## INDEX

Note: Italicized page locators refer to figures or tables in exhibits.

ABC classification system, 347 Accountable care organizations (ACOs), 378 Activity-based costing (ABC): final aggregation of activity costs per visit, 376; initial data and allocation rate calculation, 375; steps in, 374 Additive property of probability, 180-81, 182 Administrative space, evaluating, 382 Advanced-access scheduling, 283, 323, 337-41; for an operating and market advantage, 337; benefits of, 324; fears about, 340-41; going live, 339; heijunka and, 273–74; implementing, 337–39; metrics for evaluating, 339-40 Adverse events, 4 Affordable Care Act (ACA), 5, 81, 370; accountable care organizations and, 378; global payments and, 380; healthy lifestyles and, 8; innovation centers and, 125; on mission of PCORI, 53; operational issues with health insurance exchanges and, 97-99; passage of, 3; strategy execution and, 72; systems of care and, 63; value-based purchasing and, 57 Agency for Healthcare Research and Quality (AHRQ), 4, 6, 23, 41, 54; Effective Health Care Program, 47, 380; patient-centered medical home defined by, 51; prevention

quality indicators, 49, 50; public reporting findings of, 54-55 Agile project management, 124, 124 - 25Allegheny General Hospital (Pittsburgh), 135 ALLHAT study (NIH), 203 Allina Health (Minnesota), 204 American Association of Health Plans, 6 American Medical Association, 6, 47 American Productivity and Quality Center, 244 American Recovery and Reinvestment Act (ARRA), 53, 58, 204 America's Health Insurance Plans, 6, 47 Analytical tools, 6, 153-61; decision analysis, 157-61; optimization, 153 - 57Analytics, 7-8, 40, 59, 204, 403. See also Data analytics; Healthcare analytics Analytics department: key purpose of, 212 Analytics technology: sophisticated, 205 Andon, 270, 396, 403 Arena, 297 Arrival rate, 288 Artificial intelligence, 215 Artificial variance, 304-5 Assembly lines, 23

Assignable (or special) variation, 233

Automation tools, 381-82 Autoregressive integrated moving average (ARIMA) models, 351–52 Averaging methods, 349–52; autoregressive integrated moving average models, 351-52; exponential smoothing, 350; simple moving average, 349-50; trend, seasonal, and cyclical models, 350-51; weighted moving average, 350 Backlog: advanced-access scheduling and, 339 Back orders, 355 Bailey-Welch rule, 335 Balanced scorecard, 380; balance in, 74–75; construction of targets, 93; customer perspective and market segmentation, 78–80; defined, 73; displaying results, 90; elements of, 76, 399; feedback and strategic learning, 90, 92; financial perspective of, 77-78, 78; four perspectives of, 74–75, 75; in healthcare, 75–76; implementation of, 89–90; internal business process perspective, 80-82; learning/growing perspective, 83–84; links, 89; mission/ vision and, 77; modifications of, 92–93; perspectives in, 75; project management and, 101; strategic alignment and, 85-86; strategic management systems and, 76; strategy maps and, 75, 82, 86; targets, resources, initiatives, and budgets, 89–90; template sample, 91 Balancing feedback, 10, 11 Baldrige Award. See Malcolm Baldrige National Quality Award Bar coding, 346, 348 Bar graphs, 210, 210 Baseline plan, 117 Batalden, Paul B., 29 Bayes' theorem, 184, 185 Benchmarking, 244, 378, 380, 402

Benefits Health System (Montana), cost reduction case example, 384, 386 Best practices: identifying and replicating, 291-92 Big data, 6; analytics and, 7–8; predictive models and analysis of, 205; three Vs of, 40 BJC HeathCare, 38 Black belts, Six Sigma infrastructure, 227, 228 Blended balanced scorecard-strategy mapping approach, 59 Blitzes. See Kaizen events Block appointment model, 334 Blogs, 382 Bottlenecks, 291, 311 Bundled payments, 377–78 Burwell, Sylvia Mathews, 57 Business intelligence reports, 206 Buzan, Tony, 138 Calendaring tools, 381–82 Cambridge Health Alliance Whidden Hospital (Massachusetts): process improvement and patient flow at, 281 Capacity: matching to demand, 290, 323; predicting, advanced-access scheduling and, 338 Capacity of a process, 286–87 Capacity utilization, 287; defined, 141, 142; maximiing, 142-43 Capture and reporting system, 396 Care paths, 270 Catalyst for Payment Reform, 57 Cause-and-effect diagrams, 140, 146-48, 378; example, 147; processtype, 148; typical categories in, 146 c-charts, 233 Center for Medicare & Medicaid Innovation: Bundled Payments for Care Improvement Initiative, 57 Centers for Disease Control and Prevention (CDC), 167, 207

Centers for Medicare & Medicaid Services (CMS), 4, 36, 54, 63, 98, 369; accountable care organizations information, 378; Acute Care Episode Demonstration, 57; Merit-Based Incentive Payment System, 82; regulatory compliance measures and, 204 Centra Health: advanced access implementation at, 274 Central limit theorem, 185-86, 233 Cerner Corporation, 204 Change control, 117–18, 400 Checklist Manifesto, The (Gawande), 270-71 Check sheets, 140, 170–71, 304, 401, 407; use in quality management and Six Sigma, 232, 232 Chemotherapy: linkages within healthcare system, 12 Chronic care model (CCM), 51 Chronic disease management, 50–53; chronic care model, 51; patientcentered medical homes, 51–53; shared savings model, 379 Clinical care, 3 Clinical decision support systems, 59-61, 60 Clinical microsystems, 8-9 Clinical practice guidelines: barriers to patients' compliance with, 47–48; evidence-based medicine and, 46 - 48Clinical space optimization, 382 Clinical systems, 8-9 Cloud storage, 204 Clustering, 215; Medicare data, 216; methodology, 215 CMS. See Centers for Medicare & Medicaid Services Coefficient of determination  $(r^2)$ , 194, 194 Coefficient of variation (CV), 177 Cognitive computing systems, 217, 218

Common cause, 29 Common variation, 233 Commonwealth Fund, 125 Communications plan: scope creation and, 118 Comparative effectiveness research: infrastructure required for, 7; priorities in, 53 Competing on Analytics: The New Science of Winning (Davenport & Harris), 203 Conditional probability, 182–85 Confidence interval (CI), 185-87 Conformance quality, 222 Consumer-directed healthcare, 8, 394 Contingency plans, 289 Contingency tables, 183, 183 Continuous improvement: kaizen philosophy of, 259; Six Sigma and mind-set of, 226 Continuous quality improvement (CQI), 34, 256 Control charts, 140, 233, 378, 396 Control limits, 233 Control systems, 395–96 Correlation coefficient (r): defined, 194; problems with, 195–96 Cost and revenue models, linking together, 383-84 Cost-effective process improvement: enabling, 282 Cost/importance chart, 382, 383 Cost of quality, 223–25; defined, 223; four parts in, 224 Cost reduction: evidence-based medicine and, 49-50 Cost-reimbursement contracts, 121 Cost-volume-profit (CVP) analysis, 394, 395 Council of Supply Chain Management Professionals, 38 Critical path: establishing, 290; slack and, 115 Critical path method (CPM), 26, 27, 98, 115

Critical pathway, identifying, 290 Critical ratio, 331 "Critical to quality" characteristics (CTQs), 230 Crosby, Philip B., 35 Cross-functional process maps, 143 Crossing the Quality Chasm: A New Health System for the 21st Century: (IOM), 5, 223CTQs. See "Critical to quality" characteristics (CTQs) Customer measures, 79 Customer perspective: balanced scorecards and, 74, 75, 78-80; performance metrics from, 79 Custom patient care, 48, 48-49 Cycle time, 263, 288 Dashboards, 212–14; key performance

Dashboards, 212–14; key performance indicators, 213; metrics, 212–13; reports, 214; scorecards, 213

Data: goal of, 205; increase in, 204; in knowledge hierarchy, *20*, 21; mathematical descriptions of, 174–78, 404; visualization techniques, 171–74

Data analysis, 169-99

Data analytics, 205–9; descriptive analytics, 206, 214; predictive analytics, 206–7, 209, 214; prescriptive analytics, 209, 214

Data collection: goal of, 168

Data mining: cognitive computing for, 217; for discovery, 214–17

Data visualization tools, 209–14; bar graphs, 210, *210*; dashboards, 212–14; histograms, 212; line graphs, 210, *211*; map functionality, 210–11; scatter plots, 212

Data warehousing and management, 346

Date constraints, slack and, 115 Davenport, Thomas, 203

Decision analysis, 157–61

Decision-making: analytical tools, 153–61; barriers, 136, 137; brilliant, ten barriers to, and key elements related to, 137; framework, 136, 136–38; mapping, 138–43; measures of process performance, 141–43; problem identification tools, 143, 145–53

Decision Traps: The Ten Barriers to Brilliant Decision-Making and How to Overcome Them (Russo & Shoemaker), 136

Decision trees, 157, 207, 208; construction of, 158; HMO vaccination program, 158, 158–61, 159, 160

Deeming authority, 36

Defects per million opportunities (DPMOs), 225, 226, 238

Define-measure-analyze-improvecontrol (DMAIC) cycle, 225, 229, 229–32, 250, 276, 397, 401

Delays: feedback and, 11

Demand: dependent, 355; independent, 355; matching capacity to, 290, 323; predicting, advancedaccess scheduling and, 338

Demand forecasting, 349–54; averaging methods, 349–52; model development and evaluation, 352; VVH diaper demand forecasting, 352, 353, 354

Deming, W. Edwards, 27, 28–32, 34, 35; adaptation of the 14 points for medical service, 29–31

Deming System of Profound Knowledge, 31–32

Departmental activities, prioritized, 382

Dependent demand, 355

Deployment champions, Six Sigma infrastructure, 227, 228–29 Descartes, René, 22

Descriptive analytics, 206, 214

Diabetes care: chronic care model and, 51 Diagnosis-related groups (DRGs), 153-56, 154, 156 Discrete event simulation (DES), 297, 298, 299-301 Disease management: predictive models and, 207 Disintermediation, 364 Disruptive innovation, 126 Division of labor, 22-23 DMAIC. See Define-measure-analyzeimprove-control (DMAIC) cycle Donabedian, Avedis, 9, 32–34, 35 Dot plots, 173, 173 "Drip rate," in Lean system, 263 Duke University Health System, 49 Duplicate activities: eliminating, 288 Earliest due date (EDD), 331, 332, 334 Early finish date, 115 EBM. See Evidence-based medicine Ebola virus, 167–68 Economic order quantity (EOQ) model, 354–58; cost curves, 357, 358; inventory order cycle, 356, 357 EHRs. See Electronic health records 80/20 rule, 172 Electronic health records (EHRs), 7-8, 9, 204, 291; clinical decision support systems and, 59, 60; population health and, 205; shared savings model and, 379; text mining of, 215; unintended consequences and, 58 Electronic medication orders, 348 Electronic procurement (e-procurement), 364 Empirical probability, 178 Empiricism, 21 Employees: balanced scorecard and, 75, 75; laying off, 393;

redeployment or retraining of, 392, 393; skills/abilities, 83 Engineering a Learning System (IOM), 221 Enterprise resources planning (ERP), 363 Environment: delivery of care and, 9 Epic Systems Corporation, 204 Equal variance t-test, 189–90 Errors: eliminating, 282-83 Evidence-based medicine (EBM), 6-7, 17; barriers to, 47-48; bundled payment models and, 378; care paths and, 270; chronic disease management and, 50-53; comparative effectiveness research and, 53-54; consistent application of, 46; cost reduction and, 49–50; criticisms of, 48; defined, 6, 45; financial gains from, 49-50; future of, 62–63; guidelines of, 46–48; operational excellence and, 405, 406; standard and custom patient care, 48, 48-49; tools to expand use of, 54-59; wider adoption of, 9 Excellence in healthcare: major areas of expertise related to, 3 Exploration in Quality Assessment and Monitoring, 33 External operational metrics: today and into the future, 82-83 Facility and capital costs, 382–83 Failure mode and effects analysis (FMEA), 230, 245; defined, 149; patient falls, example, 151; steps for, 149-50 Feasibility analysis, 104 Feasible solution, 153 Feedback: definition of, 10; reinforcing/balancing, systems with, 10, 11 Fee-for-service (FFS), 374, 377; advan-

tage with, 59; problems with, 57

Feigenbaum, Armand V., 35 Financial accounting: managerial accounting vs., 393 Financial improvement, defined, 371 - 72Financial management: improvement of, 369–87; improvement tools, 374, 377; systems approach to, 372-80, 373 Financial perspective: balanced scorecards and, 77-78; performance metrics from, 78 Financial reports, 73, 73 Financial stakeholders: balanced scorecard and, 74, 75 First come, first served (FCFS), 331, 332 Fishbone diagrams, 304, 401, 407; defined, 146; use in quality management and Six Sigma, 232, 232 5 Million Lives Campaign, 34 Five Ss, Lean and, 264–65, 266, 305, 382, 403 Five whys technique, 145–46 Fixed costs, 394 Fixed order quantity with safety stock (SS) model, 359–61, 362 Fixed-price contract, 121 Fixed time period with safety stock (SS) model, 361 Flowcharts, 286, 304; creating, steps for, 140–41; standard symbols, 142; use in quality management and Six Sigma, 232, 232 Force field analysis, 162, 162–63, 163, 401Ford, Henry, 23 Forecasting, 349, 401 Formal change mechanism, purpose of, 117–18 Four perspectives, 399 Framing, 138 F-test, 196 Full capitation, 379 Futurescan: Healthcare Trends and Implications 2016-2021, 12

Galileo, Galilei, 22 Gantt, Henry, 26 Gantt charts, 26, 113, 114 Gawande, Atul, 270 Gilbreth, Frank, 25–26 Gilbreth, Lillian, 25–26 Global payments, 380 Goal, The (Goldratt & Cox), 150 "Gold plating," 109 Graphic display of data, 404 Graphic tools, 169–74; check sheets, 170-71; dot plots, 173, 173; histograms, 171–72; mapping, 170; Pareto diagrams, 172–73; scatter plots, 173-74, 174 Graphs, 210, 210 Green belts, Six Sigma infrastructure, 227, 228 Gross domestic product (GDP): health spending projections and, 4 Group Health Cooperative (Seattle), 379 HaDoop database system, 215 HaDoop software, 40 Harris, F. W., 354 Harris, Jeanne, 203 "Harvesting the low-hanging fruit," 288 Hawthorne studies, 32 Healthcare: balanced scorecard in, 75 - 76Healthcare, systems view of, 8-11, 9; clinical system, 8-9; reinforcing and balancing feedback in, 10; system stability and change, 10–11 Healthcare analytics, 203–18. See also Data analytics; data mining for discovery, 214-17; data visualization, 209-14; defining, 203-4 Healthcare Benchmarks and Quality Improvement, 244 Healthcare Finance: An Introduction to Accounting and Financial Management (Gapenski & Reiter), 391 HealthCare.gov, 98, 99

Health Care Homes intitiative (Minnesota), 52–53 Healthcare leaders: complex world of, 72, 73 Healthcare organizations: of the future, 407, 408; strategy execution and, 72 Healthcare Quality Book: Vision, Strategy and Tools (Joshi et al.), 4 Healthcare savings accounts (HSAs), 8,394 Healthcare spending: growth projections for, 4 Health Catalyst (Minnesota), 204 Health insurance exchanges, 78 HealthPartners (Minnesota): Six Sigma Clostridium difficile study, 221 - 22Heijunka, 273–74, 289, 403 Hennepin County Medical Center (HCMC), 207 High-Tech Digital Imaging (HTDI): actual versus trend in utilization of, 61; benefits with, 61 Histograms, 140, 171, 171–72, 175, 212, 304, 402; defined, 171; use in quality management and Six Sigma, 232, 232 Holding (carrying) costs, 355 Holding the gains, approaches to, 391–409; control system, 395–96, 404; human resources planning, 391-93, 404; managerial accounting, 393–95, 404; tools to use: general algorithm, 397–404 Homeostasis, 11 Hospital census: rough-cut capacity planning and, 324–26 Hospital Compare, 54 Hospital financial model, 385 Hospitals: bundled payments in, examples, 377 Hoteling, 382 Human resources (HR) planning, 391–93; ongoing and comprehensive, 393; process for, 392

Human Resources in Healthcare: Managing for Success (Fried & Fottler), 391 Hypothesis testing, 187–92 IBM Watson Analytics, 217; description of, 217; opening page screenshot, 218 Idle time, 288 If Japan Can... Why Can't We?, 28 Income statement: financial health indicators on, 371-72 Independent demand, 355 Individual appointment model, 334 Industrial Revolution, 22 Informatics systems: maturing of, 6 Information: in knowledge hierarchy, 20, 21Information feedback: embedding, 290 Information technology (IT): necessary, 84; patient flow and investing in, 284 Innovation centers, 59, 125, 125–26 Innovation process, 81 Institute for Clinical Systems Improvement (ICSI), 60 Institute for Healthcare Improvement (IHI), 41, 274; Triple Aim, 223 Institute of Medicine (IOM), 7, 28; clinical practice guidelines defined by, 47; Crossing the Quality Chasm, 5, 223; Engineering a Learning System, 221; To Err Is Human, 21 Integrated patient care, 48, 49 Intermountain Health Care (IHC), 49 Internal business process perspective, 80 - 82International normalized ratio (INR), 255 International Organization for Standardization (ISO), 35 Internet, 291 Internet of Things, 6 Inventory, 288; classification systems, 347-48; defined, 347; theory of

constraints and, 152; tracking systems, 348-49 Ishikawa, Kaoru, 35, 232 ISO. See International Organization for Standardization ISO 9000, 35–36, 38, 225 Jidoka, 270, 396, 403 Job loss, 393 Job/operational scheduling, 330–34 Joint Commission, The, 4, 149 Juran, Joseph M., 27, 32, 34, 35, 167; quality trilogy, 32, 33 Juran's Quality Handbook, 32 Just-in-time (JIT), 37. See also Lean; inventory systems, 362-63; production, 256 Kaizen, 83, 259, 276, 402–3 Kaizen events, 83, 265, 267-69, 303, 305, 403Kanban, 37, 271, 271–72, 272, 362– 63, 403 Kant, Immanuel, 21, 22 Kaplan, Robert, 59, 83 Key performance indicators: dashboard visualizations and, 212, 213 Key process indicators (KPIs), 167 Knowledge-based management (KBM), 20-21Knowledge hierarchy, 20, 20-21 Labor shortages, widespread, 393 Lagging indicators, 85 Late finish date, 115 Layoffs, 393 Leadership, 3; Six Sigma, 226–27; skills, 128 Leading indicators, 86 Lead time, 355 Lean, 25, 37-38, 284, 304, 379, 380, 400; andon, 270, 403; cycle time, 263; development of, 256; five Ss, 264-65, 266, 305, 382, 403;

heijunka, 273–74, 403; human

resources planning and, 392; jidoka, 270, 403; kaizen, 83, 259, 276, 402–3; kaizen event or blitz, 265, 267-69, 305, 403; kanban, 271, 271–72, 272, 362–63, 403; merging of Six Sigma programs and, 274–76, 275; muda, 257; operational excellence and, 405; overview, 255; philosophy of, 257; process improvement and, 305; rapid changeover, 272-73; report evaluation and, 381; service cost optimization and, 377; standardized work, 269-70, 305, 403; successful SCM initiatives and, 365; Takt time, 261, 263, 264, 305, 403; throughput time, 263, 264, 403; tools, 257; value stream mapping, 259–61, 305, 403; waste, types of, 257-58 Lean Production House, 256, 257 Leapfrog Group, 23 Learning/growing perspective, 83 Length of stay (LOS): IT investments and impact on, 284 Lewin, Kurt, 162 Linear optimization problems, 153 Linear programming, 327, 400; example, 153–56 Linear regression, 351. See also Simple linear regression Line graphs, 210, 211 Little's law, 294-95, 338 Litvak, Eugene, 283 Load balancing (or load leveling), 289 Localizing Care to High-Volume Centers (AHRQ), 23 Locke, John, 21, 22

MacColl Center for Health Care Innovation, 51
Machine That Changed the World, The (Womack, Jones, & Roos), 38, 256
Malcolm Baldrige National Quality Award, 36–37, 38, 71–72; criteria,

successful SCM initiatives and, 225, 365 Management: traditional theory of, 73, 73 Management tools: failure of, reasons for, 73–74 Managerial accounting, 393–95; CVP analysis, 394, 395; financial accounting vs., 393; steps in, 394-95 Maps and mapping, 170, 170, 399; functionality, 210-11, 211; value stream, 259-61 Margin, 371 Massachusetts General Hospital: care path for CABG surgery, 270 Mass production, 22-23 Master black belts, Six Sigma infrastructure, 227, 228 Master production scheduling (MPS), 330 Material requirements planning (MRP), 363, *363* Mathematical descriptions of data, 174-78,404 McDonald, Bob, 75 Mean, 174–75 Mean absolute deviation (MAD), 176, 352, 354 Mean square error (MSE), 196, 352, 354 Mean square regression (MSR), 196 Measures of central tendency, 174-75 Measures of variability, 176–78 Median, 175 Medicaid: creation of, 45 Medical home. See also Patientcentered medical home (PCMH): shared savings model and, 379 Medicare: breakeven efforts, Benefits Health System and, 384, 386; bundled payments, 377; creation of, 45; Hospital VBP program, 57; making ends meet on, 370-71; PGP Demonstration Project, 57;

Shared Saving Program, 57; value purchasing, 57 Medicare Payment Advisory Commission (MedPAC), 63, 369–70 Medicare prospective payment, 377 Medication orders, electronic, 348 Meetings, 381 Merit-Based Incentive Payment System (MIPS), 82–83 Metformin, 62 Metrics, 167-68, 399; dashboard visualizations and, 212-13; for evaluating advanced access, 339-40 Microsoft Project software, 27, 108, 115, 117Milestones, 110 Mind mapping, 138, 139, 170, 170, 285, 399 Minnesota State Fair: text mining at, 215–16, 217 Mitigation plan, 120 Mixed block-individual model, 334-35 Mobile applications: primary care and, 6 Mode, 175 Model Hospital Statistical Form, 17 Modularized patient care, 48, 49 Monitoring and response plan, 396 Monte Carlo simulation, 119, 335 Motorola, 225 Muda (waste), 257 Multicare Health System: outcome improvements in pneumonia care at, 45-46 Multiplicative property of probability, 180 Narrow networks: pressure of, 370–71 National Academy of Science, 7 National Committee for Quality Assurance, 4 National Guideline Clearinghouse, 6, 47

National Institutes of Health (NIH), 54,203 National Quality Forum, 4, 55 Network diagrams, 113, 113 Neural networks, 207, 209 New Economics for Industry, Government, Education (Deming), 31 Nightingale, Florence, 17–18 Nonlinear optimization problems, 153 Non-value-added activities: eliminating, 288 Non-value-added-time, 288 Norton, David, 59, 83 No-shows: reducing, 282 Null hypothesis, 188 Number of defects or errors, 288 Observed probability, 178–79 Ohno, Taiichi, 37, 256, 258 100,000 Lives Campaign, 34 Operating expenses: theory of constraints and, 152 Operational excellence: scale for, 405 - 6Operational perspective: performance metrics from, 82 Operational reports, 73, 73 Operations: balanced scorecard and, 75, 75; complex healthcare delivery systems and, 3 Operations improvement tools: cost reduction with, 377 Operations management, 22; defined, 18; effective, framework for, 13; theory of contraints and, 152; value purchasing and, 59 Operations research, 26 Optimal Outpatient Scheduling tool, 335 Optimization, 153 Optum Labs: diabetes example, 62 Ordering (setup) costs, 355 Organizational infrastructure: delivery of care and, 9 Organizational performance indica-

tors, 371

Outcome indicators, 85-86

Outliers, 177–78

Out of the Crisis (Deming), 29

Outsourcing, 364

Overhead costs, 394

Overhead expenses, 380–82; consolidated activities, 381; departmental activities, 382; facility and capital costs, 382; meetings, reports, and automation tools, 381–82; process improvement, 380; reduction in, 372; staffing layers, 381

Parallel processing, 289

Pareto, Vilfredo, 347

Pareto charts and diagrams, 140, *172*, 172–73, *248*, 304, 378, 402, 407; defined, 172; use in quality management and Six Sigma, 232, *232* 

Pareto principle, 32, 172, 347

- Park Nicollet (Minnesota): Lean tools and anticoagulant delivery system at, 255–56
- Patient appointment scheduling models, 334-35

Patient behavior models, 59

Patient care microsystem: elements of, 8

Patient-centered medical home (PCMH), 77; defined, 51; functions and attributes of, 51–53

Patient-Centered Outcomes Research Institute (PCORI): chronic disease management and, 54; mission of, 53

Patient flow, 282; improving, management solutions for, 283–84; IT investments and, 284; poor, causes of, 283

Patient Protection and Affordable Care Act. *See* Affordable Care Act (ACA)

Patient self-service, 291

Patients-in-process, 288

Pay-for-performance (P4P), 24, 57, 393; issues in, 55; methods of, 55;

Vincent Valley Hospital and Health System and, 63–64 Payment reform, 55, 56 p-charts, 233 Percent value added: Lean initiatives and, 260-61, 264 Per diem, 377 Performance drivers, 85-86 Performance improvement: important events in, 19; philosophies, 34-38 Performance metrics, 63 Performance quality, 222 Pharmacogenetics, 6 Physician compensation: value purchasing and, 63 Physician Group Practice Demonstration, 57 PinnacleHealth (Pennsylvania), 348 - 49Plan-do-check-act (PDCA), 28, 29, 35, 137, 229, 267, 281-82 Point-of-use data entry and retrieval, 346 Point-of-use systems, 348 Poka-yoke, 245, 304, 402 Population health, 3, 205; accountability and management, 6; predictive models and, 207 Post-sale service, 81-82 Poudre Valley Health System (PVHS), 71 - 72Practical significance, 191–92 Predictive analytics, 205, 206–7, 209, 214Predictive tools: decision trees, 207, 208; neural networks, 207, 209; regressions, 207 Prescriptive analytics, 209, 214 Prevention quality indicators (PQIs), 49,50 Primary care: redesign of, 6 Principles of Scientific Management (Taylor), 22, 23-24 Probability, 178-85; additive property of, 180–81, 182; bounds on, 179-80; conditional, 182-85;

determination of, 178–79; multiplicative property of, 180; properties of, 179–85 Problem identification tools, 143, 145–53; cause-and-effect diagram, 146, 146–48, 147, 148; failure mode and effects analysis, 149–50; five whys technique, 145–46; rootcause analysis, 143–45; theory of constraints, 150–53 Problem types, 282–83 Process capability, 402; common measures of, 238; Six Sigma limits, 239; Six Sigma quality and, 238 Processes: describing, 285

Process improvement, 81, 137, 281; Lean, 305; overhead expenses and, 380; in practice, 304–18; Six Sigma, 304–5; VVH emergency department project, 305–18, *308*, *310*, *311*, *313*, *315*, *316*, *317*, *318* 

Process improvement, approaches to, 284–92; overview, 284–85; problem definition, 285; process mapping, 285–86, *287*; process measurements, 286–88; tools for process improvement, 288–92

Process improvement tools, 288–92; alternative process flow paths and contingency plans, 289; combine related activities, 289; critical path establishment, 290; eliminate duplicate activities, 288; eliminate non-value-added activities, 288; embedding information feedback and real-time control, 290; ensuring quality at the source, 290; identifying best practices, 291-92; letting patient do the work, 291; load balancing, 289; matching capacity to demand, 290; parallel processing, 289; technology use, 291; theory of constraints application, 291

Process maps and mapping, 139–41, 140, 285–86, 399, 407; creating, steps for, 140–41; cross-functional,

143; defined, 139; service blueprinting, 143, 145; steps in, 286; VVH emergency department example, 286, 287 Process measurements, 286–88 Process owner: identifying, 285 Process performance measures, 141 - 43Process-type cause-and-effect diagrams, 148, 148 Procurement system: contracting, 121–22; selecting a vendor, 122; streamlining processes, 364 Product quality: eight dimensions of, 222 Program evaluation and review technique (PERT), 26, 27, 98, 110, 115 Project charter, 100, 102–5, 108, 400; document elements, 105; factors constraining execution of, 102 Project leadership: skills needed for, 128 Project management, 26–27, 400; agile, 124, 124-25; complete process of, 101; matrix, 102; overview, 97–98; tools, 107–8; when to use, 100 Project Management Book of Knowl*edge*, 98 Project Management Institute (PMI), 98,100 Project management office (PMO), 122 - 23Project management software, 107–8 Project manager, 103, 126, 127 Project plan, 100 Project(s): closure, 123; contracting, 121-22; control, 117-20; crashing, 116; definition of, 99–100; failures, 103; feasibility analysis, 104; with increased performance requirement and shortened schedule, 103; procurement system, 121-22; quality manage-

ment, 120-21; risk management,

118–20; scheduling, 113–16;

selection, 100–101; stakeholders, 103–4; team, 126–28; well-managed, 99–100

Project scope: document, 108–9; mathematic expression of, 102; relationship to performance, level, time, and cost, *103*; statement, 100

Proportions, 190–91

Public health initiatives: text mining applied to, 215–16, *217* Public reporting, 54, 57

*p*-value of statistical significance test, 190

Quality: cost of, 223–25; defining, 222-23; introduction to, 27-34; at the source, ensuring, 290 Quality Assurance Project, 223 Quality bonuses or penalties, 379-80 Quality circles, 37 Quality function deployment (QFD), 81, 240-43, 304, 402; defined, 240; house of quality, 240, 241; **Riverview Clinic diabetes patients** and, 242–43, 243, 244 Quality improvement: slow pace of, 4 - 5Quality management, 120-21 Quality measures: criticism of, 58 Quality tools: additional, in process improvement, 240-45; fundamental, 140 Quality trilogy (Juran), 33 Queue discipline, 293 Queuing priority, 331 Queuing system: simple, 292 Queuing theory, 292–304; defined, 292; discrete event simulation and, 297; notation, 293; solutions, 293-95

Radio-frequency identification (RFID), 346, 348–49 Range, calculating, 176

Range (r) chart, 233 Rapid changeover, 272–73 Rapid process improvement workshop (kaizen event), 83 RASIC (responsible, approval, support, informed, and consult), 112, 112, 117 Rationalism, 21, 22 Real-time control: embedding, 290 Regression, 192, 207 Regression analysis, 378, 405 Regulatory environment: analytics and, 204 Reinforcing feedback, 10, 11 Related activities: combining, 289 Relative frequency, 178–79 Reports, 214; evaluating, 381 Request for information (RFI), 122 Request for proposal (RFP), 122 Resource leveling, 114 Revenue, 371; expenses directly related to, 372, 374; improving, 382-83 Revenue cycle, optimized, 383 Risk adjustment, 54 Risk management, 118–20, 400 Risk mitigation plan, 120, 120 Risk priority number (RPN), 149, 150 Risk register, 120 Riverview Clinic (VVH). See also Vincent Valley Hospital and Health System (VVH): appointment schedule, 335, 336; clinic timing issues and Lean, 263–64, 264; high-level process maps, 140; patient check-in process map, 141; process capability, 238–39; quality function deployment at, 242–43, 243, 244; Six Sigma generic drug project, 245-48, 246, 247, 248, 249; statistical process control, 233, 234, 235, 235-37, 237; urgent care staffing at, 326–30, 327, 328, 329

Robots, 6

Rolled throughput yield (RTY), 239– 40, 240 Root-cause analysis (RCA), 143, 145, 149, 230, 285, 399 Rough-cut capacity planning: defined, 325 Run charts, 140, 232, 232, 304, 378, 396, 396, 402 Safety stock (SS) model: fixed order quantity with, 359-61; service level and, 360, 360; variable demand inventory order cycle with, 359 Scatter plots, 140, 173-74, 174, 212, 232, 232, 304, 378, 402, 407 Schedules and scheduling, 400; advanced-access, 337-41; compression of, 116; job/operational, 330–34; patient appointment models, 334-35; projects, 113-16; staff, 326-30 Scientific management, history of, 22 - 26Scope creep, 103 Scorecards, 213 Second Street Family Practice (Maine): scheduling management, 323 Seiketsu (standardize), 265 Seiri (sort), 265 Seiso (shine), 265 Seiton (set in order), 265 Senge, Peter, 10 Sensitivity analysis, 156–57, 157 Sequencing rules, 331 Service blueprint, 143, 145 Service level, 359 Service lines: growing, 372 Service quality: five dimensions of, 223 Service time, 288 Setup time, 288 Shared savings model, 378–79 Shewhart, Walter, 27-28, 32, 35 Shewhart's rule, 177 Shingo, Shigeo, 37, 272

Shitsuke (sustain), 265 Shortage costs, 355 Shortest processing time (SPT), 331, 332 Shouldice Hospital (Toronto), 23 Simple linear regression, 192–98; assumptions of, 197; coefficients and, 194-96; defined, 192; interpretation of, 193-94; statistical measures of model fit, 196–97; transformations, 197-98 Simple moving average (SMA), 349-50 Simul8, 297 Simulation, 400; appointment scheduling models and rules, 335; discrete event simulation, 297–304; model development, 302; model validation, 302; Monte Carlo method, 297, 335; output analysis, 301; queuing theory, 292–97 Single exponential smoothing (SES), 350 Single-minute exchange of die (SMED), 272, 273, 403 Six Sigma, 25, 35, 38, 225–40, 256, 284, 304, 379, 380, 383, 400; *Clostridium difficile* study, 221–22; culture, 226; defects per million opportunities (DPMOs), 225, 226; define-measure-analyze-improvecontrol (DMAIC) cycle, 225, 229, 229-32, 250, 276; development of, 225; fundamental philosophical tenet of, 229; human resources planning and, 392; infrastructure, 227; leadership, 226–27; merging of Lean and, 274–76, 275; operational excellence and, 405; organizational infrastructure and training, 227-29; primary function of, 304; process capability and, 238-39, 239; process improvement and, 304–5; process metrics, 230–31, 231; program themes, 225–26; quality tools, 232, 232,

304, 401–2, 407; Riverview Clinic generic drug project, 245-49, 246, 247, 248, 249; rolled throughput yield (RTY), 239-40; service cost optimization and, 377; shared savings model and, 378-79; statistical process control (SPC), 233–38; strategy and measurement, 226; successful SCM initiatives and, 365 Slack, 115 Slack time remaining (STR), 331 Smartphones, 204 Smith, Adam, 22, 23 Social media, 382 Solver, 384, 386 Spaghetti diagrams, 265, 267, 305, 403 Special cause, 28–29 Specialization, 22–23 Sputnik launch, 27 Staffing layers, 381 Stakeholders, 103-4 Standard deviation, 177 Standardized work, 269-70, 305, 403 Standard patient care, 48, 48-49 Statement of work (SOW), 121-22 Statistical process control (SPC), 28, 233-37, 402; description of, 233; Riverview Clinic (VVH) vignette, 233, 234, 235, 235–37, 237 Statistical significance, 191–92, 192 Statistical tests, 405 Statistical thinking, 167, 168 Stockouts, 355 Storage space: minimizing, 382 Strategic management systems: balanced scorecards and, 76 Strategic plans, 73, 73 Strategic view, supply chain, 364-65 Strategy execution: challenge of, 72 - 73Strategy maps, 75, 82, 86–89, 87, 88, 92 Strengths, weaknesses, opportunities, and threats (SWOT) analysis, 119 Sum of squares error (SSE), 196 Sum of squares regression (SSR), 196

Supply chain management (SCM), 38-39, 380, 400, 404; defined, 346; demand forecasting, 349–54; importance of, in healthcare, 345; inventory systems, 362–63; inventory tracking, 347-49; order amount and timing, 354–62; overhead expenses, 380-82; procurement and vendor relationship management, 364; strategic view, 364-65 Supply chains, 6 Swim lane process map, 143, 144 SWOT. See Strengths, weaknesses, opportunities, and threats (SWOT) analysis Systems improvement, 281 Systems thinking, 39 Systems view, of provision of services, 20 Tactical plan, 73 Taguchi, Genichi, 243 Taguchi methods, 240, 243-44 Takt time, 261, 263, 264, 305, 403 Taylor, Frederick, 22, 23–25, 26 Teams: meetings and, 127–28; quality bonuses or penalties and, 379–80; structure and authority, 127 Technology: analytics, 205 Telemedicine, 6 Texting, 382 Text mining at the state fair (case example), 215–16, 217 Theoretical probability, 179 Theory of constraints (TOC), 150–53, 284, 295; applying, 291; defined, 150; operations management and, 152; steps for, 150-51,

Theory of swift and even flow (TSEF), 282

400-401

Things-in-process, 288 Throughput: theory of constraints and, 152 Throughput rate, 287

Throughput time, 141, 263, 264, 287, 295, 310, 403 Time-and-materials contract, 121 Time fences, 330 Time series analysis, 349 Time series forecasting, 351 To Err Is Human (IOM), 21, 28 Tool selection: general algorithm, 397-404, 398; analytics, 403; balanced scorecard for strategic issues, 399; basic performance improvement tools, 400-401; holding the gains, 404; issue formulation, 397, 399; Lean, 402–3; project management, 400; quality and Six Sigma, 401–2; strategic or operational issue, 399; supply chain management, 404 Total quality management (TQM), 34, 35, 256 Toyoda, Sakichi, 270 Toyota Group, 270 Toyota Production System (TPS), 37, 135, 256, 258Transformations, 197–98 Tree diagrams, 147–48; additive property of probability, 182; Bayes' theorem example, 185; ED wait time, 184; multiplicative property of probability, 180, 181 Trend-adjusted exponential smoothing technique (Holt), 350–51 Trinity Health (Michigan): supply chain management techniques at, 345 - 46Triple Aim (IHI), 223 t-test, 190, 196–97 Tukey's rule, 178 Two-bin system, 348, 362 Type I ( $\alpha$ ) error: clinic wait time example, 188-89, 189; court system example, 188, 188; defined, 188 Type II ( $\beta$ ) error: clinic wait time example, 188-89, 189; court sys-

For permission, please contact Copyright Clearance Center at www.copyright.com

tem example, 188, *188*; defined,

Understanding: in knowledge hierarchy, 20, 21 UnitedHealth Center for Health Reform & Modernization, 57, 58 United States: opportunities for health system in, 6–8; six aims for health system in, 5, 5; systemic waste and healthcare in, 223-24 US Department of Health and Human Services (HHS), 6, 54 US Navy, 34 Value-added time, 288 Value proposition: customers and, 79-80; defined, 79; Vincent Valley Hospital and Health System and, 80 Value purchasing (or value-based purchasing), 54, 57–59, 82; implications for operations management, 59; Medicare and, 57; physician compensation and, 63; policy issues in, 58 Values-based standardization, 364 Value stream mapping, 259–61, 305, 311, 403 Variable costs, 394 Variance, 176; artificial, 304-5; ubiquity of, 167

Variation: reducing, 282, 401

Vendor relationship management, 364 Venetian Arsenal, 23

- Venn diagram: multiplicative property of probability, 180, *181*
- Veterans Health Administration (Minnesota): sample 5S form, 266
- Vidant Health (North Carolina): Flexwork portal, 369–70
- Vincent Valley Hospital and Health System (VVH), 14. See also Riverview Clinic (VVH); ambulatory care network growth, 409; balanced scorecard, 77; birthing center strategy map, 87; cause-and-effect diagram, 147, 148; census for, 324,

325, 326; CVP analysis of outpatient services at, 394, 395; diaper demand forecasting, 352, 353, 354, 355; diaper order quantity, 358–59, 361, 362; discrete event simulation software example, 297, 298, 299-304, 300, 301, 302, 303; emergency department strategy map, 88; force field analysis, 162–63, 163; improvement projects and associated training, 85; internal business processes, 83; kaizen event, 83, 268–69; laboratory sequencing rules, 332, 332, 333, 334, 334; learning/growing perspective, 83; linear programming example, 153– 56, 154, 156; mission and vision of, 77; operational excellence and, 406–7; pay-for-performance (P4P) and, 63-64; process improvement project: emergency department, 305–18, 308, 310, 311, 313, 315, 316, 317, 318; process mapping emergency department example, 285-86; project charter, 105, 106-7; queuing theory, 295–97; simulation, 297–304; strategy maps, 86–89; value proposition, 80; value stream mapping and birthing center at, 261, 262

Virginia Mason Medical Center: Patient Safety Alert System at, 271 Voice of the customer (VOC), 240 Vorlicky, Loren, 29

Wagner, Edward, 51
Waiting line theory. See Queuing theory
Wait time, 288
Warehouse management, 349
Warfarin, 255
Waste: Lean and types of, 257–58
Web conferences, 381
Weighted moving average (WMA), 350, 354

Wellness, healthy lifestyle and, 8
Winter's triple exponential smoothed model, 351
Wisdom: in knowledge hierarchy, 20, 21
Work-at-home policies, 382
Work breakdown structure (WBS), 109–12, 111, 119, 400; defined, 109; general format for, 109
Work-in-process, 288

Workloads: balancing, 289 World Health Organization (WHO), 167, 168, 255

X-bar chart, 233, 236

Yellow belts, Six Sigma infrastructure, 227, 227

Zika virus, 167