

**American Society for Quality (ASQ)
2022 CERTIFIED SIX SIGMA BLACK BELT (SSBB)
BODY OF KNOWLEDGE**

The topics in this Body of Knowledge include additional detail in the form of subtext explanations and the cognitive level at which test questions will be written. This information will provide guidance for the candidate preparing to take the exam. The subtext is not intended to limit the subject matter or be all-inclusive of what might be covered in an exam. It is meant to clarify the type of content to be included in the exam. The descriptor in parentheses at the end of each entry refers to the maximum cognitive level at which the topic will be tested. A complete description of cognitive levels is provided at the end of this document.

I. Organization-wide Planning and Deployment (12 Questions)

A. Organization-wide considerations

1. Fundamentals of six sigma and lean methodologies

Define and describe the value and goals of these approaches and describe the integration and complementary relationship between them. Identify and understand an organization's lean six sigma maturity model. (Understand)

2. Six sigma, lean, and continuous improvement methodologies

Describe when to use six sigma instead of other problem-solving approaches and describe the importance of aligning six sigma objectives with organizational goals. Describe screening criteria and how such criteria can be used for the selection of six sigma projects, lean initiatives, and other continuous improvement methods. (Apply)

3. Relationships among business systems and processes

Describe the interactive relationships among business systems, processes, and internal and external stakeholders, and the impact those relationships have on business systems. (Understand)

4. Strategic planning and deployment for initiatives

Define the importance of identification and strategic planning of six sigma projects and lean initiatives as part of the business planning process taking into consideration outcomes such as return on investment and measured intangibles. Use strengths, weaknesses, opportunities, and threats analysis (SWOT), contingency planning, and business continuity planning to enhance strategic planning and deployment. (Apply)

B. Leadership

1. Roles and responsibilities

Describe the roles and responsibilities of executive leadership, champions, sponsors, process owners, master black belts, black belts, and green belts in driving six sigma and lean initiatives. Understand the importance of coaching multiple levels of leadership and belts on appropriate six sigma tools and techniques. Understand the importance of finance and its role supporting a project and confirming its outcome. Describe how each group influences project deployment in terms of providing or managing resources, enabling changes in organizational structure, and supporting communications about the purpose and deployment of the initiatives. (Understand)

2. Organizational barriers

Describe how an organization's structure and culture can impact six sigma projects. Identify common causes of six sigma failures, including lack of management support and lack of resources. (Apply)

3. Change management

Apply and facilitate change management techniques, including stakeholder analysis, readiness assessments, proactive change management, and communication plans to overcome barriers and drive organization-wide change. (Apply)

II. Organizational Process Management and Measures (12 Questions)

A. Impact on stakeholders

Describe the impact six sigma projects can have on customers, suppliers, and other stakeholders. (Understand)

B. Benchmarking

Define and distinguish between various types of benchmarking, e.g., best practices, competitive, collaborative, and breakthrough. Select measures and performance goals for projects resulting from benchmarking activities. (Apply)

C. Business measures

1. Performance measures

Define and describe balanced scorecard, key performance indicators (KPIs), key behavior indicators (KBIs), objectives and key results (OKRs), customer loyalty metrics, and leading and lagging indicators. Explain how to create a line of sight from performance measures to organizational strategies. (Analyze)

2. Financial measures

Define and use revenue growth, market share, margin, net present value (NPV), return on investment (ROI), and cost-benefit analysis (CBA). Explain the difference between hard cost measures (from profit and loss statements) and soft cost benefits of cost avoidance and reduction. (Apply)

III. Team Management (15 Questions)

A. Team formation

1. Team types and constraints

Define and describe various teams, including virtual, cross-functional, and self-directed. Determine what team type will work best for a given a set of constraints, e.g., geography, technology availability, staff schedules, time zones. (Apply)

2. Team roles and responsibilities

Define and describe various team roles and responsibilities for the leader, facilitator, coach, and individual member. (Understand)

3. Team member selection criteria

Describe various factors that influence the selection of team members, including the ability to influence, openness to change, required skills sets, subject matter expertise, and availability. (Apply)

4. Team success factors

Identify and describe the elements necessary for successful teams, e.g., management support, clear goals, ground rules, and timelines. (Apply)

B. Team facilitation

1. Motivational techniques

Describe and apply techniques to motivate team members. Identify factors that can demotivate team members and describe techniques to overcome them. (Apply)

2. Team stages of development

Identify and describe the classic stages of team development: forming, storming, norming, performing, and adjourning. (Apply)

3. Team communication

Describe and explain the elements of an effective communication plan, e.g., audience identification, message type, medium, and frequency. (Apply)

4. Team leadership models

Describe and select appropriate leadership approaches (e.g., direct, coach, support, and delegate) to ensure team success. (Apply)

C. Team dynamics

1. Group behaviors

Identify and use various conflict resolution techniques (e.g., coaching, mentoring, and intervention) to overcome negative group dynamics, including dominant and reluctant participants, groupthink, rushing to finish, and digressions. (Evaluate)

2. Meeting management

Select and use various meeting management techniques, including using agendas, starting on time, requiring pre-work by attendees, and ensuring that the right people and resources are available. (Apply)

3. Team decision-making methods

Define, select, and use various tools (e.g., consensus, nominal group technique, and multi-voting) for decision-making. (Apply)

D. Team training

1. Needs assessment

Identify the steps involved to implement an effective training curriculum: identify skills gaps, develop learning objectives, prepare a training plan, and develop training materials. (Understand)

2. Delivery

Describe various techniques used to deliver effective training, including adult learning theory, soft skills, and modes of learning. (Understand)

3. Evaluation

Describe various techniques to evaluate training, including evaluation planning, feedback surveys, pre-training and post-training testing. (Understand)

IV. Define (20 Questions)

A. Voice of the customer

1. Customer identification

Identify and segment customers and show how a project will impact both internal and external customers. (Apply)

2. Customer data collection

Identify and select appropriate data collection methods (e.g., surveys, focus groups, interviews, and observations) to gather voice of the customer data. Ensure the data collection methods used are reviewed for validity and reliability. (Analyze)

3. Customer requirements

Define, select, and apply appropriate tools to determine customer needs and requirements, including critical-to-X (CTX when 'X' can be quality, cost, safety, etc.), CTQ tree, quality function deployment (QFD), supplier, input, process, output, customer (SIPOC), and Kano model. (Analyze)

B. Business case and project charter

1. Business case

Describe business case justification used to support projects. (Understand)

2. Problem statement

Develop a project problem statement and evaluate it in relation to baseline performance and improvement goals. (Evaluate)

3. Project scope

Develop and review project boundaries to ensure that the project has value to the customer. (Analyze)

4. Goals and objectives

Identify SMART (specific, measurable, actionable, relevant, and timebound) goals and objectives on the basis of the project's problem statement and scope. (Analyze)

5. Project performance measurements

Identify and evaluate performance measurements (e.g., cost, revenue, delivery, schedule, and customer satisfaction) that connect critical elements of the process to key outputs. (Analyze)

6. Project charter review

Explain the importance of having periodic project charter reviews with stakeholders. (Understand)

C. Project management (PM) tools

Identify and use the following PM tools to track projects and document their progress. (Evaluate)

1. Gantt charts

2. Toll-gate reviews

3. Work breakdown structure (WBS)

4. RACI model (responsible, accountable, consulted, and informed)

D. Analytical tools

Identify and use the following analytical tools throughout the DMAIC cycle. (Apply)

1. Affinity diagrams

2. Tree diagrams

3. Matrix diagrams

4. Prioritization matrices

5. Activity network diagrams

6. Process decision program chart (PDPC)

7. Interrelationship digraph (ID)

V. Measure (25 Questions)

A. Process characteristics

1. Process flow metrics

Identify and use process flow metrics (e.g., work in progress (WIP), work in queue (WIQ), touch time, takt time, cycle time, and throughput) to determine constraints. Describe the impact that "hidden factories" can have on process flow metrics. (Analyze)

2. Process analysis tools

Select, use, and evaluate various tools, e.g., value stream maps, process maps, work instructions, flowcharts, spaghetti diagrams, and gemba walk. (Evaluate)

B. Data collection

1. Types of data

Define, classify, and distinguish between qualitative and quantitative data, and continuous and discrete data. (Evaluate)

2. Measurement scales

Define and use nominal, ordinal, interval, and ratio measurement scales. (Apply)

3. Sampling

Define and describe sampling concepts, including representative selection, homogeneity, bias, accuracy, and precision. Determine the appropriate sampling method (e.g., random, stratified, systematic, subgroup, and block) to obtain valid representation in various situations. (Evaluate)

4. Data collection plans and methods

Develop and implement data collection plans that include data integrity, accuracy, and processing tools, e.g., check sheets and data normalization. Avoid data collection pitfalls by defining the metrics to be used or collected, ensuring that collectors are trained in the tools and understand how the data will be used, and checking for seasonality effects. (Analyze)

C. Measurement systems

1. Measurement system analysis (MSA)

Use gauge repeatability and reproducibility (R&R) studies and other MSA tools (e.g., bias, correlation, linearity, precision to tolerance, and percent agreement) to analyze variable measurement system capability. Use audit MSA for attribute measurement system. (Evaluate)

2. Measurement systems across the organization

Identify how measurement systems can be applied across all functional areas of the organization (e.g., marketing, sales, engineering, research and development (R&D), supply chain management, operations and customer experience). (Understand)

3. Metrology

Define and describe elements of metrology, including calibration systems, traceability to reference standards, and the control and integrity of measurement devices and standards. (Understand)

D. Basic statistics

1. Basic statistical terms

Define and distinguish between population parameters and sample statistics, e.g., proportion, mean, and standard deviation. (Apply)

2. Central limit theorem

Explain the central limit theorem and its significance in the application of inferential statistics for confidence intervals, hypothesis tests, and control charts. (Understand)

3. Descriptive statistics

Calculate and interpret measures of dispersion and central tendency. (Evaluate)

4. Graphical methods

Construct and interpret diagrams and charts, e.g., box-and-whisker plots, scatter diagrams, histograms, normal probability plots, frequency distributions, and cumulative frequency distributions. (Evaluate)

5. Valid statistical conclusions

Distinguish between descriptive and inferential statistical studies. Evaluate how the results of statistical studies are used to draw valid conclusions. (Evaluate)

E. Probability

1. Basic concepts

Describe and interpret probability concepts, e.g., independence, mutually exclusive events, addition and multiplication rules, conditional probability, complementary probability, and joint occurrence of events. (Understand)

2. Common distributions

Describe, interpret, and use normal, Poisson, binomial, chi square, Student's t, and F distributions. (Evaluate)

3. Additional distributions

Identify hypergeometric, bivariate, exponential, lognormal, and Weibull distributions. (Understand)

F. Process capability

1. Process capability indices

Define, select, and calculate C_p and C_{pk} . (Evaluate)

2. Process performance indices

Define, select, and calculate P_p , P_{pk} , C_{pm} , and process sigma. (Evaluate)

3. General process capability studies

Describe and apply elements of designing and conducting process capability studies relative to characteristics, specifications, sampling plans, stability, and normality. (Evaluate)

4. Process capability for attributes data

Calculate the process capability and process sigma level for attributes data. (Apply)

5. Process capability for non-normal data

Identify non-normal data and determine when it is appropriate to use Box-Cox or other transformation techniques. (Apply)

6. Process performance vs. specification

Distinguish between natural process limits and specification limits. Calculate process performance metrics, e.g., percent defective, parts per million (PPM), defects per million opportunities (DPMO), defects per unit (DPU), first pass yield, and rolled throughput yield (RTY). (Evaluate)

7. Short-term and long-term capability

Describe and use appropriate assumptions and conventions when only short-term data or only long-term data are available. Interpret the relationship between short-term and long-term capability. (Evaluate)

VI. Analyze (22 Questions)

A. Measuring and modeling relationships between variables

1. Correlation coefficient

Calculate and interpret the correlation coefficient and its confidence interval and describe the difference between correlation and causation. (Evaluate)

2. Linear regression

Calculate and interpret regression analysis and apply and interpret hypothesis tests for regression statistics. Use the regression model for estimation and prediction, analyze the uncertainty in the estimate, and perform a residuals analysis to validate the model. (Evaluate)

3. Multivariate tools

Understand sources of variation through multivariate tools (e.g., factor analysis, discriminant analysis, and multiple analysis of variance (MANOVA)). (Understand)

B. Hypothesis testing

1. Terminology

Define and interpret the significance level, power, type I, and type II errors of statistical tests. (Evaluate)

2. Statistical vs. practical significance

Define, compare, and interpret statistical and practical significance. (Evaluate)

3. Sample size

Calculate sample size for common hypothesis tests: equality of means and equality of proportions. (Apply)

4. Point and interval estimates

Define and distinguish between confidence and prediction intervals. Define and interpret the efficiency and bias of estimators. Calculate tolerance and confidence intervals. (Evaluate)

5. Tests for means, variances, and proportions

Use and interpret the results of hypothesis tests for means, variances, and proportions. (Evaluate)

6. Analysis of variance (ANOVA)

Select, calculate, and interpret the results of ANOVAs. (Evaluate)

7. Goodness-of-fit (chi square) tests

Define, select, and interpret the results of these tests. (Evaluate)

C. Risk analysis and management

1. Types of risk

Identify, assess, and prioritize various types of risk such as, enterprise, operational, supplier, security, product, and cyber-security. (Analyze)

2. Failure mode and effects analysis (FMEA)

Describe the purpose and elements of FMEA, including risk priority number (RPN), and evaluate FMEA results for processes, products, and services. Distinguish between design FMEA (DFMEA) and process FMEA (PFMEA) and interpret their results. (Evaluate)

D. Additional analysis methods

1. Gap analysis

Analyze scenarios to identify performance gaps, and compare current and future states using predefined metrics. (Analyze)

2. Root cause analysis

Define and describe the purpose of root cause analysis, recognize the issues involved in identifying a root cause, and use various tools (e.g., 5 whys, Pareto charts, fault tree analysis, cause and effect diagrams, and A3) to resolve chronic problems. (Analyze)

3. Waste analysis

Identify and interpret the seven classic wastes (overproduction, inventory, defects, over-processing, waiting, motion, and transportation) and resource under-utilization. (Analyze)

VII. Improve (21 Questions)

A. Design of experiments (DOE)

1. Terminology

Define basic DOE terms, e.g., independent and dependent variables, factors and levels, response, treatment, error, and nested. (Understand)

2. Design principles

Define and apply DOE principles, e.g., power, sample size, balance, repetition, replication, order, efficiency, randomization, blocking, interaction, confounding, and resolution. (Apply)

3. Planning experiments

Plan and evaluate DOEs by determining the objective, selecting appropriate factors, responses, and measurement methods, and choosing the appropriate design. (Evaluate)

4. One-factor experiments

Understand when to use completely randomized, randomized block, and Latin square designs. (Understand)

5. Two-level fractional factorial experiments

Understand these types of experiments and describe how confounding can affect their use. (Understand)

6. Full factorial experiments

Understand these types of experiments. (Understand)

B. Lean methods

1. Waste elimination

Select and apply tools and techniques for eliminating or preventing waste, e.g., pull systems, kanban, 5S, standard work, and poka-yoke. (Analyze)

2. Cycle-time reduction

Use various tools and techniques for reducing cycle time, e.g., continuous flow, single-minute exchange of die (SMED), and heijunka (production leveling). (Analyze)

3. Kaizen

Define and distinguish between kaizen and kaizen blitz and describe when to use each method. (Apply)

4. Other improvement tools and techniques

Identify and describe how other process improvement methodologies are used, e.g., theory of constraints (TOC) and overall equipment effectiveness (OEE). (Understand)

C. Implementation

Develop plans for implementing proposed improvements, including conducting pilot tests or simulations, and evaluate results to select the optimum solution. (Evaluate)

VIII. Control (17 Questions)

A. Statistical process control (SPC)

1. Objectives

Explain the objectives of SPC, including monitoring and controlling process performance, tracking trends, runs, and reducing variation within a process. (Understand)

2. Selection of variables

Identify and select critical process characteristics for control chart monitoring. (Apply)

3. Rational subgrouping

Define and apply the principle of rational subgrouping. (Apply)

4. Control chart selection

Select and use control charts in various situations: $\bar{X} - R$, $\bar{X} - s$, individual and moving range (ImR), p, np, c, u, short-run SPC, and moving average. (Apply)

5. Control chart analysis

Interpret control charts and distinguish between common and special causes using rules for determining statistical control. (Analyze)

B. Other controls

1. Total productive maintenance (TPM)

Define the elements of TPM and describe how it can be used to consistently control the improved process. (Understand)

2. Visual controls

Define the elements of visual controls (e.g., pictures of correct procedures, color-coded components, and indicator lights), and describe how they can help control the improved process. (Understand)

C. Maintain controls

1. Measurement system reanalysis

Review and evaluate measurement system capability as process capability improves, and ensure that measurement capability is sufficient for its intended use. (Evaluate)

2. Control plan

Develop a control plan to maintain the improved process performance, enable continuous improvement, and transfer responsibility from the project team to the process owner. (Apply)

D. Sustain improvements

1. Lessons learned

Document the lessons learned and benefits realized from all phases of a project and identify strategies for reinforcing and replicating improvements. (Apply)

2. Documentation

Develop or modify documents including standard operating procedures (SOPs), work instructions, and control plans to ensure that the improvements are sustained over time. (Apply)

3. Training for process owners and staff

Develop and implement training plans that are handed off to process owners to ensure consistent execution of revised process methods, KPIs to confirm sustained benefits, and standards to maintain process improvements. (Apply)

4. Ongoing evaluation

Identify and apply tools (e.g., control charts and control plans) for ongoing evaluation of the improved process, including monitoring leading indicators, lagging indicators, and additional opportunities for improvement. (Apply)

IX. Design For Six Sigma (DFSS) Framework and Methodologies (6 Questions)

A. Common DFSS methodologies

Identify and describe DMADV (define, measure, analyze, design, and validate) and DMADOV (define, measure, analyze, design, optimize, and validate). (Understand)

B. Design for X (DFX)

Describe design constraints, including design for cost, design for manufacturability (producibility), design for test, and design for maintainability. (Understand)

C. Robust designs

Describe the elements of robust product design, tolerance design, and statistical tolerancing. (Understand)

Levels of Cognition

Based on Bloom's Taxonomy – Revised (2001)

In addition to **content** specifics, the subtext for each topic in this BOK also indicates the intended **complexity level** of the test questions for that topic. These levels are based on “Levels of Cognition” (from Bloom’s Taxonomy – Revised, 2001) and are presented below in rank order, from least complex to most complex.

Remember

Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.

Understand

Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

Apply

Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.

Analyze

Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario.

Evaluate

Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards.

Create

Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn.