

**INDUSTRIAL REVOLUTION 4.0
REGULATORY DEMAND COMPLIANCE WITH
HUMAN RESOURCE PRACTICES FOR
SMALL MEDIUM MANUFACTURING SECTOR
ENTERPRISES IN MALAYSIA**

MURUGIAH A/L SUPPIAH

**ASIA e UNIVERSITY
2024**

INDUSTRIAL REVOLUTION 4.0 REGULATORY DEMAND
COMPLIANCE WITH HUMAN RESOURCE PRACTICES FOR SMALL
MEDIUM MANUFACTURING SECTOR ENTERPRISES IN MALAYSIA

MURUGIAH A/L SUPPIAH

A Thesis Submitted to Asia e University in
Fulfilment of the Requirements for the
Degree of Doctor of Philosophy

April 2024

ABSTRACT

The Industrial Revolution evolved from manual labor to the adoption of mechanical, electrical, and electronic technologies over time. However, the electronics industrial development led to digital technology. Germany in 2017 introduced the term industrial revolution 4.0 (IR 4.0), for the engineering process which on implementation can lead to manufacturing efficiency, increased business capacity, quality control, and greater flexibility in operation and production. Since then the basic IR 4.0 technology has evolved from robotics to digital and IOT. As for Malaya/Malaysia, the process of change from manual labor to mechanical, water power and the steam engine was introduced and developed during the tin mining industry in about 1878 that then progressed to Electrical and electronic technology and a well-structured legislation which also provided well-structured and seamless training and certification of mostly mechanical and electrical manpower with the relevant skills and talent. [2]IR 4.0 is developing exponentially, and if Malaysia is to meet with the challenges in technology there is a need to develop the manpower of relevant skills and talent. Malaysian government formalized the IR 4.0 transformation through the 4WRD policy which has identified Funding, Infrastructure, Regulations, Skills and Talent and Technology as elements for the IR 4.0 transformation. This thesis is a study on IR 4.0 development in Malaysia with emphasis on the three important elements that is Skills and Talent, technology requirement and more important compliance with Regulatory requirement of the Malaysian government's 4WRD policy. The data collection from 395 sampling from among 70,000 SME industries by Competent Engineer qualified under the Electricity Supply Act 190 and Electricity Regulations 1994. who are actively undertaking technical inspection and audit on a regular basis as a requirement of the Energy Commission? A briefing was given to these Engineers on the requirement of the data collection Forms and the process. Since all these Engineers are experienced in reporting in accordance with the Electricity Regulations 1994 the briefing given was well understood by the Engineers. Theses Engineers we also informed to main ethical values in the data collection industry owners must be informed on the intention and purpose of the data collection which is for academic study and analysis and the personal particulars of the owners and the details of the factory shall remain confidential. It was also explained that result of the survey and report will in fact be useful information for the benefit of the SME industry. Data collection was undertaken and completed without any hindrance. The data so collected was analyzed. The results of the data analysis indicate that the talent and skills, technology and regulatory are in most cases at or below IR3.0.

Keywords: Industrial revolution, funding, infrastructure, regulations, skills

APPROVAL

This is to certify that this thesis conforms to acceptable standards of scholarly presentation and is fully adequate, in quality and scope, for the fulfilment of the requirements for the degree of Doctor of Philosophy

The student has been supervised by: **Assoc. Prof Dr. Oo Yu Hock, AeU**

The thesis has been examined and endorsed by:

Assoc Prof Dr Ilham Sentosa, Adjunct Assoc Prof, SOM

Examiner 1

Prof Dr Asif Mahbub Karim, Binary University

Examiner 2

This thesis was submitted to Asia e University and is accepted as fulfilment of the requirements for the degree of Doctor of Philosophy.

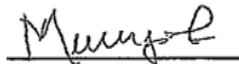


.....
Professor Dr. Siow Heng Loke
Asia e University
Chairman, Examination Committee
[9 April 2024]

DECLARATION

I hereby declare that the thesis submitted in fulfilment of the PhD degree is my own work and that all contributions from any other persons or sources are properly and duly cited. I further declare that the material has not been submitted either in whole or in part, for a degree at this or any other university. In making this declaration, I understand and acknowledge any breaches in this declaration constitute academic misconduct, which may result in my expulsion from the program and/or exclusion from the award of the degree.

Name: MURUGIAH A/L SUPPIAH

A handwritten signature in black ink, appearing to read 'Murugiah', is written over a horizontal line.

Signature of Candidate:

Date: 9 April 2024

Copyright by Asia e University

ACKNOWLEDGEMENTS

I WISH TO ACKNOWLEDGE WITH THANKS:

Associate **Prof. Dr. Oo Yu Hock** for the guidance and advice given in the preparation, review and approval of this thesis. Council members of the Institution of Certified Engineers Malaysia, who are professional and /or registered competence electrical engineers of the Institution of Certified Engineers Malaysia, in the data collection from SME installation for the survey. Senior members at SMES for their valuable comments on the regulatory requirement at SME installations.

Mr. Lee Heng Seong for assisting in the thesis document formatting to comply with AeU requirement. The Lecturers, in particular **Prof. Dr. Siow Heng Loke** at AeU during the course of my study and the invaluable advice given. Staff of the AeU library for the detail review and comment on the format of the thesis to comply with AeU requirement. Lastly, and certainly not least, I thank my family for their encouragement in completing this thesis, which I hope will benefit the industry, particularly SMEs, in achieving IR4.0 transformation in Malaysia.

MURUGIAH SUPPIAH

TABLE OF CONTENTS

ABSTRACT	ii
APPROVAL	iii
DECLARATION	iv
ACKNOWLEDGEMENTS	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF ABBREVIATION	xiv
CHAPTER 1 INTRODUCTION	1
1.0 Background of Study	13
1.1 Problem Statement	23
1.2 Research Questions	26
1.3 Research Objective	27
1.4 Research Hypothesis	28
1.5 Signification of Study	29
1.6 Scope of Study	33
1.7 Chapter Summary	36
1.8 Conclusion	38
CHAPTER 2 REVIEW OF LITERATURE	40
2.0 Introduction	40
2.0.1 The Problem in Adoption of IR 4.0 Technology	57
2.0.2 Industrial Revolution in This Country	60
2.0.3 The Effects of Covid-19 Pandemic on IR4.0 Transformation	63
2.1 Malaysia Policy and Framework of IR 4.0	68
2.2 Job Analysis	111
2.3 Training Need Assessment	113
2.4 Reward System and Career Path	115
2.4.1 Job Satisfaction	116
2.5 Talent Acquisition	118
2.6 Automation	119
2.7 Autonomy	119
2.8 Professionalism and Expertise	125
2.9 Theoretical Framework	126
CHAPTER 3 METHODOLOGY	135
3.0 Research Design	135
3.1 Research Philosophy	139
3.1.1 Objectivism (Positivism)	140
3.1.2 Subjectivism (Phenomenology)	140
3.1.3 Rationale / Justification of Research	142
3.2 Methodology	145
3.2.1 Theory/Model	145
3.2.2 Research Plan	146
	vii

3.2.3	Methods	149
3.3	Conceptual Framework	159
3.3.1	Independent Variables	159
3.3.2	Dependent Variable	160
3.3.3	Moderating Variables	160
3.3.4	Competence Requirements	161
3.4	Population, Sample, Sampling	162
3.4.1	Population	162
3.4.2	Sample	163
3.4.3	Sampling Technique	165
3.4.4	Units of Analysis	168
3.5	Data Collection	168
3.5.1	Research Instrument	168
3.5.2	Survey	169
3.5.3	Data Sources - Interview	170
3.5.4	Data Processing	170
3.6	Statistical Analysis	171
3.6.1	Tools of Analysis	171
3.6.2	Reliability and Validity (Pilot)	172
3.6.3	Measurements	183
3.7	Ethical Considerations	184
3.8	Data Collection and Analysis	186

CHAPTER 4 RESULTS AND DISCUSSION 188

4.0	Introduction	188
4.1	Descriptive Statistics	189
4.2	Modal Summary	201
4.3	Testing of Hypothesis	204
4.3.1	Hypothesis 1	205
4.3.2	Hypothesis 2	206
4.3.3	Hypothesis 3	209
4.4	Reliability test	211
4.5	Validity	212
4.6	Summary	214

CHAPTER 5 Results and Discussions 216

5.0	Introduction	216
5.1	Major Findings	217
5.2	Descriptive Statistics	218
5.3	Results	223
5.4	Results and Discussion	227
5.4.1	Ascertaining Manpower Competency Required for I.R4.0 Transformation	227
5.5	Comprehending Existing SME Regulatory Requirement for I.R4.0 Transformation	232
5.6	Identifying Current Organizational Technological and Standards in Desired IR 4.0 Transformation	238
5.7	Summary	242

REFERENCES
APPENDICES

243
271

LIST OF TABLES

Table		Page
3.1	Item-total statistics	174
3.2	Reliability statistics 1	175
3.3	SPSS Result	176
3.4	Correlations 1	178
3.5	Research question 3 (objective 1)	179
3.6	Skill and talent Employees	180
3.7	Descriptive statistics	180
3.8	Regulation requirements	181
3.9	Multivariate tests 1	181
3.10	Fourth objective	183
4.1	Descriptive Statistics 1	190
4.2	Skill & talent of employees (objective 1)	192
4.3	Operational training needs of employees (objective 2)	193
4.4	Maintenance and repair training needs of employees (objective 3)	194
4.5	Responsibility of employee (objective 4)	195
4.6	Regulatory requirement (objective 5)	196
4.7	Technology of factory (objective 6)	197
4.8	Multivariate 2	198
4.9	Modal summary	201
4.10	Anova	201
4.11	Correlations 2	202
4.12	Level of current manpower at Malaysia MSME	203

4.13	Hypothesis 2	207
4.14	Hypothesis 3	210
4.15	Item total statistics	211
4.16	Reliability statistics 2	212
4.17	Reliability statistics 2	213
4.18	Item-total statistics 3	213
5.1	Reliability statistics 4	218
5.2	Descriptive statistics 2	219

LIST OF FIGURES

Figure	Page
1.1 Definition of MSMEs by size in Malaysia	8
1.2 MSME statistic by sector	13
1.3 The Malaysia IR transformation	18
1.4 History of global industry revolution	20
1.5 The growth of small medium enterprises-SMEs in Malaysia	22
1.6 Malaysia policy framework	26
1.7 Framework of independent variable and dependent variable	28
1.8 Modal hypothesis	33
2.1 MSME statistics by sector 2	55
2.2 Industry 4.0 transformation	68
2.3 Government national policy	76
2.4 Consumer behavior	88
2.5 Vision, goals, factors and enabler for IR 4.0	93
2.6 Advance technology	98
2.7 Human capital training	102
2.8 Training need assessments	113
2.9 Factors influencing employee embeddness	118
2.10 Principal legislation relevant to IR 4.0	119
2.11 Framework of independent variable and dependent variable	127
2.12 Typical theoretical framework of Industry 4.0 technologies	132
2.13 Theoretical framework	134
3.1 Conceptual framework	159

3.2	Source Krejcie and Morgan	163
4.1	Skill and talent employees	192
4.2	Operational training needs of employees	193
4.3	Maintenance and repair training needs of employees	194
4.4	Responsibility of employees	195
4.5	Regulatory requirement	196
4.6	Technology of factory	197
4.7	Level current manpower at Malaysia MSME	204

LIST OF ABBREVIATION

SMEs	Small and medium enterprises
MSMEs	Malaysia small and medium enterprises
HRM	Human resources management
IR 4.0	Industry revolution 4.0
AI	Artificial intelligent
SCM	Supply chain management

CHAPTER 1

INTRODUCTION

1.0 Chapter Overview

This chapter highlights the background of the study which share insights on human capital development relevant to the Industrial Revolution 4.0. (IR4.0), in particular on the readiness, compliance with regulatory requirements and the challenges in the small and medium enterprises manufacturing sector in Malaysia. The SMEs now also include micro-level industries and are generally referred to as MSMEs. The emergence of Industry 4.0 does not only mean technological development; it represents a profound change in the way industries operate and interact with the world around them. This paradigm shift is characterized by the integration of many cutting-edge technologies that are collectively redefining manufacturing processes, supply chains, and even business models. The focus of Industry 4.0 is on digital technologies including artificial intelligence (AI), Internet of Things (IoT), big data analytics, cloud computing, and robotics. These technologies are not isolated entities, but components that are interconnected and reinforce each other to improve productivity, innovation, and competitiveness together. (Mckinsey & company, 2022)

In Industry 4.0, manufacturing processes are no longer limited to traditional assembly lines and manual labor. Instead, they are evolving into intelligent, interconnected systems that can operate autonomously and make data-driven decisions. Integrating sensors, devices, and machines with IoT capabilities enables real-time data collection and transmission. This data, when analyzed by advanced algorithms and AI, enables predictive maintenance, quality control, and process

optimization. As a result, downtime is reduced, production quality is improved, and operational efficiency is increased.

The transformation to IR4.0 will necessitate significant technological advancements beyond IR3.0, which evolved gradually from IR2.0. IR3.0 to IR4.0 is a major rapid shift. This will require a major change in skill and development, all progressing within regulatory requirement and funded by the industry owners and the certainly by the government due to the large financial assistance required.

SMEs play a central role in economies around the world, contributing to job creation, innovation and economic growth. In Malaysia, the SME manufacturing sector occupies an important part of the country's industrial scene. However, the road to Industry 4.0 adoption can be difficult for these companies. Unlike large enterprises, SMEs often face constraints in terms of financial resources, technological expertise, and workforce capacity. The potential benefits of Industry 4.0 adoption are too great to be ignored. (Lauren Thomas, 2020).

The willingness of SMEs to join the adventure of Industry 4.0 changes dramatically. While some forward-thinking companies have begun to integrate smart technologies into their operations, many others remain uncertain about the relevance and feasibility of these advances. Complying with Industry 4.0 requires investment not only in capital but also in human resource development. This includes developing the existing workforce to effectively operate and manage these new technologies. (The Occupational Safety and Health Act, 1970)

Government initiatives, educational institutions and industry associations in Malaysia have recognized the importance of preparing SMEs for Industry 4.0. Training programs, seminars and knowledge-sharing sessions were introduced to

bridge the knowledge gap and provide SMEs with insight into the potential benefits that they can gain from digital transformation.

In Industry 4.0, manufacturing processes are no longer limited to traditional assembly lines and manual labor. Instead, they are evolving into intelligent, interconnected systems that can operate autonomously and make data-driven decisions. Integrating sensors, devices, and machines with IoT capabilities enables real-time data collection and transmission. This data, when analyzed by advanced algorithms and AI, enables predictive maintenance, quality control, and process optimization. (Adnan & Anuar, 2021)

SMEs play a central role in economies around the world, contributing to job creation, innovation and economic growth. In Malaysia, the SME manufacturing sector occupies an important part of the country's industrial scene (Lauren Thomas, 2020).

The importance of skills and talent development, and the need to comply with regulatory requirement, in particular the requirement of the Electricity Supply Act 1990 and Regulations, the Factories and Machinery Act 1967, the Registration of Engineers Act and the Occupational Safety and Health Act 1994 and Regulations will be explained to ensure that study is comprehensive for IR4.0 transformation at MSMEs. Skills and talent development are the cornerstone of a successful Industry 4.0 transition for micro, small and medium enterprises (MSMEs). As the manufacturing landscape undergoes a dramatic shift towards digitization and automation, the role of the workforce is evolving from traditional manual labor to operating and maintaining sophisticated technologies. Recognizing and responding to skills and talent development needs is critical for MSMEs to harness the full potential of Industry 4.0 and remain competitive in a globalized economy.

The advent of Industry 4.0 introduces new tools, software and machines that require a certain level of technological skills to function effectively. MSMEs need to invest in upskilling their workforce to equip them with the skills to use these technologies. This includes training in programming, data analytics, robotics, and AI. Such upskilling not only enhances the value of employees to the business but also allows them to make a significant contribution to process optimization and innovation. Industry 4.0 relies on data-driven decision-making and innovative problem-solving. A skilled workforce is better equipped to collect and interpret data, identify patterns, and come up with innovative solutions to challenges. Skills development should not be limited to technical ability; fostering creativity and adaptability is equally important. MSMEs that prioritize these aspects of their workforce will be better positioned to seize the opportunities presented by Industry 4.0, improving their products, services, and overall competitiveness.

As MSMEs begin their Industry 4.0 journey, compliance with regulatory requirements becomes increasingly important. Several key regulations, including the Electricity Supply Act of 1990, the Factories and Machinery Act of 1967, and the Occupational Safety and Health Act of 1994 and their respective regulations, have had a profound impact when focusing on the application of Industry 4.0 technologies.

The Electricity Supply Act of 1990 and Electricity Regulation 1994 regulates the generation, transmission and distribution of electricity in Malaysia. As MSMEs integrate advanced technologies and automation into their processes, electricity consumption can increase drastically. Compliance with this law ensures that the growing demand for electricity is met legally and safely. In addition, it encourages the adoption of energy-efficient practices, in line with the sustainability goals that often accompany Industry 4.0 initiatives.

The Factories and Machinery Act of 1967 establishes regulations for the safe operation of factories and machinery in Malaysia. With the advent of automation, robots and AI-driven machines, safety has become paramount. Compliance with this law ensures that the integration of these technologies does not affect the welfare of workers. MSMEs should adhere to the principles of inspection, maintenance, and staff training in the use of new technology machines to reduce risks associated with Industry 4.0 adoption.

The Occupational Safety and Health Act 1994 emphasizes protecting the health, safety and welfare of employees in the workplace. As Industry 4.0 introduces new technologies and processes, it is imperative that MSMEs adapt their security protocols to these changes. Compliance involves assessing risks, training appropriate staff and maintaining safe working conditions. Ensuring the well-being of the workforce is not only ethically necessary, but it is also necessary to maintain continuity of operations and Synergy between skill development and regulatory compliance. (The Occupational Safety and Health Act, 1970)

Skills and talent development are the cornerstone of a successful Industry 4.0 transition for micro, small and medium enterprises (MSMEs). As the manufacturing landscape undergoes a dramatic shift towards digitization and automation, the role of the workforce is evolving from traditional manual labor to operating and maintaining sophisticated technologies. Recognizing and responding to skills and talent development needs is critical for MSMEs to harness the full potential of Industry 4.0 and remain competitive in a globalized economy.

The advent of Industry 4.0 introduces new tools, software and machines that require a certain level of technological skills to function effectively. MSMEs need to invest in upskilling their workforce to equip them with the skills to use these

technologies. This includes training in programming, data analytics, robotics, and AI. Such upskilling not only enhances the value of employees to the business but also allows them to make a significant contribution to process optimization and innovation. (Ministry of Investment, Trade and Industry (MITI), 2017)

Industry 4.0 relies on data-driven decision-making and innovative problem-solving. A skilled workforce is better equipped to collect and interpret data, identify patterns, and come up with innovative solutions to challenges. Skills development should not be limited to technical ability; fostering creativity and adaptability is equally important. MSMEs that prioritize these aspects of their workforce will be better positioned to seize the opportunities presented by Industry 4.0, improving their products, services, and overall competitiveness.

As MSMEs begin their Industry 4.0 journey, compliance with regulatory requirements becomes increasingly important. Several key regulations, including the Electricity Supply Act of 1990, the Factories and Machinery Act of 1967, and the Occupational Safety and Health Act of 1994 and their respective regulations, will have a profound impact on focus on the application of Industry 4.0 technologies.

The Electricity Supply Act of 1990 and Electricity Regulation 1994 regulates the generation, transmission and distribution of electricity in Malaysia. As MSMEs integrate advanced technologies and automation into their processes, electricity consumption can increase drastically. Compliance with this law ensures that the growing demand for electricity is met legally and safely. In addition, it encourages the adoption of energy-efficient practices, in line with the sustainability goals that often accompany Industry 4.0 initiatives. (Malaysia. 2001. Electrical Supply Act 1990).

The relationship between skills development and regulatory compliance is a symbiotic relationship in the context of Industry 4.0 transformation for MSMEs. A

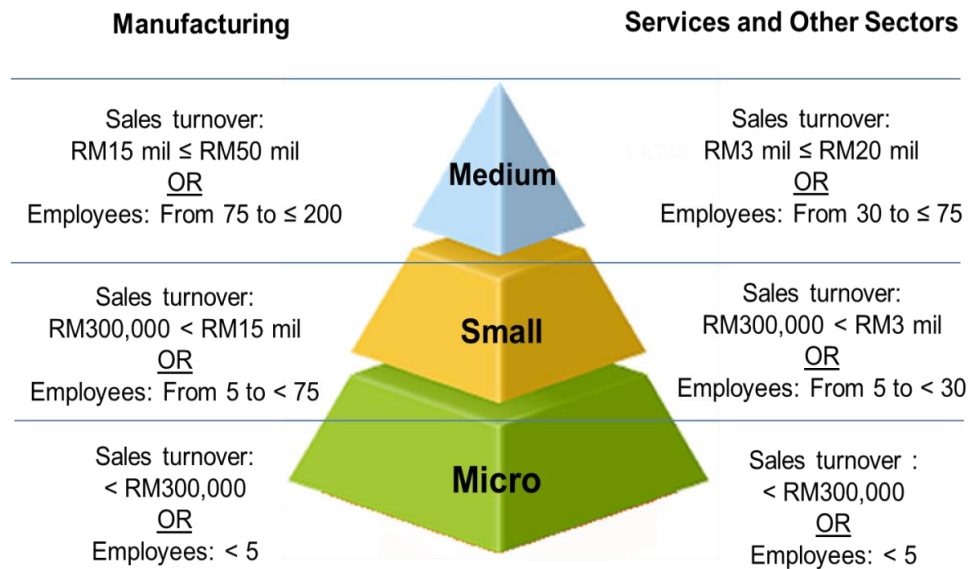
skilled workforce is better equipped to understand and comply with complex regulations. In contrast, compliance with regulations often requires the development of specific skills. For example, regulations related to machine safety and employee welfare require specialized knowledge and training. A well-trained workforce is more likely to recognize potential hazards and take appropriate action to reduce risks.

Compliance with regulatory requirements is an essential component of any manufacturing and services activity. Normally the authorities responsible for such regulatory requirements are required to check for compliance with such relevant regulatory requirements. However, what is important is that importers and purchasers of goods and services, especially foreign importers or local purchasers who are in the supply chain for re-export to established purchasers require evidence of compliance with the many local regulatory requirements.

This is evidenced by the internationally recognized certificate issued by the International Standards Organization –ISO with head office in Geneva. The local representative being the Department of Standards Malaysia and SIRIM authorized to conduct the audit on an annual basis.

All efforts in the transformation to IR4.0 will be a failure if the ISO standard is not met and the ISO certificates are not obtained.

Figure 1.1: Definition of MSMEs by size in Malaysia



MSMEs though representing Micro, Small, and Medium Enterprises are projected to contribute 45 percent of the country’s Gross Domestic Products (GDP) and 25 percent of the total exports by 2025. (Petrillo, 2018)

According to Bengkit Kembali, the Malaysian Prime Minister acknowledged MSMEs in his speech at the 2022 Small and Medium Enterprise Annual Showcase (Smidex) themed ‘PMKS’ for contributing RM 298 billion to the country’s GDP and surging to RM 512 billion last year with new job opportunities for 7.3 million people. Emphasizing on the MSME’s recovery, he continues to highlight its primary focus on the two areas as its recovery catalyst:

- 1) Optimization of innovation.
- 2) Digitalization and technology usage by the sector to boost the recovery agenda.

He also added that the activities which are done through e-commerce like digital payment, long-distance learning, video conferencing as well as logistics services have become the new norm in today’s economy, due to the increasing needs and opportunities.

Therefore, the above can be taken as the factors in the effort to help MSMEs with the Fourth Industrial Revolution's (IR4.0) opportunities.

The adoption and compliance with Regulatory changes that will have to be complied with or adopted due to this technology transformation will be included in this study.

The concept of IR4.0 affirms that technological change is a driver of transformation relevant to all industries and parts of society (Philbeck & Davis, 2019). Changing Technology will require changes in Human Resource Development to bring about changes and improvements in skills and talent which need to be achieved in a structured approach considering of the global technological advancement. In the context of the rapidly evolving Industry 4.0 landscape, the integration of changing technology with a structured human resource development approach stands as a pivotal strategy for organizations aiming to navigate the complexities of this transformative era. Industry 4.0, characterized by technologies like automation, artificial intelligence, and the Internet of Things, demands a dynamic workforce that possesses the skills and talents required to harness the potential of these advancements. This structured approach encompasses several essential facets, including upskilling and reskilling initiatives, fostering a culture of continuous learning, recognizing the significance of global technological advancements, nurturing cross-cultural competence, promoting innovation and critical thinking, and embracing agility and adaptability as core competencies.

In this dynamic landscape, agility and adaptability emerge as core attributes. Changes in management training equip the workforce with the skills to navigate transitions seamlessly, while the cultivation of a learning mind-set ensures that change is embraced as an opportunity for growth. Encouraging employees to develop diverse