Identification of Significant Factors and Topics for Establishing a Standard Evaluation Instrument for Six Sigma Black Belt Projects

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Abstract

A review of quality literature reveals that the most important aspect of granting Six Sigma Black Belt (SSBB) certification is the candidate's ability to successfully complete the required project with the most skillful use of Six Sigma techniques. However, no standardized project evaluation instrument exists, and therefore, it is left up to the experience and subjective interpretation of the trainer to determine if a candidate has mastered the necessary skills to earn certification. This issue has created great controversy in the quality profession, and leaders have called out for the creation of a Six Sigma common core body of knowledge and a standardized project evaluation instrument.

This research presents the results of an international survey of Master Black Belts to understand their perceptions of the American Society for Quality's (ASQ) Certified Six Sigma Black Belt body of knowledge major topics for use in evaluating a Black Belt candidate's project. The study found that a master Black Belt's experience in evaluating projects is a statistically significant factor. Those having this specific experience placed a much higher importance on the ASQ's Certified Six Sigma Black Belt body of knowledge (BoK) topics of Business Process Management and analysis than those having lesser experience. Conversely, the study also found no significant influence based upon where trainers received their certification or by the amount of experience they had in conducting projects. These important empirical findings will provide foundational information for other quality researchers to continue the development of a Six Sigma common core body of knowledge and a standardized project evaluation instrument.

Introduction

Black Belts have developed an elite status in business because of their ability to produce tremendous financial success for a company. To help protect the integrity of this title, different Black Belt certification processes have been developed by several companies and by one professional quality organization. All of these entities require a Black Belt candidate to successfully complete a Six Sigma project. There is overwhelming agreement that the Six Sigma project is the most important aspect of

the certification step [1], yet a project evaluation standard that would add consistency to this important certification process is lacking. This research has identified the major topics within the ASQ Six Sigma BoK that have statistically significant importance compared to other major topics for use in a Six Sigma project evaluation instrument.

Identifying the Need

Master Black Belts and Six Sigma executives from five major companies [2, 3, 4, 5, 6] were interviewed and asked what research they believed was needed in the Six Sigma certification process, how a Black Belt candidate is evaluated, and what is the most critical aspect of the evaluation. All of them stated that the most important aspect of evaluating a Black Belt candidate's performance was his or her Six Sigma project at the completion of the course.

When asked what type of assessment instrument was used to evaluate the project, all of the experts said that an instrument did not exist. They relied either on their experience or their trainer's experience to give a fair and accurate assessment. They went on to indicate that they thought there would be a large amount of assessment variation between Master Black Belts if given the opportunity to evaluate the same project. All of this information shows that an evaluation criterion for Six Sigma projects does not exist and that there is a need for a valid and reliable standard instrument for performing this critical assessment.

As part of the ASQ's role as the authoritative source of quality, they have developed a comprehensive BoK specifically for the Black Belt certification [7]. The Black Belt BoK is comprised of 10 topic areas that also serve as the foundation for developing the examination's questions [8]. According to the ASQ [9], 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, paragraph 11). This definition makes the BoK both the standard and foundation for performing an objective evaluation of Black Belt learning and performance.

The purpose of the study was to explore the perceptions of Black Belt trainers with respect to the criteria used to evaluate Six Sigma projects. More specifically, the study tried to answer the question "What are trainers' perceptions of the topics' applicability for use as evaluation criteria for Six Sigma projects?"

This research sought to identify the perceptions of Black Belt trainers with respect to the importance of the certification topics identified by the ASQ in the context of their use as an evaluation criterion for granting SSBB certification. More specifically, was the average agreement of the importance of each of the 10 certification topics the same or different by:

a. the total number of Black Belt projects they have evaluated,
b. the number of Black Belt projects they have completed, or
c. the type of organization that granted the trainer's certification?

Delimitations/Limitations

The population for this study was identified through a Six Sigma consultant directory on the Web site isixsigma.com [10]. While the website lists a population of 131 trainers, this may not be an equal representation of the entire population of Six Sigma trainers. Demographic data was collected to assess the qualifications and experience of each participant. Participants who have completed fewer than 10 Black Belt projects were excluded from the data analysis for lack of experience. In "What Does It Take to Become a Master Black Belt?" one of Watson's [11] recommendations is that a Master Black Belt candidate should have completed at least 10 Black Belt projects, with topics having commercial and technical applications.

Significance of the Study

The issue of certification has drawn a significant amount of concern among Six Sigma practitioners because of the many 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 [12, 13].

Hoerl [12] 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). He also stated,

> Black Belts are not valued for what they know, but rather for what they can do. Certifying knowledge is a much easier task than certifying ability. I agree conceptually with the concept of certification, but I am concerned about how to accurately measure the ability, rather than knowledge, of a Black Belt (p. 394).

Hoerl [12] suggested that 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). This study has empirically identified topics and factors that have significant importance to the certification process. These findings can begin the process for establishing a common core for all Six Sigma certifications.

Instrumentation

The ASQ's [7] BoK for Certified Six Sigma Black Belts and an extensive literature review were used as the basis for developing the survey instrument. The instrument was pilot-tested to determine face, content validity, and ease of use by a group of three Master Black Belts not included in the survey population.

The final version of the instrument consisted of 63 questions contained in four parts. In Part 1, the survey asked Six Sigma trainers to rank the importance of the 10 major topics and subsections in the ASQ BoK. Part 2 asked their opinions regarding the need for an evaluation instrument, the importance of soft skills, and the appropriate amount of scoring that should be given in evaluating a Black Belt candidate. Part 3 collected basic demographic data regarding the trainers' experience, and Part 4 solicited voluntary contact information if the respondent wished to

participate in a more extensive interview. Participants were e-mailed an Internet link to a Web site containing the online survey instrument.

Study Population

The population for this study included 131 independent Master Black Belts who have taught Black Belt training courses and listed their consulting services on the popular Six Sigma Web site, isixsigma.com. The 131 consultants represented an international cross-section of the Six Sigma trainers who are leading this global transformation.

Of the 131 questionnaires, 11 were returned due to incorrect addresses. An adjusted sample of 120 was used. Of the remaining 120 questionnaires, 36 qualified participants produced a response rate of 30 percent. While a response rate of 30 percent may seem low, it is not unusual. Alreck and Settle [14] noted that mailed surveys with response rates of more than 30 percent are rare. In a study by Colombo [15], the author stated that, "typical response rates from mailed surveys are about 20 percent" (p. 2).

Research Validity

To achieve survey validity from an external perspective, it is important to have a high response rate. 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 are. According to Bennekom [16] a 30 percent (36/120) response rate yields a statistical accuracy of 95 percent ±15 percent. Ninety-five percent was chosen by convention. If the accuracy is ± 15 percent and the survey instrument uses questions with a measurement scale that ranges from one to five, then there are four intervals on the scale. Plus or minus 15 percent on the scale is slightly more than one full interval point (25 percent of four.) Therefore, the authors are 95 percent 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 percent of the scores would lie in a band from 2.975 to 4.025.

Alpha is the likelihood of being wrong that the authors are willing to accept. Five percent (.05) being wrong is the same as 95 percent certainty that the author's findings are correct. In this example, if the mean for a particular survey question was 3.5 on a one - five scale and the confidence was 0.15, then the authors are therefore 95 percent 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 percent. Therefore, 95 percent of the time the mean will fall in a range from 3.35 to 3.65.

Analysis of Survey Participants

Table 1 presents the 36 respondents divided into three groups (low, medium, high) for the purpose of conducting a further analysis of their responses. The groups were established based upon the frequency of the number of Six Sigma projects the respondents have conducted and evaluated.

Table 1: Respondent Identification by the Number of Six Sigma Projects Conducted and the Number of Six Sigma Projects Evaluated

	Projects Completed		Projects Evaluated	
Group	Range	Frequency	Range	Frequency
Low	1–7	11	1–30	11
Medium	8–30	12	31–100	13
High	31–400	13	101–999	12

Table 2 presents the number of Six Sigma Black Belt trainers who responded to the survey. This data shows where the respondents received their certification. Note that the response from trainers who received their certification from industry comprised 41.7 percent of the respondent population.

Table 2: 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

Results

The results of the study were analyzed using a one-way ANOVA. An alpha value of .05 was required to determine whether there would be a level of significance between the mean value of the three different factors and the importance of various ASQ SSBB BoK topics. The F-statistic was used to determine if there was a statistically significant difference in the average agreement of the importance of each of the 10 certification topics by

a. the total number of Black Belt projects the trainers have evaluated,
b. the number of Black Belt projects the trainers have completed, and

c. the type of organization that granted the trainer's certification.

Evaluation Factor

The significance of project evaluation experience is shown in Table 3. These data represents the respondents' perceptions of the importance of ASQ SSBB BoK major topics and the level of experience of respondents in evaluating Six Sigma projects. F-values were computed to determine the level of significance associated with major topics and the number of projects they had evaluated (low, medium, high). An alpha value of .05 was required to determine whether there would be a level of significance between the mean values of low, medium, and high levels of project involvement and the importance of various ASQ SSBB BoK topics. The analysis determines if the mean values for the rating of importance are equal between each of the major topics within the ASQ BoK and the number of Black Belt projects evaluated by the respondent.

Table 3: One-way ANOVA of Topic Importance between Levels of Projects Evaluated

BoK Topic	Level	N	Mean	S.D.	F	Sig.
1. Enterprise-wide Deployment	Low	11	4.36	0.67	0.519	.600
	Med.	13	4.00	1.22		
	High	12	4.25	0.62		
	Total	36	4.19	0.89		
2. Business Process Management	Low	11	4.18	0.60	3.458	.043*
	Med.	13	4.77	0.60		
	High	12	4.75	0.62		
	Total	36	4.58	0.65		
3. Project Management	Low	11	4.27	0.79	2.022	.148
	Med.	13	4.38	0.87		
	High	12	4.83	0.39		
	Total	36	4.50	0.74		
4. Define Stage	Low	11	4.55	0.69	2.171	.130
	Med.	13	4.46	0.66		
	High	12	4.92	0.29		
	Total	36	4.64	0.59		
5. Measure Stage	Low	11	4.45	0.52	3.140	.056
	Med.	13	4.62	0.51		
	High	12	4.92	0.29		
	Total	36	4.67	0.48		
6. Analyze Stage	Low	11	4.36	0.67	4.691	.016*

BoK Topic	Level	N	Mean	S.D.	F	Sig.
	Med.	13	4.46	0.66		
	High	12	5.00	0.00		
	Total	36	4.61	0.60		
7. Improve Stage	Low	11	4.00	1.18	1.789	.183
	Med.	13	4.62	0.51		
	High	12	4.25	0.62		
	Total	36	4.31	0.82		
8. Control Stage	Low	11	4.27	0.65	2.671	.084
	Med.	13	4.54	1.13		
	High	12	5.00	0.00		
	Total	36	4.61	0.80		
9. Lean Enterprise	Low	11	3.82	1.08	1.058	.359
	Med.	13	3.92	0.95		
	High	12	4.33	0.65		
	Total	36	4.03	0.91		
10. Design for Six Sigma	Low	11	4.09	0.83	.899	.417
	Med.	13	3.69	0.63		
	High	12	4.00	0.85		
	Total	36	3.92	0.77		

*Alpha < .05

There was statistical significance established in the mean values between the number of projects evaluated and a topic's perceived importance with respect to Business Process Management (F = 3.458) and Analyze Stage (F = 4.691). Respondents who had evaluated a medium to high number of Six Sigma projects tended to rate the importance of Business Process Management greater (medium = 4.77) than those who had evaluated a small number of projects (low = 4.18). Also, respondents who had evaluated a high number of Six Sigma projects tended to rate the importance of the Analyze Stage greater (high = 5.00) than those who had evaluated a small number of projects (low = 4.36).

Experience Factor

Analysis was performed on the data representing the respondents' perceptions of the importance of ASQ SSBB BoK major topics and the level of experience of respondents in conducting Six Sigma projects. While there were some differences between mean values for those low and medium groups that conducted Six Sigma projects, mean values within each ASQ topic were not different enough to reach the established level of significance. The major topics and their respective level of significance are as follows: Enterprise-wide Deployment, .620; Business Process

Management, .440; Project Management, .102; Define Stage, .539; Measure Stage, .588; Analyze Stage, .510; Improve Stage, .801; Control Stage, .348; Lean Enterprise, .561; and Design for Six Sigma, .149.

Certification Factor

Data examining the influence where trainers received their certification were analyzed against the same criteria as the evaluation and experience factors. Mean values within each ASQ topic were not substantially different to reach the established level of statistical significance. The major topic and respective level of significance are as follows: Enterprise-wide Deployment, .809; Business Process Management, .699; Project Management, .562; Define Stage, .369; Measure Stage, .063; Analyze Stage, .281; Improve Stage .995; Control Stage, .707; Lean Enterprise, .480; Design for Six Sigma, .127

Conclusion

The study examined the perceptions of Black Belt trainers with respect to the importance of the SSBB certification topics identified by the ASQ. More specifically, the study sought to understand if the average agreement of the importance of each of the 10 certification topics was the same or different by the type of organization that granted the trainer's certification, by the level of experience the trainer had in conducting projects, and by the level of experience the trainer had in evaluating projects.

SSBB trainers are certified in a variety of ways. This study assessed perceptions of trainers certified by the ASQ, consultants, industry, and educational institutions. Regardless of where they received their certification, there was no difference in the way the trainers perceived the importance of the ASQ SSBB BoK.

Through the course of a preliminary interview in designing this study, it was hypothesized that experience would have an impact on trainers' perceptions of the importance of the BoK topics. More specifically, did trainers' perception of a topic's importance change as they conducted or evaluated more Six Sigma projects?

The study analyzed trainers' responses categorically using the number of Black Belt projects they have completed. The results showed that while there were some differences between mean values for those respondents who conducted small, medium, and large numbers of Six Sigma projects, the differences were not substantial enough to reach an established level of significance.

Next, the same type of analysis was performed with a focus on the total number of Black Belt projects that trainers had evaluated. There was a statistically significant difference ($F = 3.458$) between respondents who had evaluated a medium to high number of Six Sigma projects, with respect to importance of Business Process Management, than those who had evaluated a small number of projects. Finally, there was also a statistically significant difference ($F = 4.691$) between respondents who had evaluated a high number of Six Sigma projects, with respect to the importance of Analyze Stage, and those who had evaluated a small number of projects. It can be inferred that as Black Belt trainers evaluated more projects, they appeared to

recognize the importance of Business Process Management and the analysis stage as important parts of the Six Sigma process. Trainers noted that an evaluation instrument would be useful in reducing subjectivity in the evaluation of projects, identifying strengths and weaknesses of candidates, and identifying deficiencies in training.

References

[1] DeRuntz, B. D. (2005). "The Importance of Training Content for Six Sigma Professions." *Perceptions of Black Belt Trainers*. Department of Workforce Education and Development. Southern Illinois University Carbondale: 136.

[2] Anheuser-Busch, personal communication, August 12, 2003.

[3] Boeing, personal communication, September 23, 2003.

[4] General Electric Capitol Services, personal communication, November 4, 2003.

[5] General Electric Railcar Services, personal communication, October 17, 2003.

[6] S. Lakhavani, personal communication, January 15, 2004.

[7] ASQ. (2004). *Six Sigma Body of Knowledge*. Retrieved February 15, 2004, http://www.asq.org/cert/types/sixsigma/BoK.html.

[8] Moran, J. W., & La Londe, P. C. (2000). "ASQ Certification Program Gains Wider Recognition. *Quality Progress*, 33, 29–41.

[9] ASQ. (2008). *Quality Glossary*. Retrieved May 31, 2008, http://www.asq.org/info/glossary/q.html.

[10] iSixSigma. (2004). *Six Sigma Consultants Directory*. Retrieved March 5, 2004, http://www.isixsigma.com/co/six_sigma/.

[11] Watson, G. H. (2003, May). "What Does It Take to Be a Master Black Belt?" *Six Sigma Forum Magazine*, 2, 34–39.

[12] Hoerl, R. W. (2001). "Six Sigma Black Belts: What Do They Need to Know?" *Journal of Quality Technology*, 33(4), 391–417.

[13] ASQ. (2002). *Implementing Six Sigma for Results*. Retrieved April 15, 2004, http://www.asq.org/ed/qconvs/101002sixsigma/6.html.

[14] Alreck, P. L., & Settle, R. B. (1995). *The Survey Research Handbook* (2nd ed.) Chicago: Irwin.

[15] Colombo, R. (2000). "A Model for Diagnosing and Reducing Nonresponse Bias." *Journal of Advertising Research*, 40: 85–93.

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

Biography

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