
Contents

Preface.....	xiii
About the Author	xv

Section I Why Lean Six Sigma?

1. Definition and Motivation for Lean Six Sigma	3
1.1 Introduction	3
1.2 Definitions.....	5
1.2.1 Acronyms and Symbolism	7
1.2.2 Units.....	9
1.3 System Approach to Lean Six Sigma Implementation	10
References	13
2. History and Fundamentals	15
2.1 Introduction	15
2.2 Brief History of Lean Six Sigma.....	15
2.2.1 Industrial Revolution (1760s).....	15
2.2.2 Scientific Management (1890–1940)	16
2.2.3 Toyota Production System/Lean Manufacturing (1945–1950).....	16
2.2.4 Information Revolution (1950–1980).....	17
2.2.5 Total Quality Management (1950–1985).....	17
2.2.6 ISO 9000 (1985 and Beyond)	17
2.2.7 Six Sigma (1990 and Beyond).....	18
2.2.8 Lean Six Sigma (2005 and Beyond).....	18
2.3 Quality and Lean Leaders	19
2.3.1 Fredrick Winslow Taylor (1856–1915).....	19
2.3.2 Henry Ford (1863–1947).....	19
2.3.3 W. Edwards Deming (1900–1993).....	20
2.3.4 Joseph M. Juran (1904–2008)	20
2.3.5 Kiichiro Toyoda (1894–1952)	20
2.3.6 Philip B. Crosby (1926–2004)	21
2.3.7 Armand V. Feigenbaum (1922–2014).....	21
2.3.8 Kaoru Ishikawa (1915–1989).....	21
2.3.9 Genichi Taguchi (1924–2012)	21
2.3.10 Mikel Harry (1955–).....	22
2.4 Quality Standards and Systems.....	22
2.4.1 ISO 9001	22
2.4.2 QS 9000.....	23
2.4.3 ISO 14000.....	23

2.5	Relevant Organizations and Individual Certifications	23
2.5.1	American Society for Quality (ASQ)	23
2.5.2	Society of Manufacturing Engineers (SME)	26
2.5.3	Institute of Industrial Engineers (IIE).....	27
2.6	Quality and Lean Awards	28
2.6.1	Malcolm Baldrige National Quality Award.....	28
2.6.2	Eli Whitney Productivity Award.....	28
2.7	Relevant Laws and Regulations.....	29
	References	29
3.	Benefits of Lean Six Sigma	31
3.1	Introduction	31
3.2	Profitability and Cost Reduction	31
3.3	Quality and Customer Satisfaction	33
3.4	Management Strategy, Flexibility, and Agility	33
3.5	Environmental Protection.....	34
3.6	Employee Skill Development and Job Satisfaction	34
	References	34
 Section II Lean Six Sigma Methodologies and Strategies		
4.	The Goal: Improving Quality and Reducing Costs	37
4.1	Introduction	37
4.2	Cost of Poor Quality	37
4.3	Cost Reduction and Customer Satisfaction Benefits of Lean.....	40
4.4	Profit Potential and Customer Satisfaction of Six Sigma.....	40
4.5	Blending Lean and Six Sigma for Maximum Benefit	41
	References	41
5.	Metrics and Performance Measurement.....	43
5.1	Introduction	43
5.2	Six Sigma versus Three Sigma Quality Levels	43
	Reference	45
6.	Deployment Alternatives.....	47
6.1	Introduction	47
6.2	Choosing a Lean Six Sigma Provider or Partner.....	50
6.3	Essential Elements of Deployment Plan	51
6.4	Six Sigma Calculators Available on the Internet	53
6.4.1	Overview of Calculators and Comparisons.....	53
6.4.2	iSixSigma Process Calculator	53
6.4.3	Statistical Solutions Six Sigma Calculator	54
6.4.4	KnowWare QI Macro Calculator	54
	References	54

7. Overview of Statistical Analysis	55
7.1 Introduction	55
7.2 Discrete and Continuous Data	55
7.3 Means and Variance	56
7.4 Random Variables and Probability Distributions	58
7.5 Normal Distribution	59
7.6 Sampling and Sample Sizes	60
7.7 Confidence and Prediction Intervals	60
7.8 Hypothesis Testing	61
7.9 Design of Experiments	61
References	62
8. General Approach to Implement Lean Six Sigma	63
8.1 Introduction	63
8.2 Overview of Lean Six Sigma Approach and Systems	64
8.3 Step-by-Step Implementation Guide	65
8.3.1 Step 1: Establish Team and Define Project	66
8.3.1.1 Upper Management Support	67
8.3.1.2 Project Team	67
8.3.1.3 Initial Training and Introductory Meeting	69
8.3.1.4 Problem Clarification and Goal Identification with Metrics	69
8.3.1.5 Team Charter	73
8.3.1.6 Project Timeline	74
8.3.1.7 Project Budget	76
8.3.2 Step 2: Review Existing Records and Data	76
8.3.3 Step 3: Create Process Flowcharts and Conduct Throughput Analyses	77
8.3.4 Step 4: Collect Process and Quality Data	83
8.3.4.1 Preparation for On-Site Data Collection	84
8.3.4.2 Assessment Guide	88
8.3.4.3 Productivity Analysis and Time Studies	89
8.3.5 Step 5: Analyze Data by Work Unit and Establish Baseline	89
8.3.5.1 Example Overview	91
8.3.5.2 Cycle Time Analysis	92
8.3.5.3 Machine and Labor Utilization Analysis	93
8.3.5.4 Machine Overall Equipment Effectiveness (OEE)	94
8.3.5.5 Throughput, Capacity, and Demand Analysis	95
8.3.5.6 Value-Added Process Analysis	96
8.3.5.7 Activity-Based Costing Analysis	97
8.3.5.8 Defects per Million Opportunity—Quality Analysis	97
8.3.5.9 Failure Mode Effects Analysis (FMEA)	98

8.3.5.10	Cost of Quality Analysis	99
8.3.5.11	Process Capability	100
8.3.5.12	Sigma Level Calculation and DPMO Analysis...	101
8.3.5.13	Pareto Analysis for Improvement Opportunities	101
8.3.6	Step 6: Identify Major Cost and Quality Improvement Opportunities	102
8.3.7	Step 7: Determine, Evaluate, and Select Improvement Alternatives.....	102
8.3.7.1	Generating Alternatives	102
8.3.7.2	Screening Alternatives	106
8.3.7.3	Analyzing and Selecting Alternatives	109
8.3.8	Step 8: Develop Lean Six Sigma Deployment and Execution Plan.....	118
8.3.8.1	Overview of Deployment Plan.....	120
8.3.8.2	Contents of Deployment Plan.....	123
8.3.9	Step 9: Execute and Implement Lean Six Sigma Plan.....	128
8.3.10	Step 10: Validate Program versus Goals	129
8.3.11	Step 11: Monitor and Continually Improve Performance.....	130
	References	133
9.	Training and Implementation.....	135
9.1	Introduction	135
9.2	Training Strategy.....	135
9.3	Training Agendas.....	137
10.	Common Pitfalls	139
10.1	Introduction	139
10.2	Common Pitfalls.....	139
	References	141
11.	Best Practices and Lessons Learned.....	143
11.1	Introduction	143
11.2	Best Practices and Lessons Learned.....	143
	References	144
 Section III Lean Six Sigma Implementation via Case Studies		
12.	Case Study 1: Logistics and Transportation Networks	147
12.1	Introduction	147
12.2	Background.....	147

12.2.1	About the US Postal Service	147
12.2.2	Service Measurement	148
12.2.3	Airmail Processing Overview	148
12.3	Application of Lean DMAIC Process	149
12.3.1	Define.....	149
12.3.2	Measure	149
12.3.3	Analyze	152
12.3.4	Improve the Process	155
12.3.5	Control the Process	156
12.4	Lessons Learned.....	157
	References	158
13.	Case Study 2: Final Assembly Operations	159
13.1	Introduction	159
13.2	Background	160
13.2.1	About the Company	160
13.2.2	Targeted Areas for Improvement	160
13.3	Application of Lean DMAIC Process	161
13.3.1	Define.....	161
13.3.2	Measure	161
13.3.3	Analyze	162
13.3.3.1	Current-State Map (Process Flowchart)	163
13.3.3.2	Baseline Time Studies of Current Process	165
13.3.3.3	Opportunity Identification for Continuous Improvement and Identification of Methods to Reduce Non-Value-Added Activities	166
13.3.4	Improve	167
13.3.4.1	New Facility Layout.....	167
13.3.4.2	Labor Utilization	168
13.3.5	Control.....	168
13.4	Improvement Results.....	168
13.5	Conclusions.....	169
	Reference	169
14.	Case Study 3: High-Volume Printing Operations.....	171
14.1	Introduction	171
14.2	Application of Lean DMAIC Process	172
14.2.1	Define.....	172
14.2.2	Measure	172
14.2.2.1	Delay Study	172
14.2.2.2	Process Diagram.....	173
14.2.2.3	Time Study	173
14.2.2.4	Work Sampling	175

14.2.3	Analyze	177
14.2.3.1	Layout Evaluation and Material Storage and Material Handling.....	177
14.2.3.2	Man–Machine Chart.....	177
14.2.3.3	Standardized Work	178
14.2.4	Improve	178
14.2.4.1	Production Configuration.....	178
14.2.4.2	Plant Layout	179
14.2.4.3	Man–Machine Chart.....	182
14.2.4.4	Inspection Process.....	184
14.2.4.5	Implementation of Kanbans	185
14.2.5	Control.....	185
References		187
15.	Case Study 4: Material Recovery and Recycling Processing Facilities.....	189
15.1	Introduction.....	189
15.2	Application of Lean DMAIC Process	190
15.2.1	Define.....	190
15.2.1.1	About the Organization	190
15.2.2	Measure	192
15.2.2.1	Pareto Analysis	192
15.2.2.2	Time Studies.....	192
15.2.3	Analyze	194
15.2.3.1	Machine Utilization Analysis.....	195
15.2.3.2	DPMO.....	195
15.2.3.3	Cost Analysis	197
15.2.4	Improve	197
15.2.4.1	Value-Added versus Non-Value-Added Analysis	198
15.2.4.2	Capacity	199
15.2.5	Control.....	200
15.2.5.1	Control Charts	201
15.2.5.2	Process Capability	202
15.2.5.3	Managerial Implications	202
15.3	Conclusions.....	203
References		203
16.	Case Study 5: Healthcare.....	205
16.1	Introduction.....	205
16.1.1	Background and Terminology	206
16.2	Application of Lean DMAIC Process	206
16.2.1	Define.....	206
16.2.2	Measure	207
16.2.3	Analyze	209

16.2.4	Improve	214
16.2.5	Control.....	217
References		217
17. Case Study 6: Manufacturing—Small and Medium-Sized Operations		219
17.1	Introduction	219
17.2	Application of Lean DMAIC Process	219
17.2.1	Define.....	219
17.2.2	Measure	219
17.2.3	Analyze	220
17.2.4	Improve	220
17.2.5	Control.....	223
18. Case Study 7: Manufacturing—Automotive Supplier		225
18.1	Introduction	225
18.2	Application of Lean DMAIC Process	225
18.2.1	Define.....	225
18.2.2	Measure	226
18.2.3	Analyze	226
18.2.3.1	Quality Improvement	226
18.2.3.2	Lean Process Design	228
18.2.4	Improve	230
18.2.4.1	Quality Improvements	230
18.2.4.2	Lean Process Design Improvements	231
18.2.5	Control.....	231
19. Case Study 8: Service—Emergency Plumber Dispatching		233
19.1	Introduction	233
19.2	Application of Lean DMAIC Process	233
19.2.1	Define.....	233
19.2.2	Measure	233
19.2.3	Analyze	235
19.2.4	Improve	236
19.2.5	Control.....	237
20. Case Study 9: Service—15-Minute Oil Change		239
20.1	Introduction	239
20.2	Application of Lean DMAIC Process	239
20.2.1	Define.....	239
20.2.2	Measure	239
20.2.3	Analyze	241
20.2.4	Improve	243
20.2.5	Control.....	244

21. Case Study 10: Education	245
21.1 Introduction	245
21.2 Application of Lean DMAIC Process	245
21.2.1 Define.....	245
21.2.2 Measure	246
21.2.3 Analyze	247
21.2.4 Improve	248
21.2.5 Control.....	248
 22. Case Study 11: Nonprofit and Government	249
22.1 Introduction	249
22.2 Application of Lean DMAIC Process	249
22.2.1 Define.....	249
22.2.2 Measure.....	250
22.2.3 Analyze	251
22.2.4 Improve	251
22.2.5 Control.....	254
 Index	255