Contents

Part I Understanding Industry 4.0

1 A Conceptual Framework for Industry 4.0 3
Ceren Salkin, Mahir Oner, Alp Ustundag and Emre Cevikcan
1.1 Introduction 4
1.2 Main Concepts and Components of Industry 4.0 5
1.2.1 State of Art 6
1.2.2 Supportive Technologies 7
1.3 Proposed Framework for Industry 4.0. 17
1.4 Conclusion 21
References. 22

2 Smart and Connected Product Business Models 25
Sezi Cevik Onar and Alp Ustundag
2.1 Introduction 25
2.2 Business Models. 26
2.3 Key Business Model Components of Smart and Connected Products 28
2.4 Proposed Framework 29
2.4.1 Value Proposition 29
2.4.2 IoT Value Creation Layers and Technologies 31
2.5 Conclusion and Further Suggestions. 40
References. 40

3 Lean Production Systems for Industry 4.0 43
Sule Satoglu, Alp Ustundag, Emre Cevikcan and Mehmet Bulent Durmusoglu
3.1 Introduction 43
3.2 Literature Review 45
3.3 The Proposed Methodology 47
3.4 Automation Based Lean Production Applications. 53
3.5 Conclusion 56
References. 57

4 Maturity and Readiness Model for Industry 4.0 Strategy 61
Kartal Yagiz Akdil, Alp Ustundag and Emre Cevikcan
4.1 Introduction 61
4.2 Existing Industry 4.0 Maturity and Readiness Models 63
4.2.1 IMPULS—Industrie 4.0 Readiness (2015). 63
4.2.2 Industry 4.0/Digital Operations Self-Assessment (2016) 65
4.2.3 The Connected Enterprise Maturity Model (2016). . . . 66
4.2.4 Industry 4.0 Maturity Model (2016) 67
4.3 Comparison of Existing Industry 4.0 Maturity and Readiness Models 68
4.4 Proposed Industry 4.0 Maturity Model 68
4.5 An Application in Retail Sector 74
4.6 Conclusion 77
Appendix: Survey Questionnaire 77
References. 93

5 Technology Roadmap for Industry 4.0 95
Peiman Alipour Sarvari, Alp Ustundag, Emre Cevikcan, Ihsan Kaya and Selcuk Cebi
5.1 Introduction 95
5.2 Proposed Framework for Technology Roadmap 97
5.2.1 Strategy Phase 98
5.2.2 New Product and Process Development Phase 100
5.3 Conclusion 102
References. 103

6 Project Portfolio Selection for the Digital Transformation Era 105
Erkan Isikli, Seda Yanik, Emre Cevikcan and Alp Ustundag
6.1 Introduction 106
6.2 Literature Review 107
6.3 Project Portfolio Optimization Model 111
6.4 Application 113
6.5 Conclusion 118
References. 119

7 Talent Development for Industry 4.0 123
Gaye Karacay
7.1 Introduction 123
7.2 Skill Requirements in the Digital World. 126
7.3 Talent Development Practices for Industry 4.0 130
7.4 Conclusion 134
References. 135

8 The Changing Role of Engineering Education in Industry 4.0 Era 137
Sezi Cevik Onar, Alp Ustundag, Çigdem Kadaifci and Basar Oztaysi
8.1 Introduction 137
8.2 New Education Requirements 139
8.2.1 Education Content 139
8.2.2 E-Learning Technologies 141
8.2.3 Working in Interdisciplinary Teams 142
8.3 New Engineering Education Requirements and the Current Engineering Education 143
8.3.1 Innovation/Entrepreneurship 144
8.3.2 Data and Computing Technologies 145
8.3.3 Value Added Automated Operations 146
8.4 Conclusion and Further Suggestions 147
Appendix A 147
References 151

Part II Technologies and Applications

9 Data Analytics in Manufacturing 155
M. Sami Sivri and Basar Oztaysi
9.1 Introduction 155
9.2 Literature Review 156
9.2.1 Power Consumption in Manufacturing 157
9.2.2 Anomaly Detection in Air Conditioning 158
9.2.3 Smart Remote Machinery Maintenance Systems with Komatsu 159
9.2.4 Quality Prediction in Steel Manufacturing 161
9.2.5 Predicting Drilling Efficiency 162
9.2.6 Estimation of Manufacturing Cost of Jet Engine Components 162
9.3 Methodology 163
9.3.1 Techniques Used for Predictive Analytics 164
9.3.2 Forecast Accuracy Calculation 166
9.4 A Real World Case Study 168
9.4.1 Definition of the Problem 168
9.4.2 Data Gathering and Cleaning 168
9.4.3 Model Application and Comparisons 169
9.5 Conclusion 170
References 171

10 Internet of Things and New Value Proposition 173
Gaye Karacay and Burak Aydın
10.1 Introduction 173
10.2 Internet of Things (IoTs) 175

10.3 Examples for IoTs Value Creation in Different Industries. 177
10.3.1 Smart Agriculture 177
10.3.2 Smart City 179
10.3.3 *Smart Life—Wearable Technologies* 180
10.3.4 Smart Health 181
10.4 IoTs Value Creation Barriers: Standards, Security and Privacy Concerns 182
10.4.1 Privacy Concerns. 183
10.4.2 Standardization 183
10.5 Conclusion 183
References. 185

11 Advances in Robotics in the Era of Industry 4.0 187
Barış Bayram and Gökhan İnce
11.1 Introduction 187
11.2 Recent Technological Components of Robots. 189
11.2.1 Advanced Sensor Technologies 189
11.2.2 Artificial Intelligence 191
11.2.3 Internet of Robotic Things. 191
11.2.4 Cloud Robotics 192
11.2.5 Cognitive Architecture for Cyber-Physical Robotics . . . 193
11.3 Industrial Robotic Applications. 194
11.3.1 Manufacturing 194
11.3.2 Maintenance 197
11.3.3 Assembly. 197
11.4 Conclusion 198
References. 198

12 The Role of Augmented Reality in the Age of Industry 4.0 201
Mustafa Esengün and Gökhan İnce
12.1 Introduction 201
12.2 AR Hardware and Software Technology. 202
12.3 Industrial Applications of AR 204
12.3.1 Maintenance 204
12.3.2 Assembly. 207
12.3.3 Collaborative Operations 208
12.3.4 Training. 210
12.4 Conclusion 212
References. 213

13 Additive Manufacturing Technologies and Applications 217
Omer Faruk Beyca, Gulsah Hancerliogullari and Ibrahim Yazici
13.1 Introduction 218
13.2 Additive Manufacturing (AM) Technologies 218
13.2.1 Stereolithography. 219
13.2.2 3DP. 219

13.2.3 Fused Deposition Modeling . . . 219
13.2.4 Selective Laser Sintering . . . 220
13.2.5 Laminated Object Manufacturing . . . 220
13.2.6 Laser Engineered Net Shaping . . . 220
13.2.7 Advantages of Additive Manufacturing . . . 220
13.2.8 Disadvantages of Additive Manufacturing . . . 221
13.3 Application Areas of Additive Manufacturing . . . 221
13.3.1 Medical . . . 223
13.3.2 Surgical Planning . . . 223
13.3.3 Implant and Tissue Designing . . . 223
13.3.4 Medical Research . . . 224
13.3.5 Automotive . . . 224
13.3.6 Aerospace . . . 225
13.3.7 Education . . . 226
13.3.8 Biotechnology . . . 227
13.3.9 Electronics . . . 228
13.3.10 Design . . . 228
13.3.11 Oceanography . . . 228
13.4 Impact of Additive Manufacturing Techniques on Society . . . 229
13.4.1 Impact on Healthcare . . . 229
13.4.2 Impact on Environment . . . 229
13.4.3 Impact on Manufacturing and Supply Chain . . . 230
13.5 Conclusion . . . 230
References . . . 231

14 Advances in Virtual Factory Research and Applications . . . 235
Alperen Bal and Sule I. Satoglu
14.1 Introduction . . . 236
14.2 The State of Art . . . 238
14.2.1 Research Papers and Projects . . . 238
14.2.2 The Virtual Factory Software . . . 241
14.3 Limitations of the Commercial Software . . . 247
14.4 Conclusion . . . 247
References . . . 248

15 Digital Traceability Through Production Value Chain . . . 251
Aysenur Budak, Alp Ustundag, Mehmet Serdar Kilinc and Emre Cevikcan
15.1 Introduction . . . 251
15.2 Digital Traceability Technologies . . . 252
15.2.1 Architectural Framework . . . 255
15.3 Applications . . . 257
15.4 Project Management in Digital Traceability . . . 260
15.5 Conclusion . . . 263
References . . . 263

16 Overview of Cyber Security in the Industry 4.0 Era 267
Beyzanur Cayir Ervural and Bilal Ervural
16.1 Introduction 267
16.2 Security Threats and Vulnerabilities of IoT 270
16.3 Industrial Challenges 273
16.4 Evolution of Cyber Attacks 275
16.5 Cases (Cyber-Attacks and Solutions) 276
16.6 Strategic Principles of Cyber Security. 280
16.7 Cyber Security Measures 280
16.8 Conclusion 282
References. 283

Index 285

http://www.springer.com/978-3-319-57869-9

Industry 4.0: Managing The Digital Transformation

Ustundag, A.; Cevikcan, E.

2018, XVIII, 286 p. 30 illus., 23 illus. in color., Hardcover
ISBN: 978-3-319-57869-9