Villanova Six Sigma Black Belt Study Guide

The Villanova Six Sigma Black Belt Study Guide is a free, quick-reference list of essential material to prepare for and pass the certification exam. Master the Villanova Six Sigma Blackbelt Body of Knowledge with this Study Guide.

Speaking of passing their exam, did you know that 100% of the people who pass my Green Belt practice exams report passing their exam (IASSC, ASQ, Villanova, etc) on the first try? Sign up here. That includes Black Belt candidates that want to brush up on their Green Belt Skills. 100% refund inside first 30 days.

Villanova Six Sigma Black Belt Study Guide

The Villanova Six Sigma Blackbelt exam is structured around their suggested body of knowledge. I took and passed this test in May, 2014 by following the structure below. In order to make the best use of my time I organized my study by following the outline below. For each subject I translated my paper notes and many internet bookmarks and turned to this website.

Each link goes to a page of my notes. There are many other pages in this website for six sigma-related subjects not linked here but I felt were useful. This was especially helpful during exam time as Villanova states that their exam is far more intensive than their offered study materials. In other words, they expect you to master the industry and you will be tested on far more than what they teach you. In fact, the head of Six Sigma education at Villanova sent a notice to all students stating the exam is comprehensive of the industry and far more intensive than what would be a final exam (see comment here from Dan Munson).

I. Importance of Six Sigma

a. Value of Six Sigma

i. Six Sigma-basic premise

Describe how Six Sigma has fundamentally two focuses – variation reduction and waste reduction that ultimately lead to less defects and increased efficiency.

Understand the concept of variation and how the six Ms have an influence on the process. Understand the difference between assignable-cause and common cause variation along with how to deal with each type.

ii. History of organizational improvement/foundations of Six Sigma

Understand the origin of continuous improvement tools used in Six sigma (e.g. Deming, Juran, Shewhart, Ishikawa, Taguchi, etc.)

iii. Quality improvement concepts

Define and describe concepts such as prevention versus detection, quality characteristics (i.e. nominal-is-best, smaller-is-best or larger-is-best) and how they apply to target values.

iv. Value to the enterprise

Recognize why organizations use Six Sigma, how they apply its philosophy and goals.

Describe how process inputs, outputs, and feedback impact the larger organization. Critical Success Factors to Six Sigma

v. Drivers and metrics

Recognize key drivers for business [profit, market share, customer satisfaction, efficiency, product differentiation, defects per million opportunities (DPMO), etc.] and how key metrics are developed and impact the entire organization.

vi. Financial Benefits

Understand and present financial measures and other benefits (soft and hard) of a project; understand and use basic financial models (e.g., NPV, ROI);

vii. Cost of Poor Quality

Describe, apply, evaluate, and interpret cost of quality concepts, including quality cost categories, data collection, reporting, etc.

viii. Business system and processes

Understand and distinguish interrelationships between business systems and processes.

b. Voice of the customer

i. Customer focus

Identify and classify internal and external customers as applicable to a particular project, and show how projects impact customers.

ii. Collect customer data

Use various methods to collect customer feedback (e.g. Kano diagrams, observation, etc.) and identify key elements that make these tools effective.

iii. Analyze customer data

Use graphical, statistical, and qualitative tools to analyze customer feedback.

iv. Translate customer requirements

Assist in translating customer feedback into project goals and objectives, including critical to quality (CTQ) attributes and requirements statements. Use voice of customer analysis tools such as quality function deployment (QED) and Kano diagrams to translate customer requirements into performance measures.

v. Owners and stakeholders

Identify process owners, internal and external customers, and other stakeholders in a project.

II. Six Sigma and the organization

a. Six Sigma projects

i. Project charter and problem statement

Define and describe elements of a project charter and develop a problem statement, including baseline and improvement goals.

ii. Charter negotiation

Create and negotiate the charter, including objectives, scope, boundaries, project transition, and project closure.

iii. Problem statement

Develop problem statement, including baseline and improvement goals.

iv. Metrics

Establish primary and consequential metrics (quality, cycle time, cost)

v. Process elements

Define and describe process components and boundaries.

vi. Processes

Recognize how processes cross various functional areas and the challenges that result for process improvement efforts.

vii. Project planning tools

Use project tools such as critical path method (CPM), and program evaluation and review technique (PERT) charts, etc.

viii. Project documentation

Create data-driven and fact-driven project documentation using spreadsheets, storyboards, phased reviews, management reviews, presentations to the executive team, etc.

ix. DMAIC

Describe the phases of DMAIC model including tollgate reviews.

x. Project metrics

Assist with the development of primary and consequential metrics (e.g., quality time, cycle time and cost) and establish key project metrics that relate to the voice of the customer.

xi. Project risk analysis

Describe the purpose and benefit of project risk analysis, including resources, financials, impact on customers and other stakeholders, etc.

xii. Project closure

Describe the objectives achieved and apply the lessons learned to identify additional opportunities.

b. Teams

i. Initiating teams

Know the elements of launching a team and why they are important: clear purpose, goals, commitment, ground rules, roles and responsibilities of team members, schedules, and support from management, and team empowerment.

ii. Selecting team members

Select team members that have appropriate skills sets (e.g., self facilitation, technical/subject matter expertise), and create teams with appropriate numbers of members and representation.

iii. Team stages and dynamics

Define and describe the stages of team evolution, including forming storming, norming, performing. Identify and help resolve negative dynamics such as overbearing, dominant, or reluctant participants, the unquestioned acceptance of opinions and facts, groupthink, feuding, floundering, the rush to accomplishment, etc.

iv. Roles and responsibilities

Describe and define the roles and responsibilities of participants on Six Sigma and other teams, including Black Belt, Master Black Belt, Green Belt, champion, coach, facilitator, team member, sponsor, process owner, etc.

v. Team tools

Define, select, and apply team tools such as nominal group technique, multivoting, etc.

vi. *Team facilitation techniques*

Apply coaching, mentoring, and facilitation techniques to guide a team and overcome problems such as overbearing, dominant, or reluctant participants, the unquestioned acceptance of opinions as facts, tangents, etc.

vii. Team-building techniques

Recognize and apply the basic steps in team building: goals, roles and responsibilities, introductions and both stated and hidden agendas.

viii. Team performance evaluation

Measure team progress in relation to goals, objectives and metrics that support team success.

ix. Motivation techniques

Define, select, and apply techniques that support and sustain team member participation and commitment.

x. Communication

Use effective and appropriate communication techniques for different situations to overcome barriers to project success.

xi. Negotiation and conflict resolution techniques

Define, select, and apply tools such as consensus techniques, brainstorming, effort/impact, multivoting, interest-based bargaining to help conflicting parties (e.g., departments, groups, leaders, staff) recognize common goals and how to work together to achieve them.

c. Change Management

i. Managing change

Understand and apply techniques for facilitating or managing organizational change through change agent methodologies.

ii. Organizational roadblocks

Understand the inherent structures for an organization (e.g., its cultures and constructs) that present basic barriers to improvement; select and apply techniques to overcome them.

d. Senior management elements

i. Organizational leadership

Understanding the leadership roles in the deployment of Six Sigma.

ii. Benchmarking

Understand the importance of benchmarking.

iii. Strategic planning

Describe the key elements of strategic business planning and describe why it is important at the project level and at the top level of an organization.

iv. Supply chain management

Describe why the development of suppliers is important to a Six Sigma initiative.

v. Barriers to implementation

Describe how to handle some of the common barriers to implementation.

III. Six Sigma objectives

a. Key process and product/service parameters identified

Identify key process input variables and process output variables (SIPOC), and document their relationships through relational matrices, etc.

Develop and review process maps, flowcharts, failure modes and effects analysis (FMEA) etc.

b. Measurement systems that are discriminate, repeatable, and reproducible.

Calculate, analyze, and interpret measurement system capability using control chart methods.

c. Processes in statistical control

Identify, select, construct, and apply the following types of control charts: X-bar and R, XmR, p, np, c, and u.

Describe how turning attribute data into variable discrete data.

Understand how to make 'active use' of attribute data.

d. Statistically capable processes

Identify, describe, and apply the elements of designing and conducting process capability studies, including identifying characteristics, identifying specifications, and verifying stability and normalty.

Define, select, and calculate Cp and Cpk, and assess process capability.

e. Long-term capability

Describe the assumptions and conventions that are appropriate when only short-term data are collected and when only attributes data are available.

Describe the changes in relationships that occur when long-term data are used, and interpret the relationship between long- and short-term capability as it relates to a 1.5 sigma shift.

f. Visual workplace/factory

Identify the key aspects of a visual workplace

g. Standard work

Identify the key aspects of a standard work.

IV. Six Sigma Approach

a. Process analysis and documentation

i. Quality Function Deployment (QFD)

Describe how House of Quality fits into the overall DFSS process.

ii. Process mapping

Develop and review process maps, written procedures, work instructions, flowcharts, etc.

iii. Failure mode and effects analysis (FMEA)

Define and describe failure mode and effects analysis (FMEA).

Describe the purpose and use of scale criteria and calculate the risk priority number (RPN).

iv. Data collection methods

Identify and classify continuous (variables) and discrete (attributes) data.

v. Techniques for assuring data accuracy and integrity

Define and apply techniques such as random sampling, sample homogeneity, etc.

vi. Multi-vari studies

Create and interpret multi-vari studies to interpret the difference between within-piece, piece-to-piece, and time-to-time variation.

b. Probability and statistics

i. Basic probability concepts

Describe and apply concepts such as independence, mutually exclusive, multiplication rules, complementary probability, joint occurrence of events, etc.

ii. Descriptive statistics

Define, compute, and interpret measures of dispersion and central tendency, and construct and interpret frequency distributions and cumulative frequency distributions.

iii. Graphical methods

Depict relationships by constructing, applying and interpreting diagrams and charts such as stem-and-leaf plots, box-and-whisker plots, run charts, scatter diagrams etc., and depict distributions by constructing, applying and interpreting diagrams such as histograms, normal probability plots etc.

c. Collecting and summarizing data

i. Types of data

Identify, define, classify and compare continuous (variables) and

ii. discrete (attributes) data, and recognize opportunities to convert attributes data to variables measures.

iii. Measurement scales

Define and apply nominal, ordinal, interval and ratio measurement scales.

iv. Methods for collecting data

Define and apply methods for collecting data such as coding data, automatic gaging etc.

v. Techniques for assuring data accuracy and integrity

Define and apply techniques for assuring data accuracy and integrity such as random sampling, stratified sampling, sample homogeneity, etc.

d. Hypothesis testing

i. Fundamental concepts of hypothesis testing

1. Statistical vs. practical significance

Define, compare and contrast statistical and practical significance.

2. Significance level, power, type I and type II errors

Apply and interpret the significance level, power, type I and type II errors of statistical tests.

3. Sample size

Understand how to calculate sample size for any given hypothesis test.

ii. Point and interval estimation

Define and interpret the efficiency and bias of estimators; compute, interpret and draw conclusions from statistics such as standard error, tolerance intervals, and confidence intervals; understand the distinction between confidence intervals and prediction intervals.

iii. Test for means, variances, and proportions

Apply hypothesis tests for means, variances and proportions, and interpret the results.

iv. Paired-comparison tests

Define, determine applicability, and apply paired-comparison parametric hypothesis tests and interpret the results.

v. Goodness-of-fit tests

Define, determine applicability, and apply chi-square tests and interpret the results.

vi. Analysis of Variance (ANOVA)

Define, determine applicability, and apply ANOVAs and interpret the results.

vii. Contingency Tables

Define, determine applicability, and construct a contingency table and use it to determine statistical significance.

e. Properties and applications of probability distributions

i. Distributions commonly used by black belts

Describe and apply binomial, Poisson, normal, chi-square, Student's t, and F distributions.

ii. Other distributions

Recognize when to use hypergeometric, bivariate, exponential, and lognormal distributions.

f. Measurement systems

i. Measurement methods

Describe and review measurement methods such as attribute screens, gauge blocks, calipers, micrometers, optical comparators, tensile strength, titration, etc.

ii. Measurement system analysis

Calculate, analyze, and interpret measurement system capability using repeatability and reproducibility, measurement correlation, bias, linearity, percent agreement, precision/tolerance (P/T), precision/total variation (P/TV), and use both ANOVA and control chart methods for non-destructive, destructive, and attribute systems.

iii. Metrology

Understand traceability to calibration standards, measurement error, calibration systems, control and integrity of standards and measurement devices.

g. Lean enterprise

i. Value-added and non-value-added activities

Identify waste in terms of excess inventory, space, test inspection, rework transportation, storage, etc., and to reduce cycle time to improve throughput.

ii. Characterized the classic wastes

Define and be able to differentiate the wastes (muda). (i.e., defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion, and extra processing).

iii. Value stream mapping

Define and apply methods for construction including calculating takt time, lead time, cycle time, etc.

iv. Quick change-overs

Describe the basic concepts regarding a quick change-over and why it is important to a lean enterprise.

V. Quality improvement tools and techniques

a. Tools most commonly used in projects

i. Ishikawa tools

Describe the objectives and benefits of cause-effect diagram, check sheet, Pareto chart, graphs, control charts, scatter diagram, and histogram.

ii. New management tools

Define, select and use

1) affinity diagrams,

2) interrelationship diagrams,

3) tree diagrams [including fault tree diagrams],

4) prioritization matrices,

5) matrix diagrams,

6) process decision program (PDPC) charts, and

7) activity network diagrams.

iii. Control charts

Describes the objectives and benefits of control charts, including controlling process performance, identifying special and common causes, etc.

1. Rational subgrouping

Define and describe how and why rational subgrouping is used.

2. Populations versus samples

Understand the distinction between a population parameter and a sample statistic.

3. Random sample

Understand the basic questions that should be asked about whether or not a sample is to be considered ‘random’.

4. Analysis of control charts

Interpret control charts and distinguish between common and special causes using the rules for determining statistical control (i.e. seven points in a row for shifts and trends, points out of control and non-random patterns).

iv. PRE-control chart

Define and explain PRE-control and perform PRE-control calculations and analysis.

b. Tools to address challenging situations

i. Advanced statistical process control

Understand appropriate uses of short-run SPC, EWMA, CuSum, and moving average.

ii. Design of experiments (DOE)

1. Terminology

Define independent and dependent variables, factors and levels, response, treatment, error and replication.

2. Planning and organizing experiments

Describe and apply the basic elements of experiment planning and organizing, including determining the experiment objective, selecting factors, responses, and measurement methods, choosing the appropriate design, etc.

3. Design principles

Define and apply the principles of power and sample size, balance, replication, order, efficiency, randomization, and blocking, interaction and confounding.

4. Design and analysis of one-factor experiments

Construct these experiments such as completely randomized, randomized block and Latin square designs, and apply computational and graphical methods to analyze and evaluate the significance of results.

5. Design and analysis of full factorial experiments

Construct these experiments and apply computational and graphical methods to analyze and evaluate the significance of results.

6. Design and analysis of two-level fractional factorial experiments

Construct experiments (including Taguchi designs) and apply computational and graphical methods to analyze and evaluate the significance of results; understand limitations of fractional factorials due to confounding.

7. Taguchi robustness concepts

Apply Taguchi robustness concepts and techniques such as signal-to-noise ratio, controllable and noise factors, and robustness to external sources of variability.

8. Mixture of experiments

Construct these experiments and apply computational and graphical methods to analyze and evaluate the significance of results.

9. Response surface methodology
10. Steepest ascent/descent experiments

Construct these experiments and apply computational and graphical methods to analyze the significance of results.

11. Higher-order experiments

Construct experiments such as CCD, etc., and apply computational and graphical methods to analyze the significance of the results.

12. Evolutionary operations (EVOP)

Understand the application and strategy of EVOP.

c. Process capability and performance

i. Process performance vs. specification

Distinguish between process limits and specification limits.

ii. Calculate process potential

Calculate process performance metrics (Cp and Cpk).

iii. Process performance indices

Define, select, and calculate Pp, Ppk, Cpm and assess process performance.

iv. Design for Six Sigma (DFSS) in the organization

Understand why DFSS is important to Six Sigma implementation. Understand robust design and functional requirements. Develop a robust design using noise strategies. Understand the concepts of tolerance design and statistical tolerancing. Calculate tolerances using process capability data.

d. Maintaining a solution

i. Standard operating procedures

Define methods for standardizing procedures.

ii. Error proofing/Mistake proofing/poka yoke

Define and apply methods/examples for error proofing.

iii. Audits Define and apply methods for application.

iv. Project tracking

Define and apply methods for application.