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Techniques, Tools and Methodologies Applied to Quality Assurance in Manufacturing

Springer

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Preface

The product quality and price are two characteristics that are widely evaluated by the final consumer; therefore, managers are focused on obtaining adequate and balanced levels for both sides. Although, traditionally, it is considered that these two characteristics affect each other, because the presence of one characteristic may restraint the other, because a high quality may refer to a high cost, however, this perspective is not always presented, since it is possible to offer high-quality products and low prices at the same time.

This book presents a collection of real cases from industrial practices that production system and quality managers implement to ensure high quality as well as a low cost in products. This book is divided into sections that are focused on:

- The quality and lean philosophies implemented to production systems, starting from the product design as well as from the supply system.
- The principal statistical techniques applied to the quality assurance (statistical quality control, analysis of tests and failure, quality function deployment, accelerated life tests, among others), the process of gathering information, its validation, its reliability process, and techniques for data analysis.
- The techniques applied to the integration of human resources in the process of quality assurance, such as managers and operators' participation, education, and training processes.

The specific objectives of the book can be summarized as follows:

- Generate a dissemination venue from both the academia and the industry in the topics studied in the book, presenting cases of new approaches, applications, methods and techniques in quality and manufacturing.
- Generate a collection of theoretical and practical research works in the field of quality in manufacturing.
- Establish the state of the art in the field of quality.

This book is composed of a set of chapters, each of the kind of regular research papers. These works have been edited according to the norms and guidelines of Springer Verlag Editorial. Several calls for chapters were distributed among the main

mailing lists of the field for researchers to submit their works to this issue. Twenty-eight expressions of interest in the form of abstracts were received in total, which were subject to a screening process to ensure their clarity, authenticity, and relevancy to this book. These proposals came from several countries such as Colombia, Mexico, Spain, Peru, Ecuador, Turkey, and Jordan.

After the abstract reviewing process, 25 proposals were accepted and asked to submit full versions. These versions were reviewed by at least two pairs in order to ensure the relevance and quality of the documents. After this process, 21 chapters were finally accepted for their publication once the corrections requested by the pairs and the editors were completed.

The book content is structured into three parts: (1) Quality Improvement Applications, (2) Optimization in Quality Development, and (3) Lean Techniques in Quality. The chapters in every of these parts are as follows.

Quality Improvement Applications: This part contains seven chapters.

The first chapter, entitled "An Integrated Quality Tools Approach for New Product Development", indicates that new product development (NPD) process requires a combined approach. However, the NPD team may not have experience with all stages of NPD processes. This chapter proposes an integrated tool that includes quality function deployment (QFD), failure modes and effects analysis (FMEA), Pareto analysis, and poka-yoke techniques by generating some recommendations in NPD processes to improve results.

The second chapter, entitled "Recent Optical Approaches for Quality Control Monitoring in Manufacturing Processes", identifies that optical methods have proved to be suitable for performing quality control processes in manufacturing since they present several advantages over traditional approaches such as non-destructive, non-contact, and high-speed techniques, among others. In this chapter, recent optical methods involving laser-based metrology systems and multi-parameter fiber optic sensors for quality control monitoring in areas such as materials, pharmaceutical, and chemical industry are presented.

In the third chapter, entitled "Reduction of the Scrap KPI in the Cutting Area of an Automotive Electrical Harness Company Using the Six Sigma DMAIC Methodology", the authors present the implementation of the define, measure, analyze, improve, and control (DMAIC) methodology as a tool for the reduction of scrap generated in the lines of the Ks area (cutting) of the company Electrics Plant located in Lagos de Moreno, Jalisco. The purpose sought with the implementation is to reduce the KPI of scrap in the area during the cutting and crimp process.

In the fourth chapter, entitled "Empirical Bayes Monitoring for Univariate and Multivariate Processes and Other Techniques", the authors used the basic concepts given in the celebrated Kalman filter, which can be derived using a Bayesian approach. Such an approach is implemented through Bayesian empirical monitoring for process control. The application analyzed data taken from a molding process of a critical quality characteristic of an automotive sensor. For the multivariate case, measures of the characteristics to be controlled of a molded part were taken.

The fifth chapter, entitled "Augmented Reality as an Innovative and Efficient Technology to Increase Quality in Manufacturing Processes", proposed the application of augmented reality (AR) in the clothing industry which allows, through the visualization of patterns in real time, manufacturing processes to be achieved with greater efficiency. AR provides cognitive ergonomics that lead to important benefits for the company such as optimization of manufacturing times, fast delivery of products, minimization of manufacturing costs, and greater economic profits.

In the sixth chapter entitled "Towards an Analysis of the Relationship Between Quality Management and Project Management", the authors indicate that modern quality management complements project management. This chapter presents the characteristics and models of project management that are related to quality management. Besides, a comparative analysis of the literature on quality management and project management is carried out. From research on quality, knowledge of project management should be deepened.

In seventh chapter, entitled "A Quality Management and Excellence Philosophy from an Islamic Standpoint", the author's studies adopt the inductive and descriptive approach to follow the most prominent principles of quality management in Islam's primary sources strengthened with real application cases and the deductive approach to extract the most prominent principles of quality management derived from them when compared to the modern quality philosophies.

Optimization in Quality Development: This part contains seven chapters.

In Chapter Eight, entitled "Multi-process Assessment Considering the Error of Measurement Systems Within the Process Capacity Indices", the purpose of this chapter is to make available to young researchers and process engineers the importance of integrating measurement systems with multi-process capability analysis systems using Z-values (short and long term) for continuous data considering the error of measurement systems, as well as the modification of process capacity indicators with the inclusion of the measurement error, determining its significance through ANOVA analysis.

In the ninth chapter, entitled "Experimentation and Multi-Objective Optimization in Manufacturing of Rubber for Shoe Sole", the authors indicate that improving quality and designing new products is an important research activity in industrial engineering. In this chapter, we present the study that was carried out on shoe soles through an experimental design. To find the optimal conditions of the process, the main characteristics of the sole were modeled. In that direction, the classical and generic multi-response optimization methods were compared, in this case both gave similar results. This experience will be useful to professionals working in the industry as a guide for doing research.

The tenth chapter, entitled "A Multi-agent System for the Inventory and Routing Assignment", presents a multi-agent system for solving the joint inventory and routing assignment problem, which integrates the individual and autonomously capacity and demand decisions of every network's members in a collaboration-based process that allows reducing the global distribution costs, demonstrating the impact of agent-based system on improving logistics processes.

The eleventh Chapter, entitled "Multi-objective Product Allocation Model in Warehouses", presents a multi-objective optimization model and a genetic algorithm procedure for its solutions, with the aim of simultaneously minimizing product handling costs and the required time to fulfill orders in an industrial warehouse, which allows defining the positions to locate the products in the warehouse' shelves, considering both critical objectives in warehouses.

In the twelfth chapter, entitled "Model Design of Material Requirement Planning (MRP) Applied to a Surgical Sutures Company", the authors implement the material requirements planning (MRP) to improve productivity in a company dedicated to the manufacturing of supplies for the health area. The use of material requirements planning improved the estimation of the number of raw materials required and optimized the scheduled deliveries within the company.

The thirteenth chapter, entitled "An EWMA Chart with Varying Sample Interval to Monitor Calibration Processes", is proposing an exponentially weighted moving average (EWMA) control chart with a varying sample interval based on Croarkin and Varner's statistical control chart, which was adopted by NIST. The original Croarkin and Varner chart has lower performance than some charts proposed in recent years; nevertheless, the performance of the modified chart that is proposed is comparable to that of better charts, given its detection ability in the face of changes to the calibration process.

In the fourteenth chapter, entitled "Application of Constraint Theory (TOC) on Information and Communication Technologies in Quality and Its Impact on the Circular Economy", the authors applied the TOC in the entire business value chain of a bank financial services company, from the highest level (strategy) to the primary activities of the company. The TOC model is proposed considering an analysis of the problem (design thinking), analysis related to the business processes of the payment line using LEAN-VSM (virtual stream mapping). It is applied in TOC's Drum Buffer Rope (DBR) method to define time and capacity buffers on the pay line.

Lean Techniques in Quality: This part contains seven chapters.

In the fifteenth chapter, entitled "Application of Lean Techniques and Queuing Theory in Food Services", the authors indicate that food services, specifically cafeterias, undesirable factors such as low servers' capacity, poor layout, and demand's variability may impact negatively by creating queues. This scenario is worsened during the rush time, generating the loss of customers and revenue decrease. Therefore, solutions such as lean principles jointly with queuing theory can address such problems and improve service performance. This chapter presents how the simultaneous application of such methodologies can boost the performance of a Mexican cafeteria and, thus, reduce the queues.

The sixteenth chapter, entitled "Dynamic Study of Soil Improvement for Sugarcane Cultivation in Colombia", was proposed to evaluate through the system dynamics methodology and the possible long-term impacts that this crop could generate in the Valle del Cauca's soils. The simulation's model was applied using Vensim DSS software, and it explored soil recovery scenarios using compost, which is produced from sugarcane residues composting (cachaça and bagasse). It was evident

that the utilization of this by-product can represent an important contribution in the soil's loss and degradation reduction, plus economic and environmental benefits. Although the proposed model has been applied to the specific case of sugarcane, it can be replicated in other types of crop, thus becoming a valuable tool for the decision-making process involved in crop planning.

The seventeenth chapter, entitled "Lean Manufacturing Implementation in Management of Residues from Automotive Industry—Case Study", indicates that different types of waste can appear in companies' processes and in the recycling industry is not an exemption. Therefore, the adoption of lean manufacturing techniques helps to tackle these problems by diminishing or eliminating them. This chapter presents the case of an Ecuadorian company dedicated to the management of residues from the automotive industry, which experienced an improvement due to the successful implementation of lean tools, showing an enhancement in their CTQs and the employees' culture.

In the eighteenth chapter, entitled "Case Study of Lean Manufacturing Application in a New Process Introduction into a Rail Company", the authors indicate that productivity is a determining factor in the development of organizations. The objective of this chapter is introducing a new process in the remanufacturing of compressors by documenting, analyzing, and designing the process. Using define, measure, analyze, improve, and control (DMAIC) methodology and lean manufacturing techniques eliminated the waste and was the level of quality required by the client ensured.

The nineteenth chapter, entitled "Personnel Training as a Tool for Quality Assurance: Case of Study at Plastic Injection Enterprise", described how an inappropriate training to new personnel may severely affect the performance of a factory and the quality of its final products. A case of study of an automotive business shows how the production was often affected by delays due to errors made by the quality auditors' team, damage in equipment, and high staff turnover. The lack of a proper training for new personnel was a common issue to these problems.

In the twentieth chapter, entitled "Operational Risk Management in the Supply Chain of Blood Products", the blood must be a scarce resource in the world. Blood transfusions help to save and improve the quality of life of thousands of people around the world all the time. The rate of donation is currently considered low in Colombia. However, this is not the only problem for institutions responsible for the reception, storage, and distribution of blood products. Other factors within the biological and logistical control of the chain directly affect the safety and availability of blood. Due to the above, in this chapter, the authors proposed the identification, prioritization, and definition of actions aimed at mitigating or eliminating the main risks in the chain.

Finally, in the twenty-first chapter, entitled "Taguchi's Loss Function in the Weight Quality of Products: Case Study of Cheese Making", the authors applied the Taguchi methodology in a cheese company that belongs to the dairy industry to quantify the financial loss for both the consumer and the company by deviating a quality characteristic from its nominal value (product weight), determining the economic loss for five presentations, of product, and later establishing a mathematical equation

and then applying an experimental design to improve the quality of the product in five different presentations.

Once a summary of chapters has been provided, the editors would like to express their gratitude to reviewers who kindly accepted to contribute to the chapters' evaluation at all stages of the editing process.

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Finally, the editors wish to thank our families, for their support and for allowing us to dedicate time to this project, time that sometimes we should have spent with them. We appreciate their understanding, and we hope that this book is truly a contribution that justifies the time we have not spent with them in harmony.

Ciudad Juárez, Mexico — Jorge Luis García Alcaraz
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Contents

Quality Improvement Applications

An Integrated Quality Tools Approach for New Product Development 3
Onur Dogan and Ufuk Cebeci

Recent Optical Approaches for Quality Control Monitoring in Manufacturing Processes 23
Carlos A. Calles-Arriaga, Eddie N. Armendáriz-Mireles, Enrique Rocha-Rangel, Wilian J. Pech-Rodríguez, José A. Rodríguez-García, Juan López-Hernández, and José A. Castillo-Robles

Reduction of the Scrap KPI in the Cutting Area of an Automotive Electrical Harness Company Using the Six Sigma DMAIC Methodology 49
Beatriz Adriana Esparza-Ramírez, Fernando Ricárdez-Rueda, Vicente Onofre Rojo-Romo, and Gerardo Alonso Torres-Ávalos

Empirical Bayes Monitoring for Univariate and Multivariate Processes and Other Techniques 65
Manuel Arnoldo Rodríguez Medina, Manuel Alonso Rodríguez Morachis, Luz Elena Terrazas Mata, Manuel Iván Rodríguez, and Eduardo Rafael Poblano-Ojinaga

Augmented Reality as an Innovative and Efficient Technology to Increase Quality in Manufacturing Processes 95
Marisol Hernández Hernández and Gerardo Reyes Ruiz

Towards an Analysis of the Relationship Between Quality Management and Project Management 119
Alfonso J. Gil, Mara Mataveli, and Jorge Luis García Alcaraz

A Quality Management and Excellence Philosophy from an Islamic Standpoint 139
Hesham Al-Momani

Optimization in Quality Development

Multi-process Assessment Considering the Error of Measurement Systems Within the Process Capacity Indices 175
Darwin Young-Vazquez, R. María Blanca Becerra, Elías Carrum-Siller, Cuauhtémoc Sánchez-Ramírez, and Arturo Hernández-Hernández

Experimentation and Multi-Objective Optimization in Manufacturing of Rubber for Shoe Sole 203
Armando Mares Castro and Jorge Domínguez Domínguez

A Multi-agent System for the Inventory and Routing Assignment 229
Conrado Augusto Serna-Urán, Cristian Giovanny Gómez-Marín, Julián Andrés Zapata-Cortes, and Martín Darío Arango-Serna

Multi-objective Product Allocation Model in Warehouses 249
Julián Andrés Zapata-Cortes, Martín Darío Arango-Serna, Conrado Augusto Serna-Urán, and Luisa Fernanda Ortíz-Vasquez

Model Design of Material Requirement Planning (MRP) Applied to a Surgical Sutures Company 269
Fiorella Cerna, Catherine Gómez, Nadia Sánchez, Ana Luna, and Mario Chong

An EWMA Chart with Varying Sample Interval to Monitor Calibration Processes 281
María Guadalupe Russell-Noriega and Enrique Villa-Diharce

Application of Constraint Theory (TOC) on Information and Communication Technologies in Quality and Its Impact on the Circular Economy 303
Manuel Horna and Mario Chong

Lean Techniques in Quality

Application of Lean Techniques and Queuing Theory in Food Services 335
Jonnatan Fernando Avilés-González and Sonia Valeria Avilés-Sacoto

Dynamic Study of Soil Improvement for Sugarcane Cultivation in Colombia 351
Dayhanna Stephanía Vargas-Mesa, Luz Karime Torres-Lozada, Juan Carlos Osorio-Gómez, and Patricia Torres-Lozada

Lean Manufacturing Implementation in Management of Residues from Automotive Industry—Case Study 371
Mercedes Estefanía Pérez-Naranjo, Sonia Valeria Avilés-Sacoto, and Galo Eduardo Mosquera-Recalde

Case Study of Lean Manufacturing Application in a New Process Introduction into a Rail Company 397
Rosa Hilda Félix Jácquez, María Merced Cruz Rentería, Ma. Dolores Delgado Celis, Alfonso Alejandro Lara Negrete, Daniel Torres Ramírez, and Claudia Leticia Dávila Martínez

Personnel Training as a Tool for Quality Assurance: Case of Study at Plastic Injection Enterprise 419
Abril Salaices Medrano and G. Angelina López Pérez

Operational Risk Management in the Supply Chain of Blood Products 433
Nataly Agudelo-Ibarguen, Mayerli Daniela Naranjo-Sánchez, and Juan Carlos Osorio-Gómez

Taguchi's Loss Function in the Weight Quality of Products: Case Study of Cheese Making 453
Nicolás Francisco Mateo-Díaz, Lidilia Cruz-Rivero, Luis Adolfo Meraz-Rivera, and Jesús Ortiz-Martínez

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Similarly, he has supervised six bachelor theses, nine master theses, and three Ph.D. theses, and currently he is working on four master theses and one Ph.D. thesis that are in progress. He has been the editor of the following books: *New Perspectives on Applied Industrial Tools and Techniques*, published by Springer Verlag; *Handbook of Research on Managerial Strategies for Achieving Optimal Performance in Industrial Processes*, published by IGI Global Publishing. He has given six magistral conferences and workshops on industrial engineering, mainly focused on supply chain performance; he has two international patents.

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List of Figures

An Integrated Quality Tools Approach for New Product Development

Fig. 1 Overview of the integrated framework 8
Fig. 2 House of Quality (HOQ) 9
Fig. 3 Stage 1 flowchart: project management and team building 13
Fig. 4 Stage 2 flowchart: integrated approach 15
Fig. 5 Stage 3 flowchart: quality control documentation 16
Fig. 6 House of quality created 17
Fig. 7 Prepared standard operation procedure 20

Recent Optical Approaches for Quality Control Monitoring in Manufacturing Processes

Fig. 1 Optical spectrum regions 24
Fig. 2 FTIR commercial equipment 25
Fig. 3 Optical methods for quality inspection 26
Fig. 4 Scheme for profile measurements of wind turbines (based on Moreno-Oliva et al. 2019) 27
Fig. 5 Temperature versus reflectance on the setting of cement paste. Adapted from De León Martínez et al. (2015) 29
Fig. 6 Laser doppler effect 31
Fig. 7 Machine vision system process 31
Fig. 8 Optical methods for quality inspection 33
Fig. 9 Inline apple's quality inspection system (adapted from Li et al. 2020) 33
Fig. 10 Spiruline algae absorbance spectra 34
Fig. 11 Fluorescence mechanism 35
Fig. 12 Fiber optic structure 36
Fig. 13 Long period grating fiber manufactured with laser 37
Fig. 14 Fiber taper fabricated by electric arc 37
Fig. 15 Interference pattern response of fiber interferometers 38

Fig. 16 Fabry–Perot fiber interferometer 38
Fig. 17 Mach–Zehnder interferometer 39
Fig. 18 Michelson interferometer 39
Fig. 19 Sagnac interferometer 40
Fig. 20 Inline Fabry–Perot interferometer 40
Fig. 21 Inline Mach–Zehnder interferometer 41
Fig. 22 Inline Michelson interferometer 41
Fig. 23 Fiber sensor based on materials 41
Fig. 24 MMI fiber sensor 43
Fig. 25 Bragg wavelength at different temperatures 44
Fig. 26 Embedded fiber sensors based on FBG 45

Reduction of the Scrap KPI in the Cutting Area of an Automotive Electrical Harness Company Using the Six Sigma DMAIC Methodology

Fig. 1 Types of scrap-causing problems 54
Fig. 2 Descriptive statistics: KPI 55
Fig. 3 Normally test: KPI 55
Fig. 4 Time series plot of KPI 55
Fig. 5 Gage R&R 56
Fig. 6 One-factor ANOVA, 3 levels, significance coefficient 0.05 two-way Tukey comparison 57
Fig. 7 Coded notation 58
Fig. 8 Experiment matrix for 2*k* factorial 58
Fig. 9 Sensitivity zones 59
Fig. 10 Layout simulation after DMAIC 61
Fig. 11 Simulation process after DMAIC 61
Fig. 12 Scoreboard for cutting minutes 62
Fig. 13 Linearity chart for average damage in process 62
Fig. 14 Scrap KPI variation chart 63
Fig. 15 Left side view of the Poka Yoke button measuring instrument 63

Empirical Bayes Monitoring for Univariate and Multivariate Processes and Other Techniques

Fig. 1 Real-time data behavior and short-term predicted values 73
Fig. 2 Histogram (**a**) and comparative series (**b**) of the behavior of the variable and the short-term and long-term predictions 74
Fig. 3 Comparative graph of error variance, process, and total short- and long-term variation (**b**) 79
Fig. 4 Behavior of the real-time values of the three dimensions and the calculated values 84
Fig. 5 Q-Q chart 91
Fig. 6 Hotelling square *T* chart 93

Augmented Reality as an Innovative and Efficient Technology to Increase Quality in Manufacturing Processes

Fig. 1 Process of making a garment. *Source* Author's own elaboration 101
Fig. 2 Manufacturing process of the garments 105
Fig. 3 Sample of a shirt called balloon, using AR 106
Fig. 4 Assembly parts for the collar of a Balloon Shirt using the AR 107
Fig. 5 AR system displaying the sleeve of a garment 108
Fig. 6 AR system, showing the assembly process by means of a video 109
Fig. 7 AR system for a shirt associated with a marker 110

Towards an Analysis of the Relationship Between Quality Management and Project Management

Fig. 1 Code hierarchy and concepts developed from the cross-case analysis. *Source* Lehtinen and Aaltonen (2020, p. 92) 122
Fig. 2 Project as a learning project. *Source* Gil and Mataveli (2018, p. 49) 122
Fig. 3 Several publications on 'Quality Management' and on 'Project Management' in the last ten years. *Source* Scopus (2020) 129
Fig. 4 Publications on 'Quality Management' and 'Project Management' in the last ten years 129
Fig. 5 Four reviews—'Total Quality Management and Business Excellence', 'International Journal of Project Management', 'TQM Journal' and 'Journal of Construction Engineering and Management' and three subjects—'Quality Management', 'Project Management' and 'Quality Management & Project Management'. *Source* Scopus (2020) 134

Multi-process Assessment Considering the Error of Measurement Systems Within the Process Capacity Indices

Fig. 1 Defining a six sigma process: Short term (left), Long term (right) 178

Experimentation and Multi-Objective Optimization in Manufacturing of Rubber for Shoe Sole

Fig. 1 Research methodology 208
Fig. 2 Tensile tests performed on the universal machine 209
Fig. 3 Rubber sole manufacturing process 210
Fig. 4 Box–Behnken design representation for three factors (Gutiérrez Pulido and Salazar 2012) 212
Fig. 5 Residual analysis for the max load model 218

Fig. 6 Residual analysis for the max deformation model 220
Fig. 7 Residual analysis for the hardness model 220
Fig. 8 Optimization results by desirability function 222
Fig. 9 Absolute values for max load and maximum deformation 224
Fig. 10 Value paths in the absolute range of values 225

A Multi-agent System for the Inventory and Routing Assignment

Fig. 1 Representation of IRP. *Source* The authors 231
Fig. 2 Multi-agent architecture. *Source* Serna-Urán et al. (2018) 233
Fig. 3 Multi-agent system for inventory and routing assignment. *Source* The authors 236
Fig. 4 Communication process at multi-agent system (MAS). *Source* The authors 237
Fig. 5 Communication among agents during simulation. *Source* The authors 240
Fig. 6 **a** Request protocol, **b** contract net protocol. *Source* The authors 241
Fig. 7 Routes of initial solution. *Source* The authors 244
Fig. 8 Improved solution in the MAS. *Source* The authors 244

Multi-objective Product Allocation Model in Warehouses

Fig. 1 Pareto frontier and quality measures of Pareto solutions. *Source* Shenfield et al. (2007) 255
Fig. 2 NSGAII operation scheme. *Source* Zapata-Cortes (2016) 257
Fig. 3 Chromosome used for the product allocation problem. *Source* The authors 260
Fig. 4 Crossover operator for product allocation problem. *Source* The authors 261
Fig. 5 Mutation representation. *Source* The authors 262
Fig. 6 Proposed distribution center in 3D. *Source* The authors 263
Fig. 7 Pareto frontier. *Source* The authors 264

Model Design of Material Requirement Planning (MRP) Applied to a Surgical Sutures Company

Fig. 1 Supply chain 272
Fig. 2 Inventory's months of the finished product 273
Fig. 3 Inventory's months of the raw material 273
Fig. 4 Project risk assessment 274

An EWMA Chart with Varying Sample Interval to Monitor Calibration Processes

Fig. 1 ARL values for different shifts in the intercept using the NIST, Kim-Shewhart, T^2, EWMA/R, and EWMA3 procedures . . . 293
Fig. 2 ARL values for different shifts in the intercept using the NIST, Kim-Shewhart, T^2, EWMA/R, and EWMA3 procedures . . . 293
Fig. 3 ARL values for different shifts in the deviation using the NIST, Kim-Shewhart, T^2, EWMA/R, and EWMA3 procedures . . . 294
Fig. 4 AATS values for different shifts in the intercept: VSI-EWMA/NIST and VSI-EWMA3 procedures with varying sample interval . . . 294
Fig. 5 AATS values for different shifts in the slope: VSI-EWMA/NIST and VSI-EWMA3 procedures, with varying sample interval . . . 295
Fig. 6 AATS values for different shifts in the deviation: VSI-EWMA/NIST and VSI-EWMA3 procedures with varying sample interval . . . 295
Fig. 7 AATS values for different shifts in the intercept: VSI-EWMA/NIST and VSI-EWMA3 procedures with varying sample interval . . . 299
Fig. 8 AATS values for different shifts in the slope: VSI-EWMA/NIST and VSI-EWMA3 procedures with varying sample interval . . . 299
Fig. 9 AATS values for different shifts in the deviation: VSI-EWMA/NIST and VSI-EWMA3 procedures with varying sample interval . . . 300

Application of Constraint Theory (TOC) on Information and Communication Technologies in Quality and Its Impact on the Circular Economy

Fig. 1 *Source* Closed cycle supply chain (loop) and distributed information systems. Activities in the reverse supply chain . . . 315
Fig. 2 System architecture for telephone service payment online—own elaboration . . . 316
Fig. 3 Taken from strategic plan 2017–2021—own elaboration . . . 319
Fig. 4 Taken from strategic plan 2017–2021—transactions with time out—own elaboration . . . 319
Fig. 5 TOC solution model in a bank financial services company—own elaboration . . . 320
Fig. 6 Problem tree—own elaboration . . . 321

Fig. 7 VSM (current situation value stream mapping)—online payment—own elaboration 322
Fig. 8 VSM (proposal value stream mapping)—online payment—own elaboration 324

Application of Lean Techniques and Queuing Theory in Food Services

Fig. 1 Macro view for the method applied 339
Fig. 2 Layout and route diagram 341
Fig. 3 Sample of a flowchart process. Client/Customer point of view . . . 342
Fig. 4 Value stream mapping for services 343
Fig. 5 Simulation scenarios comparing current model against proposed solution 347

Dynamic Study of Soil Improvement for Sugarcane Cultivation in Colombia

Fig. 1 Results of the bibliometric analysis VosViewer 353
Fig. 2 Results of the bibliometric analysis RefViz 354
Fig. 3 Methodological approach (Aracil 1995) 358
Fig. 4 Sugarcane cultivation influence diagram 359
Fig. 5 R1 359
Fig. 6 R2 360
Fig. 7 R3 360
Fig. 8 B1 361
Fig. 9 B2 361
Fig. 10 Forrester diagram on sugarcane planting 362
Fig. 11 Forrester diagram on sugarcane crop production 362
Fig. 12 Forrester diagram on the use of organic waste 363
Fig. 13 Forrester diagram on utilities 363
Fig. 14 Scenario 1—forrester diagram in sugarcane crop 365
Fig. 15 Scenario 2—Forrester diagram in sugarcane crop 366
Fig. 16 Approach of soil's degraded area by compaction for both scenarios 366
Fig. 17 Composting used in the scenarios 367

Lean Manufacturing Implementation in Management of Residues from Automotive Industry—Case Study

Fig. 1 Average age and level of education of AV. CORP.' Workers. *Source* Own Elaboration 378
Fig. 2 Initial layout of materials in the transfer zone. *Source* Own elaboration—AutoCAD 381
Fig. 3 Value stream mapping of AV. CORP. processes. *Source* Ow elaboration 381

Fig. 4 Cause-and-effect diagram for the big problem "Lack of order in the plant in General." *Source* Own elaboration 384
Fig. 5 Pareto diagram for volume occupied by different materials in the transfer zone. *Source* Own elaboration 385
Fig. 6 Results for paired T (Minitab Software) 385
Fig. 7 Flow process chart of disassembling wooden board pallets. *Source* Own elaboration 386
Fig. 8 Wooden boards pallets for disassembling. *Source* Own elaboration—AutoCAD 386
Fig. 9 Statistical summary of times for dissembling manually. *Source* Minitab Software 387
Fig. 10 Proposed poka-yoke for pedestrian path in AV. CORP 388
Fig. 11 Routes in AV. CORP before and after poka-yoke implementation 388
Fig. 12 Air gun implemented in the process of disassembling 389
Fig. 13 Statistical summary of times for dissembling semi-automatized. *Source* Minitab Software 390
Fig. 14 Box plot for the before and after of disassembly of pallets 390
Fig. 15 Movable table to disassembly of wooden board pallets and mobile rack to transport them. *Source* Own elaboration 391
Fig. 16 Layout of transfer zone—materials are storage in an organized way. *Source* Own elaboration 391
Fig. 17 Cost–volume relationship—breakeven point (BEP) 392

Case Study of Lean Manufacturing Application in a New Process Introduction into a Rail Company

Fig. 1 Current value stream mapping light work scope 404
Fig. 2 Future value stream mapping light work scope 405
Fig. 3 Initial spaghetti diagram, Kaizen 1 406
Fig. 4 Final layout and route compressor/operator, Kaizen 2 407
Fig. 5 Takt time versus cycle time 407
Fig. 6 Labor balance, Kaizen 3 408
Fig. 7 Layout based on lean manufacturing principles, Kaizen 4 408
Fig. 8 Simulation model. Process simulation created on ProModel software for validation and verification of the proposal, Kaizen 5 409
Fig. 9 Example of process sheet, Kaizen 6 410
Fig. 10 Quality plan. Document elaborated for record and control of CTQ's, Kaizen 7 411
Fig. 11 Sample SWCS operator 1, Kaizen 8 412
Fig. 12 Partial view JSA disassembly of electric motor, Kaizen 9 413
Fig. 13 Partial view of FMEA, Kaizen 10 414
Fig. 14 Visual management implementation, Kaizen 11 414

Personnel Training as a Tool for Quality Assurance: Case of Study at Plastic Injection Enterprise

Fig. 1 Main causes of the production delays . . . 422
Fig. 2 Job abandonment causes . . . 422
Fig. 3 Produced scrap by a wrong defect identification on production pieces . . . 423
Fig. 4 Five why's method . . . 424
Fig. 5 Why does the operator makes this type of error? . . . 424
Fig. 6 Causes of mold damage in the April–October period . . . 426
Fig. 7 Internal damage found after the operator closed the mold with a part already injected inside, the repair of this mold had a total cost of 12,000 Mexican pesos . . . 427
Fig. 8 Training plan must include theoretical and practical content . . . 427
Fig. 9 Why should a training program be developed? *Source* Alarcón (2020) . . . 428
Fig. 10 Special containers for hour-by-hour inspection . . . 429
Fig. 11 Special containers for hour-by-hour inspection . . . 429
Fig. 12 Personnel at training . . . 431
Fig. 13 Comparison of periods April–October and November–January . . . 432

Operational Risk Management in the Supply Chain of Blood Products

Fig. 1 Blood supply chain (Agudelo Ibarguen and Naranjo Sánchez 2019) . . . 435
Fig. 2 Risk management system (adapted from Manotas et al. 2016) . . . 436
Fig. 3 Methodological design (Agudelo Ibarguen and Naranjo Sánchez 2019) . . . 437
Fig. 4 Matrix impact–probability (adapted from Osorio et al. 2017) . . . 438
Fig. 5 Risk probability–impact matrix . . . 442
Fig. 6 Correlation between What's and How's . . . 443
Fig. 7 Impact of critical risks on How's to . . . 445
Fig. 8 Cause-effect equipment risk diagram . . . 447
Fig. 9 Cause-effect staff risk diagram . . . 448

Taguchi's Loss Function in the Weight Quality of Products: Case Study of Cheese Making

Fig. 1 Averages of the product weights in relation to the nominal value . . . 458
Fig. 2 Box plot for product weight . . . 459
Fig. 3 Cost ($) of each product to deviate from the nominal value . . . 459
Fig. 4 Loss function for presentation 250 gr. $L(y) = 0.0027\ [175.52 + (261.25–250)^2]$ . . . 459

Fig. 5 Loss function for presentation 350 gr. L (y) = 0.00088 [122.74 + (315.41–350)^2] 460
Fig. 6 Loss function for presentation 450 gr. L (y) = 0.0033 [203.47 + (459.16–450)^2] 460
Fig. 7 Loss function for presentation 600 gr. L (y) = 0.00017 [203.47 + (634.16–600)^2] 461
Fig. 8 Loss function for presentation 900 gr. L (y) = 0.0017 [167.35 + (882.75–900)^2] 461

List of Tables

An Integrated Quality Tools Approach for New Product Development

Table 1 Comparison of similar approaches 6
Table 2 Example of a point scale of linguistic expressions (Lange et al. 2001) 11
Table 3 Part of FMEA for processing time of oven 19

Recent Optical Approaches for Quality Control Monitoring in Manufacturing Processes

Table 1 Optical industry and methods 25
Table 2 Advantage and disadvantages of optical metrology techniques 26
Table 3 Optical quality inspection in agriculture (based on Yeong et al. 2019 and El-Mesery et al. 2019) 32

Reduction of the Scrap KPI in the Cutting Area of an Automotive Electrical Harness Company Using the Six Sigma DMAIC Methodology

Table 1 Top 5 average scrap damage in process 62

Empirical Bayes Monitoring for Univariate and Multivariate Processes and Other Techniques

Table 1 Values of weighting coefficients 72
Table 2 Analysis of variances for the comparison of population means 75
Table 3 Values of the short-term and long-term process parameters 76
Table 4 Test for variance comparison 79
Table 5 Kruskal Wallis test for comparison of means 79
Table 6 Values of weighting coefficients used 81