

Jagdeep Singh • Harwinder Singh

# Strategic Implementation of Continuous Improvement Approach

Improving the Performance of Small and  
Medium-Sized Enterprises



Springer

# Preface

In this competitive world, industrial organizations are focusing to enhance their productivity through system simplification, organization potential, and incremental improvements by using modern techniques like continuous improvement (CI) or KAIZEN. The present book seems to fulfill an obvious need to write for a variety of reasons. Firstly, although the concept of KAIZEN is familiar to engineers, their treatment of it has always been narrowly focused. Secondly, many people, including engineers, are still wrestling with the difficulties associated with the concept, its applications, and implementation on the shop floors. Thirdly, the role of engineers seems to be more and more positively enhanced nowadays. Their involvement is much more widely spread than previously thought. As KAIZEN tends to focus on business organizations as total dynamic systems, its portrayal in the present form should help engineers appreciate the level of penetration and wide implications. KAIZEN is an evolutionary but umbrella concept that covers all aspects of business units.

KAIZEN is a means to drive the business rather than just being a loose input. It is unfortunate that cynics who consider CI to be just a craze have failed to visualize the evolutionary process by which considerable growth is possible.

This book aims to present a comprehensive approach which is intended to broaden the knowledge of engineers and others concerned with KAIZEN and its implications on their working environment. It is also intended for students and researchers who have to wrestle with this concept in the course of their various studies.

Nonetheless, the authors are grateful to all the people whose ideas have helped shed some light on specific areas of KAIZEN and whose contributions in this field are valued and greatly appreciated by all those who aspire to progress and advancement.

The authors are also grateful to their parents for their support and understanding at all stages of writing this book. Finally, the authors devote this work to THE ALMIGHTY GOD, the only one who has granted them the willingness and ability to successfully complete this book.

Jalandhar, Punjab, India  
Ludhiana, Punjab, India

Jagdeep Singh  
Harwinder Singh

# Contents

<b>1</b>	<b>Introduction</b> . . . . .	1
1.1	Meaning and History of KAIZEN Approach . . . . .	1
1.2	KAIZEN and Innovation . . . . .	2
1.3	SMEs in Indian Context . . . . .	3
1.4	Definitions of Continuous Improvement Approach . . . . .	5
1.5	Different CI Strategies . . . . .	6
<b>2</b>	<b>Literature Review</b> . . . . .	9
2.1	Introduction . . . . .	9
2.2	Ongoing Continuous Improvement Process . . . . .	9
2.3	PDCA and SDCA Cycles of Continuous Improvement . . . . .	11
2.4	Principles of CI Approach . . . . .	11
2.5	Literature Survey . . . . .	13
2.5.1	Literature Related to Conceptual Framework . . . . .	14
2.5.2	Literature Related to Case Studies . . . . .	15
2.5.3	Literature Survey Related to Surveys/Empirical Research . . . . .	19
2.6	Benefits of Implementing CI Approach . . . . .	23
2.7	Concluding Remarks . . . . .	24
<b>3</b>	<b>Design of Study</b> . . . . .	25
3.1	Introduction . . . . .	25
3.2	Problem Formulation . . . . .	25
3.3	Phases of Research . . . . .	26
3.3.1	Identification of Industrial Units . . . . .	26
3.3.2	Options Field Methodology . . . . .	27
3.3.3	Options Profile Methodology . . . . .	27
3.3.4	Analytic Hierarchy Process . . . . .	27
3.3.5	Structural Equation Modeling . . . . .	28
3.4	Overall Equipment Effectiveness (OEE) . . . . .	28

3.5	Objectives and Issues of the Study . . . . .	29
3.5.1	Objectives of the Study . . . . .	29
3.5.2	Issues of the Study . . . . .	29
3.6	Overall Methodology . . . . .	29
<b>4</b>	<b>Analysis of Preliminary Data . . . . .</b>	<b>31</b>
4.1	Introduction . . . . .	31
4.2	Methodology . . . . .	31
4.2.1	Creation of Industry Database . . . . .	31
4.2.2	Pilot Testing of Questionnaire . . . . .	32
4.2.3	Filling of Questionnaire . . . . .	32
4.2.4	Hypotheses for the Study: From the Literature the Following Hypotheses Have Been Framed . . . . .	33
4.3	Level of Usage of CI Strategies . . . . .	34
4.3.1	Discussion of Level of Usage of Eight (08) Main CI Strategies . . . . .	34
4.4	Level of Usage of Sub-strategies of CI Approach . . . . .	36
4.4.1	Discussion of Level of Usage of Sub-strategies of CI Approach . . . . .	36
4.5	Input and Output Variables (CI Strategies and Performance Parameters) . . . . .	36
4.5.1	Reliability Analysis of Input and Output Factor . . . . .	36
4.6	Level of Importance of Sub-strategies of CI Approach . . . . .	37
4.6.1	Result Discussion of Level of Importance of Strategic Implementation of CI Approach . . . . .	39
4.7	Correlation Between Input and Output Variables (Validation of Hypotheses: H1) . . . . .	39
4.7.1	Result Discussion of Correlation Between Input and Output Factors . . . . .	40
4.8	Role of Key Enablers in Improving the Performance of SMEs . . . . .	42
4.9	Level of Importance of Enablers and Sub-enablers of CI Approach . . . . .	43
4.9.1	Result Discussion of Level of Importance of Key Enablers and Sub-enablers of CI Approach . . . . .	43
4.10	Correlation Between CI Enablers and Manufacturing Performance Parameters (Validation of Hypotheses: H2) . . . . .	44
4.10.1	Result Discussion of Correlation Between CI Enablers and Manufacturing Performance Parameters . . . . .	46
4.11	Benefits of CI Approach . . . . .	46
4.11.1	Result Discussion of the Findings for Important Benefits of CI Approach . . . . .	46

- 4.12 Validation of Hypothesis H3: Improvement in Manufacturing Performance Is a Function of Experience Gained by Manufacturing Organizations over an Extended Time Period . . . . . 48
  - 4.12.1 Result Discussion of Two-Tailed “*T*” Test . . . . . 50
- 4.13 Important Barriers in Implementing CI Strategies . . . . . 51
  - 4.13.1 Result Discussion of Important Barriers in Implementing CI Strategies . . . . . 52
- 4.14 Concluding Remarks . . . . . 52
- 5 Case Studies . . . . . 53**
  - 5.1 Introduction . . . . . 53
  - 5.2 Case Study I: Highways Industries Limited, Gill Chowk, Ludhiana . . . . . 53
    - 5.2.1 Introduction to Industry . . . . . 53
  - 5.3 KIP1: To Reduce Quality Rejection of Crankshaft P19 Using Six Sigma DMAIC Approach . . . . . 54
    - 5.3.1 Define Phase or Identification of Critical Areas . . . . . 54
    - 5.3.2 Measure Phase . . . . . 55
    - 5.3.3 Analyze Phase . . . . . 56
    - 5.3.4 Improve Phase . . . . . 56
    - 5.3.5 Control Phase . . . . . 56
  - 5.4 KIP2: To Reduce Setup Time Using Single-Minute Exchange of Die (SMED) . . . . . 59
    - 5.4.1 Methodology Adopted and Case Study Setting . . . . . 59
    - 5.4.2 OEE Improvement Using SMED . . . . . 62
    - 5.4.3 OEE Improvement and Validation of Increase in OEE . . . . . 62
  - 5.5 KIP3: To Reduce Forging Rejection of Crankshaft P19 . . . . . 62
    - 5.5.1 Define Phase . . . . . 62
    - 5.5.2 Measure Phase . . . . . 64
    - 5.5.3 Analyze Phase . . . . . 65
    - 5.5.4 Improve Phase . . . . . 67
    - 5.5.5 Control Phase . . . . . 67
  - 5.6 Data Collection After Implementing DMAIC Approach . . . . . 68
  - 5.7 Cost-Benefit Analysis . . . . . 69
  - 5.8 Flexible System Methodology . . . . . 70
  - 5.9 SAP-LAP Analysis for Case Study I . . . . . 70
    - 5.9.1 Situation . . . . . 70
    - 5.9.2 Actors . . . . . 70
    - 5.9.3 Process . . . . . 71
    - 5.9.4 Learning Issues . . . . . 71
    - 5.9.5 Actions Suggested . . . . . 71
    - 5.9.6 Performance Expected . . . . . 71

5.10	Case Study II: Farm Parts Industries Ltd., Ludhiana. . . . .	72
5.10.1	Introduction to the Industry and Company Strategy . . . . .	72
5.11	X-Matrix for Policy Deployment. . . . .	72
5.11.1	KIP 1: To Achieve 63% OEE. . . . .	76
5.11.2	KIP2: To Reduce Rejections to 2000 ppm. . . . .	76
5.11.3	KIP3: To Improve the Breakdown Hours (Table 5.21) . . . . .	77
5.11.4	KIP4: To Increase MTBF of Various Machines. . . . .	78
5.11.5	Increase in MTBF and Validation of Increase in MTBF . . . . .	81
5.11.6	KIP5: To Increase Operator Efficiency by Technical Training . . . . .	81
5.12	Maintenance Job Card . . . . .	82
5.13	Breakup of OEE and Rejection . . . . .	82
5.13.1	Cause-Wise Breakup for OEE: The Percentage Breakup of CNC Machine Is Given Below . . . . .	82
5.13.2	Cause-Wise Breakage of Rejection . . . . .	83
5.14	SAP-LAP on Case Study III . . . . .	83
5.14.1	Situation. . . . .	83
5.14.2	Actors. . . . .	83
5.14.3	Process . . . . .	84
5.14.4	Learning Issues . . . . .	84
5.14.5	Actions Suggested . . . . .	84
5.14.6	Performance Expected . . . . .	84
5.15	Comparison of Case Studies . . . . .	85
<b>6</b>	<b>Synthesizing of Data . . . . .</b>	<b>87</b>
6.1	Introduction . . . . .	87
6.2	Methodology Adopted . . . . .	87
6.2.1	Step 6.2.1: Degree of Preference . . . . .	87
6.2.2	Step 6.2.2: Normalized Matrix of Different Sub-objectives . . . . .	88
6.2.3	Step 6.2.3: Do Consistency Check. . . . .	88
6.2.4	Step 6.2.4: Priority Weights for Alternatives with Respect to Attribute . . . . .	91
6.3	Compromise Ranking Method. . . . .	91
6.3.1	Step 6.3.1: Determine the Values of $E_i$ and $F_i$ . . . . .	92
6.3.2	Step 6.3.2: Calculation of $P_i$ Values . . . . .	92
6.4	Methodology for Modeling . . . . .	93
6.4.1	Synthesis of Learning Issues . . . . .	93
6.5	Different Methods for Modeling . . . . .	95
6.5.1	Options Field Methodology (OFM). . . . .	95
6.5.2	Formation of Categories. . . . .	96
6.5.3	Options Profile Methodology (OPM) . . . . .	98
6.5.4	Fuzzy Set Theory . . . . .	99

- 6.6 Structural Equation Modeling ..... 103
  - 6.6.1 Measurement Model for Improving the Performance of SMEs ..... 106
  - 6.6.2 Validation of Hypotheses Framed ..... 107
- 7 Conclusions, Limitations, and Scope for Future Work ..... 111**
  - 7.1 Conclusions ..... 111
    - 7.1.1 Conclusions from the Survey ..... 111
    - 7.1.2 Conclusions from the Case Studies ..... 112
    - 7.1.3 Conclusions from Implementation Plan ..... 113
  - 7.2 Limitations of the Study ..... 114
  - 7.3 Scope for Future Work ..... 114
- Appendix: KAIZEN Questionnaire ..... 115
- Bibliography ..... 123

# About the Authors

**Jagdeep Singh** holds a bachelor's degree in mechanical engineering, master's degree in production engineering, and Ph.D. in mechanical engineering. The author has published a good number of research papers in international and national journals. The author is working as an assistant professor in the Industrial and Production Engineering Department at Dr B.R. Ambedkar NIT Jalandhar, Punjab. The field of interest of the author is management of production systems and operations management.

**Harwinder Singh** holds a bachelor's degree in mechanical engineering, master's degree in production engineering, master's degree in business administration, and Ph.D. in mechanical engineering. The author has published a good number of research papers in international and national journals. The author is working as a professor in the Department of Mechanical Engineering at Guru Nanak Dev Engineering College, Ludhiana, Punjab. The field of interest of the author is management of production systems, operations management, and decision making.



# Abstract

Continuous improvement (CI) is a technique to improve the performance at every level of operation, in every functional area of an organization, by maximum utilization of available resources. It is a management approach that focus on enhancement of manufacturing processes through incremental changes. It is a management approach of identifying and eliminating waste (all non-value-added activities) through incremental improvements by reducing the time associated with setup in pursuit of perfection. CI programs have evolved from traditional manufacturing focused systems that concentrate on the production line to reduce waste and improve the product quality, into comprehensive, systematic methodologies that is focused on the entire organization. To achieve excellence in every sphere of the world is not a fortnightly process. If it is not taken care of, the competencies gained by the organization might fade away with the passage of time. The organization must consistently send a strong message to employees that continuous improvement strategies are the core values of the company. Different strategies of CI approach are being used by the manufacturing organizations to improve the performance of current manufacturing system processes.

The present study is an attempt to check the performance of KAIZEN technique in small–medium enterprises (SMEs) of Northern India. A survey of 101 SMEs has been performed in Northern India. The level of usage, level of importance of different strategies, level of importance of different enablers, and the important benefits achieved from KAIZEN implementation have been identified. Correlation analysis shows significant relationship between different CI strategies and benefits of CI approach. SMEs use total quality management (TQM) strategies to its highest maturity level. Two case studies have been performed to ascertain the important benefits occurred after CI strategic implementation. CI strategies including value stream analysis, redesign, suggestion system, failure mode effect analysis, process flow mapping, recognition, minor stoppage elimination, and customer quality, cost and delivery analysis (QCD) through holistic CI implementation program can significantly contribute in harnessing incremental improvements in the organization, thereby providing a sound platform for the organization to compete effectively in the dynamic environment. CI activities through strategic implementation can

contribute towards quality enhancements by eliminating deteriorations in production systems but also have negative impact on the safety-related issues of employees. The study critically reveals the contributions of CI strategic implementation for achieving manufacturing performance improvement through quality initiatives in the SMEs of Northern India. The study reported in this work has revealed that there is a benefit of CI strategic implementation in the Indian industry and there is a need to develop an implementation plan to foster CI implementation practices and procedures. Overall equipment effectiveness (OEE) parameters seek to encourage the setting of ambitious, but attainable, realistic goals for raising the OEE by focusing on the losses related to availability, performance, and quality of a system. It prepares the plant to meet the challenges of competitive manufacturing by adoption and implementation of a well-conceived plan with the help of preventive maintenance teams for effective equipment maintenance.

Strategic implementation of CI approach systematically aims at improving the OEE using setup time reduction. Six Sigma approach is helpful in achieving process improvement and thereby achieving different goals of productivity and the organization. The successful implementation of single-minute exchange of die (SMED) and other CI strategies are the key to a competitive advantage for any manufacturer that produces, prepares, processes, or packages a variety of products. The reduction of defective part million opportunity (DPMO) level from 75655.25 to 455.26 has been obtained to enhance the performance of manufacturing unit. The net savings of 17.65 lacs per year have been obtained after the successful implementation of the DMAIC approach. Six Sigma provides an effective mechanism to focus on customer requirements, through improvement of process quality. CI has proven to be a means to supplement the concerted improvement efforts by addressing equipment and other related problems that affect the performance of the manufacturing system.

CI implementation in the enterprise has demonstrated the effective realization of optimized equipment effectiveness, minor stoppage elimination, and promotion of autonomous operator maintenance through day-to-day activities involving the total workforce. CI has helped the enterprise in improving the synergy between the production department and rest of the improvement functions, resulting in elimination of defects, improved process reliability like OEE, affecting cost reductions thereby strengthening sustainability efforts of the organization to meet cut-throat global competition for business excellence. It therefore becomes pertinent for the successful organizations to integrate improvement initiatives into their manufacturing strategy for realization of organizational objectives. The successful CI implementation program can facilitate the manufacturing organization's quest for achieving enhanced manufacturing performance leading to the firm's performance improvement. Thus, in today's competitive environment CI approach has proven to be an effective global strategy, for Indian organizations, rendering firms a consistent enhancement of performance in terms of achieving manufacturing performance improvement.

Implementation plan reveals that the implementation of CI strategies leads to the success of the organization by focusing on the losses related to availability, performance, and quality of a system. Structural equation modeling (SEM) shows dependency of one initiative on other initiative of CI approach. SEM is a powerful tool that enables researchers to go beyond factor analysis into the arena of determining whether one set of unobserved constructs is related to another set of constructs. Customer and supplier relations play a significant role in improving the performance of the firm and hence improve the manufacturing system processes showing high positive correlation. SEM investigates the impact of three sets of antecedent factors on the firm performance. Customer satisfaction regarding cost, delivery, and quality plays an important role in improving the firm performance by obtaining different benefits including organization achievement, increased productivity, improved quality, reducing cost, improving safety, and timely delivery of the product manufactured.