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Professional Certification: A Study of Significance

By Dr. Jeffrey M. Ulmer

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Dr. Jeffrey M. Ulmer is an Assistant Professor of Technology, Engineering Technology, and Industrial Management at the University of Central Missouri in Warrensburg, teaching both undergraduate and graduate students. Ulmer is a Certified Six Sigma Black Belt and a Certified Manager of Quality & Organizational Excellence with the American Society for Quality. Ulmer has worked 25 years in industry in the areas of product engineering, quality assurance / control, and production management.

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○ Abstract

Two hundred and thirty five American Society for Quality and Society of Manufacturing Engineers professionals participated in an internet survey to determine if professional certification by an individual makes a financial difference in Quality Cost Improvement or Waste-Cost Reductions. After a two-round posting of the survey, independent t-test statistical results indicate that neither Quality Cost Improvement nor Waste-Cost Reductions experienced significant differences between small, mid-sized, or large manufacturing companies with or without certified employees.

Introduction

The United States (U.S.) continues to face substantial economic pressure in the area of manufacturing. This fact is underscored by the recent surpassing of the General Motors Corporation (GM) by the Toyota Motor Corporation to become the number one worldwide automaker in early 2007 (Isidore, 2007). Several factors made the Toyota takeover possible. According to Swamidass (2000), from 1980 to 1999 the following competitive factors, or situations, affected U.S. manufacturers: 1. Low Asian wage rates compared to U.S. wage rates; 2. An open U.S. domestic market to foreign manufacturers; 3. Rate of technological change; 4. Customers expecting increasing levels of product quality; and 5. Customers expecting increasing levels of customer service.

Companies benefit from employee certifications through elevated company image and contract qualifications (Adams, Brauer, Karas, Bresnahan & Murphy, 2004). Likewise, motivated and knowledgeable employees are often identified and hired by companies for employment due to their certifications (Ruscitto, 2004). Many companies pur-

sue certification for their non-quality trained and non-degreed employees as demanded by the marketplace (Harrington, 2000; Jones, Knotts & Brown, 2005). ISO 9000 is yet another certification tool for manufacturing companies. In a study conducted by Arbuckle (2004), it was determined that ISO 9000 certification has a statistically significant effect on total assets and return on assets (ROA) for S&P 500 organizations.

Coupled with a desire for professional and personal advancement, many employees (in Quality, Engineering, Operations) often question if Lean Manufacturing certification, by the Society of Manufacturing Engineers (SME), or by another quality-related recognized certification agency or body, is necessary for them to help their company achieve continuous improvement success. Some professionals feel that the investment spent in time and money could be put to better use, while others contemplate that their certification efforts may help their company to reach its financial goals.

Problem Statement

Professional certification organizations claim that employee certification helps both manufacturers and employees reach business objectives and continuous improvement goals. If this is true, a study may determine if the certification of employees will truly help a company to meet its financial objectives and goals. The purpose of this survey study was to determine if certification or non-certification impacts quality cost improvement and waste-cost reductions in manufacturing organizations. Two research questions are provided in this study:

1. Is there a difference in quality cost improvement between companies with or without certified employee credentials?

2. Is there a difference in waste-cost reductions between companies with or without certified employee credentials?

Null and alternative hypotheses 1 and 2 will address research questions 1 and 2:

1. $H_{01}: \mu_1 = \mu_2$. There is no statistical significant difference in quality cost improvement between companies with or without certified employee credentials.

$H_{A1}: \mu_1 \neq \mu_2$. There is a statistical significant difference in quality cost improvement between companies with or without certified employee credentials.

2. $H_{02}: \mu_1 = \mu_2$. There is no statistical significant difference in waste-cost reductions between companies with or without certified employee credentials.

$H_{A2}: \mu_1 \neq \mu_2$. There is a statistical significant difference in waste-cost reductions between companies with or without certified employee credentials.

Assumptions Of The Study

The following assumptions were made for this study: 1. Respondents had the necessary expertise for each survey question; 2. Respondents provided information to the best of their knowledge; 3. The survey provided was neutral in content to allow for an unbiased study; 4. Responses given are generalizable to manufacturing organizations of similar sizes; 5. All survey responses are without error in accuracy or reliability; 6. T-tested variables are independent (none of the responses from one respondent is in any way related to responses from another respondent); 7. T-tested variables possess normality; and 8. Independent t-tested variables possess homogeneity of variance.

Limitations Of The Study

The following limitations are present in this study: 1. Surveyed participants were limited to members of the American Society for Quality (ASQ) and the Society of Manufacturing Engineers (SME) employed by manufacturing organizations; 2. Survey responses are

primarily from U.S. citizens, but were not limited to such; 3. A number of potential survey participants may have been restricted from participating in the study due to organizational policies; 4. Certified respondents may have been more inclined to participate in the survey than non-certified respondents; 5. Respondents may not have been employed in manufacturing; 6. More than one respondent from the same company may have participated in the survey; 7. Survey findings may not apply to other types of business outside of manufacturing (such as services, retail, non-profit organizations, etc.); 8. Violation of any of the t-test variables would have created a limitation; 9. Non-respondents to the survey may have affected the quality cost differently than the results documented; 10. Participants may not have the information necessary; and 11. Other significant relationships lack identification.

Review Of Literature

The review of literature helped to justify this research and determine survey questions for survey respondent consideration. Focal topics in the survey included certification of employees in small, mid-sized, and large organizations, and other factors encountered in industry. For the purpose of this study, dialogue is provided on manufacturing companies and key areas in certification. Small companies, per the website, consist of 1 to 499 employees, midsize are 500 to 2,499 employees, and large companies have 2,500 or more employees ("Business Size," 2004).

Manufacturing companies are engaged in the "mechanical, physical, or chemical transformation of materials, substances, or components into new products ("2002 NAICS Definition," 2002)." The Small Business Administration defines a manufacturer as a prime contractor that handles at least 50% of the cost of manufacturing (not including materials) ("Small Business Administration," 2007). Canada, Mexico and the United States use the North American Industry Classification System (NAICS) for international busi-

ness performance in North America. NAICS 2002 information came from the U.S. 2002 Economic Consensus.

The American Society for Quality (ASQ) defines certification as a "formal recognition that an individual has proficiency within, and a comprehension of, a specified body of knowledge. A certification is peer recognition, not registration or licensure (ASQ, 2005, p. 1)." Certification is the qualification of individuals performing jobs using a predefined set of standards (DeBaugh, 2005; Mulkey & Naughton, 2005; Roberts, 2005). Professional organizations such as ASQ, or onsite company programs, offer certifications. Value of the certification is dependent upon the assessment criteria (Foster & Pritz, 2006). Certifications are not the same as certificates. Certificates indicate completion of an educational experience (workshop, seminar, or college course). Certifications denote successful assessment of a defined body of knowledge, demonstrating proof of work competence (Meisinger, 2004; Mulkey & Naughton, 2005; Phillips, 2004; Schoneboom, 2005). Certifications have value when certification boards meet periodically to review and update, as required, area-specific bodies of knowledge, examination specifications and questions (Roberts, 2005).

The SME certified manufacturing technologist (CMfgT) certification provides an assessment service for educators - befitting certified students. Another benefit of the SME certification examination is the amount of feedback provided to instructors on student pass rates and student performance in specific topic areas. Once examination results are available, college program leaders can restructure and optimize curriculum for future students (Hall, 2006).

Similar to SME, the Association of Technology, Management, and Applied Engineering (ATMAE) lists certification value for examination takers as recognized expertise, external validation, and commitment to the professional (ATMAE, 2009). Certification

examinations offered by ATMAE include the certified technology manager (CTM) and the certified manufacturing specialist (CMS).

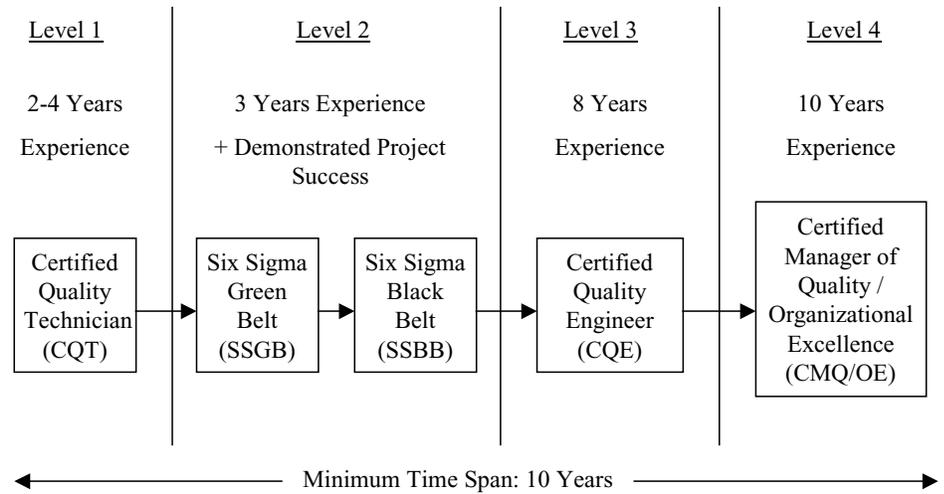
The American Society for Quality offers four levels of advancement in certifications for a quality professional's career. All of the levels prepare an individual for a career in quality management. For reference, Figure 1 contains a summarized certification career path (Walker & Levesque, 2006).

Certification in a discipline is different than earning a degree or diploma. Individuals earning a degree are typically people who have attended a college or university and participated in a prescribed program of study, earning hours and grades. Whereas, a discipline specific certification assesses an individual's understanding of key topics established by experts in a given field (Foster & Pritz, 2006).

Types of Certifications

Certifications exist for almost every profession. They are not regulated and usually do not require experience in an identified field. Certification provides evidence that a person is trainable and is continuously involved in a recertification program (i.e. one who is in a continuing education program) (Eggert, 2001). In the case of the American Society for Quality (ASQ, 2005), the body of knowledge for each certification is tightly controlled and updated regularly. A board of certified ASQ advisory members survey over 2,000 certified ASQ members for definition of each certification body of knowledge. Randomly selected survey members are from various geographic and industrial types. From the body of knowledge, certification examinations are developed and used for future examinees. All certifications undergo the same development process every five years. All certifications require a minimal span of time in an industrial discipline, and in some cases verified proof of project work and completion. Certification examples include: the ASQ-Certified Manager of Quality / Organizational Excellence; the ASQ-Certified Six

Figure 1. Quality management career path



Sigma Black Belt; the SME-Certified Engineering Manager; and the Project Management Institute (PMI) provides Project Management Professional (PMP) certification ("Project Management Institute," 2007).

CNC software, Inc. provides a certification as a Mastercam Programmer (MP). As a MP, professionals have certification proof in mastery of basic technical knowledge in precision computer numerical controlled machining (computer aided design and computer aided manufacturing - CAD/CAM). CNC Software, Inc. owns the copyrights to Mastercam software (Foster & Pritz, 2006).

Business Reasons for Certification

Certification assessment value is dependent upon industry-established standards. Assessments must closely track the standards (content validity) and allow for consistency of examination performance (reliability) for all test takers (Foster & Pritz, 2006). Documented worker competency is the reason that many companies train, assess and certify their employees (Ewing & Heinrich, 2003).

Hiring managers are more positively inclined to hire certified over non-certified individuals due to the understanding of what it takes to become certified (Davenport, 2006; DeBaugh, 2005;

Wilson, 2002). While some employers value certification, a number are neutral and some do not value it (Craig, 2002). There are many businesses that realize the professional certification makes a person more employable since it helps their organization to compete and have credibility (DeBaugh, 2003; Foster & Pritz, 2006). DeRuntz and Meier (2004) reported in their professional development study of the National Association of Industrial Technology (NAIT) that 74 out of 109 respondents (67.9%) have their current employer's support for professional certification. Sixty-three of the 109 respondents currently have one or more professional certifications.

Employers benefit due to increased employee competence, higher productivity, higher morale and increased employee loyalty. On the other side of the equation, employees benefit from training through competence in a field, higher salaries, promotions, increased credibility, attained self-confidence and empowerment. Each of the employee benefits listed also increase employer performance results (DeBaugh, 2005; Karr, 2001).

ISO 9000, QS 9000 and ISO 14001 certified quality management systems depend upon a skilled and capable quality workforce. Certification of registrars and auditors provides verification of a second party auditing firm's

understanding and competency. Certified personnel must obtain certification credentials through reputable certification agencies like ASQ, SME, and others (Chapman, 1998).

Methodology

The purpose of this study was to determine if certification impacts quality cost improvement and waste-cost reductions in manufacturing organizations. Quality cost improvement is reduced external failure costs in customer claims. Waste-cost reductions are internal failure financial data in reduced scrap, defects, rework, labor, and improved cycle time. A quality-professional developed Internet survey supplied data for t-test evaluation.

Internet surveyed participants included members of the American Society for Quality (ASQ) and Society of Manufacturing Engineers (SME) who work for small, mid-sized, and large manufacturing organizations. Professional member positions include, but are not limited to, production, quality, engineering, manufacturing, purchasing, accounting and plant managers. Many of the employees in these departments were familiar with internal (Waste-cost Reductions) and external (Quality-cost Improvement) failure cost metrics due to projects that were either in process or recently completed in their respective companies.

Internet survey participants were contacted through various avenues in a two-round methodology within the American Society for Quality and the Society of Manufacturing Engineers from August-to-December, 2007. At ASQ, respondent contact occurred through its e-section, ASQ Weekly e-newsletter (announcing survey link) to all ASQ members, emails to 237 local chapter chairs, Lean Enterprise Forum, Six Sigma Forum and the Quality Management Discussion Board Forums. At SME, contact occurred through its member-only website, Product & Process Design and Management Community website, local chapters website, Lean Directions e-newsletter, Six Sigma Quality in Manufacturing

e-newsletter, and emails sent to 160 local chapter chairs. The researcher is a member of both organizations, with affiliation to Lean, Six Sigma, and Quality Management Forums. At ASQ the researcher is a senior member in chapter 1310, and a Certified Manager of Quality in Organizational Excellence. At SME, the researcher is a senior member in chapter 287.

Research Instrumentation

An Internet 17-question survey (See Appendix) was developed by 22 quality improvement experts, and the researcher, to collect independent and dependent variable information. Quality improvement experts selected had continuous improvement program experience and knowledge in certification issues. No financial arrangement existed between the quality improvement experts and the researcher.

A modified Delphi Methodology was used to develop the Internet Survey. Per Adams & O'Brien (2004), the Delphi Method facilitates expert consensus through a multi-round, anonymous, discussion of study particulars. The Delphi Method is limited to survey development to minimize respondent time involvement to boost participation through a one shot survey. Through use of a 22-person quality improvement expert panel, as opposed to a recommended 7-12 member group, a consensus of survey questions was obtained, effective handling of lean manufacturing issues was optimized, and quality improvement experts were able to participate in order to create a worthwhile Internet Survey (DSE, 2006).

The survey required three development rounds between the quality improvement experts and the researcher. The researcher constructed the initial survey, posted it on the Internet, notified the quality improvement experts via email of its availability, and then the quality improvement experts notified the researcher of needed changes (deletion of questions, addition of questions, modifications, etc...). Per Trochim (2001, p. 20), validity is "the best available approximation to the

truth of a given proposition, inference, or conclusion" and reliability "means repeatability or consistency." Through a multi-round development of the survey questionnaire with quality improvement experts from manufacturing, validity of the research instrument is high due to content-related evidence provided, with reliability achievement through observer (or expert) agreement (Rodchua, 2005). The 22 quality improvement experts who participated in the survey development included (each person's individual names were removed to protect their identity):

1. Project Manager (ASQ-CQE, CRE & CSBB; APICS-CPIM Certified) – Missouri Enterprise.
2. Lean Six-Sigma Black Belt (SSGB & SSBB Company Certified) – Regal Beloit Corporation; Electric Motors Group.
3. Process Development Engineer – GE Global.
4. Quality Assurance Manager (ASQ-CQE Certified) – Frito Lay Corporation.
5. Lean Six Sigma Black Belt (SSBB Company Certified) – Regal Beloit Corporation; Generator Division.
6. Senior Quality Engineer (ASQ-CRE, CQE, CQA, CQM, CSSGB, CCT, & PMI-PMP Certified) – Champion Labs.
7. Master Black Belt / Six Sigma (MBB/SS Company Certified) – Regal Beloit Corporation; Marathon Electric Division.
8. Operations Manager; Quality & Packaging (Formerly ASQ-CQE Certified) – Unilever Corporation.
9. Quality Assurance Manager (SSGBelt Company Certified) – Regal Beloit Corporation; Electric Motors Group.
10. Project Engineer / Lean Manufacturing Leader – GE Energy Corporation.
11. Project Director (ASQ-SSGB Certified) – Missouri Enterprise.
12. Six Sigma Black Belt (SSBB Company Certified) – Caterpillar Financial.
13. Retired Director of Launch Operations – Skylab One (Formerly ASQ-CQE, CQE, & MBB certified) – McDonnell-Douglas.

14. Vice-President of Operations (ASQ-CMQ/OE, CQE, & MBB Certified) – SPX Test & Measurement.
15. Quality Systems Manager (ASQ-CQA, CQE, SSBB, & CMQ/OE Certified) – Honeywell Aerospace.
16. Master Black Belt (ASQ-CMQ/OE & CQE Certified) – Garmin International.
17. Quality Control Manager – Core Slab Structures.
18. Instructor (ASQ-CMQ/OE Certified) – University of Central Missouri.
19. Six Sigma Black Belt – Honeywell International.
20. Lean Manufacturing Coordinator – ABB Incorporated.
21. Quality Consultant (ASQ-CMQ/OE & CQE Certified) – DC Wood Consulting.
22. Quality Manager (ASQ-CQE, CRE, & CQM Certified) – Segway Incorporated.

Despite efforts to minimize validity issues for the survey development, it is possible that certified respondents have selection bias when taking the anonymous online survey, which is a threat to internal validity (Trochim, 2001). Likewise, respondents may have not been employed in manufacturing, although the survey was constructed to encourage participation to primarily manufacturing respondents. It is also possible that the same company may have employed a few of the respondents. Despite these limitations, to meet the purpose of the study, 17 questions were formulated and answered by 235 survey respondents.

Survey Development Procedure And Data Collection

The study encompassed the following procedure and data collection sequence:

1. Researcher randomly enlisted 22 quality improvement experts to help develop survey.
2. Researcher developed Internet website using the University of Central Missouri Survey-Builder software.
3. Survey collaboratively developed with quality-improvement experts through three development rounds.

Table 1. Certification Sources

Certification	Frequency	Percent
American Society for Quality (ASQ)	136	57.87
Association for Operations Management (APICS)	7	2.98
Society of Manufacturing Engineers (SME)	19	8.08
Certified by Employer	57	24.26
Other certification organization	61	25.96
I am not certified	43	18.30

235 Survey respondents participated in this question; providing a total of 323 responses. Some survey participants had more than one certification.

4. Human subject testing approval was obtained from both Indiana State University and the University of Central Missouri.
5. Researcher contacted American Society of Quality personnel to request notification of the survey to its membership through various media methods (website, e-newsletters, forums, etc...).
6. Researcher contacted Society of Manufacturing Engineers personnel to request notification of the survey to its membership through various media methods (website, e-newsletters, forums, etc...).
7. Survey respondents from ASQ and SME participated in the Internet questionnaire.

Statistical Analysis

For this study, alpha (α) is set at .05 (Type 1 Error: 1 out of 20 chances that H_0 will not be rejected if it is actually true). Variables consisted of employee certification status, quality cost improvement (reduced external failure costs in customer claims), and waste-cost reductions (internal failure financial data in reduced scrap, defects, rework, labor, and improved cycle time).

Independent t-tests were utilized in comparison of quality cost improvement, and waste-cost reductions, between companies with and without certified employees. To maintain validity, survey respondents who answered "I Don't Know" were not added to the statistical analysis. To meet the assump-

tions of independent t-tests, variables were independent (none of the responses from one survey individual is in any way related to responses from another survey individual), variables are normal in distribution (normal Q-Q plots and a Shapiro-Wilk analysis), and homogeneity of variance for variables were present (using Levene's Test) (Minium, Clark & Coladarci, 1999).

Survey Results

Two hundred and thirty five people responded to the survey and listed their certification sources (see Table 1).

The number of employees by company size, for 235 survey respondents, is the following: small (92 respondents; 39.15%); mid-sized (47 respondents; 20.00%); and large (96 respondents; 40.85%). The percentage results roughly approximate the U.S. Small Business Administration figures obtained for small companies consisting of 1 to 499 employees (43.9%), midsized companies at 500 to 2,499 employees (16.1%), and large companies with 2,500 or more employees (40.0%) ("Business Size," 2004).

Dollar value of the project's Quality Cost Improvement due to the use of the continuous improvement practice(s) [Quality Cost Improvement equals reduced external failure costs in customer claims (returns & rework)] is listed in Table 2.

Dollar value of the project's Waste-Cost Reductions due to the use of the

continuous improvement practice(s) [Waste-Cost Reductions equals reduced costs in scrap, defects rework, labor or improved cycle time] in Table 3.

Research Question 1 Results

After survey results were tallied and entered into SPSS 14.0, on average, Quality Cost Improvement has not experienced significant differences for companies with certified ($M = 2.94$, $SD = 1.579$) or non-certified ($M = 2.38$, $SD = 1.532$) employees with independent t-test results of $t(163) = 1.515$, $p = .132$ (two-tailed). Therefore, failure to reject the null hypothesis was the result. Reliance upon this result is minimal due to the lack of normality in the Quality Cost Improvement variable (Shapiro-Wilk value of $p = .000$). Variables were independent. Homogeneity of variance was present for Quality Cost Improvements as evaluated with Levene’s Test ($p = .936$). To maintain validity, survey respondents who answered “I Don’t Know” were not added to the statistical analysis.

Research Question 2 Results

After survey results were tallied and entered into SPSS 14.0, on average, Waste-Cost Reductions has not experienced significant differences for companies with certified ($M = 2.80$, $SD = 1.479$) or non-certified ($M = 2.71$, $SD = 1.488$) employees with independent t-test results of $t(161) = .256$, $p = .798$ (two-tailed). Therefore, failure to reject the null hypothesis was the result. Reliance upon this result is minimal due to the lack of normality in the Waste-Cost Reductions variable (Shapiro-Wilk value of $p = .001$). Homogeneity of variance was present for Waste-Cost Reductions as evaluated with Levene’s Test ($p = .929$). To maintain validity, survey respondents who answered “I Don’t Know” were not added to the statistical analysis.

Conclusions And Recommendations For Further Research

The results of this portion of the study are perplexing. Based upon the plethora of available information on certifica-

Table 2. Dollar Value of Quality Cost Improvements

Dollar Value	Frequency	Percent
0 to \$25,000	49	21.21
\$25,000 to 50,000	29	12.55
\$50,000 to 100,000	23	9.96
\$100,000 to 250,000	23	9.96
\$250,000+	41	17.75
I Don’t Know	66	28.57

231 Survey respondents participated in this question

Table 3. Dollar Value of Waste-Cost Reductions

Dollar Value	Frequency	Percent
0 to \$25,000	43	18.62
\$25,000 to 50,000	34	14.72
\$50,000 to 100,000	36	15.58
\$100,000 to 250,000	15	6.49
\$250,000+	35	15.15
I Don’t Know	68	29.44

231 Survey respondents participated in this question

tion benefits to both employees and companies, one would have expected a statistical difference between companies with or without certified employee credentials. However, it should be realized that a company’s success in Quality Cost Improvement, and Waste-Cost Reductions, is contingent upon much more than just the certification credentials of just one or two members in a manufacturing team. A team of manufacturing and business professionals typically perform process or procedural improvement, many of whose individuals may not be certified. Refinement of this question could provide results that are statistically significant. For example, instead of comparing employee certification credentials within a comprehensive segment (all manufacturing companies), the restriction of employee-specific (certified or non-certified) performance could be tied to a single segment (such as small or mid-sized manufacturing companies) or a department-specific process improvement project.

This study has exposed other opportunities for additional research. Further research includes, but is not limited to the following:

1. Analyze certification impacts upon Quality Cost Improvement and Waste-Cost Reductions between small and mid-sized to large United States manufacturing organizations.
2. Reissue the survey in hopes of attracting more manufacturing professionals to participate. The result may provide normality in the Quality Improvement and Waste-Cost Reductions variables and provide more reliable results in relation to the effects of certification on manufacturing organizations.

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Appendix – Survey Questions

continued on next page



Appendix – Survey Questions

1. The department you work for:

- Accounting
- Consultant
- Engineering
- Executive Management
- Human Resources
- Manufacturing
- Purchasing
- Quality
- Sales
- Other

2. Check the source of your certification(s) (check all that apply):

- American Society for Quality (ASQ)
- Association for Operations Management (APICS)
- Certified by employer
- Society of Manufacturing Engineers (SME)
- Other certification organization
- I am not certified

3. College education level (total number of years attended):

- 0 - 1
- 2 - 4
- 5 - 6
- 7 - 8
- 9+

4. Highest degree earned:

- Certificate
- Associate
- Bachelor
- Masters
- Doctorate
- Other
- None

5. The number of people you supervise:

- 0 - 5
- 6 - 15
- 16 - 30
- 31 - 50
- 51+

6. Your manufacturing company's size (total – all locations):

- 1 - 499 employees
- 500 - 2,499 employees
- 2,500+ employees

7. Total manufacturing company sales (total – all locations):

- 0 to \$25 million
- \$25 to 50 million
- \$50 to 100 million
- \$100 to 250 million
- \$250 to 500 million
- \$500+ million

8. Choose the continuous improvement practice(s) used in the project (check all that apply):

- 5S
- Agile Manufacturing
- Balanced Scorecard
- Benchmarking
- Business Process Improvement (BPI)
- Business Process Re-Engineering (BPR)
- Cellular Manufacturing (CM)
- Concurrent Engineering
- Continuous Process Improvement (CPI)
- Design for Assembly (DFA)
- Design of Experiments (DOE)
- Failure Mode and Effects Analysis (FMEA)
- ISO 9000 / QS 9000
- Just-In-Time (JIT)
- Kaizen
- Kanban
- Lean Enterprise
- Lean Manufacturing
- Lean Production
- Malcolm Baldrige National Quality Award
- Plan-Do-Check-Act (PDCA)
- Process Mapping
- Production Lifecycle Management (PLM)
- Production Smoothing
- Quality Function Deployment (QFD)
- Scientific Management
- Six Sigma (SS)
- Statistical Process Control (SPC)
- Statistical Quality Control (SQC)
- Supply Chain Management (SCM)
- Taguchi Loss Function
- Theory of Constraints
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Stream Mapping (VSM)
- Other

9. Choose the primary continuous improvement practice used in the project:

- Cellular Manufacturing (CM)
- Continuous Process Improvement (CPI)
- Design of Experiments (DOE)
- Failure Mode and Effects Analysis (FMEA)
- Lean Enterprise
- Lean Manufacturing
- Process Mapping
- Six Sigma (SS)
- Toyota Production System (TPS)
- Value Stream Mapping
- Other

10. Dollar value estimate of the project's Quality Cost Improvement due to the use of the continuous improvement practice(s) [Quality Cost Improvement equals reduced external failure costs in customer claims (returns & rework)]:

- 0 to \$25,000
- \$25,000 to \$50,000
- \$50,000 to \$100,000
- \$100,000 to \$250,000
- \$250,000+
- I don't know

11. Dollar value estimate of the project's Waste-Cost Reductions due to the use of the continuous improvement practice(s) [Waste-Cost Reductions equals reduced costs in scrap, defects rework, labor or improved cycle time]:

- 0 to \$25,000
- \$25,000 to \$50,000
- \$50,000 to \$100,000
- \$100,000 to \$250,000
- \$250,000+
- I don't know

12. Select the project's external failure customer claims metric BEFORE use of the continuous improvement practice(s):

- 0 to 3.4 PPM (Parts Per Million)
- 3.4 to 233 PPM
- 233 to 6,210 PPM
- 6,210 to 66,807 PPM
- 66,807 to 308,537 PPM
- 308,537 to 690,000 PPM
- 690,000+ PPM
- I don't know

13. Select the project's external failure customer claims metric AFTER use of the continuous improvement practice(s):

- 0 to 3.4 PPM
- 3.4 to 233 PPM
- 233 to 6,210 PPM
- 6,210 to 66,807 PPM
- 66,807 to 308,537 PPM
- 308,537 to 690,000 PPM
- 690,000+ PPM
- I don't know

14. Select the project's metric in terms of internal scrap, defects rework, labor, or in low cycle time BEFORE use of the continuous improvement practice(s):

- 0 to 3.4 PPM
- 3.4 to 233 PPM
- 233 to 6,210 PPM
- 6,210 to 66,807 PPM
- 66,807 to 308,537 PPM
- 308,537 to 690,000 PPM
- 690,000+ PPM
- I don't know

15. Select the project's metric in terms of internal scrap, defects rework, labor, or in cycle time AFTER use of the continuous improvement practice(s):

- 0 to 3.4 PPM
- 3.4 to 233 PPM
- 233 to 6,210 PPM
- 6,210 to 66,807 PPM
- 66,807 to 308,537 PPM
- 308,537 to 690,000 PPM
- 690,000+ PPM
- I don't know

16. Choose the number of individuals involved in the project at your company.

- 1 - 2
- 3 - 5
- 6 - 10
- 11 - 20
- 21 - 49
- 50+ (company wide)

17. List a Quality of Service Repercussion (QSR) experienced in the project due to continuous improvement practice(s) implementation (A "QSR" is a negative continuous improvement practice side effect; i.e. - one department is successful in attaining reduced inventories, but another department is forced to carry those inventories):

- Answer added to a "text box"