Quality Engineering Techniques

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Quality Engineering Techniques

An Innovative and Creative
Process Model

Ramin Rostamkhani
Mahdi Karbasian

CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

First edition published 2020
by CRC Press
6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

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CRC Press is an imprint of Taylor & Francis Group, LLC

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Library of Congress Cataloging-in-Publication Data

Names: Rostamkhani, Ramin, author. | Karbasian, Mahdi, author.

Title: Quality engineering techniques : an innovative and creative process model / Ramin Rostamkhani, Mahdi Karbasian.

Description: First edition. | Boca Raton : CRC Press, 2020. | Includes bibliographical references and index.

Identifiers: LCCN 2020004495 (print) | LCCN 2020004496 (ebook) | ISBN 9780367903817 (hardback) | ISBN 9781003042037 (ebook)

Subjects: LCSH: Quality control. | Industrial management. | Project management.

Classification: LCC TS156 .R6725 2020 (print) | LCC TS156 (ebook) | DDC 658.4/013--dc23

LC record available at <https://lcn.loc.gov/2020004495>

LC ebook record available at <https://lcn.loc.gov/2020004496>

ISBN: 978-0-367-90381-7 (hbk)

ISBN: 978-1-003-04203-7 (ebk)

Typeset in Times

by Deanta Global Publishing Services, Chennai, India

Contents

Preface.....ix

About the Authors.....xi

Chapter 1 A Review of the Basic Concepts 1

1.1 Introduction 1

1.2 The History of Research in QET.....2

1.2.1 The History of Research in Statistical Techniques2

1.2.1.1 Descriptive Statistics2

1.2.1.2 Design and Analysis of Experiments5

1.2.1.3 Statistical Hypothesis Tests6

1.2.1.4 Process Capability Analysis7

1.2.1.5 Regression Analysis.....8

1.2.1.6 Reliability Analysis9

1.2.1.7 Sampling 11

1.2.1.8 Simulation.....12

1.2.1.9 Statistical Process Control Charts12

1.2.1.10 Statistical Tolerances14

1.2.1.11 Time Series Analysis14

1.2.2 The History of Research in Non-Statistical Techniques..... 18

1.3 The History of Research in the Key Concepts of Continuous Improvement 19

1.3.1 The History of Research in Productivity for Industrial Products Manufacturing20

1.3.2 The History of Research in Sustainability for Industrial Products Manufacturing21

1.3.3 The History of Research in Added Values for Industrial Products Manufacturing21

1.4 A Summary of the Research History22

1.4.1 Innovation and Creativity in This Research: A Description22

Exercises.....23

Chapter 2 Applied Methodology.....25

2.1 Introduction25

2.2 Research Limitations.....25

2.3 Statistical Population of the Research.....25

2.4 Data Collection Tools and Methods27

2.5 Data Collection Validity27

2.6	Data Collection Reliability	27
2.7	Information Analysis Method	27
	Exercise	27
Chapter 3	Proposed Model in Triple Organizational Processes	29
3.1	Introduction	29
3.2	Identification and Determination of Three Types of Processes in Industrial Factories	29
3.3	Identification and Determination of the Desired QET in Main Processes.....	30
3.3.1	A Numerical Application of QET in the Determined Scope for Main Processes	30
3.4	Identification and Determination of the Desired QET in Leadership Processes	50
3.4.1	Numerical Application of QET in the Determined Scope for Leadership Processes.....	51
3.5	Identification and Determination of the Desired QET in Support Processes.....	56
3.5.1	Numerical Application of QET in the Determined Scope for Support Processes.....	56
3.5.1.1	Exponential Distribution Function	58
3.5.1.2	Ultra Exponential Distribution Function	59
3.5.1.3	Gamma Distribution Function	59
3.5.1.4	Weibull Distribution Function	59
3.5.1.5	Normal Distribution Function	60
3.5.1.6	Log-Normal Distribution Function.....	60
	Exercises.....	63
Chapter 4	Results of Implementing the Model	65
4.1	Introduction	65
4.2	Z-MR Control Charts for Describing the Impacts of Different Units on Productivity and Sustainability	65
4.3	Total Score Calculation of Productivity and Sustainability before and after Implementing QET	73
4.4	Demonstration of the Growth in Added Values for Industrial Products Manufacturing	75
4.5	Generalizing the Assessment Results of the Model to Other Organizations	77
4.6	Assessing the Model’s Risks and Opportunities in Manufacturing Industries	77
4.6.1	Risks and Opportunities Identification	78
4.6.2	Risks and Opportunities Assessment.....	78
4.6.3	Responding to Risks and Opportunities	78

4.7 Impacts of Implementing the Model in Industrial Economics 81

Exercise 82

Chapter 5 Quality Engineering Techniques from Past to Future..... 83

5.1 A Discussion on Comparison of Previous Research with the Proposed Model..... 83

5.2 Final Results of the Research in Manufacturing Industries 84

5.3 Suggestions for Future Research 85

References..... 87

Appendix: Assessment Questionnaire for Generalizing the Proposed Model..... 89

Index..... 107

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Preface

No one can deny the incredible pace of change and progress in today's industrial and complex world. A large amount of information is exchanged and little time is available to deal with it. Many industries and firms of small, medium, or large sizes have a profound desire to increase productivity and sustainability to gain a competitive position in the global market. One of the best tools for achieving this goal is to apply Quality Engineering Techniques (QET). Quality Engineering Techniques can be established through process-oriented models applicable to all traditional processes employed in companies or firms. The authors of this book, having had more than 20 years of intensive work in Quality Management Systems (QMS) and Integrated Management Systems (IMS), have tried to share their applied knowledge and experience on the process-oriented model of quality engineering techniques with experts and managers working at different companies or firms, particularly those in industrial factories. The essential role of employing statistical techniques as the main tool of quality engineering techniques in the growth and development of industries is a well-known fact to the specialists in the field. In applying statistical techniques, the most referenced books in the field are those by Professor Douglas Montgomery from the Arizona State University (ASU) in the United States. In writing this current book, however, we have been inspired by well-known and accomplished professors in industrial engineering in Iran—Professor Rasoul Noorossana in particular—from the Iranian University of Science and Technology. Indeed, the invaluable books and articles he has published could improve knowledge of Quality Engineering Techniques for the first time in Iran. Furthermore, we have benefited from the articles and books published by Professor Arash Shahin from the University of Isfahan; in fact, the important progress and proliferation of quality engineering techniques in Iran have given us enough motivation to write this book. To the above authorities, we have to add the professors and researchers at the Malek Ashtar University of Technology whose great contribution to developing different levels of design and implementation of the process-oriented model are to be appreciated. Also, many experts and managers within this academic organization have cooperated with us in implementing the model presented in this book through applying it to defense sectors. We are indebted to them for their sincere efforts. Special thanks are due to internal and external participants in filling out the questionnaires. We are grateful to our colleagues who played active roles in developing different stages of the model. This model has been applied to a selected industrial factory. The obtained results, however, can be generalized not only to other industries but also to general service sectors. This book introduces, for the first time, an integrated and applicable model for quality engineering techniques and numerical applications for its implementation. It is to be noted that the design of the proposed model is introduced as the main core of the research project while its implementation is indicated in numerical

application parts. So, the main thrust of our research is to provide answers to the important and essential questions listed below.

- How can we define the main specifications of a productive and sustainable model of QET in industrial organizations?
- How can different levels of the proposed model be configured?
- Which units or individuals are responsible for implementing the intended model of QET?
- How can the impacts of implementing the proposed model in question be assessed?
- Can this model create or increase added values for industrial organizations/firms?

The proposed model can prove useful to experts and managers who desire to achieve optimum productivity and sustainability through applying quality engineering techniques, whether statistical or non-statistical. The model presented can manage the application of quality engineering techniques in an integrated format for organizational processes. The most creative feature of the presented work is the idea of introducing a process map within an organization, besides exploiting several quality engineering techniques including statistical and non-statistical tools for different levels of the organization. The most innovative dimension of this book is executing the proposed model in an effective format for the defense sectors of Iran that can be generalized to other non-military sectors in each country as well as creating or augmenting added values for the manufacture of industrial products. We firmly believe that our model can be further improved by accommodating constructive experts' views from those authorities working in the manufacturing and general services sectors of organizations/firms. Please, do not hesitate to contact us (see below) and share your highly appreciated comments in regards to the content of the book.

Ramin Rostamkhani and Mahdi Karbasian

March 2019

About the Authors

Ramin Rostamkhani has an M.A. in Industrial Engineering. He earned his master's degree from the Malek Ashtar University of Technology in Tehran, Iran. He has worked in the Defense Industries Organization (DIO) in Iran. He has more than 20 years of experience in QET. Moreover, he has a lot of experience in QMS and IMS. He has written at least four articles in Scopus and ISI journals. He has extensive expertise and experience in the following areas:

- Reliability
- Productivity
- Sustainability
- Quality control
- Applied statistics
- Quality assurance
- Quality engineering
- Statistical and non-statistical techniques

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1 A Review of the Basic Concepts

1.1 INTRODUCTION

In the present century, quality engineering techniques have turned into applicable and effective tools for attaining advanced design and manufacturing technology as well as mass-production processes. The rationale behind these techniques from the very beginning was to help mass-production lines. It was only later that such methods were developed into useful instruments for other activities in the organization (both for pre-production activities such as product design, and for subsequent activities like after-sales services. Appropriate techniques are developed depending on the type of organization. The evolution path for quality engineering techniques (QET) (passing from low to high quality) has occurred synchronously with development in manufacturing lines. Various techniques have been developed and applied at each stage of the formation of a product (depending on the organization). However, it is important to note that most of the techniques are based on systematic processes, i.e., fewer inputs for converting qualitative outputs into quantitative ones. The result is that these techniques can establish a safe platform for decision making. That is to say, although these techniques can be applied individually, the logical nature is that when they are applied one after another, they act as reinforcements and exhibit double effects. The importance of the functional role of statistical techniques as a main core of QET for robust analysis of the data related to the indices of the strategic issues of quality management systems cannot be easily overlooked. The World Organization for Standardization, through one of its subcommittees, has shed light on identifying statistical techniques. This informative manual appears in two editions, in 1999 and 2003, where it is officially designated as ISO10017 which applies to all standards in the ISO9000 family, especially to those in ISO9001. This standard is a very useful tool in the identification of statistical techniques in the deployment, maintenance, improvement, and development of quality management systems. Statistical techniques as a mathematical tool in quality engineering play a crucial role in measuring, describing, analyzing, interpreting, and modeling system changes even with limited data. Statistical analyses in data can help us understand the extent and causes of changes. Hence, statistical techniques can prove beneficial in exploiting available data to help with decision making and to continuously improve the quality of products and processes, eventually improving customer satisfaction which is the most important goal of the organization. These techniques can be applied to an extensive range of activities such as market research, design, development, production, verification, and servicing.

1.2 THE HISTORY OF RESEARCH IN QET

Statistical control charts were employed by Shewhart for the first time in 1920. However, the relevant sciences flourished in the years between the two world wars. Later years witnessed the use of statistical quality control techniques in manufacturing military equipment. In the years after the war, i.e., in the 1950s and 1960s, the experiments, designs, and analysis techniques were also used. This time not only the military industries, but also the major automobile companies and their part makers turned to these sciences. Major companies like General Electric, General Motors, and Motorola provided a new era for testing these statistical techniques and even resorted to other engineering techniques that did not require strong statistical bases (non-statistical techniques) (Rezaei, 2001). In the field of statistical and non-statistical techniques, a great number of studies have been carried out whose implementation records can be seen in numerous references. It seems that a perfect application grounds for designing and implementing of QET can be realized in the defense sector where widespread and consistent processes are observable at three levels of processes: namely, main, leadership, and support procedures. One particular study discusses the advantage of applying statistical and non-statistical techniques related to quality engineering in the form of an integrated model for creating productivity and sustainability in the main domains of industrial engineering associated with manufacturing factories. (Karimi Gavareshki et al., 2018). The popular statistical techniques based on ISO10017 and non-statistical techniques are presented in Figure 1.1.

Figure 1.2 presents another categorization for QET.

1.2.1 THE HISTORY OF RESEARCH IN STATISTICAL TECHNIQUES

The family of statistical techniques that can help an organization achieve its objectives is as follows: (ISO10017:2003)

- A. Descriptive statistics
- B. Design and analysis of experiments
- C. Statistical hypothesis tests
- D. Process capability analysis
- E. Regression analysis
- F. Reliability analysis
- G. Sampling
- H. Simulation
- I. Statistical process control charts
- J. Statistical tolerances
- K. Time series analysis

1.2.1.1 Descriptive Statistics

Descriptive statistics refers to the methods employed to summarize quantitative data in such a way as to define the characteristics of data distribution. The characteristics of data mostly taken into consideration are the central value of data (e.g., averages);

FIGURE 1.1 QET; statistical and non-statistical techniques.

and the dispersion of data (e.g., domains or standard deviations). Another feature of interest is the shape of the distribution of data (e.g., symmetries). The information obtained from descriptive statistics can often be easily and effectively influenced by resorting to various types of graphical methods including histogram charts, Pareto graphs, dispersion charts, causation charts or trend graphs. These graphical methods are useful since they are capable of discovering unusual aspects in the data that are vague in quantitative analyses. These methods are widely used in data analysis when the researcher decides to discover or verify the relationship among variables and intend to estimate the parameters used to describe these relationships.

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