

# Contents

---

*Foreword* (v)

*Preface* (vii)

*About the Author* (ix)

*Acknowledgement* (xi)

*Abbreviations* (xxix)

## CHAPTER 1

### TQM – An Overview

- 1.1 What is Quality? 1
- 1.2 Quality Definitions 2
- 1.3 Quotes on Quality 5
- 1.4 The Scale of Quality 5
- 1.5 The Paradigm of Total Quality Management 6
- 1.6 How can Effective TQM change the Situation? 8
- 1.7 Quality of Design vs. Quality of Conformance 9
- 1.8 Changing Criteria of Quality 9
- 1.9 The 5 Approaches to Quality 10
- 1.10 PDCA Cycle 11
- 1.11 When to Use the PDCA Cycle 12
- 1.12 Variations of PDCA Terminology 13
- 1.13 Deming's Fourteen Points to Improve Quality 13
- 1.14 Deming System of Profound Knowledge 14
- 1.15 Juran Quality Trilogy 15
- 1.16 Some other Related Abbreviations that can be cited here 16
- 1.17 Conclusion 17
- 1.18 Further Reading 17

## CHAPTER 2

### Evolution of TQM

- 2.1 Introduction 18
- 2.2 The Historical Development of TQM 19
  - 2.2.1 Operative Quality Control 19
  - 2.2.2 Foreman Quality Control 19
  - 2.2.3 Inspection Quality Control 19
  - 2.2.4 Statistical Quality Control 21
  - 2.2.5 Total Quality Control 21
- 2.3 Quality Management in Japanese Scenario 22
- 2.4 Post-Deming/Juran Quality Scenario 23
- 2.5 Conclusion 23
- 2.6 Further Reading 24

## CHAPTER 3

### Quality Gurus

- 3.1 Wilfred Pareto 26
- 3.2 Walter A. Shewhart 27
- 3.3 Edwards Deming 27
- 3.4 Joseph Juran 28
- 3.5 Armand Feigenbaum 29
- 3.6 Prasanta Chandra Mahalanobis 30
- 3.7 Shigeo Shingo 31
- 3.8 Taichi Ohno 31
- 3.9 Kaoru Ishikawa 31
- 3.10 Genichi Taguchi 32
- 3.11 Phillip Crosby 33
- 3.12 Yoshio Kondo 35
- 3.13 Shigeru Mizuno 36
- 3.14 Yoji Akao 36
- 3.15 Noriaki Kano 36
- 3.16 Masaaki Imai 37
- 3.17 Claus Moller 37
- 3.18 Blanton Godfrey 37



- 
- 6.7 Environment 75
  - 6.8 Open and Closed Systems 75
  - 6.9 Systems and Subsystems 76
  - 6.10 Relationship between the Systems and Subsystems 77
  - 6.11 Combination of Subsystems 78
  - 6.12 The Management Cube 79
  - 6.13 Planning Pyramid 79
  - 6.14 Decision Theory 80
  - 6.15 Problem Analysis vs. Decision Making 81
  - 6.16 Characteristics of Decision Making 82
  - 6.17 Situations under which Decisions are taken 82
  - 6.18 Classification of Decisions 83
  - 6.19 Different Approaches to Decision Making 84
  - 6.20 Bias in Decision Making 85
  - 6.21 Decision Tree 87
  - 6.22 Systematic Decision Making 88
  - 6.23 Information Flow 88
  - 6.24 Summary of the Features of Management as a System 88
  - 6.25 Conclusion 89
  - 6.26 Further Reading 90
- CHAPTER 7**
- Strategic Planning**
- 7.1 Introduction 91
  - 7.2 Business Plans 92
  - 7.3 Strategic Planning 93
  - 7.4 Methodologies for Strategic Planning 93
  - 7.5 Situational Analysis 94
  - 7.6 Hoshin Kanri (方針転換) 95
    - 7.6.1 Nichijo Kanri 95
  - 7.7 Definitions of Strategic Planning 95
  - 7.8 Strategic Planning Elements 97
  - 7.9 Besterfield's Seven Steps of Strategic Planning 98
  - 7.10 Strategy Development and Strategy Deployment 98
  - 7.11 Effectiveness of the Strategic Planning 99
  - 7.12 The Four Perspectives for Translating Strategy into Operating Process 99
  - 7.13 Quality Planning 99
  - 7.14 Contingency Theory 101
  - 7.15 Organizing for Strategic Planning 102
  - 7.16 Leavitt's Diamond 102
  - 7.17 Mission and Vision Statements 104
  - 7.18 Caution in Application of Strategic Planning 105
  - 7.19 Conclusion 105
  - 7.20 Further Reading 105
- CHAPTER 8**
- Cost of Quality**
- 8.1 Introduction 107
  - 8.2 Forces Leading to the Concept 108
  - 8.3 The Categories of Quality Costs 108
  - 8.4 Hidden Quality Costs 111
  - 8.5 Cost of Lost Opportunities 112
  - 8.6 Service Costs 112
  - 8.7 Tangible and Intangible Costs 112
  - 8.8 Visible Costs and Invisible Costs 113
  - 8.9 Quality Cost Data 113
  - 8.10 Case Studies on Research done in the Area of Quality Costing 114
  - 8.11 Suggested Model for Quality Costing 115
  - 8.12 Sources for Collecting Quality Cost Data 115

8.13	Uses of Quality Cost Analysis	116	10.4	Customer's Perception of Quality	136
8.14	Pareto Principle	116	10.5	Types of Customers	137
8.15	Quality Conformance Level	117	10.6	Internal Customers	138
8.16	Top Management Role in containing Quality Costs	117	10.7	Customer Satisfaction	140
8.17	Quality and Safety	118	10.8	Customer Delight	141
8.18	Responsibility of Top Management for Product Safety	119	10.9	Kano Model of Customer Satisfaction	141
8.19	Case Study on Quality Cost	119	10.10	American Customer Satisfaction Index	142
8.20	Conclusion	120	10.11	Customer Retention	143
8.21	Further Reading	120	10.11.1	Tips for Customer Retention	143
			10.11.2	Profitability Associated with Customer Retention	144
			10.12	Customer Loyalty	144
			10.13	Factors for Establishing Loyal Customers	146
			10.14	Customer Attrition	146
			10.15	How Companies Lose their Customers	146
			10.16	Customer Surveys	146
			10.17	Customer and Quality Service	147
			10.18	The Key Elements of Service Quality	148
			10.19	Customer Retention vs. Employee Morale	149
			10.20	Action to be taken to Handle Customer Complaints	149
			10.21	Healthy Practices by Customer Focused Organizations	150
			10.22	Customer Code of Ethics to be Followed	150
			10.23	Recently held International Quality Symposia	151
			10.24	Conclusion	151
			10.25	Further Reading	152
<b>CHAPTER 9</b>					
<b>Organisation for TQM</b>					
9.1	Why Organization?	122			
9.2	What are to be Organized in the Quality Function?	123			
9.3	Principles of Organization	123			
9.4	Classes of Organizational Structures	125			
9.5	Organization for the Quality Function	128			
9.6	Centralised Organization	128			
9.7	Decentralized Organization	129			
9.8	Matrix Type of Organization	130			
9.9	Factors shall be Considered for Deciding the Manpower Requirement	132			
9.10	Size and Type of an Organization	132			
9.11	Conclusion	132			
9.12	Further Reading	133			
<b>CHAPTER 10</b>					
<b>Customer Satisfaction</b>					
10.1	Sellers' Market vs. Buyers' Market	134			
10.2	Customer is the King	135			
10.3	Position of the Customer in an Organization	136			

**CHAPTER 11****Total Employee Involvement**

- 11.1 What is Total Employee Involvement? 154
- 11.2 Motivation 155
  - 11.2.1 Theory X and Theory Y 155
  - 11.2.2 Maslow's Theory of Hierarchy of Basic Needs 156
  - 11.2.3 Herzberg's Two Factor Theory 157
  - 11.2.4 Achieving a Motivated Workforce 157
- 11.3 Employee Involvement Strategies 158
- 11.4 Teamwork 159
  - 11.4.1 The Three Elements of Teamwork 159
  - 11.4.2 Categories of Teams based on Natural Work Units 160
  - 11.4.3 The Basic Functions of the Team 161
  - 11.4.4 Characteristics of Successful Teams 161
  - 11.4.5 Some Nicknames for the Non Conducive Team Members 162
- 11.5 Empowerment 163
  - 11.5.1 Types of Supervisors as per Harvard Business School Study 163
- 11.6 Participative Management 164
  - 11.6.1 Resistance to Change 164
  - 11.6.2 Types of Changes that usually meet Resistance 164
  - 11.6.3 Reasons for Resistance 165
  - 11.6.4 Some Criticisms Encountered by Industrial Engineers from Higher-Ups 166
- 11.7 Effect of Worker Representation on Productivity 166
- 11.8 How to Successfully Implement a Change 167
- 11.9 Theodore Kinni's 8 Tips for Achieving Motivated Workforce 167
- 11.10 Benefits of Employee Involvement 168
- 11.11 Role of Senior Management in Employee Involvement 169
- 11.12 Recognition and Rewards 170
- 11.13 Forms of Recognition and Rewards 170
- 11.14 Criteria for Effective Recognition of Employees 171
- 11.15 Advantages of Effective Rewarding Systems 171
- 11.16 Conclusion 172
- 11.17 Further Reading 172

**CHAPTER 12****Supplier Partnership**

- 12.1 Introduction 175
- 12.2 Traditional vs. TQM Oriented Vendor Relations 176
- 12.3 Partnership Definition 177
- 12.4 Strategic Partnership 177
- 12.5 Principles of Customer/Supplier Relations 178
- 12.6 The Three Primary and Necessary Requirements for Partnering 179
- 12.7 Multiple Supplier Partnership 180
- 12.8 Advantages of Supplier Partnership 180
- 12.9 Supplier Selection 180
- 12.10 Vendor Rating 182
- 12.11 Criteria for Evaluation 182
- 12.12 The Partnership Indices 184
- 12.13 Supplier Certification 185

- 12.14 Benefits of Supplier Rating 186
- 12.15 Lean Inspection through  
Supplier Partnership 186
- 12.16 Vendor Managed Inventory 186
- 12.17 Retailer Supplier Partnership 187
- 12.18 Impact of Supplier Partnership  
on Inventory Norms 187
- 12.19 Conclusion 188
- 12.20 Further Reading 188

### **CHAPTER 13**

#### **Total Productive Maintenance**

- 13.1 Introduction 190
- 13.2 The Meaning of TPM 191
- 13.3 Evolution of TPM 192
- 13.4 Definitions of TPM 192
- 13.5 TPM is an Extension of TQM 193
- 13.6 TPM Starts with Cleaning 194
- 13.7 The Seven Types of  
Abnormalities 195
- 13.8 The Eight Pillars of TPM 197
- 13.9 The Five Zeros of TPM 197
- 13.10 Why Operatives Fail to Adapt  
TPM as a Way of Life? 198
- 13.11 What can TPM Achieve? 199
- 13.12 Overall Equipment  
Effectiveness (OEE) 199
- 13.13 The Six Losses from Poor OEE 200
- 13.14 The Three Levels of Autonomous  
Maintenance in TPM 201
- 13.15 The Five Goals of TPM 201
- 13.16 Procedure for the Implementation  
of TPM 203
- 13.17 Maintenance Work Sampling 204
- 13.18 Conclusion 204
- 13.19 Further Reading 204

### **CHAPTER 14**

#### **Quality Awards**

- 14.1 Why Quality Awards? 209
- 14.2 International Quality Awards 210
- 14.3 International Quality  
Award Trio 212
- 14.4 Deming Application Prize 212
  - 14.4.1 Qualifications and Criteria  
Specified by JUSE for the  
Deming Prize 212
  - 14.4.2 Check List for Deming  
Application Prize 213
- 14.5 Malcolm Baldrige National  
Quality Award 216
  - 14.5.1 Criteria for the Performance  
Excellence Framework 216
  - 14.5.2 Organizations/Individuals  
Involved in the  
Awarding Process 218
- 14.6 European Quality Prizes 219
  - 14.6.1 Categories of the  
Award 220
- 14.7 Australian Business  
Excellence Award 221
- 14.8 Canadian Award for  
Business Excellence (CABE) 221
- 14.9 Rajiv Gandhi National  
Quality Award 221
  - 14.9.1 Assessment Criteria 222
  - 14.9.2 Eligibility of Organizations  
for this Award 223
- 14.10 Golden Peacock National  
Quality Award 223
- 14.11 IMC-Ramakrishna Bajaj  
National Quality Award (IMCRBNQA) 224
- 14.12 China Quality Award 224

- 
- 14.13 National Quality/Business Excellence Awards in different Countries 224
- 14.14 Basic Differences among the Award Trio 225
- 14.15 Conclusion 225
- 14.16 Further Reading 225
- CHAPTER 15**  
**Quality Circles**
- 15.1 What is a Quality Circle? 233
- 15.2 Origin of Quality Circles 234
- 15.3 The American Scenario 234
- 15.4 The Indian Scenario 235
- 15.5 Significance of Quality Circles 235
- 15.6 Objectives of Quality Circles 235
- 15.7 Nature of problems that can be Solved by Quality Circles 236
- 15.8 Ten Conditions for Successful Quality Circles 236
- 15.9 Road Map to be followed in a Quality Circle Meeting 237
- 15.10 Characteristics of an Effective Quality Circle Meeting 237
- 15.11 Structure of a Quality Circle 238
- 15.12 Conclusion 239
- CHAPTER 16**  
**Fundamentals of Statistics – Part I**
- 16.1 Definition of Statistics 240
- 16.2 Role of Statistics in Analysis 241
- 16.3 Limitation of Statistics 241
- 16.4 Elements of Statistical Techniques 242
- 16.5 Methods of Collecting Data 242
- 16.6 Data Classification 243
- 16.7 Data Presentation 243
- 16.8 Population vs. Sample 244
- 16.8.1 Population 244
- 16.8.2 Sample 245
- 16.9 Attributes and Variables 245
- 16.10 Graphs 245
- 16.10.1 Principles of Graph Construction 245
- 16.10.2 Class Interval 246
- 16.10.3 Class Limits 246
- 16.10.4 Class Mark 246
- 16.11 Single Dimensional Diagrams – Bar Charts 246
- 16.11.1 Simple Bar Charts 246
- 16.11.2 Component Bar Charts 247
- 16.11.3 Percentage Component Bar Chart 247
- 16.11.4 Multiple Bar Charts 247
- 16.11.5 Dimensional Diagrams 248
- 16.11.6 Pie Diagrams 248
- 16.11.7 Doughnut Diagrams 250
- 16.11.8 Pictograms 250
- 16.12 Innovative Graphs 251
- 16.13 Frequency Graphs 251
- 16.13.1 Histograms 251
- 16.13.2 Frequency Polygon 252
- 16.13.3 Frequency Curve 252
- 16.14 Ogive 252
- 16.15 ‘Z’ Chart 252
- 16.16 Lorenz Curves 254
- 16.16.1 Application of Lorenz Curves 255
- 16.17 Frequency Distribution 255
- 16.18 Central Tendency 256
- 16.19 Measures of Central Tendency 257
- 16.20 Mean or an Average 258
- 16.21 Arithmetic Mean 258
- 16.21.1 Characteristics of Arithmetic Mean 258

- 
- 16.21.2 Advantages of Arithmetic Mean 259
  - 16.21.3 Disadvantages of Arithmetic Mean 259
  - 16.22 Geometric Mean, Quadratic Mean and Harmonic Mean 259
  - 16.23 Median 260
    - 16.23.1 Definition 260
    - 16.23.2 Calculation from Ungrouped Data 260
    - 16.23.3 Calculation from Grouped Data 260
    - 16.23.4 Characteristics of Median 260
    - 16.23.5 Advantages of Median 261
    - 16.23.6 Disadvantages of Median 261
  - 16.24 Mode 261
    - 16.24.1 Definition 261
    - 16.24.2 Characteristics of Mode 261
    - 16.24.3 Advantages of Mode 261
    - 16.24.4 Disadvantages of Mode 262
  - 16.25 Dispersion 262
  - 16.26 Range 262
    - 16.26.1 Characteristics of Range 262
  - 16.27 Mean Deviation 262
    - 16.27.1 Characteristics of Mean Deviation 263
    - 16.27.2 Computation of Mean Deviation 263
  - 16.28 Standard Deviation 263
    - 16.28.1 Computation of  $\sigma$  from Ungrouped Data 264
    - 16.28.2 Computation of  $\sigma$  from Grouped Data 264
    - 16.28.3 Characteristics of Standard Deviation 264
  - 16.29 Skewness 265
  - 16.30 Kurtosis 265
  - 16.31 Conclusion 266
  - 16.32 Further Reading 266
- CHAPTER 17**  
**Fundamentals of Statistics – Part II**
- 17.1 Correlation 267
    - 17.1.1 Scatter Diagram 268
    - 17.1.2 Coefficient of Correlation 269
    - 17.1.3 Types of Correlation 269
  - 17.2 Regression 270
  - 17.3 Relation between Correlation and Regression 272
  - 17.4 Sampling Theory 272
    - 17.4.1 Introduction 272
    - 17.4.2 Random Number Tables 273
    - 17.4.3 The Sampling Process 273
    - 17.4.4 Sampling Methods 273
    - 17.4.5 Factors for Selection 275
    - 17.4.6 Frequency of Sampling 275
    - 17.4.7 Estimating the Sample Size 275
    - 17.4.8 Factors that Influence the Sample Size Include 276
  - 17.5 Probability 276
  - 17.6 Laws of Probability 277
    - 17.6.1 The Law of Addition 277
    - 17.6.2 Mutually Exclusive vs. Mutually Non-Exclusive 277
    - 17.6.3 Law of Multiplication 278
    - 17.6.4 Law of Conditional Probability 278
  - 17.7 Conclusion 278
  - 17.8 Further Reading 278
- Chapter 18**  
**Process Capability**
- 18.1 Statistical Process Control 280

- 
- 18.2 Why Control Charts? 281
  - 18.3 Reasons for Variations 281
  - 18.4 Process Capability 282
  - 18.5 Process Capability Index 282
  - 18.6 One Sided and Two Sided Specifications 282
  - 18.7 Taguchi Capability Index 283
  - 18.8 Recommended Minimum Values of  $C_{pk}$  283
  - 18.9 Conclusion 284
  - 18.10 Further Reading 284
- Chapter 19**  
**Inward Inspection**
- 19.1 Definitions of Inspection 286
  - 19.2 Objectives of Inspection 286
  - 19.3 Steps Involved in Inspection 286
  - 19.4 Classifications of Inspection Methods 287
  - 19.5 Source Inspection 288
  - 19.6 Inward Inspection 289
  - 19.7 Single and Double Sampling Inspection 290
  - 19.8 In Process Inspection and Final Inspection 291
  - 19.9 Tools of Inspection 293
  - 19.10 Normal Jobs of a Quality Control Inspector 294
  - 19.11 Requirements of an Inspector 294
  - 19.12 Conclusion 295
  - 19.13 Further Reading 295
- Chapter 20**  
**Seven Traditional Tools of TQM**
- 20.1 Introduction 296
  - 20.2 Check Sheets and Checklists 297
  - 20.3 Histogram or Bar Graph 302
  - 20.4 Scatter Diagram 303
  - 20.5 Control Chart 304
  - 20.6 Pareto Principle 305
  - 20.7 Cause and Effect Diagram 306
    - 20.7.1 Categories of Cause and Effect Diagrams 307
    - 20.7.2 Basic Illustrations of Cause and Effect Diagrams 308
  - 20.8 Flow Charts 309
    - 20.8.1 Symbols used in Flow Charts 309
    - 20.8.2 The Benefits for Process Flowchart 311
    - 20.8.3 Operation Process Chart 311
    - 20.8.4 Flow Diagram 312
  - 20.9 Conclusion 312
  - 20.10 Further Reading 313
- Chapter 21**  
**The Seven Modern Tools of TQM**
- 21.1 The Seven Traditional Tools of TQM 320
  - 21.2 The Seven Modern TQM Tools 321
  - 21.3 Affinity Diagram (KJ Method) 321
    - 21.3.1 Guidelines 322
    - 21.3.2 How to Conduct an Affinity Sort 322
    - 21.3.3 Checklist 323
  - 21.4 Interrelationship Digraph (ID) 323
    - 21.4.1 Objectives of the Interrelationship Digraph 324
    - 21.4.2 Procedure for Constructing an Interrelationship Digraph 324
  - 21.5 Tree Diagram 325
    - 21.5.1 Event Tree Analysis 326
    - 21.5.2 Fault Tree Analysis 326
  - 21.6 Prioritization Matrix 327
    - 21.6.1 Simple Prioritization Matrix vs. Weighted Prioritization Matrix 328

21.6.2	When to use a Prioritization Matrix 328	22.2	Significance of Kaizen in Continuous Improvement 345
21.6.3	The 4 Basic Steps Involved in Creating a Prioritization Matrix 329	22.3	Why Continuous Improvement? 345
21.6.4	Symbols used in the Prioritization Matrix 329	22.4	Some Illustrations of the Continuous Process Improvements 347
21.6.5	WSA's 6 Step Detailed Procedure to Create a Prioritization Matrix 330	22.5	Kaizen is the Umbrella 348
21.7	Process Decision Program Chart (PDPC) 333	22.6	Requirement's for Continuous Improvement 348
21.7.1	Steps in Drawing a PDPC 335	22.7	Industrial Engineering Principles vs. Kaizen Principles 349
21.8	Activity Network Diagram 335	22.8	Importance of Creativity 349
21.9	Single Minute Exchange of Dies 336	22.9	Creative Methodology 351
21.9.1	The Factors to be Borne in Mind before Working for SMED 337	22.10	The Principles of Creativity 351
21.9.2	Internal and External Activities 338	22.10.1	Divide and Conquer 351
21.9.3	Factors Stressed upon by Shigeo Shingo, the Originator of SMED 338	22.10.2	Set Quotas and Deadlines for Yourself 351
21.9.4	Benefits of SMED per Shigeo Shingo 338	22.10.3	Let Loose Your Mind 351
21.10	Force Field Analysis 339	22.10.4	Blue Sky Thinking 352
21.11	Criteria Rating Form 340	22.10.5	Two Heads are Better than One 352
21.12	Models that can be used to Represent a Problem 341	22.10.6	Question Each and Every Detail 352
21.13	Other Analytical Testing Methods for Safety 342	22.11	Brain Storming 353
21.14	Conclusion 343	22.11.1	When to use Brainstorming 354
21.15	Further Reading 343	22.11.2	Freewheeling vs. Round Robin 354
		22.11.3	Techniques of Brainstorming 354
		22.12	Six Thinking Hats 355
		22.13	Primary and Secondary Questions 356
		22.14	Develop 356
		22.15	Define 359
		22.16	Install 359
		22.17	Maintain 360
<b>Chapter 22</b>			
<b>Kaizen and Continuous Improvement</b>			
22.1	What is Kaizen? 344		

- 22.18 Checklist for Operation Examination 361
- 22.19 Other Continuous Improvement Techniques 363
- 22.20 Case Studies on Kaizen Applications 363
- 22.21 Some Quotations on Change 365
- 22.22 Conclusion 365
- 22.23 Further Reading 365

## CHAPTER 23

### 5 S

- 23.1 Introduction 367
- 23.2 Explanation of the 5S's 368
  - 23.2.1 Seiri (Structurise - Distinguish between the necessary and the unnecessary - Adopt Red tagging) 368
  - 23.2.2 Seiton - Systemize – (or PEEP, A Place for Everything and Everything in its Place) 370
  - 23.2.3 Seiso (Shine, Sweep or Sanitize – Look for Ways to Keep the Workplace Neat) 371
  - 23.2.4 Seiketsu (Standardize – Keep the Workplace as per the Established Standards) 372
  - 23.2.5 Shitsuke (Sustain the 5S Practices by Work Discipline – Follow the Rules) 375
  - 23.2.6 Significance of Shitsuke in 5S 376
- 23.3 9 Step Procedure for Implementing 5S 376
- 23.4 5S Audit Sheet 376
- 23.5 An Easy Way of Remembering the 5S Terms 378
- 23.6 Conclusion 379
- 23.7 Further Reading 380

## CHAPTER 24

### Six Sigma

- 24.1 Introduction 381
- 24.2 Definitions of Six Sigma 382
- 24.3 History of Six Sigma 383
- 24.4 Required Skills for Black Belted Experts in Six Sigma 383
- 24.5 The Concept of Six Sigma in the Context of TQM 384
- 24.6 Origin of this Confusion between Statistical  $6\sigma$  and TQM Six Sigma 385
- 24.7 Six Sigma According to General Electric 387
- 24.8 The Values of the Defect Percentages 387
- 24.9 Methodologies for Six Sigma 389
- 24.10 DMAIC Methodology for Six Sigma 389
- 24.11 DMADV 389
- 24.12 Detailed Methodology of DMAIC 390
  - 24.12.1 Define 390
  - 24.12.2 Measure 390
  - 24.12.3 Analyze 391
  - 24.12.4 Improve 392
  - 24.12.5 Control 392
- 24.13 Organizing for Six Sigma 393
- 24.14 Software used for Six Sigma 394
- 24.15 The Case Study of Mumbai Dabbawalas 394
- 24.16 Conclusion 396
- 24.17 Further Reading 396

## CHAPTER 25

### Terminology used in Japanese Management Practices

- 25.1 Introduction 397
- 25.2 Some of the Terminologies Cited in this Chapter 398

- 
- 25.3 History of Development of Japanese Management Practices 399
  - 25.4 Quality Circles 399
  - 25.5 Kaizen 400
  - 25.6 Genchi Genbutsu 400
  - 25.7 Monozukuri and Hitozukuri 400
  - 25.8 Nemawashi 400
  - 25.9 Heijunka 400
  - 25.10 3 Mu Checklists 401
  - 25.11 Four Wives and One Husband 401
  - 25.12 CREW 402
  - 25.13 5 Management Objectives of Factory Management 403
  - 25.14 5 Zu's 403
  - 25.15 Poka Yoke 403
  - 25.16 Andon and Hanedashi 404
  - 25.17 Jidhoka 404
  - 25.18 Chaku Chaku 404
  - 25.19 5 S 404
  - 25.20 Six Sigma 404
  - 25.21 Gemba Walk 405
  - 25.22 Warusa Kagen 405
  - 25.23 Single Minute Exchange of Dies 405
  - 25.24 Just in Time 406
  - 25.25 Kanban 406
  - 25.26 Hoshin Kanri 407
  - 25.27 Nichijo Kanri 407
  - 25.28 Kata 408
  - 25.29 Total Productive Maintenance 408
  - 25.30 Pecha-kucha 408
  - 25.31 Dakara Nani 409
  - 25.32 Kanso, Shizen and Shibumi 409
  - 25.33 Okya Kusoma 409
  - 25.34 Conclusion 409
  - 25.35 Further Reading 410
- CHAPTER 26**  
**Failure Modes and Effects Analysis**
- 26.1 Uncertainties during Development 411
  - 26.2 Failure Modes and Effects Analysis 412
  - 26.3 History of Development of FMEA 412
  - 26.4 Multiple Causes and Effects involved in FMEA 413
  - 26.5 Types of FMEA's 414
  - 26.6 When to use FMEA 415
  - 26.7 Basic Terms of Reference in FMEA 415
    - 26.7.1 Failure Mode 415
    - 26.7.2 Failure Cause 416
    - 26.7.3 Failure Effect 416
    - 26.7.4 Severity Factor 417
    - 26.7.5 Probability of Occurrence 418
    - 26.7.6 Ease of Detection 419
  - 26.8 Risk Priority Number 420
  - 26.9 Procedure for FMEA 421
  - 26.10 Responsibility for Action 426
  - 26.11 Benefits of FMEA 426
  - 26.12 FMEA Software 428
  - 26.13 Conclusion 429
  - 26.14 Further Reading 429
- CHAPTER 27**  
**Reliability Engineering**
- 27.1 Functional Reliability 431
  - 27.2 General causes for Poor Reliability 432
  - 27.3 Distinguishing between Quality and Reliability 432
  - 27.4 What is RBM? 433
  - 27.5 Bath Tub Characteristics 433
  - 27.6 Basics of RBM 435
  - 27.7 Principles of Reliability Engineering 436

- 27.8 House of Reliability 436
- 27.9 Types of Failures 437
- 27.10 Severity of Failures 438
- 27.11 Statistical Distribution
  - Curves of Failures 438
- 27.12 Probability Density Function 440
- 27.13 Procedure of Establishing
  - Reliability based Product Quality 441
- 27.14 Reliability Prediction 442
  - 27.14.1 Ingredients for
    - Reliability Prediction 442
  - 27.14.2 Purposes of
    - Reliability Prediction 442
- 27.15 Monte Carlo Simulation 443
- 27.16 Markov Analysis 444
- 27.17 Conclusion 444
- 27.18 Further Reading 445

## **Chapter 28**

### **Business Process Reengineering**

- 28.1 History of Business
  - Process Reengineering 446
- 28.2 Definitions of Business Process
  - Reengineering (BPR) 447
- 28.3 Business Process Reengineering
  - as a TQM Technique 448
- 28.4 The Role of
  - Information Technology 449
- 28.5 Methodology for BPR 450
- 28.6 Process Reengineering
  - Life Cycle Approach for BPR 452
- 28.7 Criticism against BPR 453
- 28.8 Satisfactory Underperformance 453
- 28.9 The Sweet and Sour Cycle 455
- 28.10 Business Process
  - Management (BPM) 455
- 28.11 Conclusion 456
- 28.12 Further Reading 456

## **CHAPTER 29**

### **Benchmarking**

- 29.1 What is Benchmarking? 457
- 29.2 Definitions for Benchmarking 457
- 29.3 Types of Benchmarking 458
- 29.4 Some of the Parameters that
  - can be Benchmarked 460
- 29.5 General Concept of Benchmarking 460
- 29.6 Phases of Benchmarking 461
- 29.7 Stage of Benchmarking 462
- 29.8 Different approaches
  - to Benchmarking 463
- 29.9 Tips for the Consultants 464
- 29.10 Costs of Benchmarking 465
- 29.11 Advantages of Benchmarking 465
- 29.12 Limitations of Benchmarking 466
- 29.13 Professional Associations and
  - Institutions Exclusively
    - for Benchmarking 466
- 29.14 Conclusion 466
- 29.15 Further Reading 467

## **Chapter 30**

### **Quality Function Deployment**

- 30.1 Why Quality
  - Function Deployment? 469
- 30.2 Definitions of QFD 470
- 30.3 History of QFD 471
- 30.4 Issues that would be
  - addressed by QFD 473
- 30.5 The 4 Phases of QFD 474
- 30.6 Building a House of Quality 476
- 30.7 Voice of the Customer (VOC) 476
  - 30.7.1 How to get Information
    - from the Customers? 477
- 30.8 Voice of the Organization (VOO) 478
- 30.9 Framework for House of Quality 479

- 30.10 Building up of House of Quality 479
- 30.11 Procedure for QFD 481
- 30.12 Benefits of QFD 481
- 30.13 Conclusion 482
- 30.14 Further Reading 483

## Chapter 31

### Quality Loss Function

- 31.1 What is Quality Loss? 484
- 31.2 Precision vs. Accuracy 485
- 31.3 History of the Development of the Concept of the Loss Function 486
- 31.4 Taguchi Philosophy 487
- 31.5 Quality Loss Function 487
- 31.6 Off-line Quality Control Rule for Manufacturing 488
- 31.7 Design of Experiments 489
  - 31.7.1 Outer Arrays 489
  - 31.7.2 Management of Interactions 489
- 31.8 Robustification 489
- 31.9 Noise Variables 489
- 31.10 Case Study 490
- 31.11 Conclusion 490
- 31.12 Further Reading 490

## Chapter 32

### Design for Quality

- 32.1 Design for Quality 492
- 32.2 Design for Six Sigma 494
- 32.3 Acronyms for Methodologies Akin to DMAIC 495
- 32.4 DMADV 495
  - 32.4.1 Define Phase 496
  - 32.4.2 Measure Phase 496
  - 32.4.3 Analyze Phase 496
  - 32.4.4 Design Phase 496
  - 32.4.5 Verify Phase 496
- 32.5 Scope of DFSS 497

- 32.6 Six Sigma vs Design for Six Sigma 498
- 32.7 Benefits of DFSS 498
- 32.8 Conclusion 498
- 32.9 Further Reading 499

## Chapter 33

### Value Engineering

- 33.1 What is Value Engineering? 500
- 33.2 Definitions of Value Engineering 501
- 33.3 History of Value Engineering 502
- 33.4 What is Value? 502
- 33.5 Value Analysis 503
- 33.6 Objectives of Value Engineering 503
- 33.7 Typical Benefits of Value Engineering Projects 504
- 33.8 Functions of a Product as the Customer wants it 504
- 33.9 Functional Value of a Product vs Other Values 505
- 33.10 Methodology of Value Engineering 505
  - 33.10.1 General Phase 505
  - 33.10.2 Information Phase 506
  - 33.10.3 Function Phase 506
  - 33.10.4 Investigation and Creative Phases 507
  - 33.10.5 Evaluation Phase 507
  - 33.10.6 Recommendation and Follow-up Phases 507
  - 33.10.7 DARSIRI Methodology for Value Analysis 508
- 33.11 Function Analysis System Technique (FAST) 508
- 33.12 Case Study 508
- 33.13 Conclusion 515
- 33.14 Further Reading 515

## Chapter 34

### ISO 9000 Quality Systems

- 34.1 Need for Quality Management Systems 517

---

34.2	International Organization for Standardization	518
34.3	ISO 9000 Series of Quality Standards	518
34.4	Evolution of ISO 9000 Family of Standards	518
34.5	ISO/TS16949	519
34.6	QS-9000 Series	520
34.7	Requirements as Specified by ISO 9000	521
34.8	Bureau of Indian Standards	523
34.9	SOP - Standard Operating Procedures	523
34.10	Specific Features of ISO 9004	524
34.11	Steps to be followed for getting ISO Certification	525
34.12	Benefits of ISO 9001-2000 & TS 16949 Quality Systems	525
34.13	ISO 9000:2005	526
34.14	2015 Revision of ISO 9000 Series	526
34.15	The Six Stages of the Release of the 2015 Revision	527
34.16	Revision of ISO 9000 in 2015	527
34.17	Conclusion	528
34.18	Further Reading	529
<b>Chapter 35</b>		
<b>ISO 14000 Quality Systems</b>		
35.1	Introduction	530
35.2	Evolution of the ISO Standards on Environmental Issues	531
35.3	Global Environmental Issues	532
35.4	Magna Carta on Environment	533
35.5	International Initiatives on Environmental Issues	533
35.6	Evolution of ISO 14000 Series	534
35.6.1	Formation of TC207	535
35.6.2	What is ISO 14001?	536
35.7	Water Footprint	536
35.8	The Benefits of ISO 14000	537
35.9	Engineer's Role in Environment Protection	538
35.10	Principles of Green Design	539
35.11	Basic Approaches for Resolving Environmental Problems	539
35.12	Guidelines for Social Responsibility	540
35.13	5 R's of Wastage Utilization	540
35.14	Conclusion	542
35.15	Further Reading	542
<b>Annexure – I 543</b>		
<b>Bibliography 563</b>		
<b>Index 569</b>		