KNOWLEDGE MANAGEMENT AND INDUSTRIAL REVOLUTION 4.0

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Preface

This book focuses on how the practices of Industrial Revolution 4.0 and knowledge management interact to create value. This volume mainly discusses the impact and challenges of knowledge management in the Fourth Industrial Revolution. In recent years, the value chain relationships and related activities have taken advantage of new technologies, but a new era is beginning and the existing conceptual frameworks require a roadmap for innovation strategies and effective implementation. The material collected herein includes case studies contributed from researchers and industry practitioners that showcase the impact of practices and challenges presented by technological changes, upgradation of old systems, and internal and external factors.

Knowledge Management and Industrial Revolution 4.0: Impacts and Challenges describes how knowledge management impacts the automation of the industry in secure, controlled, and optimized ways. For instance, the use of the latest technologies and sensors can lead to significant time and cost savings, and operators can utilize their machines and equipment from remote locations. The Industrial Revolution 4.0 incorporates the latest technologies for automation and, in many cases, the result is similar to working from home, even in manufacturing.

The use of deep learning should offer many quality control benefits. Furthermore, blockchain technology can help the industry with automation in secure and transparent ways. Apart from industry automation, other departments like human resources can also use effective knowledge management for better outcomes. The use of HR knowledge management allows employees to find and access the information they require without the assistance of the HR department. However, proper management is required to make all information accessible to every employee, otherwise they can become exhausted or access information not fruitful to them.

The book focuses on every aspect of the industry to help all the stakeholders of an organization. The benefits include a reduction in time required for accessing information, easier training, decreased operational expenses, improved stakeholders' satisfaction, faster problem-solving, increased pace of innovation, simpler employee review and progress reports, etc.

Chapter 1 discusses the integration of IoT (Internet of Things) into manufacturing processes. It also introduces new challenges, including cyber-security vulnerabilities and the necessity for upskilling labor forces.

Chapter 2 proposes an intelligent complex adaptive system named 4A, which insists on Agent, Algorithm, Architecture, and Adaptation. The proposed model aims to offer a more adaptable and flexible approach to KM in the context of I4.0.

Chapter 3 discusses the synergizing of knowledge management in the era of Industry 4.0.

Chapter 4 gives an overview of how knowledge production (knowledge creation, capture, sharing, and application) helps manufacturing organizations acquire new information, discuss best practices, successfully use knowledge, and incorporate new knowledge to promote innovation.

Chapter 5 sheds light on the significance of cyber security measures in safeguarding sensitive data and maintaining the integrity of interconnected systems. This comprehensive review highlights the transformative potential of Industry 4.0 and the pivotal part of knowledge management in its successful implementation.

Chapter 6 discusses the use of artificial intelligence in knowledge management and the Industrial Revolution 4.0.

Chapter 7 presents a transformative opportunity for organizations seeking enhanced efficiency and sustainable growth through the convergence of Industry 4.0 and knowledge management.

Chapter 8 provides various insights on the requirements for advanced development and dynamic change in the industrial sector.

Chapter 9 serves as a comprehensive guide for organizations seeking to harness the potential of Industry 4.0 while adeptly managing their knowledge assets.

Chapter 10 discusses the use of IoT and data analytics to enhance knowledge management in Industry 4.0.

Chapter 11 presents a study of the software-defined analysis framework for Industry 4.0, and specifically for Industrialized Control and Automation Systems (ICAS).

Chapter 12 includes the results of a survey aimed at understanding the structural relationship between interest in programming and creative attitudes among Japanese high school students as part of the knowledge management process in preparation for the Industrial Revolution 4.0.

Chapter 13 examines the concepts and roles of Blended-Mode Instruction (BMI) as an emerging knowledge management platform during the Industrial Revolution 4.0. It aims to promote Science, Technology, Reading, Engineering, Arts, and Mathematics (STREAM) education in three Southeast-Asian countries and China.

Chapter 14 gives an insightful review of advanced digital manufacturing technology solutions for Industry 4.0.

Chapter 15 presents a study for enhancing students' learning achievement, 21st-century skills, and self-regulation skills with a knowledge management and Industry 4.0 perspective.

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The 5G Technology IR4 and Knowledge Management

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Abstract

Often termed as Industry IR-4.0, the fourth revolution industry encompasses the merging of high-end technologies, with a distinct emphasis on the Internet of Things (IoT), within the manufacturing domain, leading to the transformation of the industrial landscape into a heightened state of intelligence. The IoT concept encompasses the interlinking of hardware devices, vehicles, and various objects embedded with sensors and connectivity software, facilitating processes like data collection, organization, and exchange. The swift growth of IoT in the present years has led to an upsurge in Internet-connected devices spurring the need for faster and more dependable networks to accommodate this expansion. The emergence of 5G networks offers a potential solution delivering enhanced speeds, reduced delay, and increased capacity compared to previous generations. These 5G networks are well positioned to support a wide variety of IoT devices, including sensors, wearable, smart cities, autonomous vehicles, and industrial factories. Thanks to its increased bandwidth and decreased latency, 5G facilitates real-time communication between devices enabling more efficient data transfers. This capability finds particular relevance in applications, such as industrial automation, where seamless real-time communication between machines enhances production processes. Notably, 5G networks for IoT offer support for extensive machine-type communications (mMTC), and they feature slicing of network, allowing network operators to develop virtual networks optimized for specific industrial IoT applications. However, while the integration of IoT into manufacturing processes brings about advantages, it also introduces new challenges, including cybersecurity vulnerabilities and the necessity for up-skilling labor forces.

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***Keywords*:** Radio access networks (RANs), service-aligned architecture (SAA), long term evolution (LTE), industrial revolution (IR)

1.1 Introduction

The Fourth Industrial Revolution (4IR) is the upcoming level in computerizing the mass production industry. It is fueled by ingenious developments like growth of size of data and their connectivity, analytics, machine–human interaction, and elevation in robotics. The industrial revolution 4.0, commonly known as Industry 4.0, is exemplified by the integration of advanced technologies to create smart, connected, and highly automated systems [1]. One of the key enablers of Industry 4.0 is the deployment of 5G technology, which represents the 5G mobile networks. 5G is poised to revolutionize various industries by providing unprecedented levels of speed, reliability, and connectivity. In this introduction, we will explore the necessary aspects of 5G technology and its role in powering Industry 4.0.

The 5G technology is the latest improvisation in cellular communication networks succeeding the previous generation, 4G/LTE [2]. It is designed to deliver significantly faster data speeds, lower delays (the time taken by data to travel among devices), and enhanced network capacity. 5G operates on greater frequency bands and millimeter waves, enabling it to handle more significant data volumes with minimal delays. While 5G holds immense promise for Industry 4.0, its widespread implementation faces some challenges. These include the need for significant infrastructure upgrades, ensuring network security and privacy, and addressing potential grievance regarding health effects of larger frequency radio waves [3]. The 5G technology is a critical enabler of Industry 4.0 revolutionizing various sectors by providing faster and more reliable connectivity. Its implementation has the future to transform industries, boost innovation, and expose new business models that leverage the power of smart, connected systems. As 5G networks continue to expand, we can foresee a proliferation of cutting-edge technologies that will reshape our way of living, work, and having an interaction with digital age.

1.2 5G Technology Architecture

Cellular networking has evolved across successive generations with the imminent fifth generation being the latest advancement. The primary objective of preceding iterations was to provide rapid and dependable mobile services to users. However, 5G significantly broadens this objective introducing an extensive array of wireless services available to users across diverse platforms and multi-layered networks. This new generation, 5G establishes a cohesive, dynamic, and adaptable framework comprised of forward-looking technologies capable of accommodating a wide range of applications. Employing a more advanced architecture, 5G's Radio Access Networks (RANs) are not objectified by the proximity of base stations or intricate infrastructure. Instead, 5G paves the way for a flexible, disaggregated, and virtual RAN augmented by interfaces that create additional data access points.

The 5G basic network infrastructure is crucial for supporting the increased throughput demand of 5G [4]. It follows a cloud-oriented, service-aligned architecture (SAA) defined by 3GPP. This architecture encompasses various 5G functionalities, including security, authentication, session management, and data traffic accumulation from the user end. The 3rd Generation Partnership Project (3GPP) encompasses telecommunication technologies such as RAN, core transport networks, and service capabilities [5]. It has defined comprehensive system requirements for the 5G network infrastructure, which is characterized as service-oriented compared to previous generations. These services are made available via a familiar framework to networking accessibility that are available for usage. Reusability, modularity, and self-circumscription of these 5G network functionalities are added design considerations for the 5G network infrastructure described by the 3GPP specifications.

The architecture of 5G networks is designed to support faster and more reliable wireless communication. It consists of three major components, the radio access network (RAN), the root network, and user equipment (UE). The RAN includes base stations and antennas that connect devices at the end to a network. The basic network manages the flow of data and provides services like authentication and security. The UE refers to the devices used by users to access the network, such as smartphones or IoT devices [6]. Overall, the architecture of 5G networks aims to provide enhanced connectivity and enables new applications and services. The Figure 1.1 depicts the core architecture of 5G networks per 3GPP specifications.

User equipment (UE), such as smartphones or mobile devices that utilize 5G technology, establishes connections through the 5G New Radio Access Network to the 5G core and subsequently to Data Networks (DN), including the Internet.

- Access and Mobility Management Function (AMF) [7]: The AMF serves as the indigenous point of entry for UE connections. It performs tasks such as non-access stratum (NAS)

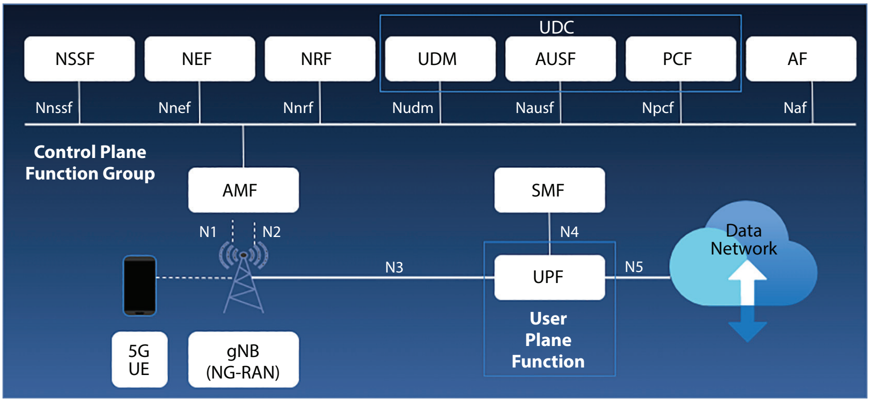

Figure 1.1 5G architecture.

signal termination, NAS encoding and protection of integrity, management of registration, connection, mobility, access authorization and authentication, and security factor management. Depending on the requested service by the UE, the AMF selects the relevant Session Management Function (SMF) to oversee the user session. Additionally, the AMF incorporates the Network Slice Selection Function (NSSF) and serves as the termination point for RAN control plane (CP) interfaces (N2).

- 5G Network Exposure Function (NEF) [8]: The NEF ensures secure and robust access to the network services and capabilities exposed by your 5G network. It provides developers and enterprises with the means to create tailored network services on-demand fostering innovation within an extended ecosystem.
- Network Repository Function (NRF) [9]: As a vital component of the 5G core, the NRF functions as an index that aids other network functions (NFs) in discovering information about other entities within the core, along with necessary service capabilities.
- Authentication Server Function (AUSF) [10]: The AUSF qualifies the AMF to authorize the UE and allow access to the 5G basic services.
- User Plane Function (UPF) [11]: The UPF supervises transporting IP datagram traffic (user plane) among the UE and other external networks.