not at all important; 2 = Somewhat not important; 3 = Neither important nor not important; 4 = Somewhat important; 5 = Essential.

$$S^2 = \frac{\sum_{i}^{n} {}_{1} [(Y_i - \overline{Y}])^2}{n\text{-}1}$$

Variance is the primary statistic used to measure variability, or dispersion, of the distribution. However, to get units back to their original (not squared) metric, it is common to report the "standard deviation(s)." This is just the square root of the variance.

For this study the following formula was used to approximate the standard error. This formula is based on the central limit theorem.

$$SE \approx \sqrt{\frac{S^2}{n}}$$

Remember the standard error gets smaller as the number sampled (n) gets larger. In other words the more one samples the more precisely one can estimate the "true" outcome. Table 3 depicts the calculations required to graph the confidence intervals for the ten major SSBB BOK topic areas.

Figure 2 illustrates graphically the confidence intervals for each of the ten topics or factors included in the SSBB BOK. The graphical depiction of the data allows for easy interpretation of the findings. For example, as one examines the confidence interval for the measure stage, it is easily seen that it overlaps with the interval for the design stage, analyze stage, control stage, business process management, project management, and improve stages. Therefore, there are no significant differences between the measure stage and any of the aforementioned factors.

Continuing with examining the confidence interval for the measure stage, it is easily seen that there is no overlap of the measure stage confidence interval with the enterprise-wide deployment, lean enterprise, and design for six sigma factor confidence intervals. Thus, there are significant differences between the measure stage and the enterprise-wide deployment, lean enterprise, and design for six sigma factors. To summarize the confidence interval analysis there are no significant differences between the measure stage, define stage, analyze stage, control stage, business process management,

project management, and improve stage factors. There are also no significant differences between the define stage, analyze stage, control stage, business process management, project management, improve stage, and enterprise-wide deployment factors since their confidence intervals all overlap. Additionally, there are no significant differences between the project management, improve stage, enterprise-wide deployment, and lean enterprise factors. Significant differences do exist between the confidence intervals of the measure stage, define stage, analyze stage, control stage, and business process management when compared with the lean enterprise and design for six sigma factors.

QUALITATIVE FINDINGS

Information compiled from the survey was used to develop an interview questionnaire that would serve as complimentary research. Four Master Black Belts were interviewed and asked about the applicability of this study in a business setting. Their responses were recorded and studied using a content analysis procedure. Interviewees were asked if they thought the rank order of the major topics seemed logical to them. All the respondents reaffirmed the rank order of importance of the major topics. The majority of interviewees felt the relative importance of certification topics ranked 1-7 are absolutely fundamental and essential to the BOK and have the most value. They also felt that topics 1-7 could be classified as problem solvers and topics 8-10 could be classified as problem preventers.

Interviewees were asked how data showing the relative importance of ASQ topics can be used in their SSBB training program. They indicated that they would place greater emphasis on the topics ranked 1-7 in their training and would only use these topics when evaluating a candidate's project(s). Because Black Belts can obtain certification that may or may not include an exam as part of its process, the interviewees were asked their perception of this inconsistent requirement. All of the interviewees said they put less

Table 3. Confidence Interval Calculations for the 10 SSBB Major Topic Areas

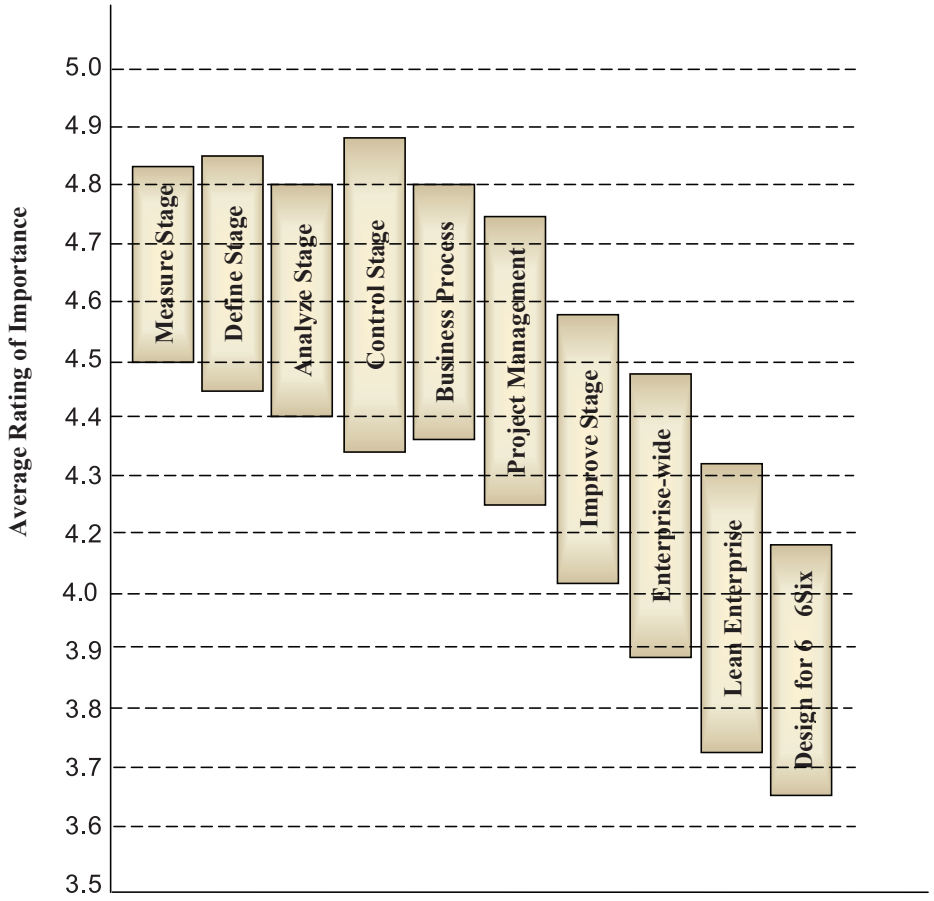
$$CI = \overline{Y} \pm (t * SE)$$

$$SE = \sqrt{\frac{S^2}{n}}$$

	$\overline{Y}$	Std Dev		$\overline{Y}$-(t*SE)	$\overline{Y}$+(t*SE)
Measure stage	4.67	0.48	0.08	4.51	4.83
Define stage	4.64	0.59	0.10	4.44	4.84
Analyze stage	4.61	0.60	0.10	4.41	4.81
Control stage	4.61	0.80	0.13	4.34	4.88
Business process Mgt.	4.58	0.65	0.11	4.36	4.80
Project management	4.50	0.74	0.12	4.25	4.75
Improve stage	4.31	0.82	0.14	4.04	4.58
Enterprise-wide deployment	4.19	0.89	0.15	3.89	4.49
Lean enterprise	4.03	0.91	0.15	3.73	4.33
Design for six sigma	3.92	0.77	0.13	3.66	4.18

n = 36

Figure 2. ASQ CSSBB Major Topic Confidence Intervals



emphasis on the exam and far greater emphasis on evaluating the BB performance in conducting their BB project. The interviewees' perceptions point out a significant problem that certification granting agencies need to address. That being that on the job performance is perceived to be of more value than passing a certification exam.

DISCUSSION

The topics that comprise the DMAIC model (Define-Measure-Analyze-Improve-Control) ranked in 5 of the top 7 positions. This disjointed ranking is surprising considering that the 5 step DMAIC model is the backbone of the Six Sigma methodology. It is thought to be highly unlikely that the importance of the sequential DMAIC model could be fractured by other equally or more important topics. The topics of Business Process Management (BPM) and Project Management (PM) achieved higher rankings for both Average Rating of Importance and number of times rated Essential. The seventh place ranking of the Improve stage and its discontinuity in not maintaining sequential association with the DMAIC model infers that it is perceived as the least important stage within the DMAIC model and that BPM and PM should receive greater emphasis in training and evaluation.

The major topics of BPM and PM represent the importance of a BB having an enterprise-wide perspective and interpersonal skills over technical knowledge. BPM and PM's elevated importance reinforce Hoerl's (2001) claim that Black Belts are valued for what they can do; not for what they know.

Two other recent studies reported on the future continuing education/training needs of manufacturing professionals. Callahan, Jones & Smith (2008) reported that the most commonly identified continuing education/training needs over the next ten years would be Lean 77.8%, Six Sigma 56.3%, Quality Management 46.7% and Statistical Analysis 46.0%. Their data was collected from 261 engineers and technology professionals who had a technical component associated with their jobs. DeRuntz and Meier (2004) in a survey of NAIT Industry Division members reported that survey respondents indicated the following programs would be most beneficial for industry members and the inclusion of these topics in the annual conference would impact their decision on conference attendance: Lean Management (40 of 102), Quality & Six Sigma (38 of 102), and Project Management (17 of 102). Based upon the increased need for people with Six Sigma related knowledge and skills it is important that educators and trainers understand the importance of each of the ten major components of the Six Sigma Body of Knowledge.

CONCLUSION

This study identified the hierarchy of importance for ASQ's Six Sigma Body of Knowledge and thereby the amount of training and the level of project evaluation needed for each major topic. The results of this research indicated that in a training context, the instructor must ensure that adequate time is spent to focus on the essential topics of business process management, project management, as well as the topics found within the Define-Measure-Analyze-Improve-Control (DMAIC) model.

This research strengthened the confirmation of the importance of the 10 major Body of Knowledge topics identified by ASQ. Finally, this valuable information can be used by the developers of ASQ's SSBB BOK and other BOK developers to more precisely craft a future BOK. Most importantly educators and trainers' can use these results to create and customize classroom and corporate training materials.

In summary, further research needs to be conducted to verify the reliability and validity of this study's findings. Additionally, this study should be repeated with a larger more comprehensive sample of Six Sigma professionals. This study's methodology needs to be repeated with each of the other three main Six Sigma Bodies of Knowledge (i.e. Rath & Strong, George Group, and Motorola) and the findings analyzed, compared and contrasted.

REFERENCES

Alreck, P. L., & R. B. Settle. (1995). The survey research handbook. 2nd ed. Chicago: Irwin.

ASQ. (2006). Six Sigma Black Belt Body of Knowledge 2006 [cited February 15 2006]. Available from http://www.asq.org/cert/types/six-sigma/bok.html.

ASQ. (2007). Quality Glossary. American Society for Quality 2007 [cited November 15 2007]. Available from http://www.asq.org/glossary/b.html.

ASQ. (2008). ASQ Celebrates Quality Milestone Certifications Still Going Strong After 40 Years. Retrieved May 30, 2008, from http://www.asq.org/media-room/press-releases/2008/20080424-certification-40.html

ASQ. (2009). Six Sigma Black Belt Certification: References. Retrieved June 12, 2009, from http://www.asq.org/certification/six-sigma/references.html

Bennekom, F. V. (2003). GreatBrook.com. Retrieved December 4, 2007, from http://www.greatbrook.com/survey_statistical_confidence.htm

Bemowski, K. (2003). Salary survey statistics. Quality Progress, 48.

Callahan, N., Jones, M., & Smith, R. (2008). Developing maximum career potential in manufacturing technology curricula. Journal of Industrial Technology, (24)4.

Cazar, J. (2006). Hiring and Training Black Belt Leaders. isixsigma.com 2006 [cited November 1 2006]. Available from http://software.isixsigma.com/library/content/a040628a.asp.

Colombo, R. (2000). A model for diagnosing and reducing nonresponse bias. Journal of Advertising Research 40:85–93.

Denzin, N. K. (1970). The research act in sociology. London: Butterworth.

DeRuntz, B. (2005). The importance of training content for six sigma professionals: Perceptions of black belt trainers. Dissertation, Department of

Workforce Education and Development, Southern Illinois University Carbondale, Carbondale.
DeRuntz, B., & Meier, R. (2004). Assessing the professional development needs of the National Association of Industrial Technology's industry division members. Journal of Industrial Technology, (20)2.
Hartman, M. (2002). Developing a new kind of certification. Quality Progress 35 (5):24-30.
Hoerl, R. (2001). Six Sigma Black Belts: What do they really need to know? Journal of Quality Technology 33 (4):391-435.
Moran, J., & La Londe, P. (2000). ASQ certification program gains wider recognition. Quality Progress, April, 29-41.
Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Applications to health research. Qualitative Health Research 8:362-376.
Pyzdek, T. (2000). What is a Black Belt? Quality Digest. Retrieved May 30, 2008, from http://www.qualitydigest.com/feb00/html/sixsigma.html
Ramberg, J. (2000). Six Sigma: Fad or fundamental? Quality Digest, May, 28-32.
Stamatis, D. (2000). Who needs Six Sigma, anyway? Quality Digest, May, 33-38.
Watson, G. (2003). What does it take to be a Master Black Belt? Six Sigma Forum Magazine, May, 34-39.

Appendix A

continued on next page

Appendix A:

SIX SIGMA BLACK BELT BODY OF KNOWLEDGE: SURVEY OF TRAINER'S PERCEPTIONS

This survey is comprised of four sections:
Project evaluation criteria
Project evaluation opinions
Demographic information
Opinion interview
Your care in following the instructions and responding to all questions is greatly appreciated.

Part I – Project Evaluation Criteria

ASQ's Six Sigma Black Belt Body of Knowledge is comprised of the following 10 major topics noted by Roman Numerals **(I, II, …X)** and subsections noted by a bullet point. **Please assign a value to each major topic from 1 – 5 corresponding to its importance to you as a part of an INITIAL project evaluation criteria.** Then assign a value to each subsection to indicate (in rank order) their relative importance within that topic (1 = **least important** to max value = **most important).**

1 Not at all Important	2 Somewhat Not Important	3 Neither Important Or Not Important	4 Somewhat Important	5 Essential

For a more precise definition of each of the topics, follow this URL to the ASQ website:
http://www.asq.org/cert/types/sixsigma/bok.html

	1	2	3	4	5
I. ENTERPRISE-WIDE DEPLOYMENT					
• Enterprise view (i.e. Value of Six Sigma, Business systems and processes, Process inputs, outputs, and feedback)					
• Leadership (i.e. Enterprise leadership, Six Sigma roles and responsibilities					
• .Organizational goals and objectives (i.e. Linking projects to organizational goals, Risk analysis, Closed-loop assessment/knowledge management)					
• History of organizational improvement/foundations of Six Sigma					

	1	2	3	4	5
II. BUSINESS PROCESS MANAGEMENT					
• Process elements – Understand process components and boundaries					
• Owners and stakeholders – Identify process owners, internal and external customers, and other stakeholders.					
• Project management and benefits – Understand the difference between managing projects and maximizing their benefits to the business					
• Project measures – Establish key performance metrics and appropriate project documentation					
• Identify customer – Segment customers as applicable to a particular project; list specific customers impacted by project within each segment; show how a project impacts internal and external customer; recognize the financial impact of customer loyalty.					
• Collect customer data – Use various methods to collect customer feedback (surveys, focus groups, interviews, observation, etc.) and understand the strengths and weaknesses of each approach; recognize the key elements that make surveys, interviews, and other feedback tools effective; review questions for integrity (bias, vagueness, etc.)					
• Analyze customer data – Use graphical, statistical, and qualitative tools to understand customer feedback.					
• Determine critical customer requirements – Translate customer feedback into strategic project focus areas using QFD or similar tools, and establish key project metrics that relate to the voice of the customer and yield process insights.					
III. PROJECT MANAGEMENT					
• Project charter and plan (i.e., Charter/plan elements, Planning tools, Project documentation, Charter negotiation					
• Team leadership (i.e., Initiating teams, Selecting team members, Team stages)					
• Team dynamics and performance (i.e., Team-building techniques, Team facilitation techniques, Team performance evaluation, Team tools)					
• Change agent (i.e., Managing change, Organizational roadblocks, Negotiation and conflict resolution techniques, Motivation techniques, Communication)					
• Management and Planning Tools					
IV. SIX SIGMA IMPROVEMENT METHODOLOGY AND TOOLS – DEFINE					
• Project scope					
• Metrics					
• Problem statement					

	1	2	3	4	5
V. SIX SIGMA IMPROVEMENT METHODOLOGY AND TOOLS – MEASURE					
• Process analysis and documentation (i.e., Tools, Process inputs and outputs)					
• Probability and statistics (i.e., Drawing valid statistical conclusions, Central limit theorem and sampling distribution of the mean, Basic probability concepts)					
• Collecting and summarizing data (i.e., Types of data, Measurement scales, Methods for collecting data, Techniques for assuring data accuracy and integrity, Descriptive statistics, Graphical methods)					
• Properties and applications of probability distributions (i.e., Distributions commonly used by Black Belts, Other distributions)					
• Measurement systems (i.e., Measurement methods, Measurement system analysis, Metrology)					
• Analyzing process capability (i.e., Designing and conducting capability studies, Calculating process performance vs. specification, Process capability indices, Process performance indices, Short-term vs. long-tem capability, Non-normal data transformations, Process capability for attributes data)					
VI. SIX SIGMA IMPROVEMENT METHODOLOGY AND TOOLS – ANALYZ E					
• Exploratory data analysis (i.e., Multi-vari studies, Measuring and modeling relationships between variables)					
Hypothesis testing (i.e., Fundamental concepts of hypothesis testing, Point and interval estimation, Tests for means, variances, and proportions, Paired-comparison tests, Goodness-of-fit tests, Analysis of variance, Contingency Tables, Non-parametric tests)					
VII. SIX SIGMA IMPROVEMENT METHODOLOGY AND TOOLS – IMPROVE					
• Design of experiments (i.e., Terminology, Planning and organizing experiments, Design principles, Design and analysis of one-factor experiments, Design and analysis of full-factorial experiments, Design and analysis of two-level fractional factorial experiments, Taguchi robustness concepts)					
• Response surface methodology (i.e., Steepest ascent/descent experiments, Higher-order experiments)					
• Evolutionary operations (EVOP)					
VIII. SIX SIGMA IMPROVEMENT METHODOLOGY AND TOOLS – CONTROL					
• Statistical process control (i.e., Objectives and benefits, Selection of variable, Rational sub-grouping, Selection and application of control charts, Analysis of control charts)					
• Advanced statistical process control					
• Lean tools for control					

	1	2	3	4	5
• Measurement system re-analysis					
IX. LEAN ENTERPRISE					
• Lean concepts (i.e., Theory of constraints, Lean thinking, Continuous flow manufacturing, Non-value-added activities, Cycle-time reduction)					
• Lean tools					
• Total productive maintenance (TPM)					
X. DESIGN FOR SIX SIGMA (DFSS)					
• Quality function deployment (QFD)					
• Robust design and process (i.e., Functional requirements, Noise strategies, Tolerance design, Tolerance and process capability)					
• Failure mode and effects analysis (FMEA)					
• Design for X (DFX)					
• Special design tools					

PART III – Demographic Information

a) Approximately how many Black Belt projects have you conducted? _____
b) Approximately how many Black Belt projects have you evaluated? _____
c) Which organization granted you Black Belt certification:

American Society for Quality _____
Consulting Firm _____
Educational Institution _____
Industry _____
Other _____

PART IV – Contact Information

Please provide your contact information if you would like to receive the results of this survey. By providing this information you may be contacted from a small random sampling to participate in a follow-up telephone interview.

Name _____

E-mail: _____

Phone: _____