Michitaka Kosaka · Jie Wu ·
Ke Xing · Shiyong Zhang *Editors*

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Preface

This book is part of a book series of case studies on business innovation in the Asia-Pacific region. The first two books of the series are "Manufacturing Servitization in the Asia-Pacific" and "Entrepreneurship in the Asia-Pacific" respectively. The success of the two books have attracted much attention from both academia and business leaders alike who have strong interest in learning practical analysis on real-life cases of business innovation across different industry sectors as well as economic bodies within the Asia-Pacific context. This has led to the third book of this series to devote on further investigation on emerging trends and patterns of "business innovation with new information and communication technologies (ICTs), such as Internet of Things (IoT), Artificial Intelligence (AI) and Smart Devices, in the Asia-Pacific region".

Since the beginning of the twenty-first century, the Asia-Pacific region has been playing an increasingly important role in the global economy. As the most populous nation in the Asia-Pacific region, China has been the second-large economy in the world on GDP basis since 2010 and still developing rapidly in various industry sectors including manufacturing, IT services, and social infrastructure. As more developed nations in the region, Japan and Australia still have been maintaining their steady pace in developing knowledge-based and service-oriented economies. They are especially successful in fostering business innovation using new technologies. Meanwhile, the Southeast Asia countries have been following Japan and China, and their economic modernization and industrialization have seen growing interest in and stronger focus on cultivating social innovation.

Now, new generation of ICTs, including IoT, AI, Smartphone and 5G network, have been instigating drastic changes in service solutions in various business fields and creating innovative, sometimes disruptive, business model paradigm. Successful services with new ICT platforms and applications not only adopt appropriate and novel technologies, but also rightly attend to human desires in relation to different cultural characteristics and economic needs. Although there have been abundant case reports and research on business science in the literature, to date, most of them focus on successful business practices with novel ICT solutions in the European Union and North America, with only very limited

Asia-Pacific cases studied. Therefore, it is deemed as necessary to analyze state-of-the-art business innovation in various industrial sectors and nations across the Asia-Pacific region. The motivation for developing new businesses with ICTs for value creation and competency in the competitive market has inspired businesses across the Asia-Pacific region to accentuate their growth strategies more on enhancing quality and sustainability.

There has been significant emphasis, both in technology development and in its application, on incubating innovation and accelerating business expansion with new ICT drives and novel business models. With unique socio-culture, political, and economic situations, the characteristics of successful services and business in the Asia-Pacific are very much different from their American and European counterparts in terms of their states of development, business strategies, management approaches, innovation and hence their paths for value creation in business. "What are emerging trends and patterns of the business innovation using new ICTs in the Asia-Pacific?" is a highly contemporary question concerning business researchers and practitioners with the region as well as around the globe. In order to answer this question, this book presents a number of studies on cases of digital-enabled service innovation and industry transformation. Through in-depth case studies, the book aims to explore main drives for change, to examine key factors for success, and to identify novel strategies, which can help to inform and inspire other business leaders and companies within the region to develop or transform their own business processes and models.

With this in mind, this book presents two theoretical and conceptual analyses and 14 case studies of successful business innovation from the mainland of China, Taiwan, Japan, Australia, Malaysia, and Vietnam. Also, the case studies cover a broad range of fields, including ICT providers, manufacturing, agriculture, education, aging society, social infrastructure, logistics, finance. Following the consistent methodology as applied in our previous book series, in this book, each case study presents detailed information of an organization's internal and external environments collected through a series of fieldwork and structured interviews. Then, the collected data are further analyzed through the theoretical lenses of service science, knowledge and culture management, organizational management, new business development, management of technology (MOT), and innovation management. These cases are analyzed and compared from the same viewpoints of value co-creation with new ICTs based on service science. It provides insights into the role of new ICT technologies, value co-creation, human desire and social requirement, business model and success factors of business drawn from the analysis. Finally, commonalities and uniqueness in business innovation with new ICTs relevant to industry sectors and social-economic-cultural contexts are clarified and the direction of business innovation with new ICTs in the Asia-Pacific is proposed.

By looking into different case examples of the similar category and comparing those across categories, readers can gain insight into and draw inference from what to do, how to do, and what opportunities to catch for creating new business and developing new companies. For ICT business leaders and ICT users in the region, the first-hand information from fieldwork presented in the book may help them to develop informed business strategies and policy decisions can be made for effectively fostering digital-enabled business innovation. We also hope that this book can provide practical research materials for scholars focusing on service science, knowledge management, innovation management and information technology.

The completion of this book will not be possible without a concerted effort by a multinational and multidisciplinary team of researchers, practitioners who conducted the case studies and contributed greatly to the writing and translation of the case reports for the book. The names of the authors are acknowledged in the respective chapters. We are also grateful to Springer for providing us with the opportunity to publish the result of our work. Not least, we like to express our sincere gratitude to all the companies and various people who participated in the case studies for assisting so willingly with data collection, case analysis, and case report development.

We hope that this book can stimulate further interest and lead to more exploratory and empirical studies on this important topic for the development of new business and attractive companies across the Asia-Pacific region and beyond. Valuable critiques and approaches for collaborative work will be highly appreciated.

Finally, we'd like to give a special tribute to Prof. Jing Wang. To our great sadness, Prof. Wang passed away on September 2018. Professor Wang was an excellent researcher and educator on supply chain management and service science. He was the initiator for this case study book series and played a leading role in shaping the concepts underpinning the development of this book series. We appreciate his contributions on this book series with great sincerity.

Nomi, Japan/Shanghai, China — Michitaka Kosaka
Shanghai, China — Jie Wu
Adelaide, Australia — Ke Xing
Shanghai, China — Shiyong Zhang

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About the Editors

Dr. Michitaka Kosaka received the M.S. and Ph.D. degrees in applied mathematics and physics from Kyoto University, Japan, in 1977 and 1984, respectively. He is currently an Emeritus Professor of JAIST (Japan Advanced Institute of Science and Technology, Japan) and a Guest Professor of Fudan University (China). He had been with Hitachi Ltd. for 31 years, especially with Systems Development Laboratory, where he was a general manager from 2001 to 2005. Then, he joined in JAIST in 2008, where he was a dean of school of knowledge science from 2011 to 2014. His research covers stochastic control theory including Kalman filter, financial information systems, R&D management, knowledge science, and service science. He is a fellow of IEEJ, a fellow of SICE and members of several institutes in Japan.

Prof. Jie Wu received the B.S., M.S. and Ph.D. degrees in computer science from Fudan University, China, in 1996, 1999 and 2008, respectively. He is currently a Professor of Fudan University (China). He is also the director of Research Engineering Center of Network Security for Ministry of Education. Dr. Wu's research interests are in Computer Networks and Security. His current work focuses on cloud computing, SDN/NFV and system security. His work has been featured on many real mission-critical application systems. His research is supported by various sources, including the National 863 program, Shanghai science& technology program, etc. Dr. Wu is the recipient of the 1st class of Shanghai Science& Technology Progress Award.

Dr. Ke Xing is a Senior Lecturer and a Program Director at School of Engineering, University of South Australia. He served as a member of Professional Development Committee at Australian Life Cycle Assessment Society (ALCAS) and is a standing committee member of Ecological Development Union International (EDUI) (Australia) (2011 to date).

In his academic career, Dr. Xing is particularly dedicated to incorporate social, economic, and environmental perspectives into tertiary engineering education and training programs to prepare graduates to become professional engineers with specialized knowledge and skills for achieving sustainability in engineering practice. In his research, he also has extensive projects and publications in the areas of resource-efficient product and service innovation, sustainable industry and community transformation, and low-carbon urban precinct system modeling. To date, he has authored over 80 research publications in books, refereed journals and international conference proceedings.

Prof. Shiyong Zhang is a professor of Computer Science School of Fudan University, China. He once worked at British Telecom and British National Computer Center in 1988 and 1993 separately, undertaking conformance testing research as a visiting scholar. He also took a short term advanced information management training class at Stony Brook in United States in 1997. His research focuses on computer networks, its application, security, testing, and evolution. He has published more than 200 papers on core journals, and about 20 books individually or with colleagues. About 20 awards were honored to Prof. Zhang in the light of his achievements in ICT field in China, such as twice the 2nd Prize of Sciences and Technology Advance at China National level, once the 1st Prize of Sciences and Technology Advance at Ministry level, a few times the 1st Prize of Sciences and Technology Advance by Shanghai Municipal Government, etc. Professor Zhang founded an IT company called Fudan Grand Horizon in 1998, and acted as the General Manager for 10 years. By which experience he knows well how to transfer the new ICT innovation to company services products.

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Chapter 1
Overview: Perspectives and Structure

Michitaka Kosaka, Jie Wu, Ke Xing, and Shiyong Zhang

Abstract ICT has been playing an essential role in value creation for customers and in profit generation for providers, contributing to various service innovation and business innovation. Now, digitalization using Internet of Things (IoT) and Artificial Intelligence (AI) provides solutions to address a wide range of challenges in our society, which is transforming services and businesses in the twenty-first century. "What is the direction of the business innovation using new ICTs?" is a highly relevant question concerned by business researchers and practitioners. The main aim of this book is to clarify patterns and trends of business innovation using new ICT technologies and platforms, such as IoT, AI, cloud computing, 5G network, and smart devices. These are analyzed through a series of case studies on successful trials and advanced business models in the industry sectors that have been experiencing rapid changes over the recent decade in the Asia-Pacific region.

1.1 Introduction

ICT has been playing an essential role in value creation for customers and in profit generation for providers, contributing to various service innovation and business innovation. Now, digitalization using Internet of Things (IoT) and Artificial Intelligence (AI) provides solutions to address a wide range of challenges in our society,

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which is transforming services and businesses in the twenty-first century. "What is the direction of the business innovation using new ICTs?" is a highly relevant question concerned by business researchers and practitioners. Creating new value added in business innovation depends not only on adopting state-of-art technologies and novel technological solutions, but also on addressing pressing societal needs and business requirements contextualized to cultural characteristics and economic circumstances of a nation or a region (Wang et al. 2016, 2019). Therefore, the innovation with new ICT technologies in the Asia-Pacific region is very much different from those cases observed and analyzed in American and European in terms of state of development, business culture and strategies, management approaches, consumer behavior, and hence paths for value creation in businesses. Now, the Asia-Pacific region has demonstrated the highest contribution to and potential of economic growth in the world through business innovation with new ICTs.

With this in mind, the main aim of this book is to clarify patterns and trends of business innovation using new ICT technologies and platforms, such as IoT, AI, cloud computing, 5G network, and smart devices. These are analyzed through a series of case studies on successful trials and advanced business models in the industry sectors that have been experiencing rapid changes over the recent decade in the Asia-Pacific region.

1.2 Business Innovation with New ICT

To identify directions of business innovation with new ICTs, a framework based on the concepts of Technology Space and Value Space is introduced to define perspectives and questions for the case analysis in this book. In order to facilitate business innovation, it is important to transform new functions of technologies into new business values, which satisfy customer desires and social needs. This transformation depends on an organization's corporate culture, business model, capabilities and resources. There can be many ways for realizing business innovation with new ICTs, which are traditional ICT providers' approaches, venture business approaches, new communities' approaches and so on.

Based on such perspectives, five subsidiary questions are set up to probe characteristics of business innovation in each of the case studies and to address the major research question on clarifying trends of business innovation with new ICTs in the Asia-Pacific.

1.2.1 Concepts of Technology Space and Value Space

An n-dimensional Euclidean space is a logic in mathematics and is applied in various fields such as stochastic space in stochastic control or observation space in Kalman filter. By adapting such concept for the business field (Belal et al. 2012), a Technology Space and a Value Space are defined for capturing and interpreting features of innovation or value creation using new technologies as shown in Fig. 1.1. In this diagram, the Technology Space encompasses all extant forms of ICT and can expand and evolve with development/inclusion of new technologies. The Value Space is formed based on correlations between societal needs or desires of customers and functions provided by deploying pertinent technologies, which can also evolve due to the expansion of the Technology Space. Business innovation with new ICT is created by mapping of Technology Space into Value Space.

By using the concepts of Technology Space and Value Space for interpreting the relationship between new technology and innovation, it is found that;

1. Customer value with new ICTs is created through transforming technologies in the Technology Space to services or products required by customers. This transformation is done by a company's business activities which depend on its business model, value proposition and organizational culture.
2. The Technology Space for ICT has been expanding due to new technology development all over the world and along with the generational trends of technological evolution, i.e. intranet technologies, internet technologies and new ICTs such as IoT and AI. This expansion is a source of innovation, leading to new businesses and business models corresponding to contemporary customer requirements.
3. All companies can utilize technologies in the ICT Technology Space. However, the Value Space depends on the transformation of ICT technology to cater for customers with provision of products or services. Such a transformation and its success are highly dependent on, and coupled with, a company's business strategy and business model. For example, successful companies such as IBM in the intranet-based information system business cannot transform internet technology to meet new customer requirements which are satisfied by Google and Apple in the internet era. This transformation from the ICT Technology Space to the Value Space is the key for business innovation using ICT technology.

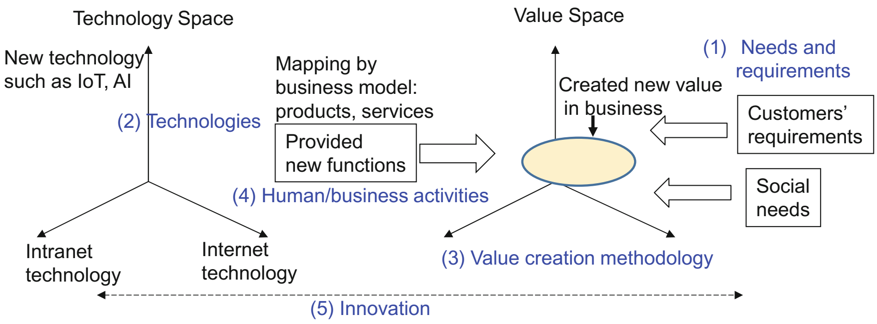

Fig. 1.1 Technology space and value space

1.2.2 Perspectives for Analyzing Business Innovation with New ICT

Based on the concepts and perspectives discussed above, business innovation with new ICT can be analyzed from five perspectives as shown in Fig. 1.1, i.e. needs and requirements, technologies, value creation methodology, business/human activities, and innovation. These lead to a set of questions that need to be answered for identifying directions of business innovation.

1. **Needs and requirements**: What are issues and desires in a society or a business that drive needs for utilization of ICT? What are new application fields for innovative ICT products or services?
2. **Technologies**: What technologies and functions are utilized in order to address the issues or needs?
3. **Value creation methodology**: What are value creation methodologies, considering the optimization of total system, collaboration among businesses or industries, and value co-creation between providers and users? What is the role of ICT in value creation?
4. **Human/business activities**: What are relations among human/business (including employee, organizational culture, leadership, etc.) activities and ICT system, the relationship among users, ICT providers, and other stakeholders (i.e. collaboration)? What are suitable business models?
5. **Innovation**: How have consumer, business and/or societal needs changed? How and in what forms do innovations in ICT products and services, business models, business eco-system, and customer/end-user engagement help to address such needs?

1.3 A Case Study Approach

In order to answer these questions and analyze business innovation with new ICTs in the Asia-Pacific, the case study approach is very effective and reasonable, as the truth of successful innovation exists and can be revealed only in real cases of successful business innovation. Such analyses are useful for readers, both professionals and academia alike, and can contribute to both knowledge and practice of innovation in the region. Also, this book presents, compares and analyzes various cases of business innovation using new ICT, such as IoT, cloud technology and AI, in the Asia-Pacific from the viewpoints of value creation in the practical business environment.

It is postulated that business innovation generally needs to create new values for customers or societies by using new technologies. Therefore, from the viewpoint of value creation with new ICTs, the case studies collect and analyze information related to the following aspects of the targeted companies and their ICT applications;

1. Outline of the company or society, organization, history of the company

2. Background and the objective of new approach such as
   Business issues, human desire, social requirements, business strategy,
3. Outline of total system, total services
   Relationship among customers, providers, system, service, community, etc.
4. Created new service, new value
   What is new compared with previous situation
5. Process of developing new system, new service new business
   Difficulties of development, How to solve the difficulties
6. Role of new technologies and how to solve technology issues such as privacy, ethical issues
7. How does the new business or the new service change business or society, or human life?
   Business model innovation, social innovation.

In each case, detailed information about the company's internal and external environments are collated through a series of fieldwork and structured interviews. After collecting enough data, the collected data are further analyzed to reveal main factors of successful business innovation in the Asia-Pacific region by applying relevant theories related to Service Science (Cambridge University. 2007; Lusch and Vargo 2006) and innovation management. Especially, these cases are analyzed and compared from the viewpoints of value creation for people and societies considering culture or business situation.

Figure 1.2 shows the approach for analyzing case studies in this book, consisting of five parts that probe characteristics of business innovation with new ICT applications from both theoretical and practical grounds, as well as viewpoints of stakeholders.

Firstly, the directions of business innovation with new ICT from theoretical and conceptual perspectives are discussed in Part 1. By analyzing the general trend of service innovation using ICTs and its impact on business innovation, a new concept of the 3rd generation service innovation, powered by novel ICT solutions, and a

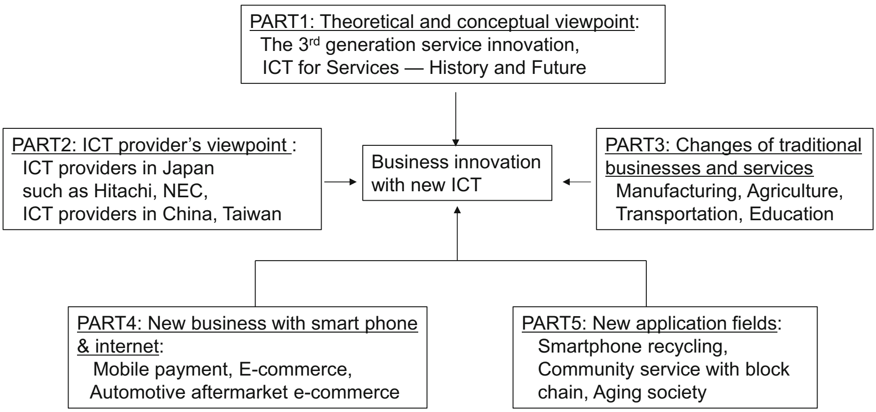

Fig. 1.2 A case study approach for analyzing business innovation with new ICTs

framework for analyzing changes in business model and value creation methodology with new ICT are presented (Chap. 2). Then, the history and the future of ICT-enabled services, as well as how their generational progress influences ways of life and businesses development/operations are examined through surveying extant literature and considering new ICTs' capabilities for innovation (Chap. 3).

Thereafter, fourteen cases studies of different types of business innovation are selected from Mainland China, Taiwan, Japan, Malaysia, Vietnam, as well as Australia. Each case examines social needs and human desires, new value created, roles of new technologies, processes and difficulties in developing new businesses, the relationship among customers, providers and stakeholders, value chain co-creation and optimization, factors of success, and business models. Corresponding to the perspectives of analysis as depicted in Fig. 1.2, these case studies are categorized and clustered in four parts: (1) four case studies from ICT providers' perspectives (in Part 2), (2) four case studies from changes of traditional businesses and services (in Part 3), (3) three case studies from new business with smartphones and internet (in Part 4), and (4) three case studies from new application fields with new ICT solutions (in Part 5). Collectively, they render practical lenses to reveal key attributes and roles of developing/deploying ICT products and services in innovating businesses and transforming industries within the Asia-Pacific region.

Finally, the last chapter of the book summarizes all findings of each case study and examines them through the theoretical lens of value creation in Service Science. Grounded on such analysis, the directions of business innovation with new ICT in the Asia-Pacific are suggested. By looking into different case examples and comparing those across categories, readers can gain insight into and draw inference from what to do, how to do, and what opportunities to catch for creating new business and developing new companies. For business leaders and innovators in the region, the first-hand information from fieldwork presented in the book may help them to develop informed business strategies and policy decisions can be made for effectively fostering business innovation. We also hope that this book can provide practical research materials for scholars focusing on business innovation, innovation management, IoT&AI applications and service science.

1.4 Outline of Selected Cases

To provide an overview of the case studies presented in this book, the topic, the context and the focus of analysis of each case and the respective chapter are outlined as follows:

1.4.1 Part 2: Case Studies from ICT Providers' Perspectives

Case 1: Hitachi's social innovation business (Chap. 4)
Hitachi is a unique company which has accumulated manufacturing expertise, ICTs and operational technologies since its founding more than a century ago. Hitachi is now evolving its Social Innovation Business through digital technology and accelerating collaborative creation with customers by Lumada, an open IoT platform that condenses a wide range of solutions and use cases. This case shows how Hitachi embeds its knowledge into Lumada and creates new values with customers.

Case 2: NEC's "Digital inclusion" (Chap. 5)
NEC has been one of the leading ICT companies in Japan. Its business covers public, enterprise, telecom carrier, and system platform areas around the world. NEC views a society in which digital technologies permeates all areas of life as the "Digital Inclusion" society, and endeavors to realize a society that creates a brighter future for all. This case introduces successful examples of social value creation leveraging NEC various assets such as well-being factory, smart cities, smart stores.

Case 3: Advantech in Taiwan (Chap. 6)
Advantech is the world No.1 industrial PC manufacture. Since 2015, Advantech has launched an ambitious project in taking the lead in establishing IoT service ecosystem. It works with domain-specific solution integrators to build IoT analytics platforms that incorporate devices, cloud storage, and AI techniques in domains such as factories, hospitals, cities, and transportations. This case investigates the co-creation process, the business models, the current difficulties, and the strategies in their business.

Case 4: NEXTTAO in China (Chap. 7)
NEXTTAO is a leading new retail solution and platform provider emerging from China. Based on the cutting-edge unified commerce platform, NEXTTAO provides real-time retail solutions to brand companies in apparel, cosmetics and other fashion industries. NEXTTAO accelerates digital transformation by leveraging innovative data technologies and rich experience in new retail.

1.4.2 Part 3: Case Studies on Changes of Traditional Businesses and Services

Case 5: Industry 4.0 transformation in the city of Salisbury (Chap. 8)
This case has strong industrial footprint in the manufacturing sectors and sees Industry 4.0-inspired technology advancement and business innovation playing a defining role to reshape the industry structure of the region. This case presents a systematic analysis on barriers and challenges faced by, capability and readiness

of, as well as potential strategies for local manufacturing firms (most of which are SMEs) in adopting digital innovation toward Industry 4.0 transformation.

Case 6: Agricultural ICT (Chap. 9)
Agricultural business has been globally noticed as an important application fields of new ICT such as IoT and AI, which are expected to solve yield optimization, crop protection improvement, food supply chain optimization. Three case studies are conducted, which are Fujitsu case (in Japan) as an existing big ICT company, Spread case (in Japan) as a plant factory venture company, MimosaTEK case (in Vietnam) as an IoT venture company.

Case 7: Transportation services in East Japan Railway company (Chap. 10)
Railway business is one of important social infrastructure which provides "transport" as a core service. In the past, railway operation and maintenance work had been labor-intensive. JR-East have started innovation of operation and maintenance applying IoT to realize more efficient management and high level service. This case introduces some successful topics of IoT applications in JR-East.

Case 8: Higher vocational education with new ICT in China (Chap. 11)
This case takes higher vocational education in China as an example to study the effect of IoT on the education. By conducting a comprehensive case study on Wuxi Vocational Institute of Commerce, this case reveals some fundamental findings that we believe are instructional and helpful in reforming teaching and learning in the education.

1.4.3 Part4: Case Studies on New Businesses with Mobile Devices and Internet

Case 9: Mobile payment of China UnionPay (Chap. 12)
Mobile payment is one of the most popular FinTech applications in China. In order to achieve the balance of financial security and user experience, TEEI (Trusted Executive Environment Integration) and Payment Tokenization technologies are developed and deployed on mobile phones. Security data is stored and processed in TEE to ensure financial security while general data is processed in REE (such as Android and iOS) to achieve good user experience.

Case 10: Automotive aftermarket e-commerce of Sparke Autoparts (Chap. 13)
This case is an industrial internet company specializing in automotive aftermarket transactions and services. Its B2B service platform is the first in Malaysia, forming a closed loop of auto parts trading services from part search, quotation, payment and delivery. Its industry-leading online transaction solution is expected to make Sparke Autoparts a leader in transforming and consolidating the traditional, fragmented auto parts industry in Malaysia.

Case 11: E-service innovation in Malaysian (Chap. 14)
With the rapid growth of the internet usage in Malaysia, consumers are now starting to purchase product and services via online medium. This case focuses on how Malaysian consumer value online services as alternatives of getting service. Two online services, e-hailing and e-hypermarket are studied, and found that the gathered consumer value help industry in providing better e-service.

1.4.4 Part5: Case Studies on New Fields of Application with New ICT

Case 12: Mobilephone recycling of Aihuishou (Chap. 15)
This case is the biggest digital devices recycling and exchange company in China. It has more than 30 M users, deal with more than 10 M devices every year. Unlike other recycling company, Aihuishou develops own recycling and exchange platform, users and resellers can sell or bid second-hand devices (like mobile phones, notebooks) through the platform. The platform applies intelligent algorithms to ease the process.

Case 13: Public services with blockchain in regional communities (Chap. 16)
This case is service innovation in regional communities by blockchain technology. One of the important characteristics of blockchain is the activation of the interaction. This case examine how blockchain make effective use of local assets in the city and improve interaction among citizens. The possibility of multi-faceted service innovation enabled by blockchain is discussed.

Case 14: Life care system for aging society in a local city in Japan (Chap. 17)
Currently, Japan is rapidly aging. Towards solving issues in aging society, the community-based integrated healthcare system is introduced in Japan. This case is to provide elderly people living at home with appropriate health, medical and welfare services. This case shows a system of sharing information about the elderly at home among multi-stakeholders such as families, home-care workers, caregivers, nurses, doctors and nursing care centers.

References

Belal HM, Shirahada K, Kosaka M (2012) Knowledge space concept and its application for servitizing manufacturing industry. J Serv Sci Manage 5(2):187–195

Cambridge University (2007) Succeeding through service innovation: a service perspective for education, research, business and government. A white paper based on Cambridge service science, management and engineering symposium, Cambridge University

Lusch RF, Vargo SL (2006) The service dominant logic of marketing. M. E. Sharpe Inc., Armonk, New York

Wang J, Kosaka M, Xing K (2016) Manufacturing Servitization in the Asia-Pacific. Springer, Berlin

Wang J, Kosaka M, Xing K, Bai H (2019) Entrepreneurship in the Asia-Pacific: case studies. Springer, Berlin

Part I
Concepts and Frameworks for Cases Analyses from Service Science Perspectives

Chapter 2
General Trends of Service Innovation with ICT and Their Impact on Business Innovation

Michitaka Kosaka, Jie Wu, Ke Xing, and Shiyong Zhang

Abstract The general trend of service innovation using ICT and the impact on business innovation is analyzed, which is a basic concept for conducting case studies in this book. First, service and service innovation using ICT are defined. Then service value creation mechanisms with ICTs and successful cases in each generation are illustrated. Then, we show that the ICT revolution significantly influences ICT businesses through investigating the changes of major ICT providers by using Fortune 500 data. A major reason for such changes is the changes to the service value creation mechanism with ICTs and its business model. The most important question in this book is "What are the likely business innovation with new ICT, that is, in the 3rd generation business innovation?" To consider answers to this question, we propose four viewpoints regarding business innovation with new ICTs: (1) expansion of business fields with new ICTs, (2) changes to human desires and social needs, (3) changes in the role of ICT providers, and (4) conversion of new ICTs in the technology space into values in the value space, depending on the organization's culture and abilities.

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2.1 Introduction

Information and communication technologies (ICTs) have been contributing to various service innovations (Cambridge University 2007) and business innovations, through service development and service enhancement, and play an important role in creating value for customers and generating profits for providers. The business innovations with ICT until date can be categorized into three generations (Kosaka and Wang 2016).

The 1st generation is the intranet era. Companies introduced enterprise information systems using hardware such as a mainframe, a database, and terminal equipment and streamlined their work or collected customers' information for creating value for them. Typical examples are point-of-sales (POS) systems in distribution industries (Kunitomo 1997) and online banking systems in financial industries. Here, providing solutions to customers' problems or to meet their requirements are the major businesses of ICT service providers. International Business Machines Corporation (IBM), Fujitsu, and NEC were major players in this generation.

The 2nd generation is the internet era. The internet connects service providers and customers worldwide for 24 h a day, 365 days a year. The internet has brought various types of services, such as service mediators (Doan et al. 2014) and information retrieval services. New hardware equipment, such as personal computers (PCs) and smartphones, and services using such devices are major ICT businesses. In this era, new economy sciences, such as the experience economy (Sundbo and Darmer 2008; Pine and Gilmore 1999), the sharing economy, and the platform economy (Kenney and Zysman 2015; Farrell and Greig 2017) were discussed, instead of the traditional marketing science (Lovelock and Wirtz 2007; Fisk et al. 2008). In ICT businesses, new business players, such as Apple, Google, and Amazon, have become major players instead of IBM.

Currently, the 3rd generation of the ICT revolution, which employs new technologies, such as the Internet-of-things (IoT) and artificial intelligence (AI), is under discussion. These technologies will change services to provide solutions for various issues in the twenty-first century, such as those related to manufacturing servitization (Wang et al. 2016), care for an aging society (Spitzer and Davidson 2013), and agriculture (Li et al. 2013). Service science for business innovation in the 3rd generation should pursue service value creation with new ICT. Service-dominant (SD) logic (Lusch and Vargo 2006; Vargo and Lusch 2004) is one such new service science. "What will be the developments as regards business innovation with new ICT?" is a significant research question in business science.

In this chapter, we analyze the general trend of service innovation using ICT and the impact on business innovation, which is a basic concept for conducting case studies in this book. First, we define service and service innovation using ICT. We illustrate service value creation mechanisms with ICTs and successful cases in each generation. Then, we show that the ICT revolution significantly influences ICT businesses through investigating the changes of major ICT providers by using Fortune 500 data. A major reason for such changes is the changes to the service value creation mechanism with ICTs and its business model. The most important question in this book is "What are the likely business innovation with new ICT, that is, in the 3rd generation business innovation?" To consider answers to this question, we propose four viewpoints regarding business innovation with new ICTs: (1) expansion of business fields with new ICTs, (2) changes to human desires and social needs, (3) changes in the role of ICT providers, and (4) conversion of new ICTs in the technology space into values in the value space, depending on the organization's culture and abilities. These viewpoints are deeply related to the research framework and research questions described in Chap. 1. All case studies in this book provide answers to five research questions by considering these viewpoints. Further, we present the answers for our main research question by summarizing the results of all case studies in the last chapter.

2.2 Key Concepts of Service Innovation

In this section, we introduce several key concepts of service innovation, which are definition of "service", definition of "service innovation" and trends of service innovation with ICT.

2.2.1 Definition of "Service"

Why is service so important in considering business innovation with ICTs? It is important because creating value for customers by using ICTs is essential in business. If we consider business innovation with new ICTs, many real business innovation cases teach us that business innovation is generated by introducing new value for customers through new services with new ICTs.

First, we define ***"service" as activities of value creation for people or society*** based on the following discussions on service. According to this definition, the term "service" can be applied not only to service industries but also to all human activities in the business or social environment.

1. **Definition of service in a traditional service organization in Japan**

Kagaya is among the most well-known Japanese traditional inns, which provides traditional Japanese hospitality (*omotenashi*) services. Sadahiko Oda, the former chairman of Kagaya and a well-known service practitioner, describes service as an activity that (a) provides professional techniques for achieving the customer's objective, (b) satisfies the customer, and (c) results in compensation. These three factors in service are necessary conditions for successful service businesses and inspire the fundamental philosophy of service science (Kosaka and Shirahada 2013).

2. **Definition of service from the viewpoint of management of technology**

Kameoka (2007, 2010) defined service as an activity to support people or organizations for them to achieve their objectives from the management of technology viewpoint. The definition of service covers services in various industries—not only traditional service industries but also manufacturing or information industries. This concept of service can be transversally applied to various fields, such as service management, service engineering, and social service.

3. **Definition of service from the viewpoint of service-dominant logic**

Vargo and Lusch (2004) proposed a new concept of service, SD logic, arguing that the global economy has been shifting from a goods economy to a service economy. They define service as the application of competences to benefit another entity and a distinct service (singular) as a process related to "services," which are particular types of goods. The SD logic concept has been having a substantial impact on recent service science, and it is particularly important in the manufacturing industry. The value of products is determined by customers on the basis of "value in use". Even products that have excellent functions and perform very well have no value if customers do not want to use such functions or do not need such performance. Vargo and Lusch defined this mindset on service value as "value in use," which is the fundamental concept of SD logic.

4. **Definition of service in this book**

Based on these definitions, in this book we define service as an activity that supports human beings or organizations and enables them to achieve their objectives or desires. We use this definition of service in this book. This definition indicates that most productive human activities for value creation are considered services, and service covers value creation activities in various types of business.

2.2.2 Definition of "Service Innovation"

As the term implies, it fuses the two perspectives of "service" and "innovation". One focuses on innovation in the current service industries. It aims to provide the means to improve the productivity and quality of service industries, such as the hotel and the travel industries. The other focuses on applying service concepts and individual service approaches (Kosaka and Shirahada 2013).

The first is the conventional viewpoint of service innovation by which new technologies, such as information technology and new hardware technology, are employed to create new value or to improve productivity in traditional service industries, such as the hotel and travel businesses. Determining the ways to apply new technologies and to improve productivity is a major issue in innovation in the service industry. For example, financial industries introduced information and network technology in their business processes, and they implemented various innovations to improve their productivity. However, these innovations have contributed to increasing the competitiveness in this industry.

The second view involves innovation introduced through value creation activities in business from the viewpoint of SD logic. Recent new services or new businesses, which create new values in products or new services from the perspective of customer value creation, fit this category. This type of service innovation creates new business fields, such as those created by Apple. It emphasizes new value creation by using ICTs to help customers. The rise of Google, mobile phone services, and Integrated Circuit (IC) card applications clearly indicates that such emphasis is needed. In this sense, service innovation is an important business issue in the era of the internet and globalization. We define service innovation as the second view in this book, which yields business innovation through value creation using ICTs.

2.2.3 Trends of Service Innovation with ICT

ICTs have strongly influenced service innovation. From the viewpoint of ICT progress, we can categorize service innovation into three generations, as shown in Fig. 2.1.

The 1st generation service innovation was developed by using intranet information systems with a network and customers' database, and the aim was to enhance the

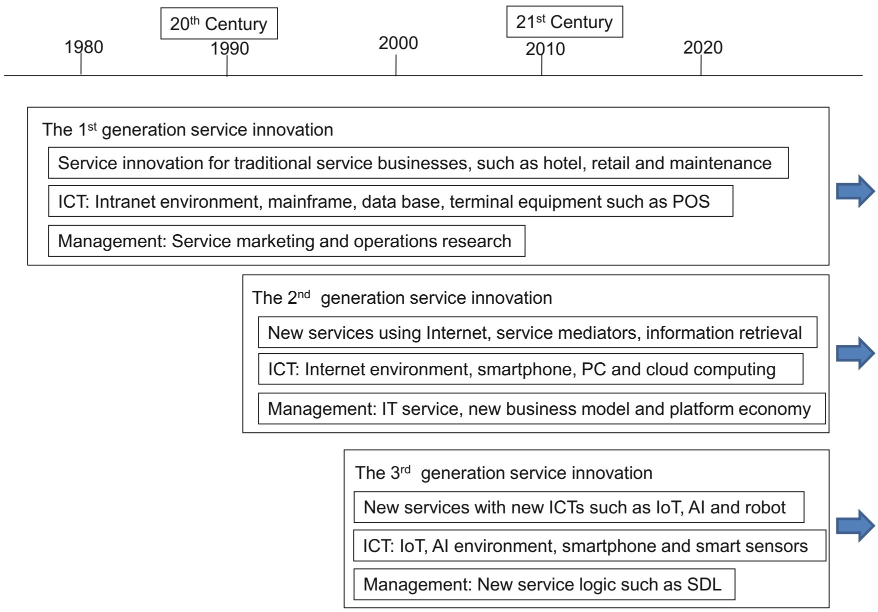


Fig. 2.1 Three generations of service innovation

service quality in traditional service sectors, such as the hotel, transportation, and maintenance sectors. The service marketing theory (Lovelock and Wirtz 2007) was used as a theoretical framework for service value creation.

The 2nd generation service innovation was developed in the internet environment. Service value creation is conducted in the cyberspace, and new business models, such as the long tail model, have been developed. Moreover, the service concept is applied to develop new information technologies, such as service-oriented architecture and web services.

The 3rd generation service innovation has started recently and is based on the new ICTs such as IoT and AI (i.e. deep learning). Meanwhile, new service research, such as SD logic, asserts the importance of value co-creation or resource integration in creating service value. Considering these trends, the research on the 3rd generation service innovation should clarify the role of the new ICTs in service value creation.

Various service sciences and technologies for value creation have been researched and developed for service innovation. These are service marketing (Lovelock and Wirtz 2007) and service management in the 1st generation and IT service management and web service in the 2nd generation. Recently, service system research (Demirkan et al. 2011) and SD logic (Lusch and Vargo 2006) in the 3rd generation have attracted research attention. Such research is deeply related to ICT progress.

2.3 Evolution of Value Creation with ICT in Service Innovation

In this section, we explain the role of ICTs in value creation and discuss successful cases in three generations of service innovation.

2.3.1 The 1st Generation of Service Innovation

1. **Role of ICT in Value Creation**

The 1st generation service innovation was realized based on the service marketing logic and the use of intranet systems. Service marketing mainly consists of operations research and service management. In the twentieth century, research on service marketing generated numerous methods for customer value creation, and most companies introduced their enterprise intranet systems for improving business performance. They utilized online networks and their customer/sales database to create value for customers.

Service value depends on the relationship between the provided service and its context, which shows the necessity of the service for customers. Even if the quality of the service is high, the service value is determined based on customers' needs. Service value is dependent on whether the customers' contexts correspond to the

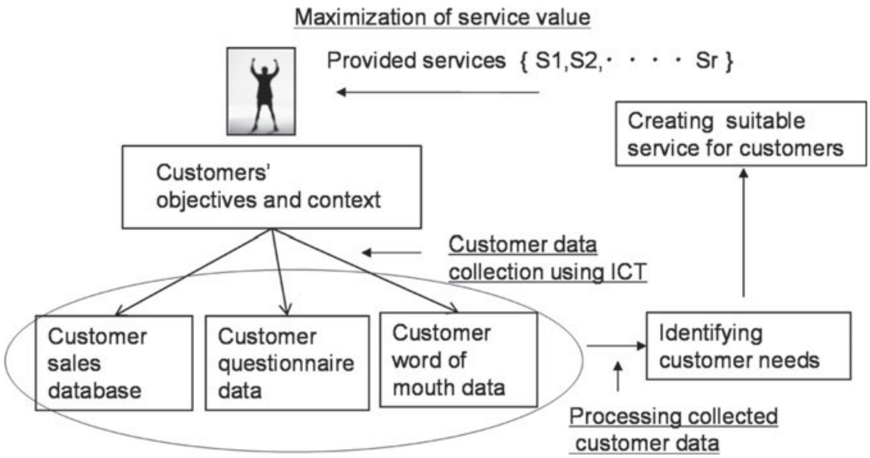


Fig. 2.2 Service value creation process

provided service. Service innovation is pursued to create or enhance service value based on this characteristic of service value creation. That is, the service context should be investigated and the relationship between the service and its context should be clarified. How can we create service value using ICTs? This is an important research question about the role of ICTs in service innovation.

In the 1st generation service innovation, service value was generated by identifying the customers' context using their sales data collected through intranet systems. The service value creation process (Kosaka 2012) is shown in Fig. 2.2. First, the context is determined by using various methods and data. Then, a suitable service corresponding to the context is provided. Various types of data, such as interview data, questionnaire data, and sales data, are utilized for identifying the customers' context. In particular, ICTs, such as data mining, are more powerful methods because these can analyze large volumes of data and ascertain the proper context related to customer requirements in real time.

Thus, the role of ICTs in the 1st generation service innovation is to understand the customers' context related to the provided services. If organizations can identify the appropriate relationship between a service and its context, they can provide high service value to customers, as shown in Fig. 2.2. Several examples, such as the 7-Eleven POS system, show the effectiveness of ICTs in improving organizations' service productivity and their profit.

2. **Examples of Successful 1st Generation Service Innovation**

The many examples of successful 1st generation service innovation include the POS systems in distribution industries and yield management systems in airline companies and hotels, which we discuss next.

(1) **POS system in 7-Eleven convenience stores** (Kunitomo 1997)

The POS system of 7-Eleven is a successful example of improving service value by using ICTs. This system is used to predict customers' needs at any time in each store by analyzing POS sales data, and suitable products satisfying their needs are provided from the distribution center to each store. This means that the ICT reveals the customers' context related to their product purchases. This system can improve service productivity by providing goods with large variety and small quantity.

(2) **Yield management system in airline companies** (Belobaba 1987)

In airline companies, yield management systems have been introduced to optimize profit. The system provides optimal price planning by changing prices according to the low and high seasons. This planning is performed by combining mathematical optimization methods in operations research and the customer sales database.

2.3.2 The 2nd Generation of Service Innovation

1. **Role of ICT in Value Creation**

The 2nd generation service innovation was developed owing to the internet, which resulted in a global business environment of 24 h and 365 days a year. Services have changed dramatically, and service value has been created at anytime and anywhere in the cyber space. Therefore, new service business models using the internet were developed.

In the 2nd generation service innovation, the essential value creation is to connect new service providers and new customers for achieving their objectives, as shown in Fig. 2.3. Based on the new value creation, various new service business models, such as the long tail model and the service mediator model, were developed in the internet environment. As shown in Fig. 2.3, the relationship between new services and new customers' contexts can be revealed in the internet environment by removing the restriction of time and space. In this business model, service providers do not examine customers and their needs directly. The mediator has the important role in service value creation. This is the significant change in service value creation in the 2nd generation service innovation.

2. **Examples of Successful 2nd Generation Service Innovation**

In the 2nd generation of service innovation, the long tail business model and the service mediator business model are representative examples of new service models.

(1) **Long tail business model** (Elberse 2008)

Services in the internet environment can be accessed from all over the world. This accessibility means that the number of customers and service providers is potentially unlimited. A business focusing on a specific customer target can survive by collecting

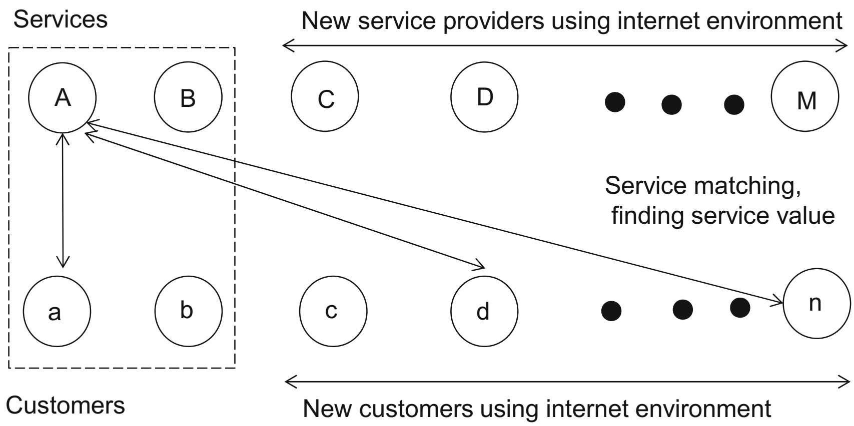


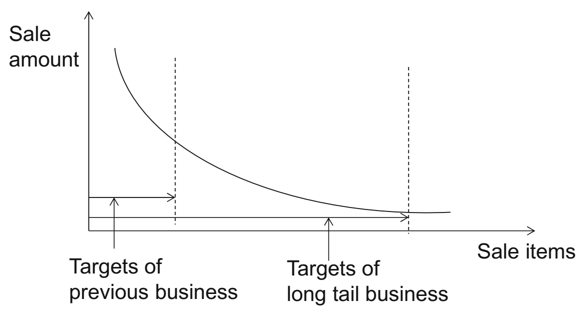
Fig. 2.3 Service value by connecting in the internet environment

customers worldwide. This business model is termed the long tail business model and is illustrated in Fig. 2.4. The success factor is the connection in the internet environment between specific services and customers who want them. One successful example is that of global science publishers, such as Springer. They hold various types of digital content and provide them to specialists through the internet or a "book-on-demand service".

(2) **Internet service mediator**

The internet environment has various customers and service providers. They have no knowledge about the services provided and the types of customers. Therefore, new service value is generated by connecting customers to suitable services (Doan et al. 2013). This is the connecting service value that the internet service mediators provide, as shown in Fig. 2.5. Among the many examples of successful internet service mediators, a representative example is Airbnb (www.airbnb.com), which connects lodgings all over the world to travelers who have interests on them.

Fig. 2.4 Long tail business model



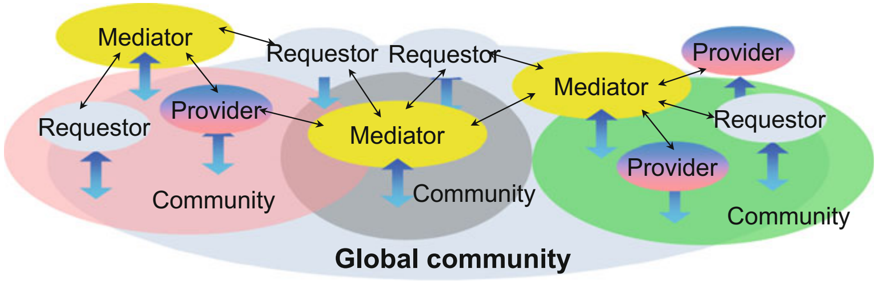


Fig. 2.5 Service mediator in the global internet community

2.3.3 The 3rd Generation of Service Innovation

1. **Role of ICT in Value Creation**

Two important trends are visible as regards the 3rd generation of service innovation. One is the appearance of new service sciences, such as SD logic (Lusch and Vargo 2006) and service systems (Demirkan et al. 2011). SD logic claims "*our economy is a service economy and that value is co-created between providers and customers by resource integration*", as displayed in Fig. 2.6. All resources related to providers and customers are integrated and optimized for service value creation.

Another important trend is the emergence of new ICTs, such as IoT, deep learning, and cloud computing. All systems and devices are connected in the internet environment, and various types of data and AI technologies, such as deep learning, are utilized for service value creation through resource integration. These two important

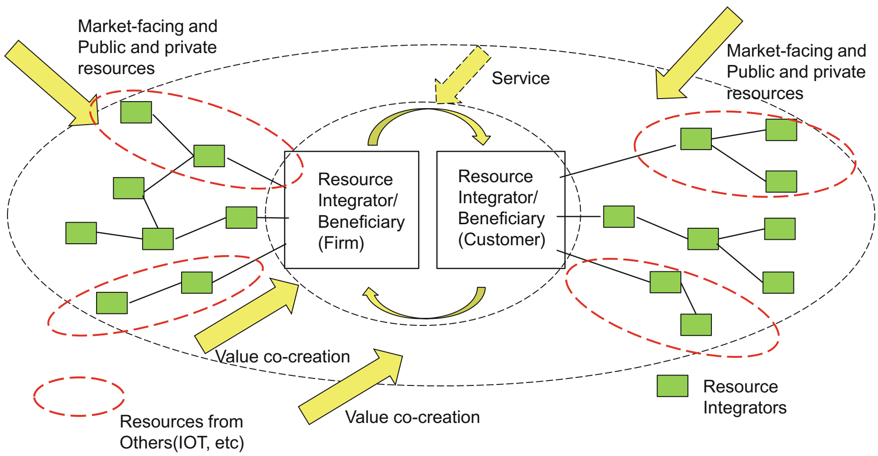


Fig. 2.6 Resource integration in service-dominant logic

trends are effective in providing solutions to recent issues, such as facilitating manufacturing servitization, conducting agriculture using ICT, and ensuring a healthy aging community, where the optimization of service systems by using advanced technologies is expected. This is the direction of the 3rd generation service innovation, which yields service value by optimizing service systems using advanced ICTs.

In particular, IoT appears to be an important factor in revolutionizing new service businesses as well as those changed by the internet during the 2nd generation service innovation. New technologies have been applied in several branches of the 3rd generation service innovation. By using IoT, we can understand the changing context of users in real time. Further, AI technologies, such as deep learning, can optimize service according to the changing context. Value co-creation between providers and customers can be performed through resource integration using IoT and AI. The most important aspect is to create high service value by optimizing the service system. From the viewpoint of service value, the relationship between the provided service and its context is to be retained at the optimum level by using advanced technologies, such as IoT, AI and robots.

2. **Example of Successful 3rd Generation Service Innovation**

The 3rd generation service innovation has just commenced. Therefore, limited examples are available. However, as an example, machine-to-machine (M2M) technologies have already been used in the construction machine industry.

(1) **Utilization of IoT in construction machine industry**

Komatsu Ltd. (Sumi and Kitatani 2013) and Hitachi Construction Machine Co. (Matsuda and Kosaka 2016) install sensors in their construction machines worldwide and collect operation data of each machine, as shown in Fig. 2.7. They use the data to enhance their services, such as maintenance services, and in various applications and services in the cloud computing environment. Moreover, they are developing the automatic control system. These trends seem to establish ICT infrastructure for manufacturing servitization of the construction machine industry. This is an example of successful 3rd generation service innovation.

3. **Direction of Change**

Concerning the direction of the 3rd generation service innovation, Prof. Murai, who is a pioneer of internet technology in Japan, stated:

> The development of internet has matured and completed once. Internet is just communication among people. However, IoT can connect everything such as sensors, cameras and controllers with the Internet. We can share and utilize IoT hardware resources for creating new services. The utilization of IoT has serious problems such as privacy issues or data ownership issues. However, IoT can change the concept of service and our society has been developing according to the progress of ICT technology. (cited from Murai 2015)

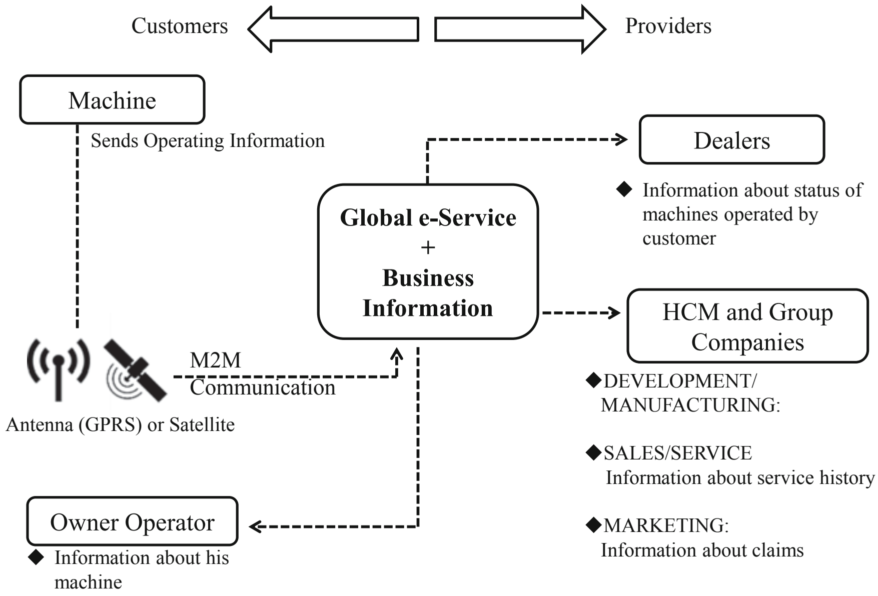


Fig. 2.7 Global e-service of Hitachi Construction Machine Co. *Source* Matsuda and Kosaka (2016, p. 83)

In addition, Porter and Heppelmann (2014) highlighted:

> Now, in the third wave, IT is becoming an integral part of the product itself. Embedded sensors, processors, software, and connectivity in products (in effect, computers are being put inside products), coupled with a product cloud in which product data is stored and analyzed and some applications are run, are driving dramatic improvements in product functionality and performance. Massive amounts of new product-usage data enable many of those improvements.
>
> The third wave of IT-driven transformation thus has the potential to be the biggest yet, triggering even more innovation, productivity gains, and economic growth than the previous two. (cited from Porter and Heppelmann 2014, p. 5)

2.4 Discussion: What Has Occurred?

2.4.1 Change of Major Business Players

We consider the revolution of the ICT/electronics business due to service innovation through ICTs by investigating the transition of the top 10 companies in the ICT/electronics business in the Fortune 500. What is the Fortune 500?

> The Fortune 500 is Fortune magazine’s yearly list of 500 of the largest companies ranked by total revenues for their respective fiscal years. The list is compiled using the most recent

Table 2.1 Top 10 ICT/electronics companies in Fortune 500

	2000	2005	2010	2015	2018
1	GE(9)	GE(9)	GE(13)	Samsung(13)	Apple(11)
2	IBM(16)	IBM(20)	HP(26)	Apple(15)	Samsung(12)
3	Siemens(21)	Siemens(21)	Samsung(32)	GE(24)	Amazon(18)
4	Hitachi(23)	Hitachi(23)	Siemens(40)	Hon hai(31)	Hon hai(24)
5	Panasonic(24)	Panasonic(25)	Hitachi(47)	HP(53)	GE(41)
6	Sony(30)	HP(28)	IBM(48)	Siemens(63)	Alphabet(52)
7	Toshiba(38)	Samsung(39)	Panasonic(65)	IBM(82)	Siemens(66)
8	HP(44)	Sony(47)	LG(67)	Amazon(88)	Microsoft(71)
9	Fujitsu(45)	Toshiba(72)	Sony(69)	Hitachi(88)	Hauwei(72)
10	NEC(51)	Dell(84)	Toshiba(89)	Microsoft(95)	Hitachi(79)
					Alphabet:Google

figures for revenue and includes both public and private companies with publicly available revenue data. To be a Fortune 500 company is widely considered to be a mark of prestige. (https://www.investopedia.com/terms/f/fortune500.asp)

Table 2.1 shows the transition of the top 10 companies in the ICT/Electronics business every five years from 2000 to 2018.

The companies listed in this table can be classified into the following three categories:

Category 1: Companies who deal with only ICT products and services, comprising hardware such as the mainframe and database, the software, solutions, and services. These are related to the 1st generation service innovation. IBM, HP, Fujitsu, and NEC belong to this category.

Category 2: Companies who deal with not only ICT products and services but also industrial products and solutions, such as transportation, manufacturing, and social infrastructure. GE, Siemens, Hitachi, and Toshiba belong to this category.

Category 3: Companies who deal with hardware, such as smartphones, and internet and mobile services related to the 2nd generation service innovation. Apple, Amazon, Google, Samsung, and Huawei belong to this category.

Before 2000, the 1st generation service innovation was the major business target for ICT providers. From 2000 to 2010, these targets related to ICTs shifted from the 1st generation service innovation to the 2nd generation service innovation. After 2015, the 2nd generation service innovation has become key to ICT business. Through analyzing Table 2.1, we can summarize the trends of major companies in the ICT/electronics business as follows:

1. The Category 1 companies in the Fortune 500 have been descending in position according to the transition of the major business target from the 1st generation to the 2nd generation. In particular, the rank of IBM, which was a successful company in the 1st generation, has been decreasing from 2000 onward, and this expresses the characteristics of the Category 1 companies clearly.

2. The Category 2 companies, such as GE, Siemens, and Hitachi, retained their positions in the top 10. Their businesses were active in both the 1st and 2nd generations.
3. After 2015, most major business players are the Category 3 companies. They deal with smartphones, internet and mobile services, and network hardware related to the internet. US companies, such as Apple, Google, and Amazon, and Asian companies, such as Samsung, and Huawei, are listed in the top 10.
4. Companies in Category 2 and Category 3 deal with not only services and solutions but also have a strong product business. Technological progress has introduced new hardware products that provide new functions for creating new value through new services. The emergence of a new hardware product changes the related service and promotes service innovation and business innovation. The current business situation related to smartphones demonstrates the validity of this claim. Service innovation depends on not only the service logic and service business but also on the revolution of hardware products owing to technology development. This fact reveals the importance of the hardware product business in service innovation.

2.4.2 Reasons for the Changing Major Players: Observations from the IBM Case

1. **Business Strategy of IBM**

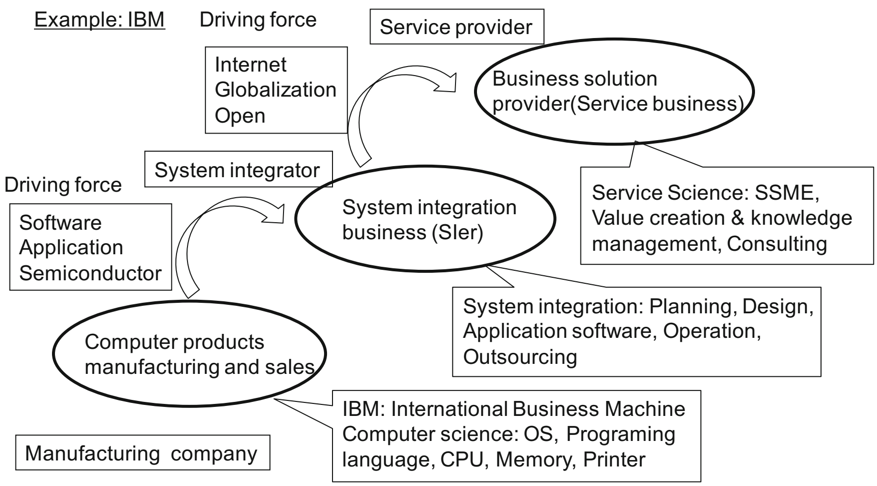


Fig. 2.8 Servitization in IBM business. *Source* Kosaka and Shirahada (2013, p. 8)

IBM is the representative company for the 1st generation service innovation. Figure 2.8 outlines IBM's trend in the information system business, which is applicable to Fujitsu, NEC, and the other information companies in Category 1.

IBM was originally involved in manufacturing and sales of computer products. IBM shifted from being a manufacturing company to a system integrator because of the driving force of software technology, the importance of applications, and the development of semiconductor technology. System integration needs system engineering, such as planning, system design, application software, project management, and operation. Then, it shifted from being a system integrator to a business solution provider owing to certain driving forces, such as the internet and the trend toward globalization and open innovation. IBM understood the importance of service and proposed the concept of service science, management, and engineering, which emphasized the necessity of intensive research in service science.

IBM considers it important for a service business to solve customers' issues, create service value for them, and satisfy their requirements. Therefore, it has strengthened its service activities at the customer contact point to ensure value co-creation. It sold its hardware product business, which manufactured products such as PCs and storage systems, since the profitability was less than that of services or solutions and outsourced its system development business. It shifted from the products and system business to the service business. Thus, IBM shifted their management resources to the upstream of their business and to the left-hand side of the smile curve shown in Fig. 2.9. In the 1st generation, this business strategy was very reasonable. However, the business situation has largely changed owing to the emergence of smartphones and the internet and mobile services. In the 2nd generation, customers created service value by themselves and shared their ideas in communities with the same value standard. Therefore, IBM's business strategy has not covered new service business related to service innovation with new ICTs, such as smartphones.

2. **From the Viewpoint of Customer's Total Value**

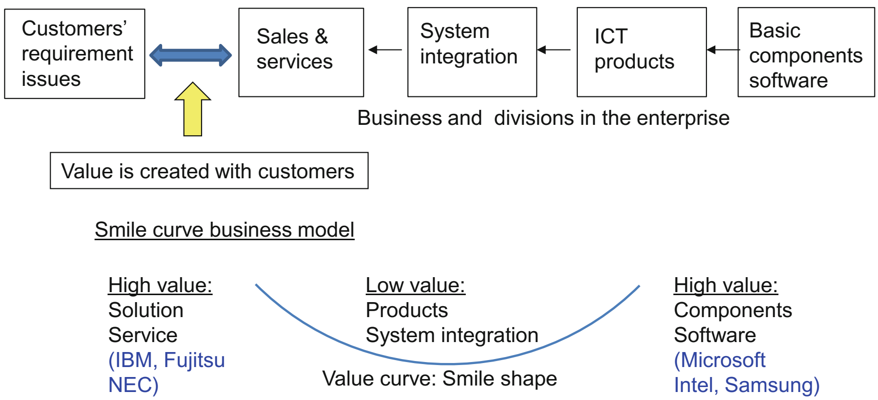


Fig. 2.9 IBM's shift to becoming a service company and the related smile model

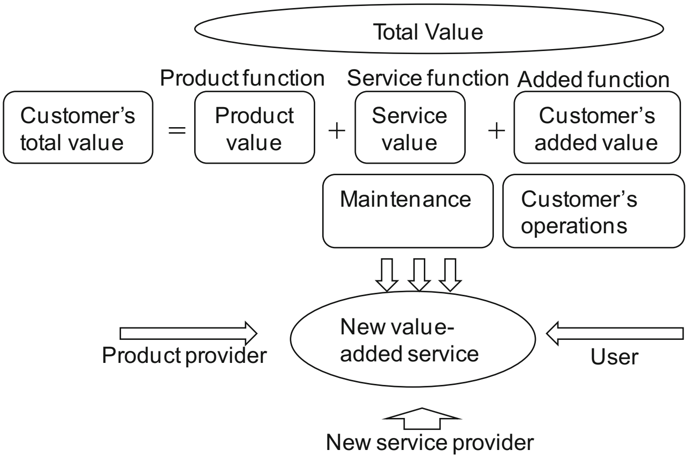


Fig. 2.10 Customers' total value as defined by Kameoka (2007)

Figure 2.10 illustrates Kameoka's (2007) definition of the concept of total customer value. The total value of customers consists of the product value, the service value provided by service providers, and the customers' added value. Hence, service innovation developers should consider these three factors.

In the era of the 2nd and the 3rd generation service innovation, new products, such as smartphones and IoT, have become more sophisticated and new product values have been introduced. The new functions of innovative products are key factors in creating new services. The services provided through the internet have also become more important in customers' total value. Service providers offer many services to customers' smartphones through the internet environment. Customers can select the desired service to achieve their objectives and gain satisfaction. Further, their added value has been increasing. They can create suitable services by themselves based on their experience in using the various functions of smartphones and the services in the internet environment. Thus, new technologies introduce innovative products that can change the value creation mechanism and promote business innovation. Major business players, such as IBM and Fujitsu, could not provide cheap, high-quality smartphones to the market and catch up with the business revolution caused by customers' self-service creation with smartphones.

New value-added services are co-created by product providers, new service providers, and users, as shown in Fig. 2.10. This consideration means that not only service providers but also product providers and customers have important roles in service value creation. Traditional companies in service industries, manufacturing industries, and information industries should consider this aspect of value co-creation in business with new ICTs. Moreover, new economy logics, such as the experience economy, the sharing economy and the platform economy have been discussed as regards business innovation in the new ICT business environment.

2.4.3 Importance of Business Model: Observation of Japanese ICT Companies

Next, we investigate Japanese cases in the 1st generation and the 2nd generation. In 2000, six Japanese companies were listed in the top 10 of the Fortune 500 in this business field, as shown in Table 2.1. These companies were mainly in the consumer electronics and ICT businesses. At present, the consumer electronics business has shifted to the smartphone business, and Apple and Samsung have become major players. Regarding the ICT business, most Japanese ICT companies have followed an IBM-style business strategy. Consequently, most of them could not catch the global business trend in the 2nd generation service innovation related to the internet and smartphones.

Most major Japanese companies developed internet technologies, such as security solutions, networks, and related applications, in their research laboratories. They had enough technologies related to the internet and attempted to create new businesses using the internet. We consider two types of Japanese internet business: (1) expansion of an existing business field (B to B) and (2) creation of a new business field (B to C).

1. **Expansion of an existing business field (B to B)**

There are several examples related to the successful expansion of an existing business field using the internet. A typical example is an internet banking system. Hitachi, Fujitsu, and NEC have banks as customers. Banks wanted to expand their services using the internet environment. For satisfying banks' needs, Japanese ICT providers developed internet banking systems. This is a successful case that uses the internet but is just an expansion of a 1st generation service innovation. Another example of a successful expansion is Hitachi's TWX-21, which provides B-to-B internet services. TWX-21 links approximately 66,000 companies in 400 industries globally to accelerate corporate collaboration (https://www.twx-21.hitachi.ne.jp/contents/outline/about/index_en.html). TXW-21's business field is B to B, and therefore, this successful example is considered the expansion of an existing business field.

2. **Creation of a new business field (B to C)**

In Japan, Fujitsu, NEC, and NTT started the internet service business of B to C. As its B-to-C internet service, Fujitsu started Nifty (https://www.nifty.com/), NEC started BIGLOVE (https://www.biglobe.ne.jp/), and NTT started i-mode. These services were provided to Japanese customers but have not become major businesses, because these companies' business models are strongly influenced by the traditional B-to-B business model and they could not change it to the new B-to-C business model. However, there are several successful venture companies, such as Kakaku.com. (https://corporate.kakaku.com/?lang=en), whose sales and operating income in the 2018 fiscal year amounted to approximately JPY54.8 billion and JPY25 billion, respectively. Thus, successful companies achieve high business performance.

Kakaku.com's president's message shows that the company is very active and flexible in reacting to environmental change:

> We established a successful new business. Since its founding in 1997, Kakaku.com, Inc. has offered Internet services that enrich people's daily lives, continuously broadening the scope of business activities to include shopping, food, travel, cinema, real estate, and other fields. The Kakaku.com Group currently provides more than twenty services in Japan and overseas, and the Group companies continue to work as one to provide even more valuable services. Although the Internet market has continued to rapidly develop over the past twenty years, it is now poised to enter a new period of transformation, and the pace of change is likely to further accelerate. For the Group to continue to contribute to society in such a rapidly changing market environment, I think it is important for us to create innovation while we ourselves flexibly and rapidly change.

Thus, most successful companies in the 2nd generation service innovation have a different value sense and different corporate culture from that of traditional and successful companies in the 1st generation service innovation.

2.5 Emerging Trend of the 3rd Generation Service Innovation

What will occur in business owing to the 3rd generation service innovation? This is an important research question in business innovation research. We hypothesize that the following three important factors change the business owing to the 3rd generation service innovation: (1) expansion of the business field using new ICTs, (2) changes in human desires and social needs, and (3) changes in the role of ICT providers.

2.5.1 Expansion of Business Fields with New ICTs

Figure 2.11 shows the expansion of services and businesses using ICTs from the 1st generation to the 2nd and 3rd generations.

In the 1st generation, IBM, Fujitsu, and NEC expanded their business by conducting the enterprise information system business or information service business. Following the emergence of the internet and smartphones, the 2nd generation service innovation has been growing and new business has been developing. The internet connects people world over, and using intelligent equipment, such as smartphones, people can create a desired service by themselves. In the 2nd generation, the major players are Apple, Amazon, and Google, which are new players in the ICT business and have a different business model from that of major players in the 1st generation. They have expanded their business with new ICTs such as smartphones.

In the 3rd generation service innovation, everything is connected in the internet environment and the following attributes are expected to result in business innovation:

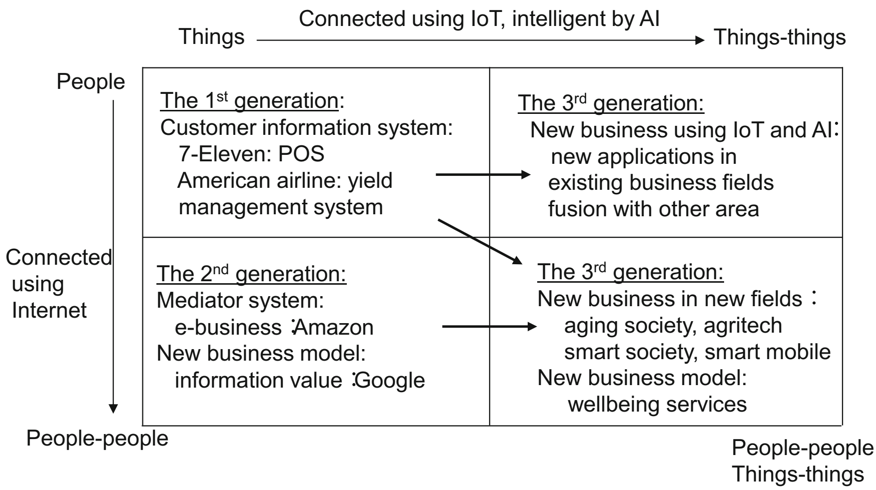


Fig. 2.11 Expansion of service/business by new ICTs

1. Utilization of new sensing data by IoT: By using various new sensors and collected data, an information system can expand the application field from business information systems to various applications, such as those for agriculture, health care of aging people, and the automobile industry.
2. Cross-industry data analysis: By integrating data in different business fields, new knowledge creation is expected to lead to new business opportunities.
3. Automatic decision-making: By applying AI, we can reduce human power in decision-making or replace human labor. This is very helpful in the business environment in Japan, which is undergoing a decrease in the number of young people and an increase in the elderly population.
4. Intelligent social infrastructure: By using technologies such as IoT and AI, social infrastructure systems, such as transportation, auto-driving, secure and smart societies, and new financial/payment systems, become more intelligent.

Figure 2.11 shows that in the 3rd generation service innovation, major players in the 1st generation and the 2nd generation will expand their existing business fields by applying new ICT technologies, such as IoT or AI. Further, new business players are expected to emerge, similar to Google and Amazon in the 2nd generation service innovation, who will develop new business fields and new business models.

2.5.2 Changes in Customer Desires and Societal Needs

A value is created by the relationship between functions using technologies and human desires or social needs. Therefore, the two major factors for new value creation are new ICT technologies and new requirements owing to changes in human desires or social needs. These are always changing with the times. Concerning the change of users' ICT literacy, people all over the world use smartphones. They retrieve and use information from the internet for creating value by themselves. Social infrastructures, such as payment and transportation systems, are changing on the premise of services through smartphones. Another example is the change in the automobile industry owing to social requirements, such as CO_2 reduction, or the emergence of the sharing economy. New technologies or new services have been developed in the automobile industry for satisfying such new needs. Thus, new needs or new requirements are major factors for business innovation.

Concerning changes in human desires, "Maslow's hierarchy of needs" describes the five stages of desire growth in humans, which uses the terms "physiological," "safety," "belonging and love," "social needs" or "esteem," and "self-actualization" to describe the pattern of human motivations. According to the progress of ICT technology and its applications, human beings want to realize their needs in the higher stages of Maslow's hierarchy by using ICTs, as shown in Fig. 2.12. Recently, service research has been expanding its research target from consideration of ways to make more money in the traditional service marketing to investigate the pursuit of human happiness in wellbeing services. This direction of service research should be considered in business innovation based on the 3rd generation service innovation.

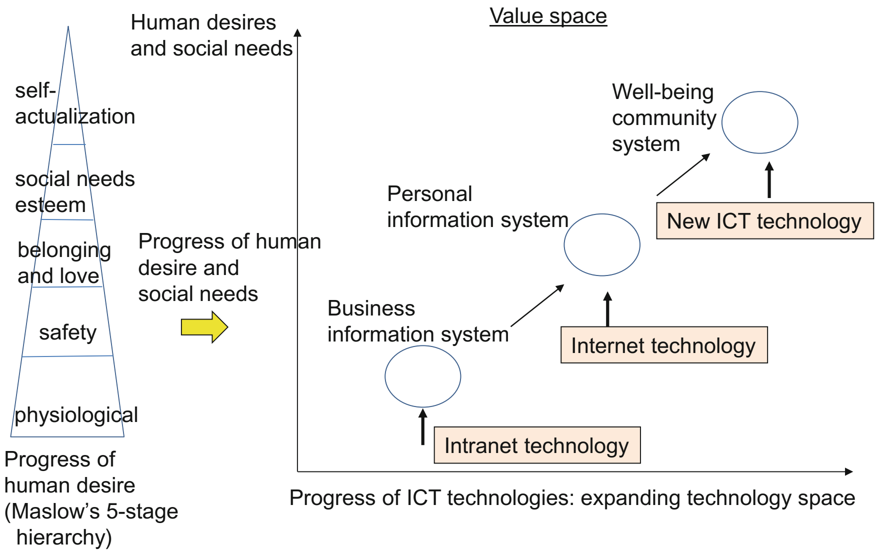


Fig. 2.12 Progress of value using ICT in the value space

2.5.3 Changes in the Role of ICT Providers

Many new technologies have been developed in the 3rd generation, including IoT or sensors as the device layer, 5G network technology as the network layer, AI or block chain as the processing layer, and cloud computing technology for user's applications. Thus far, ICT providers have provided these technologies to customers as a product or a service. However, users' literacy on ICTs has advanced further, and they or their communities want to make desirable services by themselves. Moreover, various resources, such as big data or application software, have begun to be shared in the internet environment. In such an ICT business environment, what is a suitable business style for providing ICT technologies to customers? One direction of the ICT business is to provide a platform with an easy-to-use interface through the cloud computing environment. IBM (https://www.ibm.com/cloud), Fujitsu (https://www.fujitsu.com/us/), and NEC (https://www.nec.com/) as successful companies in the 1st generation, and Google (GCP: Google cloud platform) as a successful company in the 2nd generation, have considered this direction.

We should investigate further about the role of ICT companies in the 3rd generation. In the 3rd generation, further open innovation is needed, and ICT technologies and resources, various types of data, and knowledge on creating service value are shared among a community with the same value standard. That is, the community creates the service value required in the community by themselves. In such a business environment, ICT providers are expected to prepare the value creating platform by sharing various resources with an easy-to-use interface, as shown in Fig. 2.13.

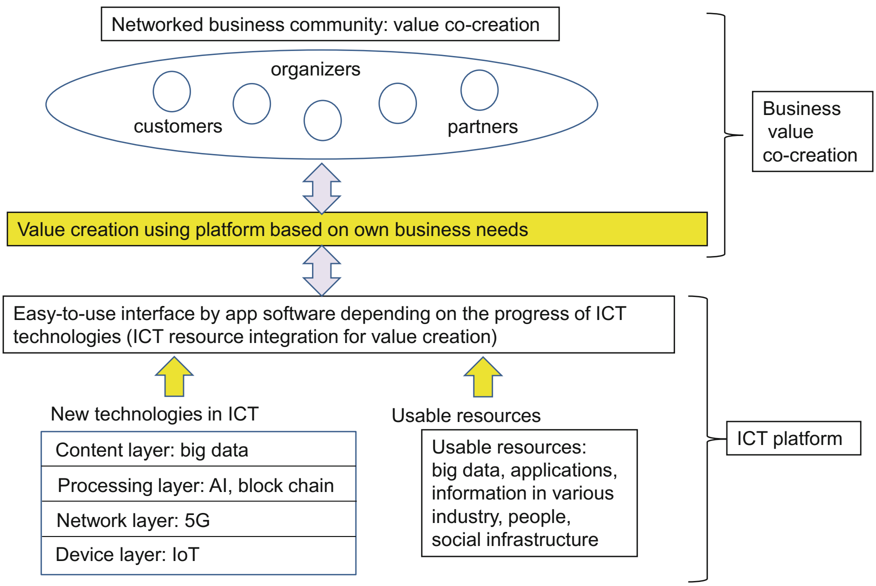


Fig. 2.13 Platform for the 3rd generation service innovation

2.5.4 From Technology to Value Creation

The mapping of technologies in the technology space into business values in the value space, which is discussed in Fig. 1.1 in Chap. 1, is the key to business innovation with new ICTs. This mapping is performed by providing new products or new services. Therefore, this mapping depends on the business model or business strategy of companies. Even if the same technology is applied for creating value, the value space and created values differ according to the companies' business fields and business models. Hence, the business model, the business strategy, and the application fields are critical factors in creating value with new ICTs. When new technologies create a new business field, a new mapping method suitable for that field should be considered. This fact can be demonstrated by explaining the change of major players from the 1st generation to the 2nd generation, as described in Sect. 4.

Figure 2.14 shows the relationship between the technology space, the value spaces, and the conversion methods of business categories explained in Fig. 1.1. The technologies in the 3rd generation are converted to different value spaces depending on the business model of each business category. We should ascertain the conversion method that is suitable for the target company in creating value for customers and societies in the 3rd generation.

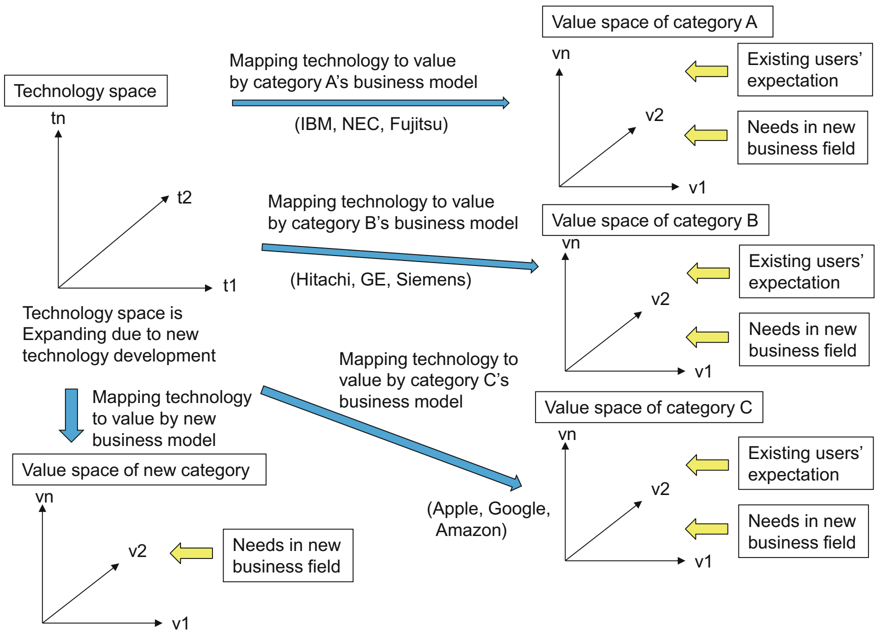


Fig. 2.14 Mapping from technology space to value space

2.6 Conclusion

In this chapter, we discussed the 3rd generation service innovation using new ICTs, such as IoT and AI. ICT technologies have brought about an extensive revolution in the ICT society of the 2nd generation service innovation. What revolution can we expect in the 3rd generation? This is a significant and common research question not only for researchers in the fields of information science, technology management, service research, and business management, but also for businesspeople seeking a future big business. To answer this question, we propose important viewpoints: (1) expansion of business fields with new ICTs, (2) changes in human desires and social needs, (3) changes in the role of ICT providers, and (4) conversion of new ICTs in the technology space into values in the value space depending on the organizational culture and abilities, which influence the business innovation of the 3rd generation.

References

Belobaba PP (1987) Survey paper—airline yield management an overview of seat inventory control. Transp Sci 21(2):63–73

Cambridge University (2007) Succeeding through service innovation: a service perspective for education, research, business and government. A white paper based on Cambridge service science, management and engineering symposium. Cambridge University

Demirkan H, Spohrer J, Krishna V (2011) The science of service systems. Springer, New York

Doan MC, Shirahada K, Kosaka M (2013) Service mediator model for value co-creation based on service dominant logic. J Serv Sci Manage 6(1):11–19

Doan MC, Le ND, Kosaka M (2014) A new service mediator for human resource management. Int J Knowl Syst Sci 5(3):1–17

Elberse A (2008) Should you invest in the long tail? Harvard Bus Rev 1–10

Farrell D, Greig F (2017) The online platform economy has growth peaked? The report of the JPMorgan Chase Institute

Fisk RP, Grove SJ, John J (2008) Interactive services marketing. Houghton Mifflin Company, Boston

Kameoka A (2007) Service science. NTS, Tokyo (in Japanese)

Kameoka A (2010) Services science empower next generation MOT: just-in-time innovation management by service layer integrated strategic road mapping. In: Hefley B, Murphy W (eds) Service science, management and engineering: education for the 21st century (Service science: research and innovations in the service economy). Springer, New York, pp 363–364

Kenney M, Zysman J (2015) Choosing a future in the platform economy: the implications and consequences of digital platforms. In: Kauffman foundation new entrepreneurial growth conference (discussion paper) at Amelia Island Florida

Kosaka M (2012) A service value creation model and the role of ethnography. In: An ethnography of global landscapes and corridors. InTech, Rijeke, Croatia, pp 109–130

Kosaka M, Shirahada K (2013) New trends in service science and education for service innovation. In: Progressive trends of knowledge and system based science for service innovation. IGI Global, pp 1–21

Kosaka M, Wang J (2016) A conceptual model of optimizing service system for the 3rd generation service innovation. In: Knowledge and systems sciences, volume 660 of the series communications in computer and information science. Springer, Berlin, pp 68–81

Kunitomo R (1997) Seven-Eleven is revolutionising grocery distribution in Japan. Long Range Plan 30(6):877–889

Li M, Zhu Z, Chen G (2013) Information service system of agriculture iot. Autom J Control Meas Electron Comput Commun 54(4):415–426

Lovelock L, Wirtz J (2007) Services marketing, 6th edn. Pearson Prentice Hall, Upper Saddle River

Lusch RF, Vargo SL (2006) The service dominant logic of marketing. M. E. Sharpe Inc., Armonk

Matsuda F, Kosaka M (2016) Hitachi Construction Machine Co., Ltd.—M2M and cloud computing based information service. In: Manufacturing servitization in the Asia-Pacific. Springer, Berlin, pp 75–92

Murai J (2015) The next industrial revolution will be driven by the internet of things. Diamond Harvard Bus Rev 28–37 (in Japanese)

Pine BJ II, Gilmore JH (1999) The experience economy. Harvard Business School Press

Porter ME, Heppelmann JE (2014) How smart, connected products are transforming competition. Harvard Bus Rev 3–23

Spitzer WJ, Davidson KW (2013) Future trends in health and health care: implications for social work practice in an aging society. Soc Work Health Care 52:959–986

Sumi T, Kitatani T (2013) Trends and issues in service business innovations in Japanese manufacturing industry. In: Progressive trends of knowledge and system based science for service innovation. IGI Global, pp 237–257

Sundbo J, Darmer P (2008) Creating experiences in the experience economy. Edward Elgar Publishing

Vargo SL, Lusch RF (2004) Evolving to a new dominant logic for marketing. J Mark 68:1–17

Wang J, Kosaka M, Xing K (2016) Manufacturing servitization in the Asia-Pacific. Springer, Berlin

Chapter 3
Innovation Drivers of ICT Toward Service Evolution: A Study of Service Generations in Japan

Shigeru Hosono

Abstract This article discusses the history and future of ICT-enabled services and how their generational progress enriches our lives. ICT contributed to the efficiency and productivity of services in the first generation. Subsequently, ICT substantiated a large scale of service platforms in the second generation and where product/service providers can collaborate with consumers. Now, ICT extends the possibility of services in the third generation, where well-being of both customers and employees and the society can be increased. These advancements of service are clearly visualized by the interactions of four innovation drivers and exemplified with epoch-making services in Japan.

3.1 Introduction

Information processing and telecommunication are essential to our lives. Data represented by characters and figures can provide intellectual information and can help with decision making during our daily activities. Looking back on the history of humankind, data and information gained through folklores, hieroglyphs, numbers, figures, mathematical formulas and languages have brought us knowledge on which to base our social norms and activities. Additionally, telecommunication infrastructure has supported the exchange of information. Long ago, telecommunication began with a wall painting and a beacon. As telecommunication technologies progressed, the rapid transmission of information became possible through inventions such as paper, Morse code, the telephone, the radio and TV sets. These are now indispensable means to fill our minds with knowledge and to gain wisdom to better the lives of everyone.

Information processing and communication infrastructure have continued to evolve remarkably since the invention of computers. Initially, this field was researched and developed for specific purposes, such as military use. However, as computers have evolved through software, hardware and networking, they have

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become increasingly commoditized and widely accepted in our social and private lives. Today, this information and communication technology (ICT) has permeated every corner of our lives, from home appliances used in everyday life to business processing systems in companies, government offices and public facilities, as well as personal computers (PC), tablets, and smartphones used by both individuals and businesses.

During the development of ICT, significant changes in its use have occurred in the following stages: the expansion of the user group of ICT, the improvement of its business efficiency, the shift in its business model, and the renewal of its everyday lifestyles. Additionally, the purposes that ICT is utilized for have become more sophisticated, from improving the efficiency of routine work to actualizing individual life goals.

In other words, the forms of the services provided by ICT have evolved as a result of being influenced not only by disruptive emerging technologies in the field of ICT but also by changes in social environments, values, policies and institutions. This process consists of a series of value propositions, which are provider-oriented, receiver-oriented, and cocreated between two parties, and accomplishes the self-realization of individuals through the evolution of product and service systems.

Considering these issues, this paper refers to cases in Japan to examine how stakeholders' needs have transformed and how service innovations have been made to meet these needs.

3.2 Innovation Drivers

We have pursued safe, secure and affluent lives through innovations that overcome everyday problems and social issues. ICT has been a major innovation driver in the creation of new services. However, advanced ICT is sometimes used in ways that are not regulated by conventional social rules, and its use has created new demands from users. These uses of ICT have created new societal demands and a need for a new political agenda. This situation motivates people to develop new technologies. The interactions between ICT and the social environment of an individual or an organization have paved the way for further innovation. These innovations are propelled by the interactions between four main drivers: (1) the introduction of new ICT (*New ICT*), (2) the expectations and demands of society (*Social Belief*), (3) the common interest that arises from the relationships between providers, receivers and the environment (*Common Interest*) and (4) policies and rules (*Policy*) (Fig. 3.1).

New ICT is a substitute for conventional ICT, has new software and hardware and replaces manual work with new business applications and ICT infrastructures. For example, ICTs have replaced private-line services used by internet providers with ADSL and optical lines; plain text files with hypermedia files using hypertext markup language (HTML) specifications; in-house servers for business applications with commercial cloud services; manual optimization for factory operations and automated analysis and improvement using internet of things (IoT) sensors, actuators

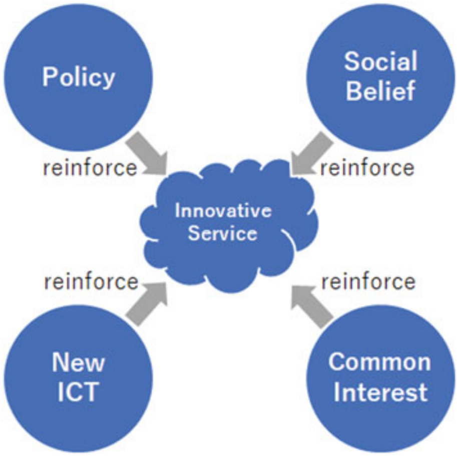


Fig. 3.1 Innovation drivers

and robots; and analysts' labor with automated prediction technology using artificial intelligence (AI). *Social belief* expresses the social wisdom of a time period. During periods of remarkable economic development, society pursues further economic advantages; during a downswing in the economy, they pursue stability for the lives of economically and socially vulnerable groups and individuals. Likewise, during natural calamities and disasters, people seek to have closer relationships with others and with society. *Common interest* refers to the relationships between consumers, business owners, employees, and other stakeholders such as companies, local governments, and schools, and the needs that arise in those relationships. *Policy* is about economic and diplomatic laws, rules, regulations and deregulations: this category includes funds for new business fields and emerging industries, deregulations, tax relaxations and incentives for starting businesses. In addition to these drivers, innovations that symbolize the times have been created during the last few decades (Table 3.1). It is thought that region-specific characteristics, such as culture and nationality, also affect the four drivers of innovations. Therefore, we pay special attention to ICT, as it is inseparable from innovation, and analyze the relationships between these drivers and innovation based on the transition of ICT over time.

Table 3.1 Service innovation

	1980s	1990s	2000s	2010s	2020s
Innovation	Office automation	Multimedia	E-market place	Internet shopping	Sharing
	Convenience store	Supply chain management	E-government	Subscription	

3.3 History of Disruptive ICT and Its Usage

Disruptive ICT, in contrast to the continuous improvement of conventional technologies such as performance enhancement, has introduced a new paradigm into the business models of services. Table 3.2 shows the changes in ICT that have brought this new paradigm to service infrastructures since the 1980s—the period in which the business model of manufacturing rapidly shifted from being goods-dominant to being service-dominant.

During this transition, applications have continually repeated the steps of consolidation (*centralization*) and distribution (*decentralization*). From the viewpoint of centralization and decentralization, this transition can be described by (1) high-speed data processing achieved by introducing strategic information systems (SIS), (2) system distribution based on service-oriented architecture (SOA), (3) partnership building via platforms and (4) an application programming interface (API) economy established by microservices.

1. **High-speed data processing achieved by strategic information systems**

Electronics corporations such as NEC, Sharp, Fujitsu and Hitachi led the trend of downsizing full-sized computers around the mid-1980s, and they began to focus on developing and selling PCs designed for companies and individuals. Alongside these trends, PCs were widely welcomed in various industries and were introduced to be used for building information systems for strategic data use. With the release of Microsoft Windows 3.1 in the 1990s, the user interface (UI) of PCs was dramatically improved. Soon after this release, Windows PCs with their popular office software, Microsoft Word, Excel and PowerPoint, were introduced to offices. The work environment where each worker occupies one PC spread quickly; the mass production of PCs was achieved and their prices were reduced. Concurrently, business applications were developed, not for large-scale computers but for PCs. Thus, PCs entered mainstream use in the business fields, and they were used for multiple purposes.

In this trend, the digitalization of analog data, including that of the paper documents previously used in business, has progressed, and these data were collected

Table 3.2 Disruptive technology

	1980s	1990s	2000s	2010s	2020s
ICT	PC	Windows 3.1	E-commerce	Cloud	AI
	Macintosh	Internet	Web2.0	Big Data	IoT
	Word processor	Java	Web/cloud	SNS	Edge
	Spread sheet	Object orientation	Mobile	Smart phone	Blockchain
		XML	Ubiquitous	Machine learning	Microservice
		Grid	Agile	Open data	
		Web service			

and processed within companies to be used as sources of corporate competitiveness, leading to the advancement of the integration of information systems.

2. **System distribution based on SOA**

Since the late 1990s, programming environments and database software have been streamlined as to be used as middleware facilitating the development of business applications. Meanwhile, standardizations of business components and specifications to develop business applications were established. The productivity of application development and management improved rapidly, as can be seen in the interface of Enterprise Java Beans (EJB)—a standardization of a software component, including messaging specifications between client-server modules, three-layer web architecture, and business protocols using applied extensive markup language (XML) formatting.

With these technologies in place, it became easier for business components to cooperate with each other through messaging; simple object access protocol (SOAP) and Web Service specifications were standardized by the major organizations, namely, the Worldwide Web consortium (W3C) and the Organization for the Advancement of Structured Information Standards (OASIS). These advancements enabled ways of coordinating software components through common integration with messaging, and thus various business applications were developed. Further distribution technologies were developed and applied widely, including Common Object Request Broker Architecture (CORBA), which made the mutual use of software written on various computers in various programming languages possible; and Grid computing, which enabled the utilization of computer resources on a wide-area network. These distribution infrastructures prevailed on the business platforms.

As these loose coupling technologies were well proportioned, the decentralization and the distribution of information systems became the primary architecture of new systems. While in-house systems were decentralized, the development of an application for terminals and mobile phones progressed, and ubiquitous computing played a leading role in the introduction of the next computing paradigm.

3. **Partnership building on service platforms**

In the late 2000s, the use case of on-demand software services through the internet had taken the place of installing and holding software program products for each PC. Until then, the concept of the service mainly consisted of the maintenance of the software and the hardware that had been delivered via the information systems. Instead, this era ushered in the concept of services spread throughout the lifecycle of an information system and services during different development phases of such systems, such as those of consulting, planning and designing service systems. Furthermore, as the integration of hardware, network resources and software in the data center became software-defined resources, layered cloud services were able to deliver software functions, such as middleware, databases, and applications. It can be said that the concept of SOA was adopted for cloud services because hardware and network resources could thus be controlled seamlessly as they were abstracted as software functions controlled by the application software.

In this way, the in-house information system of each business was replaced with major cloud services and was absorbed into the mega clouds. This trend induced the creation of mega clouds provided by the U.S.-based multinational firms collectively called GAFA (Google, Amazon, Facebook and Apple), and these clouds became major platforms that supported businesses and everyday lives in many regions of the world. At the same time, it became easier to develop application prototypes using the software interfaces provided by these clouds, and the agile development method (web ref.) that repeats hypothesis and verification cycles began to be adopted.

Regarding individual environments, mobile phones were upgraded to smartphones. Smartphones ran the standard types of mobile OS—Android, iOS and MS Windows Mobile, and were equipped with Radio Frequency Identification (RFID) and Near Field Communication (NFC) for electronic payments. Furthermore, biometric authentication devices, such as fingerprint recognition and facial recognition, were added to these devices, and the field of computing that dealt with the mobile environment began to progress. Social networking services (SNSs) such as Twitter and Facebook also spread widely during this time, and mobile devices such as tablet terminals and smartphones began to replace PCs. As computing and mobile computing became more common and pervasive, these various devices and their data were comprehensively managed by servers on the cloud platforms.

4. **API Economy established by microservices**

In the late 2010s, cloud services were disseminated widely, and these services were layered from lowest to highest based on the categories of the OSI Reference Model (web ref.), namely, infrastructure-as-a service (IaaS), platform-as-a-service (PaaS) and software-as-a-service (SaaS). These layered service structures were divided further with the advancement of container and API technologies; an upper layer of PaaS was subdivided to form container-as-a-service (CaaS), and a lower layer of SaaS was segmented to create a new category, namely, function-as-a-service (FaaS), which can constitute the APIs of microservices (web ref.). This advancement in technology enabled service providers to abstract their application functions as APIs. A new group of APIs called serverless architecture was created to form the infrastructure of a new service system. This trend of system integration moved technology toward the distribution of the consolidated architecture that is currently dominated by mega clouds. Connected APIs created a new business ecosystem and generated an economic zone called an API Economy. These trends produced new business models, e.g., through interconnecting the APIs of conventional retail services and that of FinTech startups. The mega clouds, namely, Microsoft Azure, Amazon Web Services (AWS), Google Cloud Platform (GCP), IBM Cloud, Oracle Cloud and Salesforce Platform, provided users with cognitive APIs, such as those with character and speech recognition, equipped with artificial intelligence (AI) engines that could take the place of the perception of human sensing. The combination of these various flexible functions had the ability to reveal the hidden problems of consumers, elicit their wants and realize their needs. This API approach enhances customer engagement on the related platforms, and this system of engagement (SoE) (Moore 2011) brought a new sphere of service innovation. This SoE orientation changed the target values and the development processes of service infrastructures, in contrast with the improvement and enhancement approaches in which system integrators focused only on fastened data processing, as system-of-record (SOR) system development stipulates the requirements and finalizes the system specifications at the beginning of development planning.

Furthermore, the digitization of data accelerated the creation of SoE-oriented services whose infrastructure foundations were natively supported by cloud technologies, thus native digital environments became the standard in service development and delivery.

3.4 Transition of Innovation Patterns

Advancements of ICT and its usage patterns have created new business models. This section focuses on the use of ICT in Japan.

3.4.1 Provider-Centric Innovation

Since the 1980s, the development of information systems using ICT has driven innovation. Information system development and the latest ICT have always been prioritized issues among many industries, including those of distribution, finance and manufacturing. SISs hosted business applications such as those used to analyze customer data and perform the automatic processing of purchase orders. They took the place of manual operation and empirical rules within offices, achieving the eradication of human errors and efficient data processing. Hence, they became a source of competitiveness in business.

In the retail industry, convenience stores, which were born in the 1970s, had been actively introducing ICT while they increased their franchise outlets and extended their store chains across the nation. Seven-Eleven Japan, the major convenience store enterprise, developed an information system that comprehensively collected and analyzed merchandise data, the purchase data of users, and information on local events. The system reduced excess inventory and prepared the company's best-selling products as needed. Moreover, in the 1990s, the company developed store computers and Graphic Order Terminals (GOT), which sent real-time data from individual stores to a hub office; this office was used for the curation of strategic suggestions for inventory management, assisting with the decision making done by the shop owner and staff (Table 3.3). After this process, many industries began constructing SISs, including finance and retail businesses.

Due to the SISs created in businesses, paper slips and manual processing disappeared from these workplaces. The implementation of an information systems department in an organization was strongly expected, and investment in these systems

Table 3.3 Advancement of SIS

The 4th SIS for Order Management (1990–)		
Sept. 1990	GOT, store computer	POS data analysis
Apr. 1991	ISDN	Real time data transfer between stores and the head office
Mar. 1992	New POS Register	
The 5th SIS for Order Management (1996–)		
Nov. 1996	Purchase order system	Networking with satellite and ISDN
May. 1997	Groupware	Multimedia data
June 1997	Multimedia	Open architecture
Nov. 1997	Store System	EC infrastructure
Sept. 1998	POS information system	
Mar. 1999	Store POS register system	

Fig. 3.2 Relationship for exchange-value

increased. Hence, the mindset that each company should develop and own ICT equipment independently and handle their data in their own way was created.

At this stage of innovation, manual work was replaced by ICT, which pursued efficiency through high-speed processing. In addition, the value provided by ICT service providers and integrators was increased accuracy and efficiency through an integrated SIS. Providers focused on relationships with customers and users (Fig. 3.2). The value of this innovation was an "exchange value", according to the value classification of service-dominant logic (Lusch and Vargo 2014), and allowed customers to pay for an information system in the same way as they would purchase products.

3.4.2 Cocreation for Innovation

Clouds and SNSs were leading to new innovative services during the time that the Internet became available around the year 2000. Communities utilizing the Internet expanded, and information systems were reformed through SOA. Furthermore, with the development of cloud computing technologies and the practical use of cloud services during the 2010s, cloud services were used as "places of cocreation" between customers, who were third party service providers, and users, who were the end users of the products or services of the third party. Activities to create new services were conducted between third parties and customers who were users of the services. Collaboration such as idea offering and new feature implementation on trial bases was promoted by providers, who had intentions to incorporate the concepts of user-centric designs (UCD) and human-centered designs (HCD) (Brown 2009) as mindsets in this ecosystem. Uploading data to these platforms became easy to do, and sharing personal experiences, thoughts and opinions through SNSs became popular in society. Due to these trends, society began place an emphasis on personalization. In addition, users of hosting services at datacenters moved to new cloud services, where more remote computing resources were available, and it became possible to build a Cyber Physical System (CPS) (web ref.) that linked the real world with cyberspace, where Big Data could be processed using high performance computations. This trend accomplished the digitalization of business as various digitalized field data were consolidated and processed to satisfy new business demands.

Innovations at this stage were accomplished through the effective use of ICT and the use of this technology was a precondition for exploring opportunities for innovation. As the pursuit of efficiency and the introduction of new functions were justified from the view of providers, the real demands of customers and users were always overlooked. To avoid dismissing the perspective of user experience, service providers must consciously view a new service development plan from the perspective of a customer when exploring potential new services. Keeping both the needs of the provider and those of the customer/user in mind can bring win-win situations through the planning, designing and delivery phases. For example, a product or service can be developed using volunteer support from a user community, which is a group of future customers, and their continuous collaborative work can reduce the asymmetry of information from the perspective of both sides and increase their loyalty to the new product or service being created.

At this stage of innovation, the introduction of ICT to service providers progressed, and ICT service businesses were developed. The providers added new features and improved upon the efficiency of their products from their own point of view, which did not necessarily align and match with their customers' perspectives, leading to customer dissatisfaction. Service providers prioritized comprehending the actual and latent demands of customers and users, placing an excessive focus on the value of the service from their own perspective. By comprehensively considering both "receivers" and "providers", it is possible to maintain win-win relationships between them through service design and delivery. Helping to establish a user community for products and services is a realistic way to foster these relationships. The community can be operated voluntarily or with the support of providers. Participants request that providers improve or develop new functions, and vice versa; providers request that customers evaluate their prototypes. This method reduces the asymmetry of information from both sides and increases loyalty to new products and services.

In this way, a platform as a place for cocreation plays a significant role between providers and receivers, supporting collaboration that in turn supports innovation. Establishing these platforms is a common strategy among service providers, who aim to dominate the market using their mega clouds. For example, the cloud services of GAFA enable service providers to analyze logs of consumer behavior and view

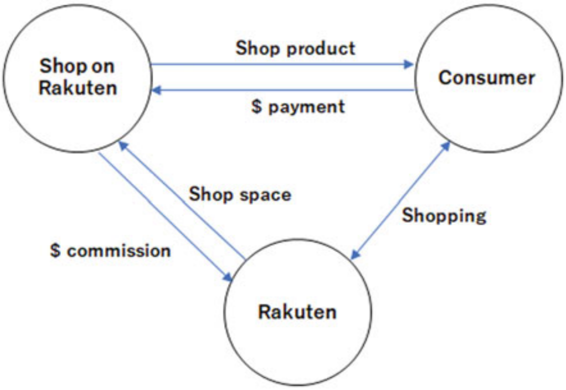


Fig. 3.3 Business model of Rakuten service

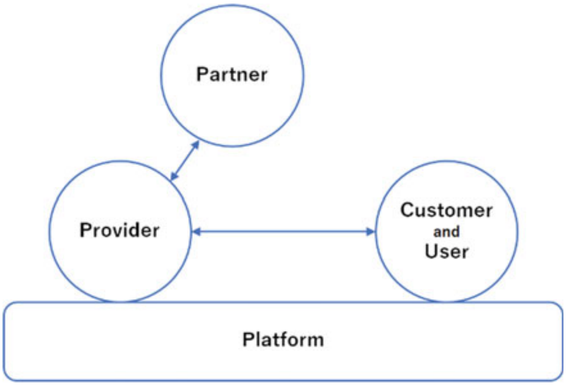
target marketing recommendations. In Japan, product sales sites such as Rakuten and Yahoo Japan! (Fig. 3.3) have provided such platforms. This provision means that customers and users are able to obtain information that can uncover and solve their minor problems, and this ability inevitably makes these services indispensable to the platforms. The company that established the platform (e.g., Rakuten) establishes an ecosystem consisting of the company that buys and sells goods on the platform and its customers.

Companies that build these platforms provide customers with places, information and resources for commercial activities. Namely, cloud service providers offer customers cyber spaces for net businesses as well as extensive computational resources as pay-by-the-hour net services. Hence, customers/users become accustomed to this new concept of "use": using computational resources only when they need these resources. They do this through giving up the concept of "owning": the responsibility for controlling the data and service level agreement (SLA) of those resources on their own. As a result, the realization that the use of a good's function is enough to start a business is achieved, and a subscription business model becomes acceptable. The value of this model is "value-in-use", such as rights and licensing, where three actors, namely, a partner, a provider and a receiver (customer and user) maintain balanced relationships on a platform (Fig. 3.4).

3.4.3 Innovation for Self-actualization

The concept of collaboration and cocreation has become prevalent in businesses since the late 2000s. Digital transformation (DX) (Stolterman and Fors 2014) has been promoted as a result, while ICT providers have attempted to expand to use platforms as a base for this concept. These providers are LUMADA (web ref.) of Hitachi, Ltd., COLMINA (web ref.) of Fujitsu, Industrial IoT (web ref.) of NEC, and these organizations support cocreation with their customers. They expect to

Fig. 3.4 Relationships of value-in-use

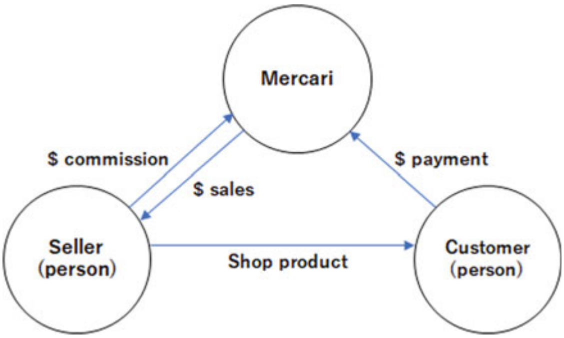


create environments that realize Society 5.0 (web ref.) and sustainable development goals (SDGs) (web ref.), aiming to create a safe, secure, and fair society and to allow individuals to maximize their abilities. The Japanese government introduced policies to achieve these goals, encouraging the advancements of ICT through actions such as collecting Big Data from various IoT devices and utilizing these data for the recognition and prediction of customer and user preferences through machine learning and deep learning.

The cost of using AI and IoT has decreased to a practical level, and ready-to-use AI and IoT environments have become widespread. Moreover, it is expected that the marginal costs in service production will become nearly zero in the future, and that the sharing economy will be more common in society, where people collaborate to produce, share, and manage goods and services (Rifkin 2014). In the past, the majority of people were reluctant to share things with others, but this concept has become more acceptable in recent years. *Mercari* is a business in which anyone can easily buy and sell personal belongings through their smartphone, which is an example of the sharing economy in Japan (Fig. 3.5).

At the next stage of its development, ICT strongly influenced the relationships of actors in Social Belief. For example, in response to the "Work Style Reform" policy

Fig. 3.5 Business model of Mercari's service



(web ref.), people became aware of their work-life balance by working remotely using ICT equipment. Parts manufacturing factories, introduced IoT devices in all their manufacturing processes, and instead of using intuition and experience to identify the causes of manufacturing defects, they analyzed the data collected from these IoT devices to quickly and accurately identify and resolve the causes of the problems. Consequently, the factory workers succeeded in reducing their working hours and increasing their living hours. Improved happiness because of ICT also leads to amplified social demands. In the retail industry, department stores and convenience stores close their businesses during the New Year holidays and late at night, increasing employees' private time, concentration during working hours and productivity per hour. This movement has been expanding not only in the retail industry but also in the tourism and manufacturing industries. The importance of measuring happiness, which shows another perspective on measuring productivity for businesses, is widely recognized. However, using this index requires the use of new ICT as an antecedent.

In the next stage, consumers did not mind either having or not having things, and a realization of what could be obtained was shaped. People became conscious about services, having good relationships within social environments and a strong sense of symbiosis (Fig. 3.6). The value of innovation here was the "contextual value" determined by the current relationships of providers, receivers, and society. The source of value lay in the self-realization of customers and of service providers. At this stage, the goal was to realize self-fulfillment for both "providers" and "receivers".

Currently, ICT continues to evolve. In the near future, microservices will be used widely, and the API economy, where various providers and users come together to form an ecosystem, will be established in various business areas. Furthermore, when a "digital native" environment, in which everything is digitized, is established, ICT is typically the basis of any kind of infrastructure for such an environment; users practically use digitized data in these environments to try to satisfy their need for self-realization and to become aware of how they could coexist with the environments surrounding them.

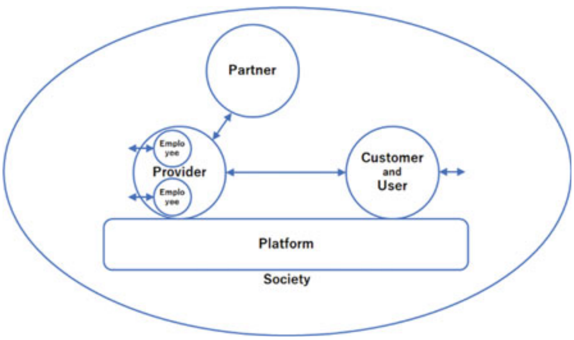


Fig. 3.6 Relationships for contextual-value

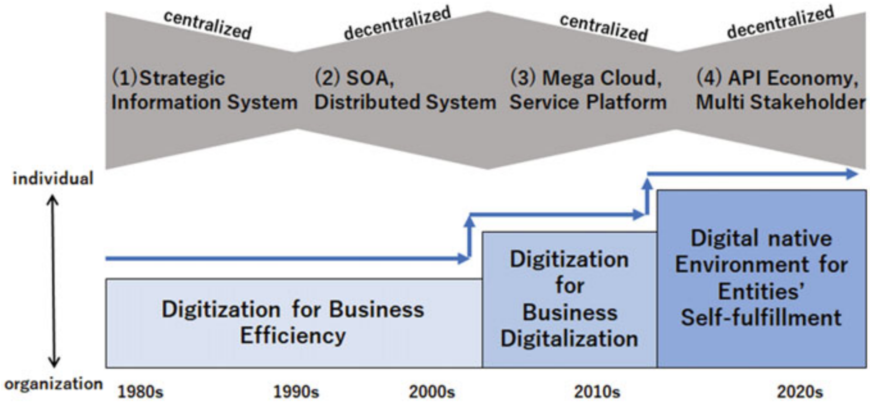


Fig. 3.7 Stages of innovation

3.4.4 Stages for Innovation

Digitizing data is the initial step of and a means for service innovation in which provider-centric and co-creative values are explored and solicited. However, if this means becomes an end without realizing its values for integrating new ICT for deliverables, its laborious and cost-conscious features may be highlighted during ICT integration while outcomes of the service are gained later after the services are delivered and operated for certain period. Today, this digitization is fully attained, and providers can begin planning new services by exploring new values with the plentiful digitalized data that is now available. Therefore, the objectives of exploration do not aim for efficiency in service operations but for effectiveness through service operations, especially for the benefit of related individuals in a service system. The digital native environments allow them to set goals for developing new ICT-enabled services for the fulfillment of personal life objectives, i.e. the attainment of well-being (Fig. 3.7).

3.5 Reinforcement Cycle for Service Evolution

3.5.1 Innovation and Needs

From the discussion in the previous section, it can be seen that, as the stages of innovation progress, the needs of stakeholders (providers, customers and users) change according to the needs of individuals (employees, customers and users, who work for providers). Based on these insights, the value proposition shifts step by step from the needs of organizations to individual needs. The stages of these needs are analyzed in the following sections by considering Maslow's hierarchy of needs theory. These discussions clarify what is required to satisfy these needs at each stage of the hierarchies in Maslow's theory in the business world and what is valued at each stage.

3.5.2 Service Generation and the Needs Hierarchy

Maslow's hierarchy of needs is divided into the following five components: physiological needs, safety needs, social needs (*Love and Belonging*), approval needs (*Esteem*) and self-actualization needs. According to Maslow's theory, when the lower-level needs are satisfied, the demands of the next layer increase (Maslow et al. 1997) (Fig. 3.8).

The stages in which innovative services have been created through the interactions of the four drivers can be connected to these levels of needs and vice versa. The associated relationships are thoroughly ascertained as follows.

Services in the first generation of development emphasized increased efficiency and productivity by replacing manual work with ICT. "High speed is power" was a slogan that expressed this value. It was taken for granted that sales would increase due to the improved efficiency, leading to more affluent lives for employees through increased income. The value of this development was rooted in a desire for security (Physiological/Safety needs) (Fig. 3.9).

The second-generation services were designed under the concepts of "customer first" and "user-centered". These ideas came from experiences obtained during the

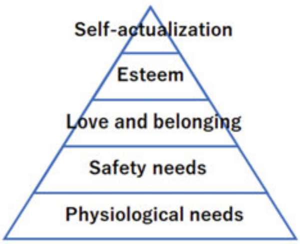


Fig. 3.8 Maslow's hierarchy of needs

Fig. 3.9 Need stage of the first generation

Fig. 3.10 Need stage of the second generation

Fig. 3.11 Need stage of the third generation

first generation of services in which the services were based on the logic of providers, namely, "faster is better", thus deviating from recipients' needs.

The need that corresponds to this generation of services is a higher-level deficiency need, i.e., a desire for recognition from society and customers (Fig. 3.10).

Third generation services required a higher level of fulfillment from individuals because second generation services had already equally considered the value of each stakeholder involved in the service ecosystems. In addition to providing customer satisfaction, value was expressed by words and concepts such as "employee satisfaction" and "well-being" (Rafael and Peter 2014). At this stage, the needs for acknowledgement had already been fulfilled and satisfying the need for growth became the issue to be solved by service experiences (Fig. 3.11). The need for growth (self-actualization) includes a sense of accomplishment, happiness, and the fulfillment of individuals who contribute to society.

The correspondence between the values of the service generations and the hierarchical needs of Maslow's model is shown in the following diagram (Fig. 3.12). As the service generations progressed, the corresponding need was also higher. Conversely, as the stages of the needs of society progressed, the corresponding services were created in the next generation of development.

3.5.3 Reinforcement for Continuous Service Evolution

According to the considerations in the previous sections, services in the first to third generations of development represent the possibilities of realizing higher-order

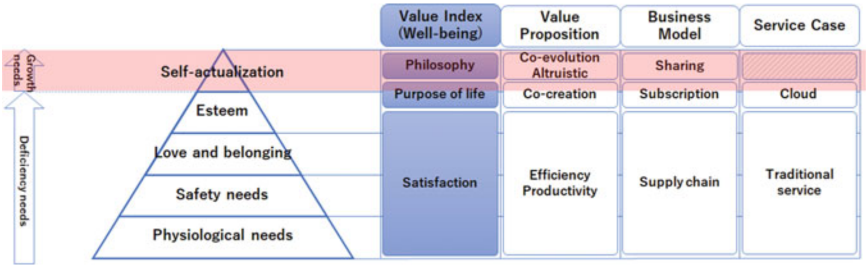
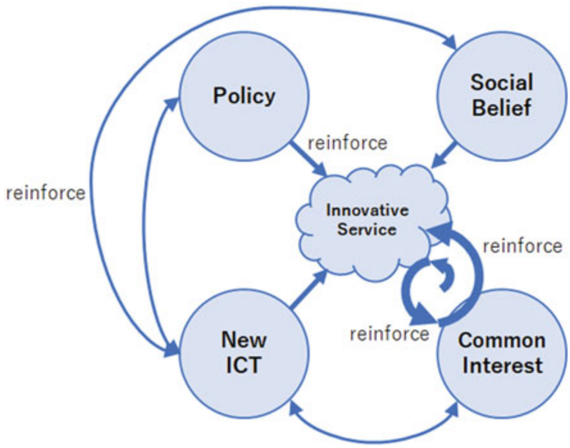


Fig. 3.12 Values and needs in service generations

Fig. 3.13 Reinforcement cycle for continuous service evolution



requirements while providing respective users with service functions. These requirements are amplified and expressed as high-order needs from actors, and these needs become driving forces for innovation. The driving forces are then strengthened by this beneficial cycle, and the demand for innovation continues (Fig. 3.13).

It is possible to analyze and comprehend the structures of innovations and their values via a timeline by using the framework described above (Fig. 3.14). Hence, the analytic framework enables us to confirm the current position of innovation in respect to the next product/service development and to determine what to provide to prospective customers next. Service evolution is brought about when actors that are surrounded by ICT have wants. If providers could be aware of the interactions between the drivers of innovation with no discrepancies between their *social beliefs* and *policies*, service innovations would happen continuously.

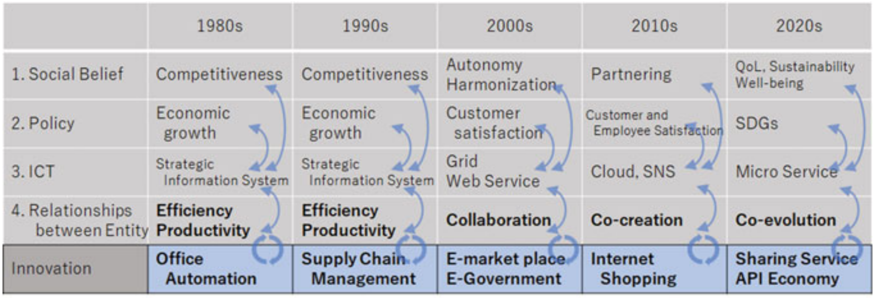


Fig. 3.14 Driving forces of service innovation

3.6 Service Innovation in Future

3.6.1 Innovation in the Digital Native Era

We have analyzed how service innovation has occurred over time based on new ICT and other drivers in Japan. Presently, this innovation is mainly in the second to third generation phases in many industries. For example, the automobile industry has been working on MaaS (mobility as a service), which brings this industry a once-in-a-century transformation of their automobile sales business. To implement new business models, they have created membership clubs as cocreation platforms, where users can become parts of the eco-system and their opinions can be shared with car manufacturers easily. In addition to the automobile industry, industries such as railways and airlines, which have played key roles in social infrastructure, have been using ICT services and platforms through ICT providers. However, they have the potential to become major platforms in their respective industrial fields by utilizing and analyzing customers' data that is collected from passenger vehicles. If a business ecosystem such as that of the GAFA companies can be built on such a platform, a path can be established for each industry to third generation service implementation as social infrastructure. Similarly, everything-as-a-service (XaaS), which expands contact with customers, is becoming widespread in other industries. In industries that are working to create new services, it is necessary to increase the number of contact points with customers to better understand them. It is expected that industries that introduce ICT have the vision to accommodate providers and their employees in their growth through interactions with customers, leading to maturity in customers' mindsets.

In the near future, the fifth generation (5G) of mobile communication systems will become prevalent in the world, and the dispersion of communication devices and information processing systems featuring high speeds, a large number of simultaneous connections, and low delays is expected to follow quickly. As digitalization progresses further, digital native environments will be realized, where providers think of customers first when creating new products and services and build services not from scratch but through prototyping. Customer engagement and employee engagement are becoming more common. Concepts such as Design Thinking, Open Data/Open API, Lean software development (Poppendieck and Poppendieck 2003), and Agile development will become widespread, meaning that various API interfaces will be available for free or at a low price. Marginal costs related to production, such as the use of 3D printers, are approaching zero. Therefore, engagement with customers, users, providers and their surrounding social environments continues to be important for innovation, and the relationships between stakeholders (multi-stakeholders) should be designed from the perspective of their surrounding environments, which is a view of the System of Systems (SoS). It is necessary to pay attention to whether the utility obtained by all stakeholders (i.e., actors) can be measured by indices such as self-realization and a sense of self-achievement.

3.6.2 Coevolution

At present, the transition from second to third generation services is beginning in the manufacturing, transportation, and distribution industries, as well as others. To accelerate the transition to third generation services, a function that works on the higher-order needs of individuals can be extracted using the proposed analysis framework, and these findings can become the target functions to be developed in the next services. It can be said processes can be improved by the creation of a cycle that amplifies, accelerates or enhances its function. For this purpose, it is necessary to cooperate to facilitate coevolution through learning from each other and to behave wisely so that the gains of all stakeholders in the service system can be maximized. An individual's self-actualization should be tolerant of the self-actualization of others. This approach will create some small disadvantages but will also help to maximize the comprehensive benefits. Conversely, when providers offer services that mutually meet the needs of customers and users, the providers can shift the focus of value proposition to delivering service functions, through which both users and employees can satisfy their high-order needs. Consequently, this shift of targets will accelerate service evolution, begin the transition to the next service generation and increase the innovation in society.

In Japan, there is a proverb called '*sanpo-yoshi*'. ('*Sanpo'* indicates three parties and '*Yoshi*' represents something good in Japanese. The proverb means "good for everyone".) The secret advice for doing business is that all stakeholders, namely, merchants, customers, and society, must enjoy themselves. Since these three parties have conflicting areas of interest, it is necessary to admit that while the three parties seek their own benefits, they also need to make concessions to one another. As the proverb once preached, promoting coevolution between actors is not meant to frustrate others but recognizes the interests of all actors involved in a service system and chooses the best combination of benefits from the perspective of overall gains and disadvantages.

3.7 Concluding Remarks

This paper discusses the structure of innovation and the corresponding stages of needs, and analyzes the service evolutions and generations of development in Japan using a framework composed of four drivers. This analysis echoes discussions on third generation services found in the Service Science and Knowledge Science SIG of the Society for Serviceology.

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References

Brown T (2009) Change by design: how design thinking transforms organizations and inspires innovation. Harper Business
Lusch FR, Vargo LS (2014) Service-dominant logic: premises, perspectives, possibilities. Cambridge University Press
Maslow HA, Frager DR, Fadiman J (1997) Motivation and personality, 3rd edn. Pearson
Moore J (2011) System of engagement and the future of enterprise IT, https://info.aiim.org/systems-of-engagement-and-the-future-of-enterprise-it
Poppendieck M, Poppendieck T (2003) Lean software development: an agile toolkit. Addison-Wesley Professional
Rafael AC, Peter D (2014) Positive computing: technology for Well-being and human potential. MIT Press
Rifkin J (2014) The zero marginal cost society: the internet of things, the collaborative commons, and the eclipse of capitalism and St. Martin' s Press
Stolterman E, Fors CA (2014) Information technology and the good life, http://www8.informatik.umu.se/~acroon/Publikationer%20Anna/Stolterman.pdf

Web Site

Colmina, https://www.fujitsu.com/jp/solutions/industry/manufacturing/monozukuri-total-support/colmina/
Cyber Physical System, https://www.nsf.gov/pubs/2010/nsf10515/nsf10515.htm
Industrial IoT, https://jpn.nec.com/manufacture/monozukuri/iot/index.html
ISO/IEC 7498-1, Open System Interconnection and https://www.iso.org/standard/20269.html
Lumada, http://www.hitachi.com/products/it/lumada/global/en/index.html
Manifesto for Agile Software Development, http://agilemanifesto.org/
Micro Services, https://web.archive.org/web/20180214171522/, https://martinfowler.com/articles/microservices.html
Society5.0, https://www8.cao.go.jp/cstp/society5_0/index.html
Sustainable Development Goals (SDGs), http://www.undp.org/content/undp/en/home/presscenter/pressreleases/2015/09/24/undp-welcomes-adoption-of-sustainable-development-goals-by-world-leaders.html
Work Style Reform, https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000148322.html

Part II
Case Studies from ICT Providers' Perspectives

Chapter 4
Social Innovation Business Through Value Co-creation with Customers Powered by Lumada: A Case Study of Hitachi Ltd.

Masaharu Akatsu

Abstract Hitachi is a unique company which has accumulated manufacturing expertise, ICT and operational technology since its founding more than a century ago. Hitachi is now evolving its Social Innovation Business through digital technology and accelerating collaborative value creation with customers. One of key success factors is Lumada: Hitachi's IoT core platform providing advanced digital solutions, services, and technologies for turning customers' data into insights to drive digital innovation. This chapter introduces how Lumada contributes to value co-creation with customers in the era of AI/IoT.

4.1 Introduction

One of Japan's leading manufacturers, Hitachi offers solutions in a wide range of fields, including ICT (information and communications technology), energy, and mobility, and had revenues exceeding ¥9 trillion in FY 2018. Since its founding in 1910, Hitachi's typical business model has been to use its high-performance and high-reliability technologies to solve customer's issues.

However, although this problem-solving approach worked in the twentieth century, in which customers' issues were clear, it is less effective in the era of VUCA (Volatility, Uncertainly, Complexity, Ambiguity), in which value creation is more important. Hitachi noticed that it cannot survive with the "old" business model alone, so that it has drastically changed its business strategy. In the era of AI (artificial intelligence)/IoT (Internet of Things), not only solution providers but also customers themselves have difficulty clarifying customers' needs and value. They need to co-create value together as Service Dominant Logic insists (Lusch and Vargo 2014). Hitachi realized this business trend, adopted a strategy that emphasizes value co-creation with customers, and reorganized itself to implement this strategy. At the same time, Hitachi has established Lumada: a business platform

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consisting of co-creation methodology, various domain knowledge bases, and an IoT platform. Through Lumada, Hitachi is now successfully evolving its Social Innovation Business through digital technology and accelerating collaborative creation with customers.

In this chapter, I introduce how Lumada contributes to value co-creation with customers in the era of AI/IoT.

4.2 Outline of Hitachi

Hitachi was founded as a mining machinery repair shop in Ibaraki Prefecture, Japan by Namihei Odaira, who wanted to utilize his own abilities to contribute to society by producing electric machines and developing Japan's machinery industry. Since its establishment, Hitachi has operated under the Mission expressed by its founder: "Contribute to society through the development of superior, original technology and products." The Mission, Values, and Vision are made to be shared in a simple concept: Hitachi Group Identity as shown in Fig. 4.1 (Hitachi 2019).

After first producing 5-horse-power motors, Hitachi subsequently developed into a comprehensive manufacturer of electrical machinery and products, including power generation equipment, railway cars, elevators, and refrigerators. In the 1960s, the company entered the ICT business by making large-scale computers and communications systems. For over 100 years, the company has solved challenges facing society during each era through developing technologies and providing services to raise people's quality of life. Moreover, Hitachi became large enough to be included in the Fortune 500.

For a long time, Hitachi's typical business model was to solve customers' issues by using its original technologies. The company developed a variety of products based on "goods dominant logic," which is the idea that if you make "good" products,

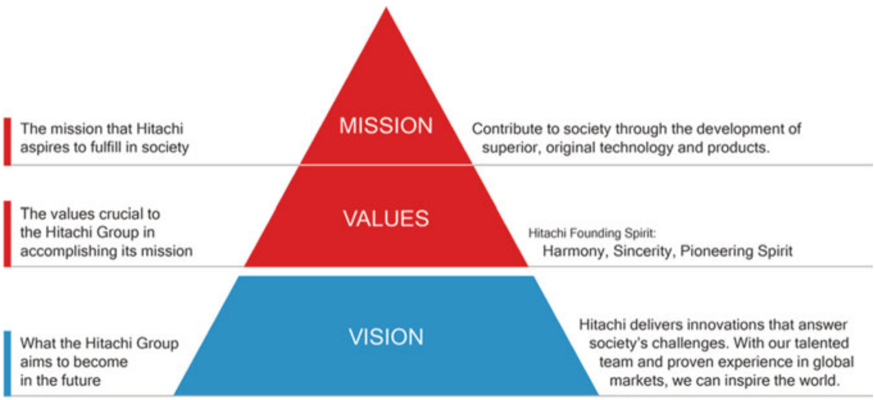

Fig. 4.1 Hitachi group identity

customers will buy them. However, times have changed in the twenty-first century. Customers themselves have difficulty clarifying their own needs and value, so that "good" products are difficult to define. Defining customer value is more important and difficult than realizing the value by problem solving. Hitachi was good at problem solving, but this is not an advantage when the problem is not known. As value creation became more important than problem solving, Hitachi's business performance stagnated. In 2008, Hitachi posted the largest loss ever for a Japanese manufacturer.

Faced with truly dire conditions, Hitachi decided to "return to its roots." Since its founding, Hitachi has focused on contributing to improving people's lives by following a corporate philosophy based on the desire to "contribute to society through the development of superior, original technology and products." In 2010, the chairman, Takashi Kawamura, and the president, Hiroaki Nakanishi, launched initiatives aimed at reviving the Hitachi Group and developing the Social Innovation Business. Social Innovation Business resolves issues faced by society and customers by accumulating manufacturing expertise, IT, and operational technology (OT).

Another crucial change of Hitachi was to shift to service dominant logic. Hitachi accelerated collaborative value creation with customers to resolve issues faced by society.

These transformations have been successfully going on. In 2019, Hitachi announced its three-year 2021 mid-term Management Plan, positioning IT, Energy, Industry, Mobility, and Smart Life as growth sectors and assigning relevant business units to each of them. These five sectors are highly compatible with Social Innovation Business. Table 4.1 shows main business of the five sectors with revenues in FY2018. The figures are based on the new segment classifications effective from FY2019.

Table 4.1 Five sectors

Sector	Revenues (FY2018)	Main services, products
IT	2121.6	System integration, cloud services, software, IT products (storage, servers), control systems
Energy	453.9	Energy solution, power grid system
Industry	895.4	Industry and distribution system, water and environment system, industrial products
Mobility	1214.5	Building services (elevators, escalators), railway systems
Smart life	1649.3	Medical equipment, smart life and ecofriendly system (refrigerator, air conditioner), automotive systems (powertrain, chassis parts)
	Billion yen	

4.3 Background of Social Innovation Business Through Value Co-creation with Customers

4.3.1 Social Innovation and Service Dominant Logic

Our world is changing at ever-increasing pace with energy and environmental issues, water-related concerns, population explosions, and increasing inequality creating new challenges that can seem insurmountable. In 2015, the United Nations announced 17 SDGs (Sustainable Development Goals) (Walker et al. 2019) as part of a comprehensive 15-year plan aimed at ending poverty, fighting inequality and injustice, and tackling climate change. In 2016, the Japanese government advocated Society 5.0, a new idea of society, and related efforts to achieve this (Hitachi the University of Tokyo Laboratory 2018). The aim is to grow the economy while addressing societal issues by deploying AI, IoT, robots, and other forms of advanced science and technology to make use of various data to create an affluent, human-centered society. The name refers to the evolution of the fifth form of society, continuing from the hunter-gatherer, agrarian, industrial, and information societies. A lot of efforts are being made to solve social issues around the world. Social Innovation Business is Hitachi's contribution to these activities.

Hitachi's obligation to sustainability is as important as its commitment to Social Innovation. Social Innovation is a part of Hitachi's culture. Hitachi is a unique company that has used OT for more than a century as well as advanced IT. By combining its strengths in OT, IT, and products, Hitachi's Social Innovation Business is well placed to respond to the issues facing society today and realize a sustainable society with improved quality of life.

Service dominant logic is crucial to accelerate Social Innovation Business. Service-dominant logic is a concept that does not distinguish goods from services and that regards all business activities as exchanges of service (Lusch and Vargo 2014). The main issue in Service Dominant Logic is how companies can create value with their customers.

In Society 5.0, a human-centric society is touted. In other words, it aims for a society where human can live a comfortably and healthily. Here, the word "human" should not be regarded as a collective noun. The values each person seeks are diverse, and the values the same person demands depend on time, place, and situation. The needs of each person must be responded to individually, and this has been made possible by using various data that has not been grasped until now. On the other hand, it is not easy to both solve social issues and realize comfort for individuals. A sustainable society cannot be created by accepting all the "self-centered demands" of each person. The micro viewpoint on what value is for people and the macroscopic perspective on how to change the world sometimes conflict with interests. Therefore, synthesis is indispensable. Synthesis is an approach that creates an entity (fact) to a request. The starting point is to formulate a hypothesis about the value that we want to achieve. This is the same as Service-Dominant Logic.

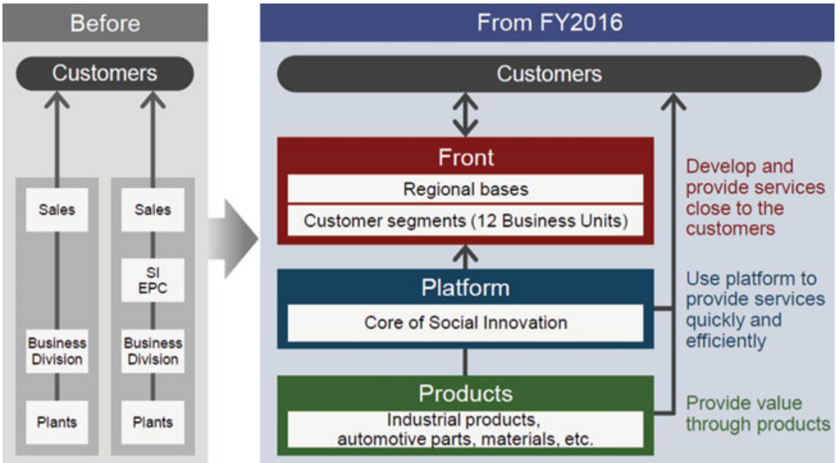

Fig. 4.2 Organization restructuring in 2016

Against this background, Hitachi has changed its strategy from *goods* dominant logic to *service* dominant logic to accelerate Social Innovation Business. Moreover, social challenges cannot be solved only by Hitachi. That is why Hitachi has emphasized value co-creation with customers. In 2016, CEO (chief executive officer) Toshiaki Higashihara reorganized Hitachi to accelerate service-oriented approaches as shown in Fig. 4.2. In the past, Hitachi had an in-house company system based on technologies and products. In contrast, the new business structure consists of three layers: Front, Platform, and Products. Each layer is closely connected on the basis of a customer-centric mindset. Suppose there is a manufacturing customer. Hitachi used to provide IT solutions and energy solutions separately to the customer. Now, front layer people discuss all issues and co-create values with the customer. A year before the business restructuring, the R&D (research and development) structure was also changed as shown in Fig. 4.3. Identifying customers' issues through conversation with customers was added to R&D group roles in addition to developing new technologies.

4.3.2 Driver to Accelerate Social Innovation Business: Lumada

When Hitachi announced its organization restructuring for Social Innovation Business through value co-creation with customers in 2016, it also unveiled Lumada: an IoT core platform for accelerating IoT solution creation for a range of industry applications while simplifying co-creation with customers. Figure 4.4 shows the role of Lumada. Lumada can make cyber-physical systems available and make the cyber and physical spaces interact mutually, as required to achieve Social Innovation

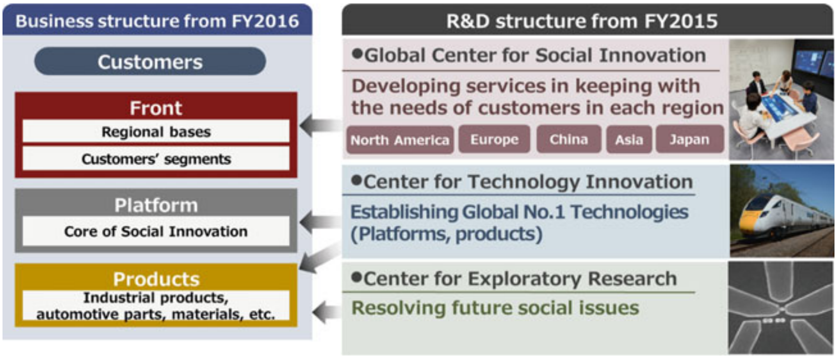

Fig. 4.3 R&D structure aligning new business structure

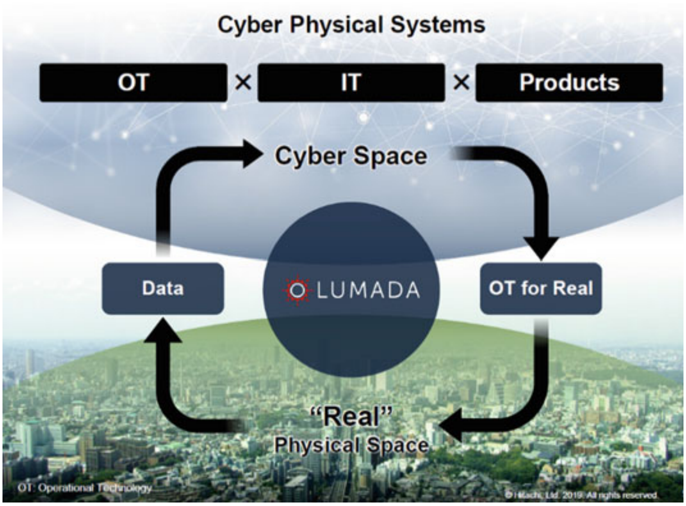

Fig. 4.4 Cyber physical systems by Lumada

Business. Lumada has strengths to connect OT, IT, and products and to accelerate innovation for customers. Hitachi has more than 100 years of experience in OT, more than 50 years of experiences in IT, and products that support them. These strengths are embedded in Lumada. In the next section, Lumada is explained in detail.

4.4 Development of Lumada

4.4.1 Outline of Lumada

Lumada is Hitachi's advanced digital solutions, services, and technologies for turning customers' data into insights to drive digital innovation. The name "Lumada" comes from the words "illuminate" and "data." This name reflects Hitachi's mission to shed light on customers' extensive data and identify potential correlations, to provide insights valuable to their businesses.

Lumada consists of three major elements: co-creation, domain expertise, and platform products and technologies as shown in Fig. 4.5. Regarding co-creation, Lumada has methodologies and tools named NEXPERIENCE. In the process of co-creation, Hitachi utilizes its deep industry-specific expertise. Such domain knowledge is compiled in Lumada in the form of customer cases, solutions, and applications. Lumada also provides an IoT platform that is a comprehensive framework of key IoT solution building blocks. It helps for implementing advanced digital solutions quickly.

The Lumada platform is different from those of GAFA (Google, Apple, Facebook, and Amazon), which aim at "winner takes all" monopolization. Lumada is an open platform, which means it can be connected to other platforms such as Amazon Web Services and Microsoft Azure. Openness is one of the key characteristics of Lumada as it enables the creation of IoT business ecosystems. Hitachi's CEO Toshiaki Higashihara said he never thought of GAFA as competitors and that they are eligible to be affiliated.

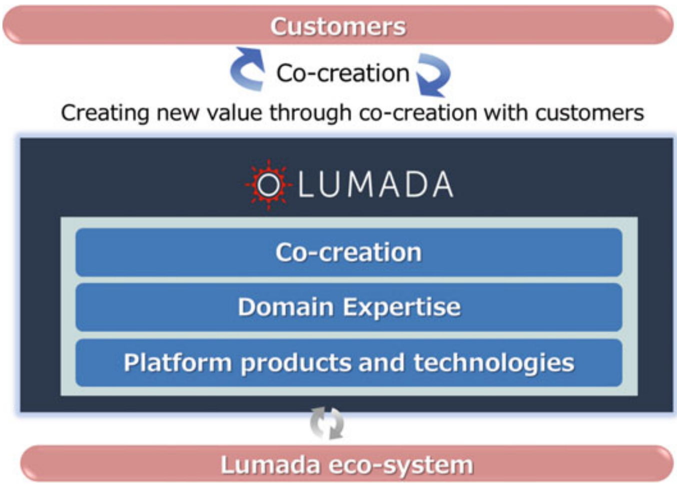

Fig. 4.5 Structure of Lumada

Lumada is applied to all five business sectors: IT, Energy, Industry, Mobility and Smart Life. The department that promotes Lumada is positioned as a cross-sectional organization of the entire company. Platform layer in Fig. 4.2 corresponds to this. Lumada-based revenues have already expanded to exceed ¥1 trillion in FY2018.

In the following sections, each of three layers is explained in detail.

4.4.2 Customer Co-creation: NEXPERIENCE

Figure 4.6 shows Hitachi's customer co-creation process. Starting with societal issues, vision is shared between a customer and Hitachi, and latent issues are identified. After working with the customer to identify issues, Hitachi uses AI and other technologies to develop a hypothesis for solving those problems. On the basis of the hypothesis, a prototype solution is created, and its value is validated. After its efficiency and feasibility are verified, Hitachi provides equipment, systems, and operation and maintenance services to deliver the solution. The success stories are accumulated in Lumada. The proposal phase of collaborative creation with customers is aggressively promoted by incorporating Hitachi's original methodology NEXPERIENCE into Lumada (Ishikawa et al. 2016; Ono et al. 2017). NEXPERIENCE was unveiled in 2016, however it is based on Hitachi's various service innovation initiatives.

The first initiative is experience design (Kashimura et al. 2013). Experiences are defined as the subjective values that user perceives. Delivering experiences requires an iterative process including analyzing users' latent needs, designing solutions, and validating their effectiveness. Hitachi applied the process to home appliance design at the beginning. Since the 1990s, the experience approach has been expanded to various industries, such as electric power systems, transportation, and ICT. In 2009, Hitachi

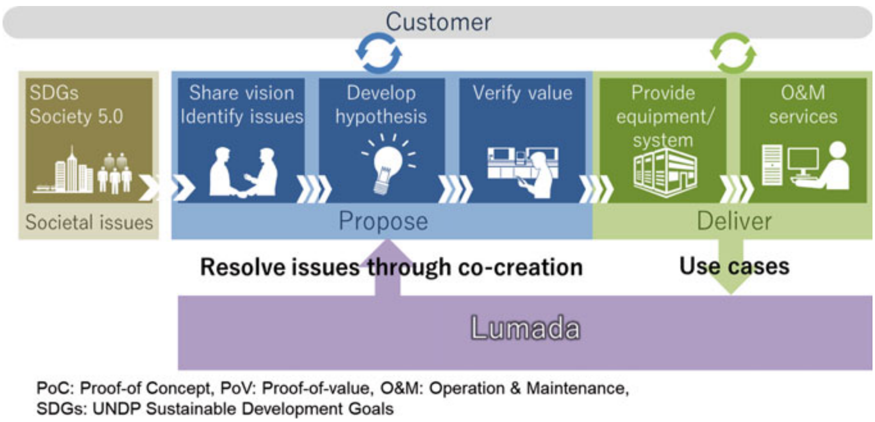

Fig. 4.6 Co-creation Process

Fig. 4.7 Overview of NEXPERIENCE (Ono et al. 2019)

announced its original experience-oriented approach as a requirement development technique in the up-stream process of system development (Kitagawa et al. 2013).

The other is identification of value of service (Akatsu 2007). SLA (service level agreement) is one approach to identify the service quality and foster common understandings between providers and customers. KPIs (key performance indicators) are selected when making a SLA. KPIs have been organized for not only assuring the quality of ICT services, such as operation and maintenance, but also identifying the business value that ICT systems provide.

The above activities are systematized as NEXPERIENCE. NEXPERIENCE covers a wide range of phases with many methods and tools for satisfying customers' goals as shown in Fig. 4.7.

The first step is sharing visions with customers to discover business opportunities. The strong approach to share a vision is vision design whereby Hitachi works with other stakeholders to identify specific scenarios for Society 5.0 by raising issues from a consumer's perspective and presenting technologies and services for resolving them (Kashimura et al. 2017). Hitachi presents "25 *Kizashi* (Future Signs)" to encourage discussion on visions with customers. They capture the embryonic movements of change through this insight into the future and suggest how people in the future may think or act. For example, in response to the signs "free exchange of people and goods," "changes in family models," and "connectivity everywhere," the following questions are posed: "What is the liberation of not owning possessions?" and "How are the roles of homes and families changing?" Future visions are illustrated by discussing these questions. Some outputs are made public in the form of short videos that present potential challenges in the future and show how they may be resolved.

In the business analysis phase, ethnographic research is used to extract potential problems and hidden needs that the customers may be unaware of through on-site observations. Ethnographic research is a social science methodology for explaining the culture and lifestyle of specific groups in terms of anthropology and sociology (Kawasaki et al. 2013). It is effective for acquiring clues to a solution by clarifying latent needs and fundamental problems that are difficult to obtain in a questionnaire or an interview. Another method for identifying customers' issues uses a modeling technique called a CLD (causal loop diagram) (Nagaoka et al. 2016). CLD represents the business structure by a directed graph network where the management indicators, operational indicators, and the factors that influence them are represented by nodes, and the cause-and-effect relationships between them are represented by links.

Regarding service ideation, Lumada has a framework with the concept of "knowledge fusion." The framework is used in workshops attended by customers and other partners as well as experts from Hitachi to encourage every stakeholder to come up with service ideas by providing an overview of the ideal values for customers, the business challenges, and the associated ICT and other products. One unique tool is business *Origami* as shown in Fig. 4.8. Participants of a workshop place *origami* models of people and buildings on the table to represent an overview of stakeholders' interests and concerns. In the workshop, AI and digital technology are also utilized. There is an idea generation tool that uses AI to perform voice analysis of workshop discussions and recommends customer cases of problem solving from the extensive range of businesses in which Hitachi is involved.

After obtaining an innovative service idea, the business model is explored. NEXPERIENCE offers a tool that helps to investigate service ideas from four perspectives: stakeholders' correlations, individual business strategy, service user stories, and revenue streams. Stakeholders' correlations are expressed by business *origami*, and revenue streams are identified by analyzing it. Business Model Canvas is also used to describe individual business strategies (Osterwalder et al. 2010).

Fig. 4.8 Using business *Origami* (Kashimura et al. 2013)

The last step of NEXPERIENCE is evaluating service value. To clarify the value, KPIs corresponding to the value are identified as well as costs. KPIs are structuralized by using the concept of a Strategy Map (Kaplan and Norton 2004), and ROI (return on investment) is calculated.

In general, the hypotheses on value formulated through co-creation process are verified by developing prototypes and preforming PoC (proof of concept). However, these hypotheses are difficult to demonstrate in the real world for things like social issues. Thus, NEXPERIENCE has Cyber-PoC: simulation tools for assessing the value. Cyber-PoC simulates the real world including human behaviors and energy consumption in cyber space. It measures KPIs and calculates ROI. The simulation can be conducted with different conditions by interactively changing solutions.

Figure 4.9 shows a screenshots of Cyber-PoC for Railway and Transportation Solutions. The screen on the left shows a visualization of the extent to which the construction of new railway lines will reduce urban traffic congestion. The top half of the screen on the right shows the results of a simulation of modal share. The bottom half of the screen on the right shows the calculation of CAPEX and OPEX as well as calculation of payback period.

Methodologies of NEXPERIENCE are common worldwide; however, they are highly dependent on cultures and customs, which vary from country to country. Thus, collaborative creation spaces have been established in not only Japan but also regions such as Europe, Asia, and North America. The facilities have IT tools and enable people to focus on collaborative creation as shown in Fig. 4.10.

In April 2019, new equipment called “Kyōsō-no-Mori,” which means Collaborative Forest, was launched within the Central Research Laboratory (Fig. 4.11). In Kyōsō-no-Mori, collaborative creation is conducted not only on a one-to-one basis but also in a more open style where partners will be invited from around the

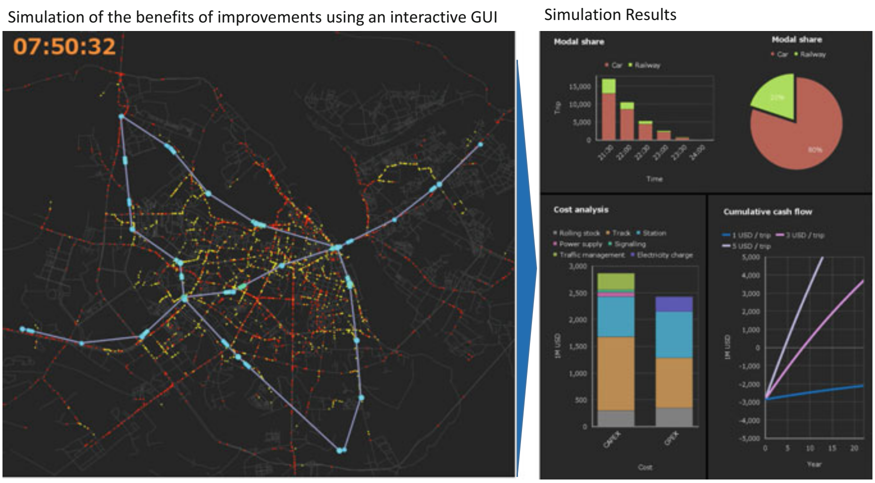

Fig. 4.9 Cyber-PoC for railway and transportation solutions

Fig. 4.10 Collaborative creation space

Fig. 4.11 Kyoso-no-Mori

world to co-create with researchers and designers and generate new ideas. Ideathons and hackathons are held in the NEXPERIENCE Space to generate new ideas or identify breakthrough measures, and the cycle of prototyping and validation is rapidly repeated in the Project Space with cutting-edge technology and Lumada's IoT platform to accelerate innovation.

4.4.3 *Utilization of Domain Expertise*

Hitachi has used its accumulated expertise in manufacturing, IT, and OT to construct various systems. However, this expertise was mainly tacit knowledge in each business unit, and expertise in IT and expertise in OT were difficult to integrate. Lumada changed this situation and accelerates the knowledge creation process.

Ikujiro Nonaka, who introduced the SECI (socialization, externalization, combination, and internalization) model that has become the cornerstone of knowledge creation and transfer theory, described Lumada as an example of practicing the SECI model (Nonaka 2020). The SECI model is a spiral process to create value throughout an organization. It identifies four specific types of knowledge conversion as shown in Fig. 4.12 (Nonaka and Takeuchi 1995). Socialization is the empathy process where tacit knowledge is created by sharing experiences. Externalization transforms tacit knowledge into explicit concept by language and figures. Combination combines multiple concepts and create a body of knowledge to make the combined concepts more usable and understandable. Internalization is a process in which newly created explicit knowledge converted into the organization's tacit knowledge.

The customer co-creation process explained in Sect. 4.4.2 corresponds to the socialization process. When working on a new co-creation project with a customer, Hitachi builds a customized solution, using the Lumada solutions and applications as its building blocks. Of the customer cases that have proven results in various industries, those that can be applied to address the customer's management problems are also incorporated. From the new solution, explicit knowledge is externalized and

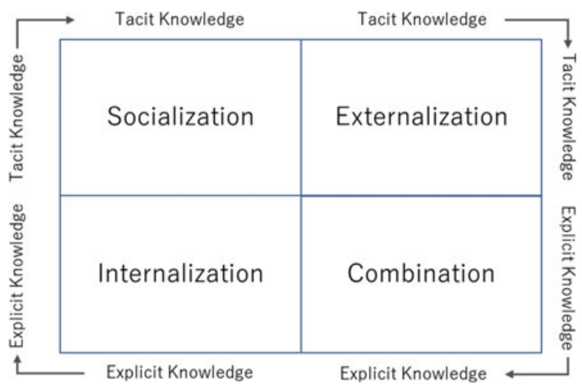

Fig. 4.12 SECI model (Nonaka and Takeuchi 1995)

combined in Lumada. Customer cases, solutions, and applications are compiled in Lumada. Hitachi's industry-specific expertise and business process knowledge can be referred to by all employees and applied in various fields through co-creation with customers. Applying existing customer cases to new problems leads to internalization and allows Hitachi to accelerate the development of the digital solutions that create value. These series of processes are spiral knowledge creation in the SECI model.

4.4.4 Platform Products and Technologies

When Lumada was first announced to the public in 2016, it was explained as an IoT platform. It is based on federated cloud services developed in 2014.

Data from the existing systems must be gathered by SORs (Systems of Record) and analyzed by SOEs (Systems of Engagement) to create a new value. Both systems need to be connected, but this is not so easy because they are made with completely different design ideas. SORs are typically constructed by waterfall methodology where the specifications should be clear in the first stage. In contrast, SOEs inevitably need agile methodology where construction and verification of hypothesis are repeated because analytics to create value cannot be defined at the beginning. Both are physically different, too. Many SORs are built on-premises, whereas SOEs usually run on the cloud. That is why a new "system of systems" is difficult to construct by integrating SORs and SOEs. To solve this problem, Hitachi developed federated cloud services in 2014. Federated cloud services help to migrate SORs to a cloud environment.

Lumada inherits the function for migrating SORs and SOEs incorporating expansive expertise in IT and OT by blending powerful and proven data orchestration, streaming analytics, content intelligence, simulation models, and other software technologies. Lumada consists of a core of platform services, technologies, and its architecture that enables the quick development and implementation of advanced digital solutions (Iwasaki and Nakamura 2020).

Lumada is comprised of six main layers that form the architecture of the platform: Studio, Analytics, Data Management, Edge, Core and Foundry as shown in Fig. 4.13 (Aoki et al. 2017). Various field data are relayed to IoT systems by *Edge*. They are accumulated in *Core*, and a data lake is created. The data are reshaped in *Data Management* to make them easier for *Analytics* to analyze. *Analytics* analyzes data using AI and analytics technology. The analysis results are visualized in *Studio*. *Foundry* provides IoT system infrastructure such as servers and networks. Together they serve as a software platform that is intelligent, composable, secure, and flexible.

1. Intelligent: Analytics technology such as machine learning and AI allow for deep insight and awareness that lead to action.
2. Composable: Hitachi's core technologies can be widely combined with OSS (open source software) and third-party technologies to maximize outcomes.

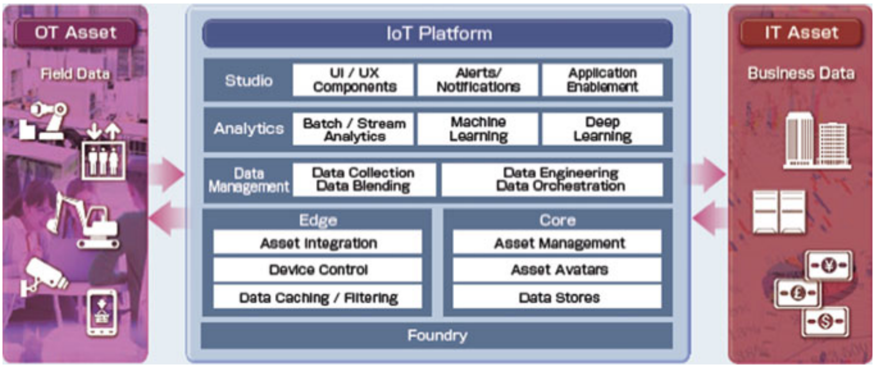

Fig. 4.13 Lumada's IoT platform architecture

3. Secure: Users can ensure high levels of security by confirming the appropriateness of connecting equipment, managing the security of stored data and controlling access.
4. Flexible: Flexible solutions can be provided that fit equipment, devices, and IT environments currently in operation both through the cloud and on-site.

Regarding being Intelligent, Lumada has a lot of unique AI technologies. It is constantly being renovated to incorporate research results of the R&D Group. The range is wide in terms of both technology and application. Typical examples are explained below.

The most impressive domain is for digital transformation in manufacturing. One of the issues in the manufacturing sector is the shrinking labor force. Hitachi's AI is trying to compensate for the lack of technical experts. The first example involves a system developed to provide work assistance and eliminate human error by analyzing data collected from wearable devices (Soga et al. 2018). The system tracks workers' activities in real time, combining a technique that uses eye-tracking glasses to identify what the worker is looking at, and another that uses arm bands to determine the worker's physical movements as shown in Fig. 4.14. Another example helps production planning by Hitachi's original constraint programming technology combining AI technology with mathematical optimization technology. By learning the incisiveness and knowledge of experts from historical plan data, computers can draft plans at nearly the same level as experts.

Anomaly detection and predictive maintenance are the tasks Lumada is good at. Lumada has several diagnostic functions such as VQC (vector quantization clustering), LSC (local sub-space classifier), and ART (adaptive resonance theory) that use statistics and data analysis techniques such as pattern recognition (Sekiai et al. 2011). After advance learning of data from the past normal operation of machines and plant devices, such as temperature, pressure, water level, and flow rate, they classify correlations of data that serve as yardsticks for evaluating possible signs and automatically create a category of normal data. They then automatically classify new

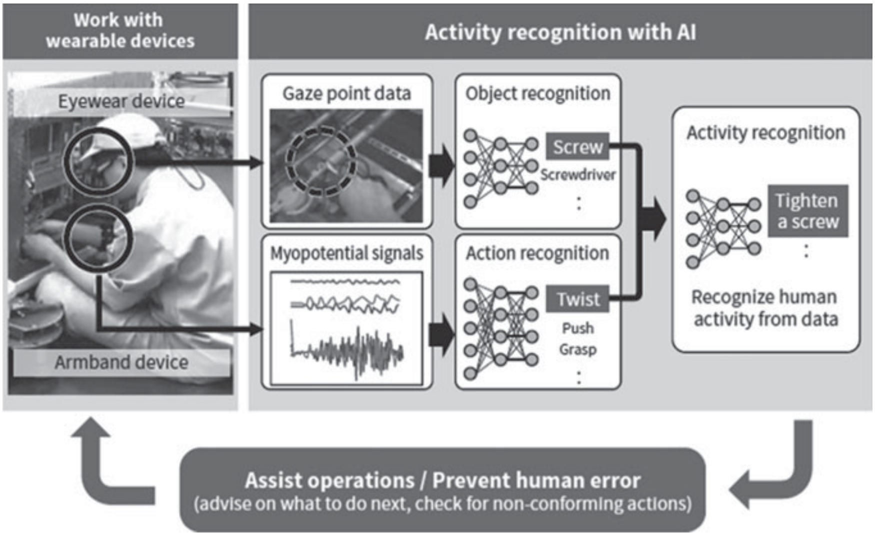

Fig. 4.14 Analyzing the activity of a worker wearing sensors

data obtained from actual operation and compare the data with the category of normal data to determine whether the operation is normal. On the basis of the analysis, they diagnose equipment and detect anomalies. Hitachi itself uses these technologies for its maintenance support service for products such as air conditioners and construction machinery (Baba et al. 2020).

Lumada AI technology is also applied in supply chain optimization (Otogawa et al. 2018). It both minimizes the built-up of inventory and improves the ability to keep up with fluctuations in demand. The key feature is interactive simulations using accumulated ERP (enterprise resource planning) system data and quickly derive suggestions for multi-stage inventory supply chain optimization.

Lumada also covers RPA (robotic process automation). One example is self-learning RPA, which receives unstructured data such as images and natural language as input and attempts to use knowledge acquired from past tasks to automate tasks for appropriate processing (Kobayashi et al. 2018). It is applied to checking accounts documentation and handling inquires. Another example is business improvement through use of digital dialogue services (Shirai et al. 2018). Dialogue AI technology used there combines speech processing (the conversation of analog speech data into digital text) with language processing (the interpretation of what the text means).

The last example is that Lumada is unique in its pursuit of people's happiness. Staff and visitors wear wearable sensors to measure and visualize happiness from the acquired behavioral data. The correlation between happiness and performance data is analyzed and high correlation behavioral characteristics are derived (Sato et al. 2018). The technologies are used in work style reform, which is popular in Japan now.

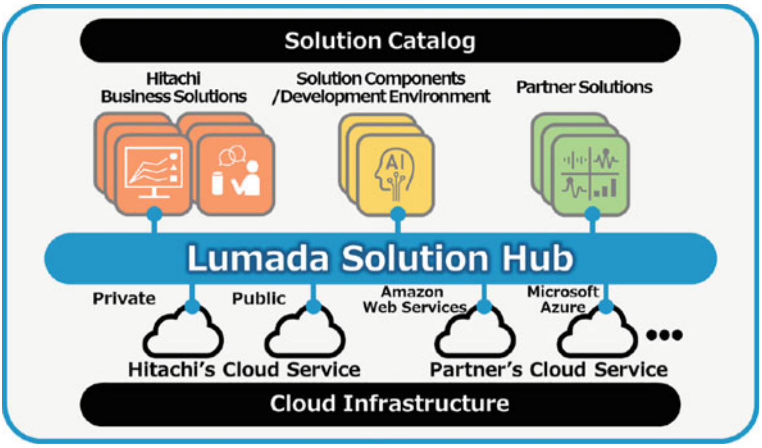

Fig. 4.15 Lumada solution hub

These examples are just a few of Lumada analytics technologies. Published use cases by using new analytics are constantly increasing. A common feature is that they not only use AI but also encompass OT.

Alongside analytics technology, another important platform feature is productivity of service. After the birth of a new good use case, its key technical components need to be made reusable. Each use case is accumulated in Lumada as a process of *Externalization* in the SECI model. However, it is a document and cannot to be used in the real running system as it is. The *Combination* process should be supported. To solve this problem, Lumada Solution Hub was launched in 2019. Lumada Solution Hub is a system that packages Lumada solutions and application development environments. (Fig. 4.15). Lumada Solution Hub can provide such packages in a cloud environment (Nakamura et al. 2019). With Lumada Solution Hub, business solutions and the application development environment, which are packaged in an easy-to-reuse format, are registered and stored. They are presented in a catalog that can be perused briefly. From the catalog, you can select the items you want to install. The environment is then built easily in IaaS (infrastructure as a service) in a multi-cloud environment, and the provided features can be used quickly. As a result, the solutions developed through co-creation with customers can be moved quickly from early verification to the production environment and can be efficiently deployed to multiple sites.

Lumada Solution Hub has two main features. First is high portability of application. Applications are built on the basis of microservice architecture (Newman 2015). Each service is packaged using container technology to enable deployment as-is on private clouds or various public clouds as demanded by the client. Second is efficiency of application development. Lumada Solution Hub provides DevOps environment. DevOps is a set of practices intended to reduce the time between committing a change to a system and the change being placed into normal production, while ensuring high quality (Bass et al. 2015). By utilizing GUI (graphical user interface) programming tools, even workers who are unfamiliar with IT can easily develop applications. Furthermore, by packaging developed applications and stocking them in the cloud infrastructure, the combination and customization to meet customer needs is simplified, enabling quicker and more efficient development than development from scratch.

Hitachi received the Nikkei Business Daily Award for Excellence at the 2019 Nikkei Superior Products and Services Awards for Lumada Solution Hub. The awards are held by Nikkei annually, recognizing the best new products and services of the year in Japan.

4.5 Successful Cases of Lumada

Lumada has so far produced so many success stories and influences all five business sectors. This section introduces two typical successful cases in detail in which value was co-created with customers by synergizing knowledge of the customer and Hitachi. Moreover, how Lumada is effective in all five business sectors is explained.

4.5.1 IoT Solution for Mass Customization by Collaboration with Okuma Corporation

Okuma Corporation is a comprehensive machine tool manufacturer established in 1898. It is a leading global player that continues to build momentum through a diverse range of machine tools that includes computerized numerically controlled lathes and multitasking machines, machining centers, and grinders. An increasingly common challenge for manufacturers is how best to cater to constantly changing demand amid rapidly diversifying customer needs and intensifying global competition. In recent years, more manufacturers have had to attain mass customization that delivers productivity equivalent to that of mass production, even for ultra-high-mix, low-volume manufacturing. Some Japanese companies have started to solve the issue by using IoT and AI. Okuma is one of the pioneers. In 2013, it built DS1 (Dream Site 1), which fully automate production facilities and visualize operational conditions.

Moreover, the company has started to consider building DS2 to realize mass customization by advanced automation and evolved visualization of DS1. It explored external collaboration to ensure success in entirely new areas. Initiatives at Hitachi's Omika Works influenced Okuma's decision. Omika Works develops and produces control systems for railways, power, water treatment, and other types of infrastructure, and engages in high-mix, low-volume manufacturing. The works built an IoT environment within the site that uses RFID (radio frequency identification) IC tags.

Fig. 4.16 Production visualization

Real-time collection and usage of manpower, machine, and material information enabled the facility to halve production lead times for its main products (Onizawa et al. 2016). A highly efficient production setup combines OT and IT. Thus, a collaborative value creation project started in 2017.

In combining Hitachi's expertise at its Omika Works and Okuma's know-how from DS1, the two partners created a process control system that accelerates factory control cycles and a progress and operational status monitoring system to underpin the evolution of production visualization (Fig. 4.16). By using the RFID tags that Hitachi's Omika Works deployed, Okuma has been able to centralize the management of parts tracking on site. Although it used to be able to track parts up to the process level, Okuma now knows where all parts are on an hourly basis, including those moving between processes. Okuma has been able to integrate production visualization by using IoT to gather and link data on production progress and facilities operational statuses. Hitachi developed a system to conduct advanced analysis of collected data. The system enables Okuma to detect process bottlenecks (including delays in prior processes and on-site failures) and deploy total optimization measures.

The solution for these process control systems is registered as Optimized Factory Solution in Lumada. The Omika Works showcases Hitachi's Lumada solutions that combine OT, IT, and products and was recognized by the World Economic Forum as a Lighthouse advanced factory in 2020.

4.5.2 Kashiwa-no-ha Smart City by Collaboration with Mitsui Fudosan

A revolutionary community development project is currently underway in the city of Kashiwa, Chiba Prefecture in Japan. In 2008, Chiba Prefecture, Kashiwa City, University of Tokyo, and Chiba University formulated the Kashiwa-no ha International Campus Town Initiative. They articulated three urban development concepts: an Environmental-Symbiotic City, a City of New Industry Creation, and a City of Health and Longevity. Mitsui Fudosan, a major urban developer who built the first skyscraper in Japan in 1968, has been continuing to support the urban development. Hitachi's initial role in the project was delivering elevators and security equipment for Mitsui Fudosan's commercial facilities and multi-unit housing. However, Kashiwa-no-ha concept coincides with the one Hitachi seeks, so they started to study problem-solving models for the Environmental-Symbiotic City (Sakakibara et al. 2017).

The Environment-Symbiotic City aims to realize a city in which both people and the environment can symbiotically co-exist by solving several issues related to the environment and energy. In their collaborative creation, Mitsui Fudosan and Hitachi tried to achieve this goal by constructing an AEMS (area energy management system). Although Hitachi has a lot of experience in building energy management systems, the AEMS was different from the viewpoint that everyone in the city will care about an environment that encourages them to do something about it (Minemoto et al. 2016). To engage in an unprecedented project for managing city energy, service design was applied in the value co-creation project. An effortless and sustainable scheme is required for people to act voluntarily through Kashiwa-no-ha AEMS. Energy visualization to fulfill the requirement was designed and verified by stakeholders including citizens.

Operation of the AEMS officially started in April 2014. In July of the same year, stage 1 of Kashiwa-no-ha Smart City opened in 2014. The Kashiwa-no-ha AEMS has two main strengths. It enables the visualization of all utilities including water and gas (Fig. 4.17), and it allows for electrical power interchange across city and ward lines for the first time in Japan (Akatsu et al. 2017). The AEMS connects offices, shopping centers, residences, and public facilities with energy sources such as solar power, and batteries through independent transmission lines and information

Fig. 4.17 Smart center for centralized management of the area's energy

networks. Hitachi's AEMS is a total solution that provides not only substations but also one of Japan's largest industrial lithium-ion storage battery systems, which promotes the stable interchange of electricity from different regions. Its core facility, the Smart Center, plays an important role in supporting a more secure and safer quality of life. The Center effectively reduces CO_2 emissions and uses peak shift and peak cut controls across regional borders in real time. It also shares and visualizes information on utility usage and prioritizes distribution of power to elevators and evacuation centers in times of emergency.

The AEMS is registered as a customer case of Lumada. Moreover, Kashiwa-no-ha Smart City development earned the LEED Neighborhood Development (LEED-ND) Platinum Certification in 2016. It was the first Japanese project to receive LEED-ND Platinum Certification, the highest international standard for ecological and sustainable neighborhood development.

4.5.3 Business Impact of Lumada on Five Sectors

Lumada-based revenues have already expanded to exceed ¥1 trillion in FY2018. Lumada is a platform for value creation and does not generate innovation by itself, but all five business sectors have generated innovation to change human life on Lumada. Typical examples as follows:

1. IT Sector: Since 2017, Finaicial Institutions Business Unit has been supporting the digitization of subsidy payment operations and other financial services offered by the state-owned Vietnam Post. In fiscal 2018, they expanded the scope of this digitization to include social security subsidy and pension payment operations. They will combine their technologies with Vietnam Post's services to improve the quality of human life.
2. Energy Sector: Energy Business Unit provides solutions, including power generation and power grid systems, to all customers involved in energy production, distribution, and consumption. They received orders for management platform for high-temperature parts for gas turbines used in privately owned industrial power generation equipment in 2019. This sector uses Lumada to improve the efficiency of inspection and maintenance work while raising the management capabilities of operations.
3. Industry Sector: One of Lumada solutions is the digital twin solution, which was launched in 2018. The solution facilitates AI analysis and simulated by using an advanced data model to link manufacturing workplace OT and IT data in cyber space, supporting the optimization of the entire production process.
4. Mobility Sector: For Denmark's Copenhagen Metro, Railway Systems Business Unit are working on the maximizing transportation capability, alleviating congestion, and reducing cost through detecting demand on the basis of the number of people waiting at station platforms and realizing autonomous and flexible operation.

5. Smart Life Sector: Healthcare Business Unit analyzed three years' worth of sensor data from 100 MRI (magnetic resonance imaging) systems and created a mechanism to investigate the cause patterns that lead to device failures. Then machine learning was used to define a normal operational state to achieve successful early detection of abnormalities and changes in status that lead to failures. Signs of impending failure have been detected several months before a breakdown is due to occur, so scheduled maintenance before systems break down has been made possible. As a result, downtime (time systems cannot be used) due to breakdowns has been reduced by 16.3%.

4.6 Analysis of Business Innovation

1. **What are the needs of people, the issues in society and business and the objective of utilizing ICT? (needs)**

A look around the world shows an unending series of changes impacting people's lives. These include resource shortages and climate change, demographic changes brought on by aging societies, and the issues accompanying urbanization. Amid such an environment, there are growing efforts around the world, including the Society 5.0 initiative in Japan to resolve through innovation the social issues outlined in the UN's SDGs. Hitachi's Social Innovation Business focuses on such social and environmental issues. Hitachi's 2021 Mid-term Management Plan, launched in April 2019, focuses on simultaneously improving social, environmental, and economic values. ICT is one of the core technologies to resolve such issues. However, combining it with OT and products is the key to success for Social Innovation Business.

2. **What technologies and functions are utilized to solve these issues or realize the needs of people? What is the role of ICT in value creation? (technologies)**

Lumada is comprised of six main layers that form the architecture of the platform: Studio, Analytics, Data Management, Edge, Core, and Foundry. Together they serve as a software platform that is intelligent, composable, secure, and flexible. Many kinds of real data are accumulated into cyber space and analyzed, and the results are fed back into physical space through Lumada. A lot of analytics technologies are especially important to create value.

3. **What are the value creation methodologies? (value creation)**

Lumada has customer co-creation methodologies and tools named NEXPERIENCE. NEXPERIENCE covers a wide range of phases for satisfying customers' goals. The first step is sharing visions with customers to discover business opportunities. The next step is uncovering on-site issues and analyzing management challenges. After working with customers to identify issues, service ideation follows for creating service ideas to solve the issues. After that, business models are designed, and the values are verified through simulations. In each step, there are tools using ICT such as AI and computer simulations.

4. **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**

Hitachi is divided into five business sectors: IT, Energy, Industry, Mobility, and Smart Life. Basically, each sector has own business strategy and is managed separately. Lumada connects them as a common platform. Lumada connects not only internal Business Units but also external stakeholders and Hitachi.

5. **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

Lumada is a platform for value creation and does not generate innovations by itself, but all five business sectors have generated innovations to change human life on Lumada. Many customer cases have accumulated in Lumada, some of which are open to the public through the Lumada website (https://www.hitachi.com/products/it/lumada/global/en/index.html). For example, Optimized Factory improves operating efficiencies by using a cost-effective, scalable technology that enables data-driven decision-making and continuous process improvement. Automated constant temperature monitoring of pharmaceutical products can maintain the quality of pharmaceutical products through proper monitoring and management and reduce waste loss. It also reduces the workload of on-site staff through automation of temperature measurement and recording. Smart Spaces and Video Intelligence Solutions can integrate disparate video and data sources to gain intelligence and automated alerts to make an organization smarter, safer, and more efficient. There are so many solutions, and each realizes value. All of them are Hitachi's Social Innovation Business, which resolves issues faced by society and customers.

4.7 Future Development and Issues to Be Solved in the Future

Lumada has already has a lot of success in value co-creation, but almost all cases are one-to-one collaboration. It must be expanded to a multi-side platform, which means to make Lumada applicable to not only Value Chain but also Value Constellation. Value Constellation is the concept that describes how value is entangled within a complex network of social and environmental connections (Normann and Ramirez 1994).

One of the leading initiatives for Hitachi to realize value constellation is Habitat Innovation Project by Hitachi the University of Tokyo Laboratory. H-Utokyo lab combines the respective efforts of both Hitachi and the University of Tokyo and enables them to collaborate under a new style of tie-up to create visions and innovations to realize Society 5.0, which will bring prosperity to humankind. Habitat

Innovation Project will build a vision to realize Society 5.0 aligned with SDGs, but also try to implement the vision into a real world. However, it is difficult to implement by only Hitachi and University of Tokyo. They need a lot of stakeholders such as construction companies, railway companies, local governments, and citizen groups. This means a new challenge for Hitachi to create Value Constellation.

Another activity is expansion of Lumada Solution Hub. It will be opened up to partners to register solutions that they have developed, in addition to the Hitachi solutions that are already a part of the Hub's catalog. With these solutions, Hitachi will accelerate the creation, distribution, and utilization of digital solutions while speeding up the construction of Lumada ecosystems.

4.8 Conclusions

I discussed Hitachi's transformation from a conventional manufacturer that produces products on the basis of goods dominant logic to a service innovation company that pursuits service dominant logic. One of key success factors is Lumada: Hitachi's IoT core platform providing advanced digital solutions, services, and technologies for turning customers' data into insights to drive digital innovation. It is applied to all Hitachi's Social Innovation Business. It is not only a technology platform but also a business platform. The president and CEO Toshiaki Higashihara declared that Hitachi will be a global business leader in the Social Innovation Business in the 2021 mid-term Management Plan. Lumada will continue to evolve further to achieve this goal.

References

Akatsu M (2007) Identifying the value for service management. In: Proceedings of IEEE joint conference on E-commerce technology (CEC'07) and enterprise computing, E-commerce and E-services (EEE '07), pp 491–492

Akatsu T et al (2017) Working toward energy solutions to meet increasingly diverse challenges. Hitachi Rev 66(5):490–499

Aoki M et al (2017) Innovative technology for digital solutions that combine OT and IT. Hitachi Rev 66(6):606–609

Baba Y et al (2020) Development of remote monitoring/predictive diagnosis service "exiida" for air conditioning. Hitachi Rev 69(1):78–83

Bass L et al (2015) DevOps: a software architect's perspective, Addison-Wesley Professional

Hitachi the University of Tokyo Laboratory (2018) Society 5.0. human-centered super smart society. Nikkei Publishing

Hitachi (2019) Hitachi integrated report 2019

Ishikawa T et al (2016) Collaborative creation with customers establishment of NEXPERIENCE. Hitachi Rev 65(2):832–839

Iwasaki M, Nakamura T (2020) Platform design concept for Lumada, Hitachi Whitepaper

Kaplan RS, Norton DP (2004) Strategy maps: converting intangible assets into tangible outcomes. Harvard Business Review Press

Kashimura K et al (2013) Experience design: theory and practice. Hitachi Rev 62(6):293–301
Kashimura K, Shibata Y, Akashi T (2017) Future vision for a super smart society that leads to collaborative creation. Hitachi Rev 66(6):560–564
Kawasaki T et al (2013) Applications and benefits of ethnographic research. Hitachi Rev 62(6):317–323
Kitagawa H et al (2013) Development of experience-oriented approach to Information and telecommunication system business. Hitachi Rev 62(6):329–336
Kobayashi Y et al (2018) Using self-learning RPA to automate a greater range of business tasks. Hitachi Rev 67(6):676–681
Lusch RF, Vargo SL (2014) Service dominant logic. Cambridge University Press
Minemoto T et al (2016) Allocation of service design and vision design by collaborative creation in urban development business. Hitachi Rev 65(2):853–859
Nagaoka H et al (2016) Development of methods for visualizing customer value in terms of people and management. Hitachi Rev 65(2):840–846
Nakamura H et al (2019) Lumada platform services for creating new value. Hitachi Rev 68(4):526–531
Newman S (2015) Building microservices: designing fine-grained systems. O'Reilly Media
Nonaka I (2020) Management based on human empathy. https://www.hitachi.com/rev/column/ei/vol15/index.html. Accessed Aug. 4, 2020
Nonaka I, Takeuchi H (1995) The knowledge-creating company: how Japanese companies create the dynamics of innovation. Oxford University Press
Normann R, Ramirez R (1994) Designing interactive strategy: from value chain to value constellation. Wiley, New York
Onizawa R et al (2016) Next-generation IoT-based production system for high-mix low-volume products in an era of globalization. Hitachi Rev 65(5):58–63
Ono T et al (2017). NEXPERIENCE: a service design process for social innovation business. In: The sixth Asian conference on information systems, pp 129–132
Ono T et al (2019) Promoting NEXPERIENCE: customer co-creation methodology-based design thinking. Hitachi Rev 68(3):402–407
Osterwalder A et al (2010) Business model generation: a handbook for visionaries, game changers, and challengers. Wiley, New York
Otogawa et al (2018) AI technology for boosting efficiency of logistics and optimizing supply chain. Hitachi Rev 67(2):232–237
Sakakibara M et al (2017) Customer collaborative creation activities in front-line sales work. Hitachi Rev 66(3):80–85
Sato N et al (2018) Enjoyably sustaining motivation for work style reforms through digitalization. Hitachi Rev 67(6):682–687
Sekiai T et al (2011) Auto tuning algorithm for vigilance parameter in the adaptive resonance theory model and its application to fault diagnosis system of thermal power plants. In: Proceedings of ASME 2011 power conference, pp 227–234
Shirai T et al (2018) Dialogue AI for financial services. Hitachi Rev 67(5):550–557
Soga S et al (2018) Development of cutting-edge technologies for next-generation logistics services. Hitachi Rev 67(2):252–258
Speed C, Maxwell D (2015) Designing through value constellations. ACM Interact 22(5):38–43
Walker J, Pekmezovic A, Walker G (2019) Sustainable development goals: harnessing business to achieve the SDGs through finance, technology and law reform. Wiley, New York

Chapter 5
Orchestrating a Brighter World: A Case Study of NEC

Miwako Sato and Hideki Sato

Abstract NEC Corporation is one of Japan's leading ICT providers and made significant progress in the late twentieth century. This chapter introduces NEC's new corporate philosophy of "Orchestrating a brighter world" by supporting new ICT technologies such as IoT and AI, and the policy of "Digital Inclusion" whereby these technologies are put to practical use. In particular, we present specific examples of how this approach can provide outcomes such as improved employee morale in the manufacturing sector, new kinds of hospitality based on ICT, and intelligent retail stores, and we discuss NEC's business development plans and how they will lead to new business innovation.

5.1 Introduction

NEC Corporation (Old name: Nippon Electric Company, Limited) stands alongside Fujitsu as one of Japan's leading ICT providers. As defined in Chap. 2, NEC is similar to IBM in that they are both category A companies that are mainly geared towards delivering ICT hardware and solutions, and both made significant progress in this field in the late twentieth century from the 1980s onward. During this period, NEC adopted the corporate philosophy of Computer & Communication (C&C), and announced its intention to contribute to the realization of a prosperous society that promotes understanding among people all over the world and allows their human qualities to flourish. Based on this philosophy, NEC worked hard on the development of semiconductors, communication equipment, computer hardware such as PCs and mainframes, and information systems for the intranet era. One of NEC's main customers was Nippon Telegraph and Telephone Corporation (NTT). Compared with

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other category A companies like IBM and Fujitsu, NTT had developed strong capabilities in the field of communications. NEC's most important business strategies are considered to be maintaining a talented technical R&D team, developing new ICT technologies for the benefit of society, and maintaining a spirit of innovation.

But NEC must now chart a course through the challenges posed by the arrival of Big Tech companies like Google/Alphabet, Amazon, Facebook and Apple (GAFA), and the emergence of new ICT technologies such as the Internet of Things (IoT) and artificial intelligence (AI). This chapter introduces NEC's new corporate philosophy of "Orchestrating a brighter world" by supporting new ICT technologies such as IoT and AI, and the policy of "Digital Inclusion" whereby these technologies are put to practical use. In particular, we present specific examples of how this approach can provide outcomes such as improved employee morale in the manufacturing sector, new kinds of hospitality based on ICT, and intelligent retail stores, and we discuss NEC's business development plans and how they will lead to new business innovation.

5.2 Company Outline: NEC

5.2.1 NEC's Current Business Overview

1. **Business Outline**

NEC is a large global ICT company, as shown in Table 5.1.

2. **Current fields of business**

Having undergone various changes, NEC is currently active in the development of ICT-related products, systems, solutions and service businesses in four main fields (NEC 2019a):

Public Business
NEC provides safe, secure and efficient social solutions for Japanese and foreign governments, governmental agencies, local governments, public institutions and other organizations by combining our distinctive technology assets, including

Table 5.1 NEC's business situation

Consolidated revenue	¥2913.4 billion (Fiscal year ended Mar. 31, 2019)
Major operations	Public business, enterprise business, network services business, system platform business, global business
Number of employees	110,595 (As of Mar. 31, 2019)
Number of consolidated subsidiaries	327 (As of Mar. 31, 2019)

network, sensor and analysis technologies, with a broad expertise in systems integration.

Enterprise Business
NEC provides IT solutions in manufacturing, transportation, logistics, retail and services, and finance in the private sector, helping customers to launch new services. We will resolve social issues and create value for customers through value chain innovation utilizing ICT assets as IoT and AI.

Network Services Business
NEC provides network control platform systems and operating services for operations management, along with equipment for network implementation. NEC's wealth of experience in large-scale network implementation and strong technical capabilities help us contribute to the resolution of social issues by providing safe, secure, and efficient high-value-added networks for the age of IoT through the creation of value with our clients and business partners.

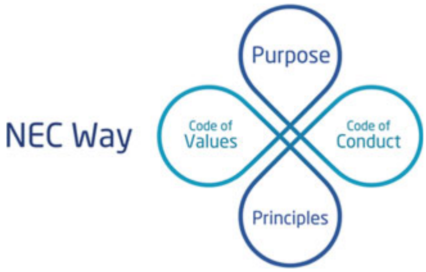
System Platform Business
NEC provides products for business, ranging from terminals to network and computer equipment, software products and service platforms, as well as integrated platforms based on them. We deliver labor-saving and efficient platforms for customers, while at the same time creating new value such as IoT platforms based on ICT as we contribute to the expansion of solutions for society.

3. **Changes in NEC's business**

[Foundation and Spirit of Innovation]
On July 17, 1899, Nippon Electric Company, Limited (known as NEC Corporation since April 1983, but still abbreviated to NEC) became Japan's first joint venture with foreign capital when it was established by Kunihiko Iwadare in association with the U.S. firm Western Electric Company (presently Alcatel-Lucent). The basic aim of the new company, expressed in the slogan "Better Products, Better Service," was to carry out the promise to provide its customers with world-class products and dependable follow-up service. World and domestic firsts in technology and research development, made possible by managerial innovation and backed by establishment, improvement and reform of its various personnel systems, as well as the early mounting of environmental projects, make it possible to say that NEC's history has been marked by constant innovation for more than a hundred years. NEC is empowered by the DNA of innovation.

[Period of Growth in ICT Products]
With the rapid expansion of telephone networks around this period, it became necessary to introduce a crossbar switching system that would facilitate automation of switching stations. Nippon Telegraph and Telephone Public Corporation designated

Fig. 5.1 The NEC Way



NEC the collaborative research partner to develop such a system. In 1954, after installation of the first prototype at the experimental station of the Electrical Communication Laboratory, the first Japanese crossbar switching system was put to practical use. It was created with systems, circuits and parts that had been developed by proprietary Japanese technologies and boasted high performance even by global standards. Exporting the product overseas met with great success thereafter.

NEC co-developed its first computer, NEAC-1102, through Tohoku University's Computer Project. A later model, the NEAC-2201, was characterized by its use of high-speed germanium-alloy transistor circuit elements, and the fact that it was built entirely from parts made in Japan. On October 10, 1977, Koji Kobayashi (then-chairman of NEC) gave a keynote lecture at INTELCOM 77, the first large-scale general communications expo in the U.S. The lecture, entitled "What communications enterprises should do to accommodate changing social needs," led to NEC's C&C business strategy, which Kobayashi stated as follows: "Early in the twenty-first century, it will become possible for people to talk to each other and see each other anytime, anywhere. This will require an integration of technologies for communications, computers, and television."

[A New Corporate Philosophy]

In 2020, NEC revised its corporate philosophy (the "NEC Way") to adapt to the new era of IoT and AI (Fig. 5.1).

In the NEC Way, the relationship between society's demands and NEC represents our purpose, which is summarized by the following statement: "Orchestrating a brighter world: NEC creates the social values of safety, security, fairness and efficiency to promote a more sustainable world where everyone has the chance to reach their full potential." The purpose of NEC's existence is to orchestrate its activities with those of various stakeholders, with the enrichment of people's existence as a guiding principle.

By adapting NEC's ICT business to the service innovation concepts adopted in the second and third generation, it could be said that the intranet era corresponds to the first generation of C&C, the Internet era corresponds to the second generation of C&C, and the third generation of IoT and AI corresponds to the task of "Orchestrating a brighter world" beyond the world that was implemented by C&C. From its earliest days, NEC has always promoted its business with the aim of enriching the lives of people around the world based on the slogan, "Better Products, Better Service". The first generation of C&C achieved great success with the development of information systems for fields such as finance and distribution, with the accompanying growth in the manufacture of IT equipment and devices. The second generation of C&C focused on the Internet and involved the development of Internet technology such as corporate information systems providing services such as Internet banking, Internet connectivity (BIGLOBE), and mobile phone services.

In the third generation of service innovation, it is expected that new businesses will emerge from the existing Internet environment and from new ICT technologies that connect everything together, such as IoT, big data, and AI. In the C&C concept, the first C (computers) includes support for AI and big data, and the second C (communication) includes support for intelligent networks connected by IoT. For NEC, the third generation can be seen as an opportunity to use IoT and AI to provide new value to society and thereby position ourselves as a new ICT vendor. It is expected that NEC's philosophy of "Orchestrating a brighter world" will be realized by making use of our organizational capabilities such as our management resources, our business processes, and our standards of value.

In this business context, NEC has laid out a new vision of "Digital Inclusion." In the words of NEC's President Takashi Niino, "We regard Digital Inclusion as a key aspect of technology that permeates to every corner of society and a natural requirement for the safe and free use of data. This will enable us to resolve various issues and help people to live fulfilling lives, resulting in a society where everyone can benefit from the application of digital technology. This is what Digital Inclusion means to us."

Table 5.2 shows the three generations of service innovation and the evolution of NEC's business.

Table 5.2 The three generations of service innovation and NEC's evolution

Age	1st generation	2nd generation	3rd generation
	1899–	2000–	2020–
Corporate philosophy → purpose	C&C		Orchestrating a brighter world
Founding spirit → vision	Better products, better services		+ Digital inclusion
Business target	B to B	B to C	B to B to society
providing value	Better efficiency and lower costs	Better efficiency and lower costs	Seven themes for social value creation
Main technology	PCs, communication equipment	The Internet, mobile phones	IoT, AI
Business leader	NEC, Hitachi, Fujitsu	GAFA, Yohoo, Rakuten	?

5.3 Orchestrating a Brighter World Through the Application of Digital Inclusion

5.3.1 What is Digital Inclusion?

According to the English dictionary, Digital Inclusion is defined as the activity of making sure that everyone is able to use computers and the Internet. At NEC, we regard Digital Inclusion as a means of delivering a society where each individual can benefit from the power of digital technology. In this way, we aim to realize a society that reaps wide-ranging benefits from the visualization, analysis and processing of real-world information, and to empower all people with the ability to enjoy the benefits of digital technology and heighten their sense of fulfillment and agency.

In 1977, NEC announced a new corporate philosophy called "C&C", referring to the fusion of computer technology and communication technology, and asked the celebrated manga artist and animator Osamu Tezuka to depict the future society that this philosophy would realize (Fig. 5.2).

In this futuristic society, everything is connected to computers via networks. Means of transport such as cars, ships, bullet trains, airplanes and rockets, and aspects of the social infrastructure such as medicine and energy have become intelligent, and

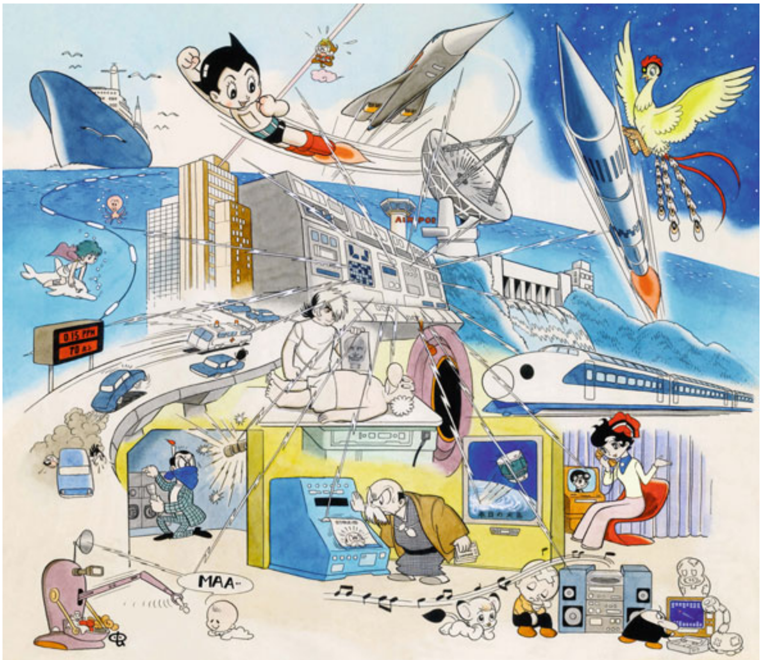


Fig. 5.2 The future of ICT, as depicted by Osamu Tezuka (©Tezuka Productions)

the “Astro Boy” robot character represents the many different ways in which people are supported by artificial intelligence.

Forty years later, many of the scenes anticipated in this picture have become reality due to developments in digital technology. With this future in mind, NEC created its vision of Digital Inclusion in the current digital transformation era, using IoT and AI engines to add new meaning to people and things. In this way, we aim to create new value by bringing deep wisdom and knowledge into reality in order to achieve real-world benefits.

5.3.2 Three Elements that Embody Digital Inclusion

To implement Digital Inclusion as a means of delivering a society where each individual can benefit from the power of digital technology, we should separately target our efforts towards society and people: (1) To increase the value of society, we should implement an intelligent social environment as a forum for human activity, and (2) to implement added value for individual people, we should empower them with the ability to enjoy the benefits of digital technology and heighten their sense of fulfillment and agency. At NEC, we aim to implement our Digital Inclusion vision and contribute to our customers’ business and social innovations by leveraging our strengths in technological fields such as security, cloud computing, simulation and AI. The challenge of “Orchestrating a brighter world” is to find ways of using IoT, AI, and new ICT technologies to transform the Digital Inclusion vision into concrete systems and service concept that can be promoted as a business plan where NEC’s organizational capabilities can be put to good use.

In the second generation of service innovation, the Internet has connected people around the world, and has created value through the exchange of information between people. However, in the third generation, the use of IoT and sensors to collect and analyze information will lead to the emergence of intelligent environments and spaces where people and businesses can operate. For Digital Inclusion, the activities of humans and businesses should themselves be targeted by ICT, and digital social spaces and business environments should be created to enrich the activities of people and businesses. Businesses that create new value should be promoted by providing intelligent spaces for social and business activity through the use of IoT and AI. By establishing a B2B society business model to promote the creation of digital society and digital communities, we aim to realize our goal of orchestrating a brighter world. As shown in Fig. 5.3, we aim to implement this Digital Inclusion vision of NEC through a combination of three elements: (a) intelligent social environments and living spaces, (b) support for invigoration of human and corporate activities, and (c) biometric authentication to connect business environments with individual people and corporate activities.

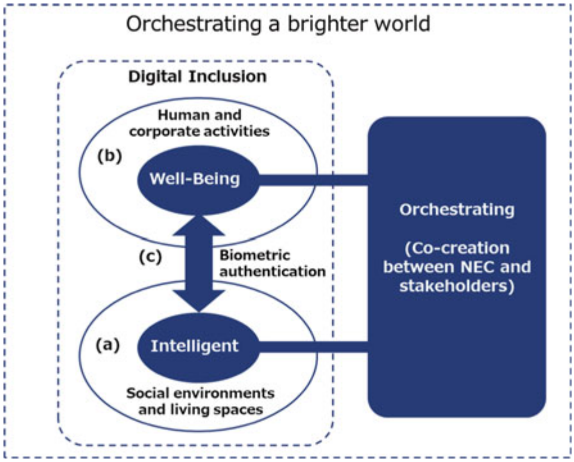


Fig. 5.3 Conceptual illustration of Digital Inclusion

5.3.3 The Importance of Biometric Authentication in Digital Inclusion, and NEC's Strengths

To realize our aim of providing better service value to the whole of society by connecting the two elements of providing intelligent social environments and supporting human and business activity, we will offer improved service value by making it possible to recognize the identity of active members in a social environment, and to ascertain the characteristics of people and organizations. The technology that connects these two requirements is high-precision, high-performance biometric authentication. NEC uses the Bio-IDiom brand for all its biometric authentication products, which provide core technology for the realization of Digital Inclusion. Biometric authentication plays an important role in connecting the real and digital worlds via secure portals. By using biometric information relating to each person as keys, we can implement advanced multimodal authentication at entrances to the digital world, combining multiple biometrics as needed, to prevent spoofing and malicious attacks. In this way, we aim to eliminate risks and create a society where everyone can fully enjoy the convenience of digital technology without any worries. NEC is a world leader in six biometric authentication technologies: face recognition, iris recognition, fingerprint/palmprint recognition, finger vein recognition, voice recognition, and ear acoustic authentication. These have been incorporated into over a thousand systems in about 70 countries and territories around the world. In the field of biometric authentication, our improvements in the accuracy, convenience and security of face recognition have resulted in NEC technology being used for face recognition not only in our traditional safety-related fields of expertise such as national ID and surveillance systems, but also in a range of other fields such as transportation, finance and large-scale events.

In November 2019, based on these circumstances, NEC announced NEC I:Delight—a new concept for the use of biometric authentication. A new boarding

Fig. 5.4 NEC I:Delight

procedure called One ID will be launched at Narita Airport in the spring of 2020. This uses NEC's face recognition system to provide a service that frees passengers from the hassle of having to produce their passports time after time. NEC's I:Delight service is centered on the use of biometric authentication as a common means of identification that can be used over an entire journey from beginning to end, even for daily commute or a trip to the shops. By connecting the authentication status of individuals between different scenes, it facilitates the provision of individually tailored services that people find more enjoyable. This experience embodies the new business concept of NEC, which seeks to realize a world where people can securely take part in corporate or regional cooperative initiatives to interconnect with other people in other countries and in other businesses (Fig. 5.4).

5.3.4 Seven Themes for Social Value Creation that Are Solved by Digital Inclusion

In 2019, NEC announced that it would work harder to promote business as soon as social issues arise (NEC 2019b), based on seven themes of social value creation associated with global issues. These seven themes are closely related to the UN's Sustainable Development Goals (SDGs), and we are working on orchestrating a brighter world through the implementation of Digital Inclusion by engaging in dialogue and co-creation with our diverse stakeholders including our customers in order to contribute to the achievement of these SDGs.

1. **Sustainable Earth**

Population growth, urbanization, and economic development have an impact on the global environment and bring increased threats that lead to a loss of biodiversity, resource depletion, and an increase in natural disasters. NEC will visualize the continually changing conditions of the earth and contribute to the realization of a society that coexists harmoniously with the earth, through the efficient and fair distribution of limited resources and measures to preempt the effects of threats to the earth.

2. **Safer Cities and Public Services**

The integrated threats from the cyber and physical worlds increase as the population concentration in urban cities grows and globalization advances, which creates greater demand for safety and security; consequently, NEC contributes to sustainable city management that will allow cities to demonstrate their regional appeal by joining hands with citizens, industry, government, and academia to realize a safe and secure citizen service platform utilizing ICT.

3. **Lifeline Infrastructure**

Global urbanization is accelerating the diversity and complexity of production and daily life infrastructures. Using advanced and flexible ICT systems to reduce differences between regions and time zones and realize 24/7/365 uninterrupted infrastructures, NEC is continuing to provide important resources safely and efficiently.

4. **Communication**

As digital networks connecting people, things, and contexts evolve and society becomes more advanced, the importance of information and knowledge increases. Through information and communication technologies spanning from the bottom of the ocean to outer space and co-creation with our customers and partners, NEC contributes to the construction of a value creation network that allows people and companies throughout the world to use information and knowledge safely, securely, and fairly.

5. **Industry Eco-System**

Industry structures are evolving as typified by the changing environment surrounding consumers, the serious social challenges around corporations, and the acceleration of game changing events due to advances in ICT. NEC drives Value Chain Innovation through the construction and co-creation of a platform for sustainable development of corporations.

6. **Work Style**

An era has come where co-creation with people having diverse backgrounds will provide countries, regions, and organizations with a competitive edge. Eventually the time will come when people will work without boundaries of generation, gender, nation, and organization, and even cooperate with AI and robots. Through ICT, NEC will design diverse work styles to create high-quality work and employment.

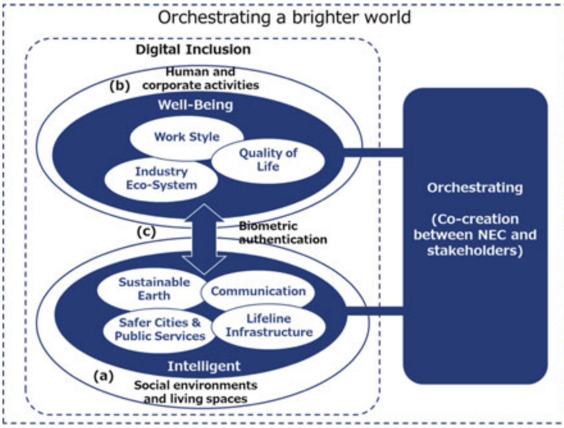


Fig. 5.5 Social value creation and Digital Inclusion

7. **Quality of Life**

Infrastructures for high-quality education and medical care have still not reached sufficient levels around the world. NEC is working to realize a fair and prosperous society by using ICT to promote advances in preventive medicine and health care, construct educational environments that overcome barriers of location and time, and enable all individuals to play an active role.

These seven themes can be broadly divided into two groups; those that relate to the social environment and living spaces (Sustainable earth, Safer cities and public service, and Lifeline Infrastructure), and those that relate to the activity of businesses and individuals (Communication, Industry Eco-System, Work style, and Quality of Life). On the conceptual illustration of Digital Inclusion shown in Fig. 5.3, they can be mapped as shown in Fig. 5.5. Under NEC's vision of Digital Inclusion, we will create intelligent social environments and support the activities of individuals and businesses to create a society that allows people around the world to lead prosperous lives.

5.4 Case Studies of Digital Inclusion

Three examples of Digital Inclusion are presented below, showing how it can be applied to manufacturing (at NEC's own factories and those of another company), the town of Nanki Shirahama in Wakayama prefecture, and the Seven-Eleven Japan chain of convenience stores. These examples show how ICT can provide better social environments and living spaces that make human activities more efficient and fulfilling.

5.4.1 An IoT Service to Improve the Well-Being of Factory Employees

1. **Background and issues**

Japan's manufacturing industry has faced many difficulties, such as the collapse of the bubble economy, the Lehman bankruptcy and various natural disasters. Combined with the rapid growth of manufacturing in emerging economies, the manufacturing industry's share of Japan's GDP has gradually declined. Nevertheless, manufacturing still accounts for about 20% of Japan's GDP and is still Japan's largest single industry sector (Ministry of Economy, Trade and Industry 2019). It is also said that Japanese manufacturers are facing increasingly severe labor shortages, especially with regard to skilled workers. Against this background, the Monozukuri White Paper of 2019 stated that Japan should prepare itself for the Fourth Industrial Revolution by using AI and IoT technology to increase its competitiveness in manufacturing. The future of Japan's manufacturing industry depends on whether or not it is possible to foster the skills needed for working with digital technology and whether or not it is possible to create workplaces and organizations where these skills can be put to effective use. (Ministry of Economy, Trade and Industry 2019).

Moreover, many jobs in manufacturing have harsh working conditions that can typically be described by the three Ds—dirty, dangerous and difficult. The introduction of work style reforms for factory workers is a major issue for production sites in the manufacturing industry, and corresponds to the "Work Style" category of the seven social value creation themes.

2. **Resolving these issues based on the Digital Inclusion concept**

Digital Inclusion frees factory workers from difficult work and allows them to spend more time working creatively. By using ICT to address the problems of the Japanese manufacturing industry, NEC aims to use the power of digital technology to transform the future of manufacturing so that people can enjoy a more rewarding work environment (Fig. 5.6).

Figure 5.7 shows the configuration of manufacturing in the future (smart factory) as envisaged by NEC. We will use ICT to implement the functions of "autonomous improvement", "automation", "remote", and "connection" both within and between factories and between value chains in both the IT domain and the OT domain.

Also, Fig. 5.8 illustrates a scenario for the implementation of NEC's smart factory concept. As the first step, we propose the introduction of a service that uses IoT to collect and visualize information about the operational status of production line equipment in real time. This service enables real-time tracking of yield reduction trends and production output. Monthly production adjustments that rely on the intuition and knack of a skilled expert can be improved in a short cycle. Furthermore, quality factors can be analyzed even by non-experts, making it possible to aim for stable production. In the OT field, technology for utilizing robots and AGVs (automatic guided vehicles) has already entered the demonstration stage. Mobile robots

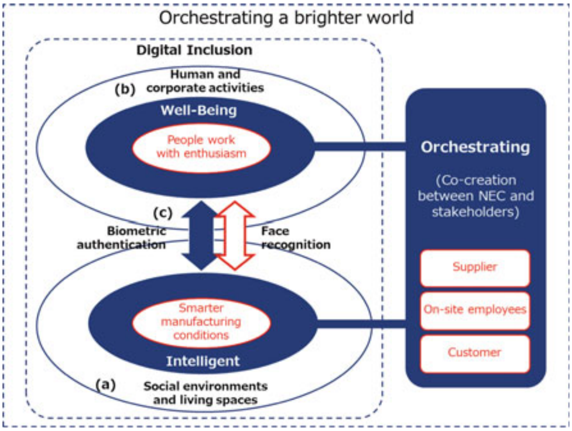


Fig. 5.6 Digital Inclusion for well-being in factories

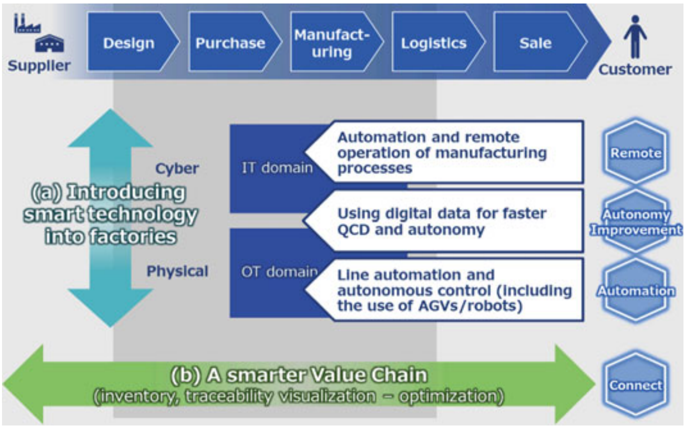


Fig. 5.7 The configuration of manufacturing in the future (smart factory) as envisaged by NEC

can be provided with rules such as one-way systems and temporary halt conditions, and can calculate optimal travel routes according to the local situation.

These technologies eliminate the need for painstaking tasks such as visual product inspection and operation monitoring, and allow robots to take care of dangerous tasks and the movement of heavy objects while humans can enjoy a more comfortable working style in the office or home without being tied to a particular location or schedule.

3. Specific examples of IoT utilization

(a) NECPF

The use of IoT at the Fukushima Plant of NECPF (NEC Platforms Ltd.; a manufacturing subsidiary of NEC), was organized by the Production Engineering Department as shown in Fig. 5.9. The left side of this figure shows the value that can be

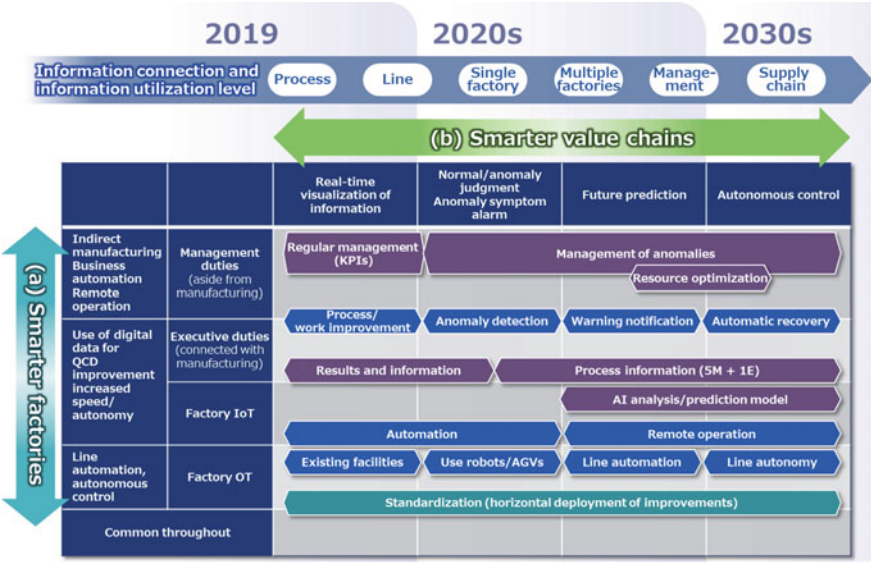


Fig. 5.8 Scenario for realizing NEC's smart factory concept

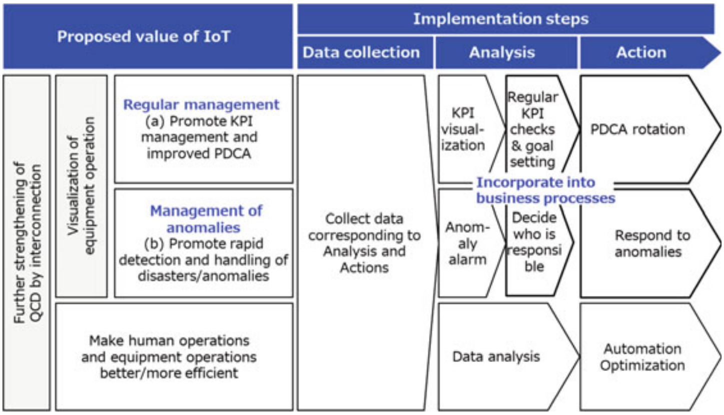


Fig. 5.9 Examples of IoT utilization frameworks

offered by services that use IoT, and the left side shows the steps whereby people working at manufacturing sites can use this value to make improvements. According to engineers, the important things here are (a) to set concrete KPIs, and (b) take action.

Figure 5.10 shows an example where specific improvement activities are set based on the results of using IoT to analyze the operational state of a facility. Based on the KPI settings, improvement activities are performed at the manufacturing site.

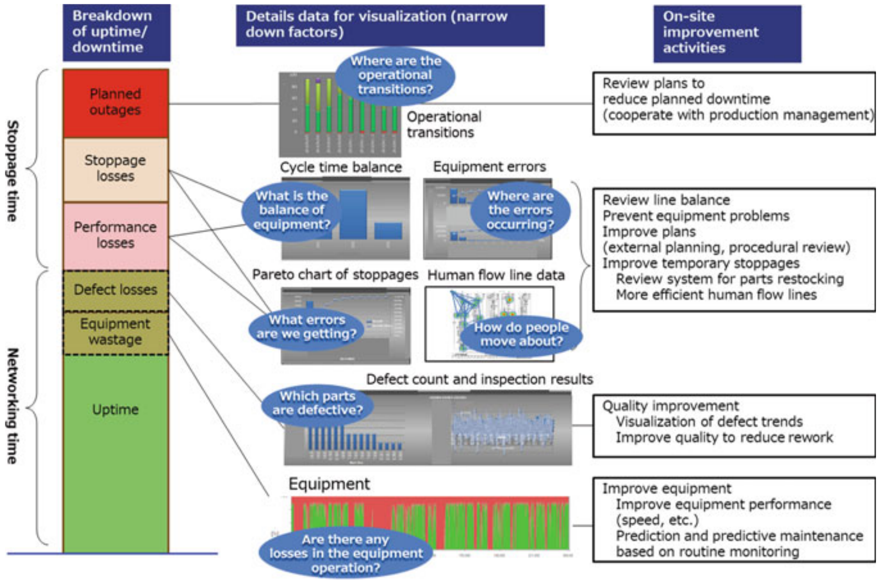


Fig. 5.10 Example of KPI setting using IoT

The improvement activity in this case is called *Senbonzakura* ("a thousand cherry trees"). In this activity, each small group is assigned one or more items for improvement. On a progress chart, brown stickers are added when planning and drafting each measure, green stickers are added when these measures are executed, and pink stickers are added to the remaining parts when the activity has been completed. This makes it possible to visualize the progress of a project (Fig. 5.11).

Fig. 5.11 A wall decorated with *Senbonzakura* progress charts

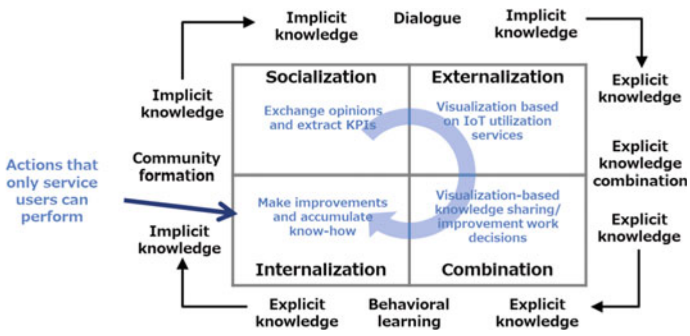


Fig. 5.12 The spiral of knowledge creation and service user activities

At the Fukushima Plant, over a thousand progress charts are hung on the wall each year. By the end of March it becomes completely pink, and takes on the appearance of a thousand cherry trees in full bloom.

By applying IoT services to the Fukushima Plant, we were able to extract ideas for improvements in the form of a *Senbonzakura*. In other words, we were able to extract themes for individual and organizational activities. This exercise also created value by enabling employees at the Fukushima Plant to make their own improvements and watch their cherry trees bloom.

When this technique is applied to the knowledge creation spiral (Nonaka and Takeuchi 1995), we obtain the result shown in Fig. 5.12. If the user of a service does not take an action (improvement activity), no value is created. There is no point in providing IoT utilization services unless the organization is prepared to implement improvement activities.

When the engineers involved in improvement activities at the Fukushima plant were asked why IoT services had received such an enthusiastic response there, they responded that the plant already had a strong culture of self-improvement, which provided the right climate for IoT to succeed. They also pointed out that the Fukushima Plant had changed its name four times since its establishment in 1973, and this had perhaps instilled the employees with the notion that the survival of the plant depended on their ability to strengthen the company and improve their competitiveness. So perhaps the improvement activities at the Fukushima plant are driven by fears about the company's continued existence. It is plausible to assume that the employees in Fukushima experience human needs (Maslow et al. 1997) and safety needs based on their desire to continue living securely in the place where they were born and raised.

(b) **Factory T of Company A (well-being created by customers themselves)**

Even greater new usage value was created at Factory T belonging to company A through the introduction of a similar IoT utilization service. At this factory, the service is used at the morning meeting, which is held every day before work begins. At this meeting, the production line group leaders, the production department, the production technology department, the maintenance department, the IT department, and NEC all participate in the discussion while looking at a monitor showing a visualization of how the factory's equipment is operating. This was announced at the T factory CEO's briefing under the title of "Introducing IoT for a happier workplace". Following the introduction of this service, the factory's group leaders no longer had to arrive early and work late in order to discuss their plans, and could instead coordinate their activities with other departments at the morning meetings. They reported that this resulted in a happier workplace where people were able to make time for the work that they themselves wanted to do, such as communicating with their subordinates and making on-site improvements. Furthermore, in the analysis of product defect causes, they were able to verify their own hypotheses by means of a simulation using the same service. The introduction of this service turned the morning meetings from an unpopular obligation into a fun exercise where everyone was able to demonstrate their own knowledge. In this way, the customer was able to create a feeling of well-being through the introduction of IoT utilization services.

4. **Evaluation**

These case studies suggest that IoT utilization services have an effect on human well-being. It is therefore worth mentioning the idea of positive computing, which has been attracting attention in recent years. Positive computing refers to the area of technology design, research and development that seeks to enhance people's psychological well-being and latent potential. According to Rafael A. Calvo and Dorian Peters, the three determinant factors that should be considered in positive computing can be placed in three categories: self, social and transcendent (Rafael et al. 2017). We therefore tried linking the determinant factors of well-being according to Calvo and Peters with the relevance of individual well-being in IoT utilization services at manufacturing sites as indicated in this case study (Table 5.3). As a result, we found that the main factors in this case are linked to "self" factors (positive emotions, motivation/immersion and self-awareness) and "social" factors (appreciation and empathy).

If IoT utilization services can be allowed to develop in relation to the well-being factors of more manufacturing sites, they will greatly contribute to solving the issues of the manufacturing industry and delivering Digital Inclusion.

5.4.2 IoT Hospitality Services in Nanki Shirahama

1. **Background and issues**

The town of Nanki Shirahama in Wakayama prefecture is a seaside resort famed for its white sandy beach. The beach is popular with bathers in the summer, but most visitors to the town come on day trips from nearby places. The area is well endowed with tourist attractions, including Shirahama Onsen (an ancient hot spring) and the Kumano Kodo (a sacred pilgrimage route, now designated as a World Heritage Site), and attracts sightseers and holidaymakers from around the world.

Table 5.3 Links between the self-factors of well-being with the main elements in this case

Classification	Factors	Links between the main elements of the case
Self-(intra-personal)	Positive emotions	• The pleasure of having no overtime or early starts, the application of subordinates, inspiration from the CEO • General application and respect for one's activates • Pride in contributing to the creation of a sense of unity in the workplace
	Motivation and immersion	• The desire for hob security for continued employment in Fukushima • The desire for self-realization (resolving workplace worries, achieving job satisfaction)
	Self-awareness	• Self-awareness through the digital representation of one's perceptions and experience
	Mindfulness	• No link found yet
	Psychological resistance/resilience	• No link found yet
Social interpersonal	Appreciation	• Appreciating the actions of others in the achievement of KPIs • Thanking colleagues for making accurate suggestions
	Empathy	• Satisfaction with KPIs, sharing personal experiences with others • Empathy of group members with the experiences with others
Transcendental (extra-personal)	Compassion	• No link found yet
	Altruistic behavior	• No link found yet

According to Shinichiro Okada, the President and CEO of Nanki-Shirahama Airport, the region has great potential. With the aim of implementing countermeasures to earthquakes in the Nankai Trough (a seismically active submarine trough located due south in the Pacific Ocean) while at the same time promoting tourism, a disaster-resistant wireless mesh network was installed in the town, including the provision of a Wi-Fi environment on the beach. To take advantage of this facility, it was decided that Nanki Shirahama should model itself as Japan's most advanced IoT destination by implementing "airport-style" regional revitalization measures involving the use of IoT to make the entire area more welcoming to visitors and invigorating the tourism industry by harmonizing the activities of local tourism and industry (NEC 2019c). In terms of the seven social value creation themes, this plan corresponds to a regional version of Safer cities and public service, together with Communication, and Industry Eco-System.

2. **Resolving these issues based on the Digital Inclusion concept**

Digital Inclusion can also contribute to local issues. By creating a database of regional information such as sightseeing spot information and making it accessible with a variety of functions, it is possible for local services to provide people with intelligent support. It can also be used to improve the experiences of individual people and tourists in connection with the area, and face recognition works as an effective tool for connecting the two roles. In this case, orchestrating our activities with those of our various stakeholders in the region is indispensable.

As a first step towards implementing this system, we proposed using face recognition to provide a more convenient service for air passengers, and we developed a system with the cooperation of other stakeholders and regional authorities. This service started at Nanki Shirahama Airport, but subsequently expanded to include participating hotels. The number of partners in the region gradually increased as the hotels invited local stores to join in, resulting in the implementation of a system close to the Digital Inclusion plan (Fig. 5.13).

3. **System overview**

NEC uses its own face recognition technology to register information such as facial data and credit card details at the airport, which is the gateway to the region. Once people have entered this environment, they can use a single common ID thereafter (Fig. 5.14).

We verified that there was an effective improvement in the hospitality provided at Nanki Shirahama Airport and various establishments in the local area, including the Shirahama Key Terrace Hotel Seamore and the Fisherman's Wharf Shirahama business center, specifically with regard to the guidance provided at the airport, the hotel pickup and registration procedures, and the ability to use cashless payment to

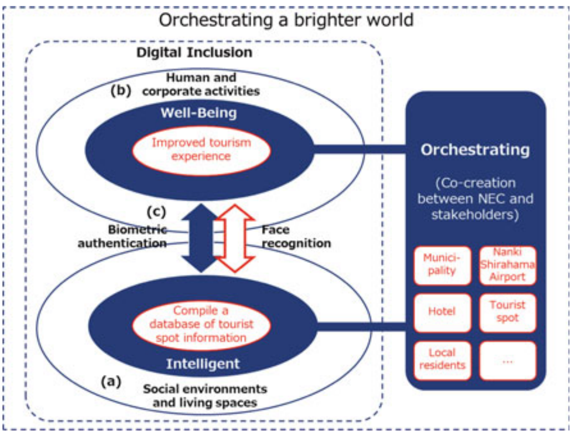


Fig. 5.13 Digital Inclusion including IoT hospitality services in Nanki Shirahama

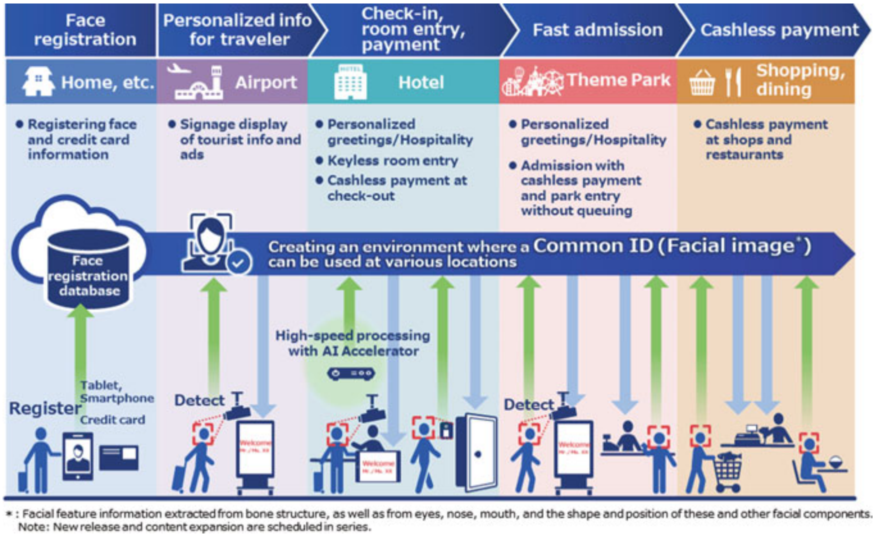


Fig. 5.14 Demonstration of IoT hospitality services in the Shirahama area

perform empty-handed shopping. By developing our new NEC AI Accelerator, which implements high-speed AI processing and is securely operated and managed by Arm® Pelion™ Device Management without using cloud technology, we were able to install a face recognition engine at the network edge. The Wakayama Adventure World theme park, which includes a zoo with six giant pandas, an aquarium, and an amusement park, also participated in the service by introducing tickets based on face recognition that enable smart entry for visitors.

The use of face recognition enables the creation of mechanisms whereby people can use various services around Nanki Shirahama that are styled with slogans such as “hands-free”, “face pass” and “cashless”. Once users have registered their face and credit card details by using a device such as a smartphone, they are able to access special hospitality services at the airport and hotels, and can use face recognition as a means of payment while shopping or dining out. There is now a plan to turn the entire area into a single amusement park that offers a comfortable VIP experience, and technology can be used to bring out the full potential of this resort.

4. Evaluation

This demonstration of hospitality services based on AI and IoT has shown that it is able to improve the convenience of tourists and business visitors, and can be expected to stimulate the local economy of the Nanki Shirahama area.

We were also able to confirm that this service provides visitors with a better experience. For example, it allows them to enter the public baths without having to bring a room key. In shops and restaurants, they can pay by touching the screen of a tablet terminal while looking into the camera. They can also use their faces to unlock their hotel rooms. At each establishment involved in this demonstration, users found themselves receiving a VIP experience that was more comfortable than they had expected. There had been concerns about the speed of face recognition, but in the end, it was possible to deliver cutting-edge hospitality and a greater level of comfort than had been anticipated.

Over the next 20 years, Nanki Shirahama Airport aims to triple its capacity to reach 300,000 tourists per year. We are therefore working to improve user satisfaction by delivering greater hospitality, including the introduction of advanced IoT throughout the entire region, and we are also working on the use of IoT to improve the productivity of the airport. To this end, NEC aims to use ICT technology to enhance the value of hospitality services.

5.4.3 An Intelligent Seven-Eleven Store

1. **Background and issues**

Seven-Eleven opened its first convenience store in Japan over 40 years ago. Since then, convenience stores have shown steady growth, and have not only made a large contribution to the modernization of small and medium-sized retail businesses, but have also become an integral part of everyday life in Japan. It is fair to say that convenience stores have always adapted to the changing social environment by embracing technological innovations and developing new services. However, in recent years, it appears that sales have become sluggish, store management has become harder due to labor shortages, and operating costs have risen due to the rising cost of labor (METI 2020).

Seven-Eleven Japan (SEJ) is one of Japan's largest chains of convenience stores. When it opened its first store, NEC was responsible for its ICT technology. NEC also worked with SEJ on system development and on the order terminal equipment that was the predecessor of modern POS terminals. This was the starting point for technological innovation between the two companies, and based on our joint efforts over the ensuing four decades, we arrived at the concept of the intelligent store.

In December 2018, with the aim of fully expanding into the micro-market sector (small-scale commerce), SEJ and NEC opened the first reduced-staff store based on AI and IoT technology on the 20th floor of the Seven-Eleven Mita Kokusai Building. The purpose of this initiative is to promote the development of so-called micro markets in places such as office buildings, hospitals and factories where there is a growing need for small-scale retail outlets (NEC 2019d).

In terms of the seven social value creation themes, the creation of reduced-staff stores corresponds to "Communication", "Industry Eco-System" and "Work style".

2. **Resolving these issues based on the Digital Inclusion concept**

There are many situations where it is possible to experience the value of Digital Inclusion, even when shopping in stores. Specifically, by visualizing, analyzing and handling customers, products, facilities and other items in the store, it is possible to

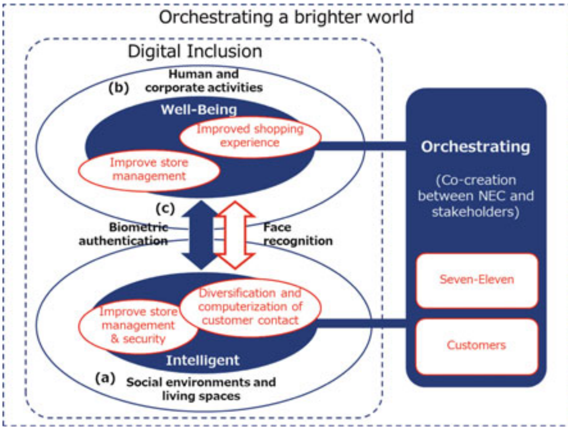


Fig. 5.15 Digital Inclusion at the Seven-Eleven reduced-staff store

not only enhance various operations but also to promote the innovation of reduced-staff stores. In addition, it makes it possible to reap the benefits of digital technology, such as greater convenience for shop workers and customers, which is expected to deliver on the Digital Inclusion goal of providing a society where everyone can reach their full potential. (Fig. 5.15).

The shortage of labor is currently one of the major social issues in Japan. Various efforts are being made to address this issue through the use of biometric authentication and AI/IoT. This reduced-staff store is one example where the use of AI and IoT results in a store that has fewer employees but is still comfortable and convenient.

3. **System overview**

In this store, in addition to the systems that support customer comfort and convenience, including facial recognition payments (which NEC was the first to introduce in Japan) and AI-based targeted advertising signage, information from refrigerators and other equipment is also collected 24 h a day to implement facility operational management and restricted area intrusion detection to support stable management. This employee support system makes it possible to reduce the number of staff at the shop.

To avoid wasting valuable break time for shoppers, the company has created a new speedy shopping experience with walk-through entrances and self-checkouts that use face recognition. It also improves store productivity by making use of ICT technologies such as for facility operation management, by collecting real-time refrigerator operation information, and in the future for AI ordering, by using AI to propose the quantity of stock to order. This allows the store employees to concentrate on tasks that can only be performed by humans, such as creating product displays and sales promotions, thereby making the store more welcoming (Figs. 5.16 and 5.17).

4. **Evaluation**

This reduced-staff store can also be promoted as a store that is friendly to people and the environment based on the active introduction of IoT/AI technology, leading

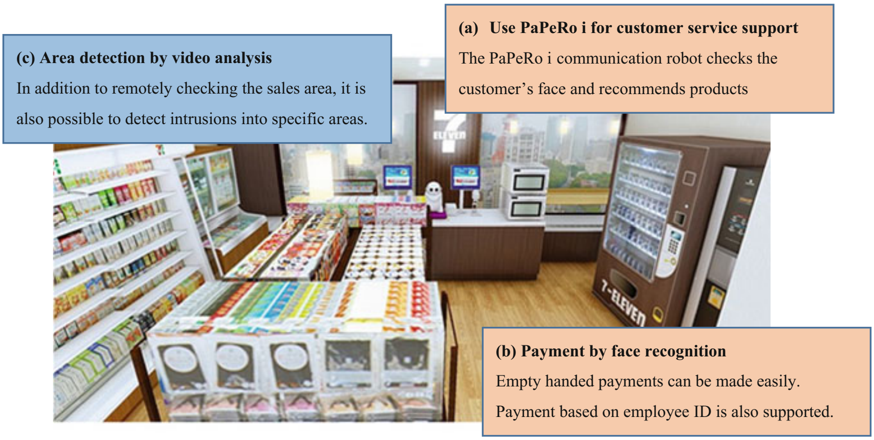


Fig. 5.16 Technology introduced at the Seven-Eleven store in the Mita International Building (1)

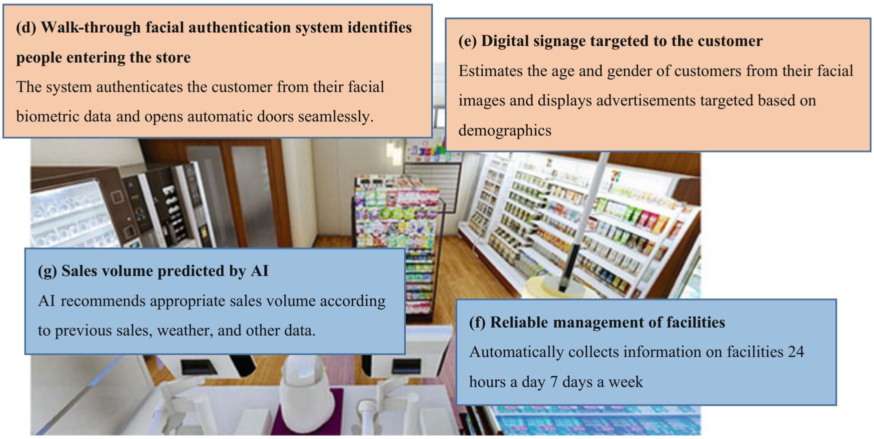


Fig. 5.17 Technology introduced at the Seven-Eleven store in the Mita International Building (2)

to improved store productivity. Customers benefit by getting a store that is closer and more convenient, with better service quality and greater operational efficiency. Benefits for the store include stable facility operation achieved through preventative maintenance based on equipment monitoring, and elimination of manned cash registers through the use of face recognition payments. SEJ and NEC will continue to work together on "close and convenient" retail methods in order to open up new markets and create new services using IoT and AI technologies.

5.5 Analysis of Business Innovation

1. **What are the needs of people, the issues in society and business and the objective of utilizing ICT? (needs)**

In these three cases, ICT was introduced to deliver well-being, hospitality, and convenience. At NEC, we believe that everyone in the world wants to live a rewarding life where their human qualities can flourish.

2. **What technologies and functions are utilized to solve these issues or realize the needs of people? What is the role of ICT in value creation? (technologies)**

Each of the three cases used services based on technologies developed by NEC (IoT, biometric authentication, and AI). Based on our original mission of "Better Products Better Service," we will continue to research and develop new technologies and contribute to the happiness of mankind.

3. **What are the value creation methodologies? (value creation)**

By orchestrating our activities with those of diverse stakeholders, we aim to implement Digital Inclusion through a combination of three elements: (a) intelligent social and business environments, (b) support for invigoration of human and corporate activities, and (c) biometric authentication to connect business environments with individual people and corporate activities.

4. **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**

NEC creates business innovation to keep up with the development of our customers, enabling us to work together on the creation of social value (B to B to Society).

5. **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

The use of ICT can help people to live rich, rewarding lives. NEC will pursue the realization of Digital Inclusion by creating social value in terms of safety, security, fairness, and efficiency.

5.6 Conclusion

NEC is one of Japan's leading ICT providers. For the IoT/AI era, NEC has adopted the corporate philosophy of "Orchestrating a brighter world" as the next step from the world that was realized by C&C. The goal of Digital Inclusion, which embodies this new philosophy, involves orchestrating our activities with those of our customers in order to (1) make social and living environments more intelligent, (2) support people and businesses, and (3) use biometric authentication to connect business environments with individual people and corporate activities. NEC aims to realize a sustainable society where everyone can live rich, fulfilling lives by creating social values of safety, security, fairness, and efficiency in a digitally permeated society.

References

Maslow HA, Frager DR, Fadiman J (1997) Motivation and personality, 3rd edn. Pearson

Ministry of Economy, Trade and Industry, Japan (2019) 2019 Monozukuri White Paper

Ministry of Economy, Trade and Industry (2020) Report on the investigative commission on establishing a new generation of convenience stores. https://www.meti.go.jp/shingikai/mono_info_service/new_cvs/index.html (in Japanese)

NEC Corporation, Japan (2019a) NEC corporation integrated report 2019

NEC Corporation, Japan (2019b) NEC vision for social value creation. https://www.nec.com/en/global/about/vision/ (in English)

NEC Corporation, Japan (2019c) How using face recognition to enhance visitor experience has brought change to Nanki Shirahama, December 2019. https://wisdom.nec.com/ja/article/2019121601/index.html

NEC Corporation, Japan (2019d) SEVEN-ELEVEN JAPAN: AI and IoT-based customer-friendly eco-friendly store. https://www.nec.com/en/global/onlinetv/en/sej_mk.html

Nonaka I, Takeuchi H (1995) The knowledge-creating company. Oxford University Press, Inc.

Rafael AC, Dorian P, Watanabe A, Chen D (trans) (2017) Well-being design theory. BNN Inc.

Chapter 6
Co-Creating Future of Artificial Intelligence of Things (AIoT) Through Ecosystem Partnership: A Case Study of Advantech Co., Ltd

Shih-Chieh Jack Hsu, Hui-Mei Hsu, and San-Yih Hwang

Abstract Advantech is the world No. 1 industrial PC manufacturer and ranked No. 5 in the list of Best Taiwan Global Brands in 2018 (Interbrand 2018). While the sales of industrial PCs and various IoT sensing/communication devices still account for more than 80% of their annual revenue, Advantech has recognized the importance of the emerging technologies, including cloud computing, IoT, and artificial intelligence, and its impact on both service and manufacturing sections. Since 2014 Advantech has launched an ambitious project in taking the lead in establishing an IoT service platform and managing its ecosystem. This platform enables domain-specific solution integrators to build industry-specific solution ready packages that incorporate devices, cloud storage, and AI techniques in domains such as factories, hospitals, cities, and transportations. The co-creation process, the business models, the difficulties, and the strategies will be addressed in this article.

6.1 Introduction

The development of new technologies has changed the business environment considerably. Moreover, computers have fastened calculation and accelerated the business operation process. Currently, the Internet connects computers and other devices, enabling global information sharing. At a recent time technology-based forms of business, such as e-commerce, have emerged and are being preferred over the traditional business operation. Innovations are required for business to survive.

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In Taiwan, which is famous for its hi-tech industry and traditionally a manufacturing-based and export-oriented country, many hi-tech companies produce and sell hardware to local and international markets. In this business model, values are generated from the transforming of materials to products, and profits mainly come from producing and selling hardware. For instance, some companies in Taiwan, such as Asus and Acer, focus on the consumer market and produce products for end customers, whereas many other companies, such as Advantech, focus on business customers and produce industrial computers for manufacturers, hospitals, retail enterprises, fleet management corporation, and other business owners.

Advantech is a company offering industrial information technology solutions to businesses. The company was founded in 1983 by Ke-Cheng Liu and Chaney Ho to provide industrial computers. Its early success enabled the global expansion of Advantech. However, with technological advancement, the success of Advantech's traditional business model became difficult. This technological advancement includes the use of Internet of Things (IoT), which facilitates the connection of everything to the Internet, thus enabling devices to communicate with each other and huge amounts of data and information to be created, gathered, and analyzed. In addition, advanced computing algorithms enable pattern detection and insight generation from accumulated data. Taken together, IoT aids organizations in making decisions and taking better actions in a smarter way. For instance, the concept of Industry 4.0 is an integration of IoT and artificial intelligence (AI), or called AIoT, which aims at improving the manufacturing process (Kramer 2019). According to statistics (ICT Spending Forecast 2018–2022), it is a major trend for traditional manufacturers to have been digitized. Approximately 85% of the interviewed companies are enhancing their technological capabilities for becoming intelligent manufacturers. However, constructing a smart manufacturing is not such an easy task. There are many legacy assets of factory that can be complicated, requiring manufacturers to be upgraded with a wide range of hardware or software for effective data utilization.

Advantech, whose focus was industrial computers, sensing devices, and communication devices production, thus has transformed itself from a hardware supplier to a solution provider. The company has constructed a collaboration platform for hardware producers, software and service providers, and system integrators (SIs) with the aim of providing solutions for different industries. In this chapter, we introduce the history and current situation of Advantech. We particularly focus on WISE marketplace that allows various players, including IaaS providers, PaaS providers, SaaS providers, and domain-focused solution integrators (DFSIs), to construct innovative services from existing components on the platform and release their services, industrial apps (I.Apps) and components on the marketplace. In particular, we introduce the development history, architecture, and business model of this platform. On the basis of the service-dominant logic,[1] this company serves as an example that

[1] Service-dominant logic, developed by Stephen Lusch and Vargo (2006), aims to contribute to the understanding of human value co-creation by developing an alternative to traditional logics of exchange.

illustrates the essentials of using a platform to trigger value co-creation (Lusch and Vargo 2006).[2]

6.2 Current Business Situation of Advantech Co., Ltd

Founded in 1983, Advantech boasts more than 8200 employees in 21 countries and 92 offices worldwide. Approximately 47% of its employees have a college degree, while another 20% of the employees received postgraduate degrees. The average employee age is about 36 years. Advantech is a leading provider of trusted, innovative products, services, and solutions in intelligent systems. In response to the emerging Smart City in an AIoT Era and diverse market needs, Advantech formed four strategic business groups to serve specific markets: Embedded-IoT, Allied DMS, Industrial-IoT, and Service-IoT. The organization structure is displayed in Fig. 6.1. Through close cooperation with partners, Advantech provides complete solutions for a wide array of applications across a diverse range of industries. Its corporate mission and goal are "Enabling an Intelligent Planet" and "Partnering for Smart City and AIoT Solutions," respectively. By enabling continuous innovation for accelerating the evolution of each industry, Advantech aims to become the most influential global corporation in the Smart City and AIoT Era (Donath 2020).

The main products of Advantech include embedded boards and chassis, industrial computer and control, and after-sales services, with 2018 production values of NT$21,354,713,000, NT$21,099,031,000, and NT$6,272,744,000, respectively. Furthermore, its domestic and export sales values are NT$3,604,440,000 and NT$45,122,074,000, respectively—both of which have demonstrated consistent annual growth. The size of its global market is however approximately 12 times that of its domestic market. About 48% of export sales occurred in Asia, followed by 25% in the US and 17% in Europe.

Advantech has three main types of business customers: distributors, machine and equipment manufacturers, and SIs. Its revenue mainly originates from the sales of embedded boards and industrial personal computers (IPCs), the growth of which depends on new application markets as well as on traditional industrial applications. Prominent new application markets are retail, logistic, energy and environment, hospital, and smart city applications. In 2017, the industrial sector was the major application market with a 51% market share, followed by the transportation and infrastructure with a 16% market share and health care with a 10% market share (Advantech Annual Report 2018).

Driven by the high demand for Internet communication and industrial IoT devices, the growth rate of revenue was 11% higher in 2019 than in 2018. In 2020, Advantech aims to reach NT$60 billion revenue.

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[2]Ramaswamy and Ozcan (2018) define co-creation as the enactment of interactional creation across interactive system environments (afforded by interactive platforms), entailing agencing engagements and structuring organizations.

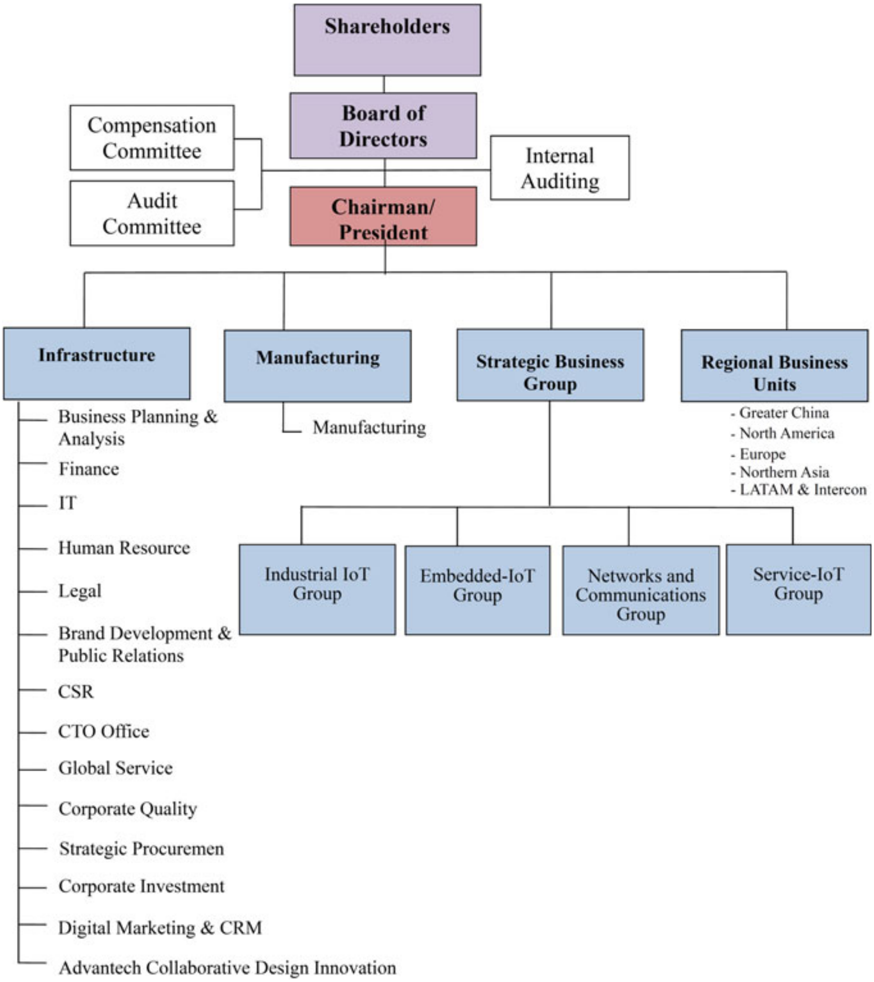

Fig. 6.1 Organization structure of Advantech

6.3 History of Advantech

The development of Advantech, which started in 1983, can be classified into several stages. Its major stages and milestones in the past 37 years, illustrated in Fig. 6.2, are listed subsequently.

(1) **The Beginning and Initial Extension (1981–1999)**

Advantech launched several standardized PC-based automatic test devices in 1985. In the next 5 years, it produced PC-Lab Cards, started business in mainland China and foreign markets, and set up a branch office in San Francisco, CA, USA. In 1989,

Fig. 6.2 Major milestones of Advantech

Advantech purchased a factory located in Xindian District, New Taipei City, Taiwan, and set up the IPC product line. As sales were very successful, IPC became the second main product line beyond the PC-Lab Card. In 1992, Advantech set up an office in Beijing, China, and succeeded in creating the Remote Data Acquisition Module of the ADAM-400 Series. By 1998, Advantech had won several awards in Taiwan and Singapore.

(2) **Business Expansion (2000–2010)**

In 2001, Advantech received numerous awards including "Taiwan Excellence Award" for WEB-2143, EH-760, ES-510, and PPC-153 products. In 2002, it won the Gold-Level Partner in Microsoft's Windows Embedded Partner ODM Category, allowing Advantech to sell its hardware directly in the market. In 2004, Advantech secured indirect investments in Thailand. In collaboration with Asus, Advantech co-founded Advansus in 2005.

Advantech was awarded "Intel Associate Partner of the Year" and "Multi-Core Solution Contest Award" in 2006 and "Microsoft Most Development Prize" in 2008. *Global Views* awarded Advantech the third "Corporate Social Responsibility Prize, Top Distinction." Advantech launched new subsidiaries in Shanghai and Xi'an, China, in 2008, called Advantech Shanghai and Advantech Xi'an, respectively. The opening of the US and European offices further provided a climate for an additional drive to develop Advantech in various sectors. Therefore, Advantech's US offices together acquired 60% of Advantech Brazil's shareholding in 2009. In addition, Advantech received the 1st place in the Industrial Computer Category of Control Magazine's 2010 Readers' Choice Awards.

(3) **Global Expansion (2010–Present)**

In 2013, Advantech's products, including human–machine interface, stationary multi-touch panel computer, and touch panel computer, received the Germany iF design award. Advantech set up a China technology hub in Kunshan, China, in 2014 and entered the intelligent system market in 2016 by starting the joint venture company AImobile. In Nikkei's 2017 Asia 300 list, Advantech was at the 36th position in Asia and 5th position in Taiwan.

Advantech supplies various products worldwide based on the support of its research and manufacturing centers scattered in different regions. Advantech has numerous products in various domains, including embedded computing, industrial automation, intelligent systems, healthcare, retail, logistics, and communication and networks. The current sales by area are North America, Greater China, Northern Asia and Europe—contributing to 28%, 31%, 14%, and 19% of sales respectively. The detailed major product categories in each area are illustrated in Fig. 6.3. Advantech also acquired 80% stock rights of Omron Nohgata, a subsidiary of Omron Corporation. Since February 2019, Omron Nohgata is known as Advantech Technologies Japan.

In 2018, Advantech's revenue was US$1.6 billion, and its market value was US$5.71 trillion in 2019. By 2020, Advantech expects its revenue to reach US$2 billion. Finally, Advantech has its activities scattered across the globe. Figure 6.4 shows global centers and offices in various geographic locations.

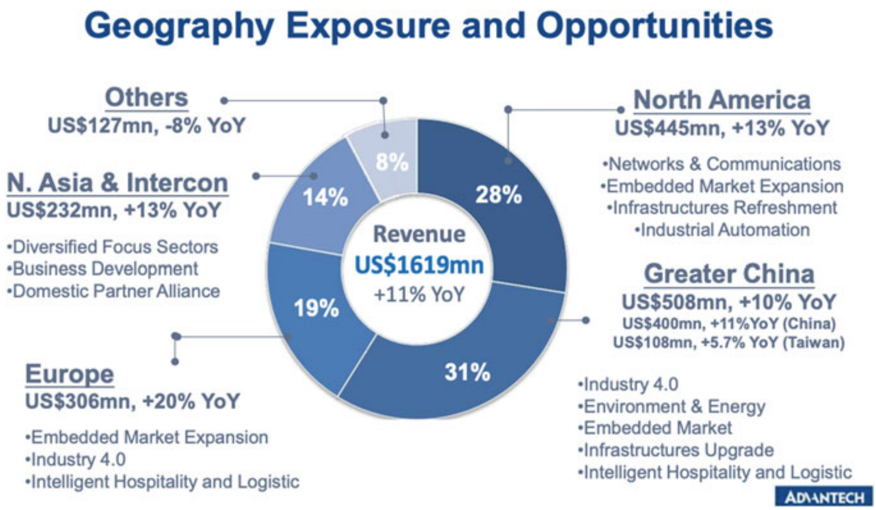

Fig. 6.3 Global distribution of Advantech's major products

Fig. 6.4 Locations of global service centers of Advantech

6.4 WISE-PaaS and Its Business Model

As indicated, in addition to providing computing hardware to manufacturers, Advantech aims at providing total solutions for smart manufacturing. These solutions include IoT-embedded systems, edge computing, AI (artificial intelligence), and a cloud platform hosting various software programs. WISE-PaaS was developed in 2014 and has been evolved to WISE-PaaS 4.0.

6.4.1 WISE-PaaS 1.0–3.0

In 2014, Ke-Cheng Liu realized that although AIoT is set to change traditional industries, many companies would not be able to respond to this trend by themselves. Advantech's analysis results indicated that in traditional industries, the collection and analysis of data from the multiple equipment types and for various standards can be challenging. Moreover, commercial software package cannot analyze such data, necessitating the development of specific solutions for individual companies. Thus, Advantech developed WISE-PaaS to serve its customers. Users of WISE-PaaS could use all required software and services on the platform, upload data, and run algorithms to train models—essentially performing a business decision-making process that previously was human operated. Two years later, Advantech found that WISE-PaaS could not reach the predefined goal because WISE-PaaS was designed in a function-oriented manner and needed to be adjusted to be data-driven. Thereafter, in 2017, Advantech proposed WISE-PaaS 2.0, which adopted a data-driven process: a large amount of data would be collected first, and then, needed functions would be developed on the basis of analytical needs. Nevertheless it was noted that WISE-PaaS 2.0 did not appear to consider the needs of all partners. Therefore, in 2018, WISE-PaaS 3.0 was proposed, which focuses on co-creation with SIs to provide Solution Ready Package (SRP) for Domain-focused Solution Integrators (DFSIs) in various industries.

WISE-PaaS 3.0 has four core services, which highlight an important role of cloud services (as indicated in Fig. 6.5): (1) WISE-PaaS/SaaS Composer, containing workflow visualization tools; (2) WISE-PaaS/AFS (AI Framework Service), including AI model training and deployment architecture; (3) WISE-PaaS/APM, for remote operation and maintenance of network connected equipment; and (4) microservice development framework for the WISE-PaaS platform.

Those four features highlight the important role of the cloud services. Of these, WISE-PaaS/AFS receives special attention because it aims at creating an AI development environment. This area has not been considered by Advantech in the past, and it focuses on enabling developers to quickly start AI model training and deploy the model on the edge computing endpoint. In the next 10 years, the momentum of AI seems to be unstoppable. The launch of the aforementioned WISE-PaaS tools also indicates the integration of service-oriented thinking in Advantech's development plan.

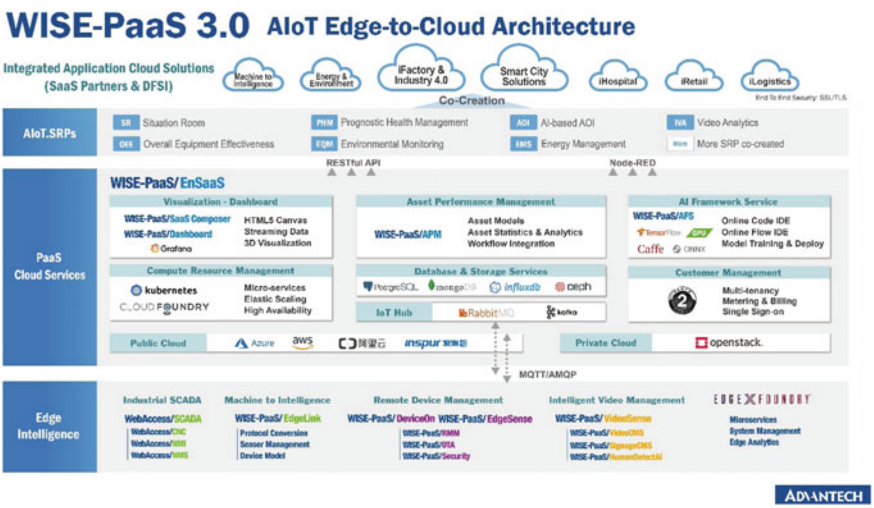

Fig. 6.5 WISE-PaaS 3.0 Architecture

In the past, manufacturers would purchase different devices from different vendors, including Advantech. However, because different vendors may implement varied standards, these devices would not function together efficiently. Therefore, some consultancy companies play the role of SIs. System integration is difficult, and often times, several months is required to integrate different systems for one individual project. It is not unusual that SI generally cannot resolve complicated technical issues and request technical support from their device providers. This may delay the implementation project. Furthermore, most manufacturers who want to adopt smart manufacturing desire the visualization and Internet connectivity for devices. Therefore, Advantech developed two application framework services, namely Dashboard and Asset Performance Management (APM), to satisfy these demands. Another issue caught Advantech's attention is low compatibility problems faced by manufacturers during implementation. To resolve this issue, Advantech integrated a variety of solution ready package (SRP) for manufacturers or domain focused solution integrators (DFSIs), whereby manufacturers can select the most suitable package and install the system by following the steps specified in the package and can upgrade to a higher-level smart factory by purchasing other software services.

Advantech's DFSI, developed using a co-creation model, is an important enabler for accelerating "manufacturing" toward "intelligent manufacturing." In the IoT world, tens of billions of devices are interconnected; thus, SIs must evolve and integrate their expertise to seize the opportunity and scale up. Domain knowledge can create value. Advantech's development strategy has been changing with the continuous IoT technological development—from the first stage of providing embedded hardware platforms and end products responsible for collecting data or performing edge computing to the second stage of promoting WISE-PaaS, the application of the industrial IoT cloud platform, and the application development of the industrial IoT solution in various industries. The goal is through forming strategic cooperation among vertical industry partners related to IoT applications to establish a complete value chain.

6.4.2 WISE-PaaS 4.0

In 2019, WISE-PaaS was upgraded to version 4.0, a comprehensive AIoT edge-to-cloud architecture (Fig. 6.6). In response to the requests of many developers, WISE-PaaS 4.0 provide support for leading technologies in the market and increases flexibility in application development and solution delivery. More specifically, WISE-PaaS 4.0 is Kubernetes based and offers users with a cloud environment that is more suitable for deploying and hosting applications with micro service architecture, and easier to implement DevOps so as to realize agile development. WISE-PaaS 4.0 also enables better subscription management and separates administrators from end-users, thereby allowing for the implementation of finer business models on the platform. The bottom layer of I.APP in the Fig. 6.6 presents its edge intelligent services, which include supervisory control and data acquisition (SCADA), the connection of

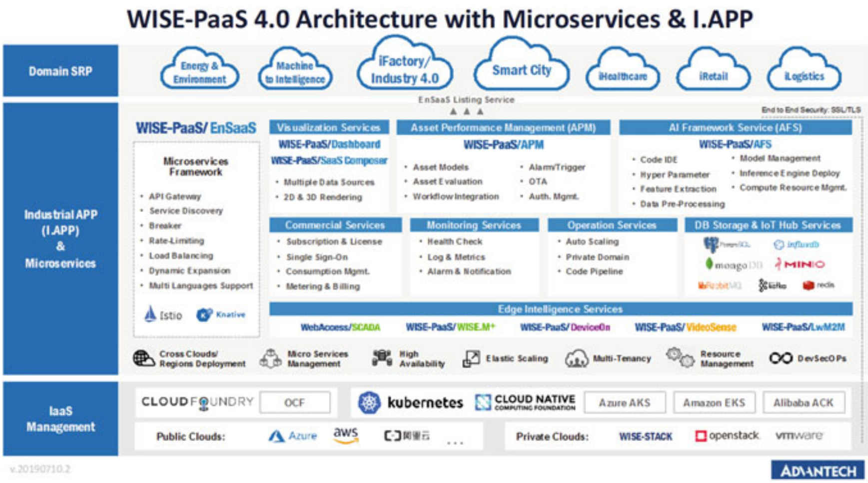

Fig. 6.6 WISE-PaaS 4.0 Architecture

machine-to-intelligence (M2I) devices, management of remote devices, and management of images. These services collect and upload data to the PaaS service layer. The PaaS service layer forms the core of Advantech's WISE-STACK private clouds or other AIoT cloud platform and provides mobile support across public clouds, such as AWS, Azure, and Alibaba Cloud and Advantech's WISE-Stack private cloud. It also contains basic services including computing resource management, database and storage, and customer management. The upper middle layer of Fig. 6.6 presents three major development frameworks that can be used to help users accelerate the development of AIoT services, including WISE-PaaS/Dashboard for fulfilling data visualization needs with dashboards, WISE-PaaS/APM for managing performance of equipment, and WISE-PaaS/AFS for making AI-based predictions.

The core concept of WISE-PaaS is that it is a shared platform for service provision. The platform membership fee generates additional revenue for Advantech. The membership level is divided into 3 levels, which are regular members, VIP member, and premier member. The two-year VIP membership fee is 2000 WISE-Points (equal to 36,000 US dollars). As of March 2020, Advantech owns over 180 WISE-PaaS VIP members. The VIP members can also access consulting and training services from Advantech, which can aid these members in quickly implementing industry 4.0 solutions, smart hospital and smart retail solutions. Advantech focused on hardware sales initially and then adopted a software–hardware integration SRP, followed by the use of the cloud and service layout. Advantech has thus transformed from an industrial computer manufacturer to a software–hardware integration service provider. However, one supplier cannot solely support the entire AIoT market. On the basis of co-creation concept, Advantech moved from a pure hardware manufacturer to a solution provider, then to a cloud PaaS and SaaS provider. In this co-creation ecosystem, customers can thus find both required hardware and software resources

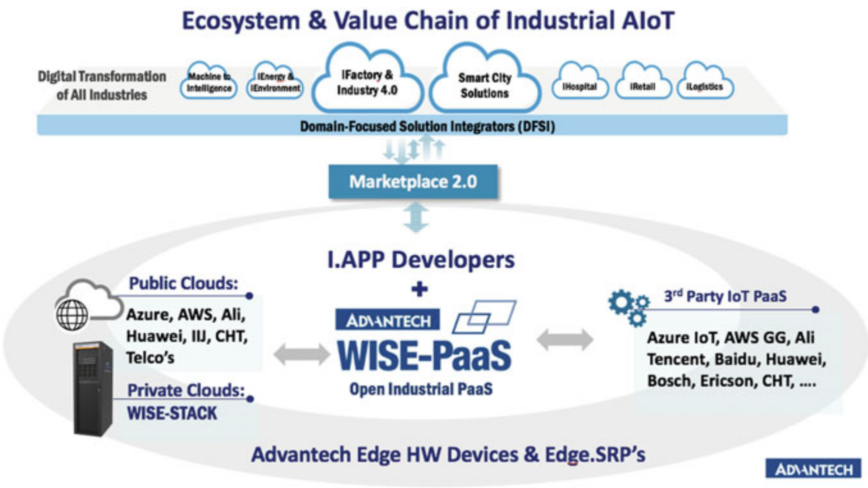

Fig. 6.7 Industrial AIoT ecosystem of Advantech

(Bettencourt and Ulwick 2008). Its strong familiarity with the domain knowledge of various industries allows Advantech to help customers in quick implementation of projects—a limitation encountered by other typical IT vendors. WISE-PaaS 4.0, an AIoT end-to-cloud architecture, has introduced Advantech the ability to work with partners to co-create cloud services and achieve win–win situations for the AIoT ecosystem. The ecosystem and value chain of AIoT are illustrated in Fig. 6.7. Advantech hopes to build an AIoT supply chain for Taiwan. Similar to the role of the semiconductor industry plays in the current economy of Taiwan, Advantech hopes that AIoT could become the engine that drives the next wave of economic growth in Taiwan.

The profit model of WISE-PaaS is different from the past hardware sales models of Advantech. In the past, Advantech's profits originated from selling the hardware it manufactured. Currently, the company is moving toward new business models involving the WISE-PaaS data application platform, in which SIs are integrated with DFSI to develop many I.Apps to provide more service solutions, and sell more services, all to facilitate value of sharing (Fig. 6.8). Therefore, Advantech assembles the members of WISE-PaaS ecosystems and value chains to form an AIoT market, WISE-marketplace, which is an online platform for members to obtain software products, consulting or marketing service, and technical support.

6.4.3 Business Model Canvas of WISE-Marketplace

This section illustrates WISE-PaaS 4.0 business model of WISE-Marketplace with a business model canvas (Fig. 6.9).

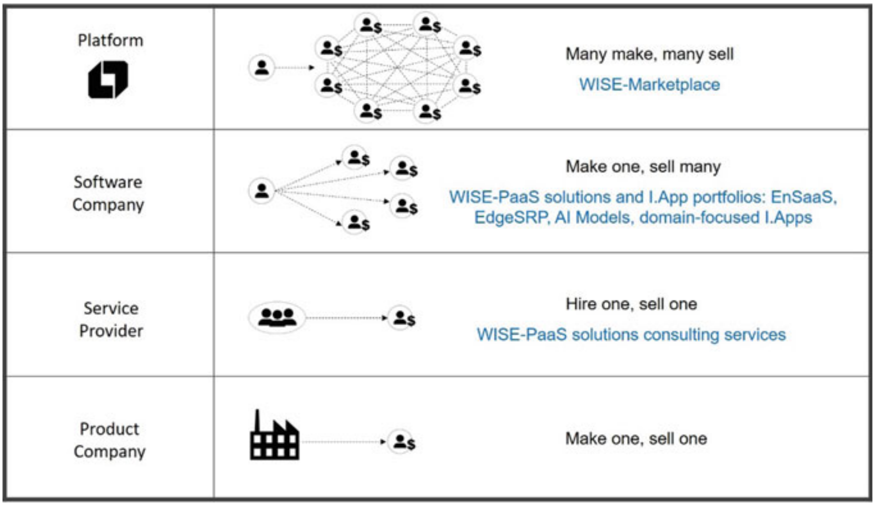

Fig. 6.8 The concept of WISE-Marketplace

(1) **Customer segments of this platform** include (1) organizations planning to adopt AIoT solutions, (2) software manufacturers, and (3) system integrators. In brief, organizations planning to adopt AIoT can find SRPs for their own industry and can check whether any available I.Apps can be applied to their contexts. Although hardware and software manufacturers are suppliers of raw products on the platform, SIs can help create solutions by integrating available hardware and software and in the end create values. SIs can also play the role of software developers and contribute their developed software.

(2) **Value proposition of WISE-PaaS** describes what WISE-PaaS contributes to different participants. Given its various participants, this platform provides unique value for each participant. SIs' main value lies in the development of effective solutions for their customers. In the past, SIs would spend a considerable amount of effort on software–hardware integration. With SRPs and useful apps developed for the specific industry, SIs can effectively improve their productivity. In addition, they can contribute and upload software developed for a specific case to the platform for reuse. Organizations interested in adopting AIoT can find SRPs for a specific industry directly and ask SIs to customize the solution for their companies. These organizations may also find a useful app available on the platform and adopt it without any compatibility issue. Furthermore, this platform allows software providers to get more exposure to their products.

(3) **New customers** are reached through various types of advertisements on various media, including partner conferences, exhibitions, the platform and Advantech's website. Customers are retained by offering customized solutions and special membership on the website. Thus, this ensures that customers can contact

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• Channel partners • Solution partners • WISE-PaaS Alliance Partners • Shipping service • Financial service • Advertisers	• Manage product hardware, apps, and packages • Develop and maintain platform • Promote the platform **Key Resources** • Global R&D Centers, Manufacturing Centers • Talents • Patents • Domain knowledge • Culture of co-creation	• Access to Solutions: Providing ready edge-to-cloud AIoT solution packages for different industries • Co-creation of value with SIs: Providing easy hardware–software components to construct domain-specific solution packages • Platform for hardware and software manufacturers: Allowing more exposure of their products to more users and buyers	• Retaining customers by offering customized solutions and special memberships for SIs • Obtaining new customers through advertisements, exhibitions, and Advantech website **Channels** • Physical channels, including, distributors, equipment makers, and system integrators) • WISE-Marketplace	• Organizations (public or private) attempting to adopt AIoT • DFSI • Hardware and software manufacturers

Cost Structure	Revenue Streams
• Research and development cost • Platform and app development and maintenance cost • Human resources cost • Marketing cost	• Membership fee • Hardware sales

Fig. 6.9 Business model canvas of Advantech's WISE-Marketplace

Advantech or SIs for maintenance services. With memberships, end customers and SIs can also access other apps that may be supplied in WISE-Marketplace.

(4) **Channels to deliver service** are physical for hardware and virtual for software. Distributors and equipment makers are the main delivery channel of pure hardware, whereas SIs represent the channel for integrated solutions (i.e., hardware–software). The platform itself serves as a pure virtual channel for SIs and end customers to subscribe and redeem Apps.

(5) **Main revenue** originates from two sources, namely hardware sales and membership fees. Advantech is the platform owner as well as a participating hardware manufacturer since hardware sales is still the main revenue source for the company. Nonetheless, SIs, end customers, and other hardware manufacturers pay membership fees to use the platform.
(6) **Resources needed for running the platform** include human resources, hardware resources, capital, and intelligent resources. Some crucial human resources include engineers (who develop and maintain the platform) and marketing personnel (who can help promote the platform). Capital is also needed for purchasing the required hardware and software. Hardware resources, including physical space, servers, and other equipment, are needed for operation. Moreover, intangible resources, such as patents and brand image, are essential to preventing competition and attracting new customers.
(7) **Key activities needed for keeping the platform running well** include promoting the platform through advertisements, offering various types of hardware and software, and developing and maintaining the platform. Advantech needs to develop and maintain the platform. Promotion is also needed to attract more participants. In addition, offering sufficient amount of hardware and software is key to attracting more players to participate.
(8) **Key partners** include channel partners, solution partners, WISE-PaaS VIP and other alliance partners. Advantech has customers worldwide, so customers can access their products or obtain service via Advantech's channel partners in various regions. In addition, solution partners could be hardware or software manufacturers, which can develop solutions individually or co-create them with Advantech. Finally, the WISE-PaaS alliance partners provide software products, uploaded to the platform and shared with the VIP members of WISE-PaaS.
(9) **Costs** of running the platform include several parts: labor cost, platform development and maintenance expense, marketing expense, advertisement cost, and leasing expense for possible hardware and space.

6.5 Successful Case of iFactory 4.0 Implementation

An air compressor converts mechanical energy into gas pressure energy by compressing air and thus has a wide range of industrial applications. For production lines, air compressors are an important power source, only second to electric power sources. However, once sold, air compressors are beyond the control of their producers because they are unaware the actual operation and idling conditions, energy consumption, temperature, pressure, gas usage, and other data known by the customer. Moreover, air compressor failure may cause shutdown of the entire production line, leading to a loss of production capacity. Thus, providing early warning regarding replacement parts is imperative to achieving the goal of preventive maintenance.

Tong Cheng, a well-established manufacturer of air compressors, has been marketing its products under the brand name SWAN for more than six decades (Tong Cheng 2011). With the rise of IoT and industry 4.0, Tong Cheng realized the need for active transformation. Data collection is the first step to realize the intelligent upgrade of air compressors. The company expects to eliminate the management bottleneck of the traditional air compressor use mode by following three aspects through IoT technology. First, the operating status of sold air compressor machines can be checked remotely at any time, including various measures, such as temperature and pressure readings, crop rate, and energy consumption. Second, if the machines fail, the producer will receive the information immediately and can take the initiative to notify their customers to check the vulnerable parts of the air compressors, including belts, bearings, oil, and filter elements. Those parts should be checked from time to time because they require replacement on a regular basis, but users often neglect it. Nonetheless, repairing broken compressors severely hinders the plant's productivity. Finally, based on the information of the status and service life of parts, preventive maintenance can thus be performed in a timely manner. This not only increases the production capacity of the factory but also extend the life of the air compressor. Therefore, based on Advantech's substantial experience in promoting IoT and WISE-PaaS cloud software and hardware solutions (Fig. 6.10) and optimism about the win–win synergy provided by the cooperation between the two companies, Tong Cheng, with the help of Advantech, began developing smart air compressors and related products in 2017.

In a smart air compressor, an external ADAM-6050 Ethernet I/O module is used for capturing data from the spiral of Tong Cheng high-end models. A signal line is then connected through RS485 to Advantech EIS-D210 edge intelligent server

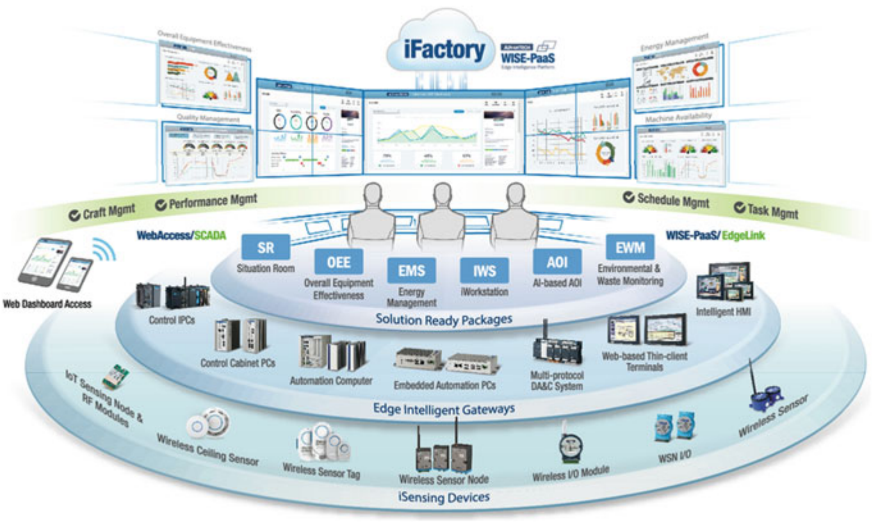

Fig. 6.10 iFactory SRP Architecture of Advantech

for capturing the machine operation information. Data are subsequently uploaded to Advantech's WISE-PaaS industrial IoT cloud platform for data collection, management, and analysis. WISE-PaaS/Dashboard, a cloud dashboard tool, is used to visualize air compressor data and present it on the terminal screen. The architecture is shown in Fig. 6.11. Through IoT, Advantech has realized remote monitoring of the operation of air compressors and provides innovative service models to estimate the time for replacing parts, which enhances the company's competitiveness with the help of industry 4.0.

On the basis of actual application requirements provided by Tong Cheng, the operation of the "Dashboard" functions smoothly. Through the display screen of the Dashboard, the staff can easily check the temperature, pressure, power consumption, and movement of each air compressor from the remote end. The utilization rates, preventive maintenance, pressure and another real-time status have enabled immediate event notifications and query functions, such as need of replacing consumables and display of historical data storage details. A dedicated monitoring system is established for air compressors. An air compressor is a high-energy consumption product. By detecting the power consumption information and optimizing the energy efficiency configuration, the energy-saving efficiency is improved more than 30%. Moreover, the system can proactively notify the parts replacement, which help Tong Cheng to be more confident in signing maintenance contracts with customers

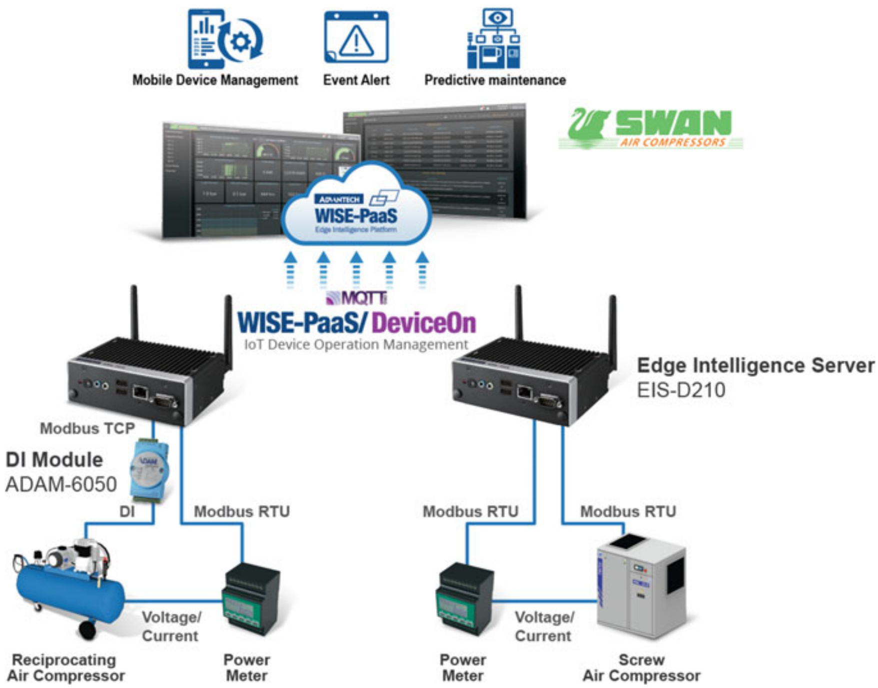

Fig. 6.11 Software and hardware solutions co-created by Tong Cheng and Advantech

and serving multiple customers in the same region. This not only improves operational efficiency but also enhances customer satisfaction. The system developed by Advantech is easy to install and highly reliable. Even if the customer has a non-Tong Cheng air compressor, the data can be collected through an external device, further enhancing the competitive advantage of the products and creating additional business opportunities.

Overall, the iFactory solution allows for real-time management, production optimization, and data-driven decision making. The major benefits that Tong Cheng customers gain include (1) 15.4% increase in the average production value per employee, (2) 8.5% increase in the energy utilization rate, (3) 43.8% reduction in the delivery cycle time, and (4) 13.8% reduction in the product defect rate—all indicating improved productivity, reduced loss, and increased profit.

6.6 Further Development

Urbanization, aging population, and excessive use of resources have caused many environmental problems (Tseng 2018). Governments of the developing and developed countries have invested a considerable amount of resources in exploring new technologies such as IoT to maintain sustainable development. IoT has been intensively applied to solve the aforementioned problems through effective environment monitoring. As an outcome, the concept of intelligence has been adopted in various managerial areas from smart manufacturing to smart city management. In fact, Taiwan also considers IoT as an essential and critical technology for economic and environmental development in the next 10 years, and it is included in "digital countries and smart islands," a national development plan for the 10-year developments in Taiwan (Executive Yuan 2016).

As IoT and cloud computing became pervasive, in 2010, Advantech proposed the concept of "Enabling an Intelligent Planet" as its vision. In addition to deepening the application area of existing products, Advantech adjusted its strategy. The major future direction of Advantech thus is the development of IoT-embedded solutions. Since 2013, the company has focused on pushing smart city oriented innovation and jointly building the paradigm of the IoT industry. Advantech thus gathered partners in the IoT industry to form an alliance, aiming at constructing an IoT ecosystem and triggering the aforementioned paradigm shift in Taiwan.

Advantech has proposed solutions for various areas, including smart healthcare, smart energy saving, smart transportation, smart retail, smart agriculture, and smart manufacturing. The proposed solutions have been adopted by some European and Asian countries as well as Australia and the United States. For instance, in the area of smart transportation, Advantech played a crucial role in the establishment of the YouBike and ETC systems in Taiwan, the smart buses in Brazil, the Qinghai–Tibet railway dispatch system in China, and the airport shuttle bus management system in Germany. In addition, Advantech's smart healthcare solution allows hospitals worldwide to build a more efficient care, diagnosis, and treatment environment.

Some salient examples include a registration system for hospitals in Taiwan, digital operating rooms in the top 10 teaching hospitals in the United States, a mobile drug delivery system in a hospital in the Netherlands, and a mobile nursing station in a hospital in Australia.

Advantech is also actively involved in numerous types of industrial cooperation to accelerate industrial ecological chain formation and promote smart cities, IoT, and industry 4.0, initiated by governments or non-government organizations. In addition, Advantech has transformed its manufacturing center into a demo site for Industry 4.0 and smart-based factory. At this site, Advantech demonstrates how IoT techniques and sensors can be used for data collection and how the data can be used to improve production efficiency, optimize production process, and assure production quality. By using the WISE-PaaS IoT cloud platform and visual display in the industry 4.0 situation room, managers can monitor smart factories continually. Advantech is more than willing to share its successful experience in industry 4.0 with others. Advantech has facilitated many manufacturers in accelerating the implementation of smart factories with the WISE-PaaS IoT cloud platform and smart factory software–hardware integration solution (i.e., SRP). These manufacturers include leading Taiwanese companies such as Sinosteel, Hongyuan Textiles, Qinglu Shoes, and Xinxing Electronics, and other domestic leading companies that have successfully transformed their plant operations into Industry 4.0. In order to accelerate IoT industry chain formation, Advantech has adopted a co-creation strategy to build complete vertical domain solutions. Advantech has collaborated with IoT industry DFSIs, including Yongjin Machinery and Nippon-RAD, to accelerate the realization process to meet the demands of the industry 4.0 market. To echo Taiwan government's call for the development of the "five plus two[3]" industrial innovation program, with the support of the Industrial Bureau, Advantech built the PCB A-team smart manufacturer alliance to boost the promotion of industry 4.0. This team includes the Industrial Research Institute, Institute of Information Technology, Dingxin Computer, Xinxing Electronics, Jingpeng Industry, Yaohua Electronics, and Xunde Machinery.

In the recent years, Advantech has also joined several IoT-related official and unofficial organizations such as Taiwan Cloud IoT Industry Association, Asia Silicon Grain Connectivity Industry Alliance, and Taiwan Automotive Internet Industry Association. Advantech is an initiating member of Aviation City Industry Alliance and formed industry alliances with industry leaders to jointly promote IoT and smart cities. In addition, Advantech participates in multiple IoT platforms and technical standards associations to accelerate IoT development and implementation in various industries.

[3]Taiwan government's "five plus two" industrial innovation program covers seven industries and projects: intelligent machinery, Asia Silicon Valley, green energy, biomedicine, national defense and aerospace, new agriculture and the circular economy ("Five plus two" innovative industries plan 2018). The focus on these areas is expected to move Taiwan forward from contract manufacturing to a new commercial model centered on high value–added business, services, and solutions. This shift will stimulate innovation, boost the competitiveness of industry and increase corporate profitability, all the while raising wages, creating jobs, and bringing more balanced development to all regions of Taiwan.

At the service-IoT conference hosted by Advantech in 2020, M.C. Chiang, the vice president of service-IoT group indicated, "Advantech benefits from the foundation and strength of the software and hardware developed for industrial-, embedded-, and service-IoT groups. Advantech's WISE-PaaS 4.0 architecture is the best platform for developing, promoting, and realizing solutions for IoT. Therefore, looking forward, Advantech will strategically focus on growing the service-IoT industry ecosystem and Smart Service Solution Franchise Ecosystem for vertical markets such as retail, hospitality, logistics, healthcare, and the smart city."

The business development of WISE-PaaS 4.0 construction includes two major parts: (1) building a smart service solution franchise ecosystem and (2) decoupling, reconstructing, and co-creation of smart service-IoT solutions. For Building a Smart Service Solution Franchise Ecosystem, Advantech focuses on three strategies to develop smart service-IoT: using the WISE-PaaS IoT cloud platform; providing vertical industry solutions with DFSI Solution Franchise Program; and incubating new DFSIs for healthcare, retail, and logistics. For decoupling, reconstructing, and co-creating of smart service-IoT solutions, Advantech focuses on deconstructing the fundamental platform structure and service procedure, restructuring industrial development with industrial apps and shared APIs, and co-creating a service-IoT industrial ecosystem.

(1) **Short-term goal**

Based on the A to A+ concept, Advantech focuses on developing AIoT technologies and cultivating the AIoT ecosystem. On the basis of the Regional Advisory Board, Advantech attempts to comprehend the organization governance and expand the brand, products, service, organization, and culture worldwide.

(2) **Mid-term goal**

Advantech, both the business and the cultural and educational foundation, aims to give back to the society tangibly and intangibly. Advantech attempts to create a platform which allows employees, customers, and other stakeholders to co-create a wonderful life. This goal, driven by its core capabilities, is based on the balance of all stakeholders.

(3) **Long-term goal**

Advantech aims to build sustainability through altruism and root deep with effective governance and balance among stakeholders. Advantech aims at solving the global societal problems using an altruistic mindset and AIoT.

6.7 Analysis of Business Innovation with New Information and Communication Technologies

We analyze the business innovation with new ICTs in Advantech's business as follows.

(1) **What are human desires and issues in the human society or business as well as the objectives of using ICT for business? (needs)**

The objectives of using ICT for business are increasing productivity and performance and providing value to customers. In this way, customers of Advantech can obtain AIoT solutions including hardware and software quickly and comprehensively.

(2) **What technologies and functions are used to solve issues or realize human desires? (technologies)**

Advantech built WISE-PaaS to serve hardware manufacturers, software developers, SIs, and organizations seeking to adopt AIoT. WISE- Marketplace can help customers find suitable solutions for AIoT implementation and aid hardware manufacturers and software developers in providing their products to customers.

(3) **What are value creation methodologies? (value creation)**

Here, value creation is performed by constructing a marketplace from which various stakeholders can benefit. For instance, SIs can co-create values with business customers and other SIs, customers can find better solutions, and other software and hardware partners can generate profits.

(4) **What are the relationship of human and business (including employee, organizational culture, and leadership) activities with ICT system and that among users, ICT providers, and other stakeholders (collaboration)? (human and business activities)**

The relationship among Advantech, business customers, hardware and software producers, and SIs is interdependent on WISE-PaaS. For the end customers, with effective AIoT-based solution, business in various industries can better understand and monitor the manufacturing or service providing process. The end customers can also find needed apps on the platform and optimize their systems and production process. For Advantech, the platform enables a better collaboration with SIs and other software providers and offers more comprehensive services without compromising each other's benefits.

(5) **How has human life, business, or society changed? (innovation)**

Through the WISE-PaaS platform, customers can have a domain-specific ready solution, which accelerates AIoT-based solution implementation. The solutions generated by the SI through platform allows customers to improve their manufacturing or service provisioning, and inspire other SIs in their future solutions. Consequently, productivity is increased and energy is saved. An intelligent planet with longer sustainability can then be built.

6.8 Conclusion

In this chapter, we introduce Advantech, an industrial PC manufacturer who constructed a cloud-based platform and transformed itself from a product producer to an AIoT-oriented cloud service provider. This cloud-based platform provides different solutions to customers directly and allows Advantech to co-create value with domain focused solution integrators and other stakeholders to provide better services to their customers. In contrast to the previous version and in addition to general software services, the current version of the platform provides industry-specific solutions given the significant differences among industries. The platform also allows end customers and SIs to select the needed apps and customize these modules on the basis of their needs, and upload and reuse the updated apps. The goal of Advantech is to build an intelligent planet. The plan of reaching this goal is to build a platform that enables the construction of the ecosystem for various AIoT stakeholders. Such an ecosystem allows for value co-creation among the different types of participants, all of whom aim to achieve the aforementioned goal without negatively affecting anyone's benefit.

References

Advantech Co. Ltd (2018) Advantech annual report 2018. Retrieved 23 Mar 2020, from https://advcloudfiles.advantech.com/investor/Shareholder-Annual-Report/108/1.pdf

Bettencourt L, Ulwick AW (2015, July 16). The customer-centered innovation map. Retrieved from https://hbr.org/2008/05/the-customer-centered-innovation-map

Donath S (2020) Deconstructing smart city IoT, ETMM. Retrieved 26 Mar 2020, from www.etmm-online.com/deconstructing-smart-city-iot-a-897757/

Executive Yan, Digital country, The development plan of innovative economics. (2016, December 20). 數位國家·創新經濟發展方案 (DIGI). Retrieved March 26, 2020. https://www.ey.gov.tw/Page/5A8A0CB5B41DA11E/f4d3319a-e2d7-4a8b-8b55-26c936804b5b

"'Five Plus Two' Innovative Industries Plan" (Executive Yuan, R.O.C. (Taiwan)-Major Policies Detail), Department of Information Services, Executive Yuan, 30 Mar. 2018. https://english.ey.gov.tw/News3/9E5540D592A5FECD/c9e63678-1c18-4674-b35f-298f9ba7a2bd

Global ICT Spending—Forecast 2018-2022 (n.d.) Retrieved 23 Mar 2020, from https://www.idc.com/promo/global-ict-spending/forecast

iFactory (n.d.) Retrieved 23 Mar 2020, from https://www.advantech.com/solutions/ifactory

Interbrand JZ (2018) Interbrand releases 2018 best Taiwan global brands—newsroom. Retrieved 23 Mar 2020, from https://www.interbrand.com/newsroom/interbrand-releases-2018-best-taiwan-global-brands/

Kramer S (2019) SAS and the artificial intelligence of things, Retrieved 26 Mar 2020, from futurumresearch.com/sas-and-the-artificial-intelligence-of-things/

Lusch R, Vargo S (2006) Service dominant logic: reactions, reflections, and refinements. Mark Theory 6(3):281–288

Ramaswamy V, Ozcan K (2018) What is co-creation? An interactional creation framework and its implications for value creation. J Bus Res 84:196–205
Tong Cheng Iron Works Co., Ltd. (2011) Swan air compressors. Retrieved March 26, 2020, http://www.swanair.com.tw/english/06_about/02_detail.aspx?pid=1
Tseng E (2018) An urban evolution. Retrieved 26 Mar 2020, from https://www.taiwan-panorama.com/Articles/Details?Guid=baffe490-5636-4adc-bce1-2625a5195c19&CatId=9

Chapter 7
Realizing Digital Transformation in Retail Businesses with a Digital Technology Platform and Solutions: A Case Study of NEXTTAO

Hua Wang

Abstract Chinese consumers are highly digitalized, thanks to the quick development of Internet business. China's traditional retail companies have felt the great urgency for digital business transformation because retailing business needs to satisfy the digitalized consumers every day across all traditional and digital channels. However, China's traditional retail companies encounter difficulties (for example, fragmented data, process-based back-end legacy system and increasing number of front-end retail applications) for digital transformation. NEXTTAO is a leading digital technology platform and digital solutions provider emerging from China in the recent years. It innovatively solves the traditional companies' dilemma by proposing a new concept of unified digital technology platform, through which the traditional companies can preserve their legacy assets as well as enjoy the benefit of digital technologies. NEXTTAO also provides multiple digital solutions such as mobile POS, promotion management, inventory optimization etc. In this chapter, we will illustrate how NEXTTAO practices their methodologies and digital technology to realize business values with their clients collaboratively.

7.1 Introduction

Digital technologies and businesses have already made great impacts on everyone's daily lives. We can use ride-hailing/sharing services such as Uber/Didi to grab a cab, pass identity checks at the airport via face recognition, and order online and pick up at nearby brick-and-mortar stores. Accordingly, digital technologies are also continuously reshaping business models and technology architectures on the corporate side. There is also no doubt that digital initiatives are top priorities for corporate Chief Information Officers ("CIO"s).

Some digital born companies have already enjoyed enormous growth by leveraging their advantages of huge user bases and data technologies such as AI and

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IoT. Traditional companies are also eager to catch up with the digitalization trends to further grow their businesses and cope with the highly digitalized customers. However, traditional companies face great difficulties when making this transformation. Unexpectedly, the millions of dollars of previous investments on legacy IT systems, such as ERP and CRM, and other traditional business assets become barriers to successful transformation. Therefore, how can we drive the transformation towards the digital age without wasting prior investments? You may find an answer in this chapter.

NEXTTAO is a leading digital technology platform and digital solutions provider emerging from China in recent years. It innovatively solves traditional companies' dilemmas by proposing a new concept of a unified digital technology platform through which traditional companies can preserve their legacy assets and enjoy the benefits of digital technologies. NEXTTAO also provides multiple digital solutions such as mobile POS, promotion management, inventory optimization, etc. so that their clients can better receive the tangible business values of the digital platform. NEXTTAO is confident that the adoption of such a digital technology platform and solutions will be a necessary decision for medium and large traditional companies in the near future.

NEXTTAO was established in late 2014 in Shanghai, the economic center of China. Its core team is composed of a group of technical veterans and industry experts, which enables them to serve as a high-level ICT partner to corporate CIOs via an in-depth understanding of CIOs' urgency and problems. NEXTTAO believes that digital business transformation means building a digital business and ecosystem supported by real-time data-driven insights to deliver a unified consumer experience at anytime and anywhere. NEXTTAO currently focuses on the retail industry since the industry is data-abundant with massive customer interactions every day. Its selected clients include some of the world's well-known brands, such as Starbucks China, BestSeller, Peacebird, and Amore Pacific.

We will introduce NEXTTAO's digital technology platform and its data technologies in detail, as well as its digital transformation methodologies derived from its hands-on working experiences with its clients. Then, we will share one case study to illustrate how NEXTTAO practices their methodologies and digital technology to collaboratively realize business values with their clients.

7.2 Background of NEXTTAO's Business

7.2.1 Digital Business Landscape

1. **Worldwide digital landscape**

Digital technology and business have been a world trend for several years. They have begun to change every individual's lifestyle. For example, you may have used or seen electronic payments, ride-hailing/sharing services, omni-channel shopping and pick-up services, and face recognition applications. Every enterprise is also pushed to redefine its business model and technology architecture to satisfy customers' digital experience. Since digital business is reshaping all industries, the digital business transformation capability has been integrated into all aspects of an enterprise's operations and is the new core competitiveness of an enterprise.

Gartner, the world's leading technology research and advisory company, conducted a 2019 CIO Agenda survey to collect feedback from 3,102 CIO respondents in 89 countries and across a broad range of industries, representing $15 trillion in revenue and public-sector budgets and $284 billion in IT spending. According to that survey, all industries have digital initiatives among their top-three-ranked priorities, as measured by the frequency that they are mentioned by respondents. Moreover, the CIOs of seven industries, including telecommunications, retail, and banking, put digital business at the top of their priorities (Fig. 7.1).

2. **China's digital landscape**

China has a very favorable digital foundation. It has the world's most mobile Internet users, which reached 817 million in 2018, representing 8% of the YoY growth rate. China also has the highest mobile payment penetration rate among the world.

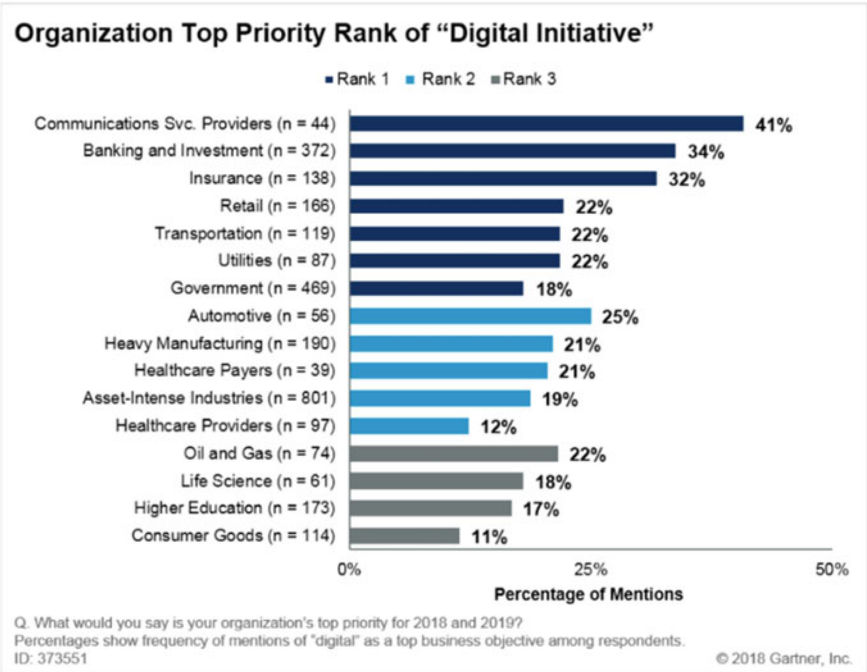

Fig. 7.1 Business priority ranking of digital initiatives. *Source* Lowendahl (2019) at Gartner 2019 CIO agenda

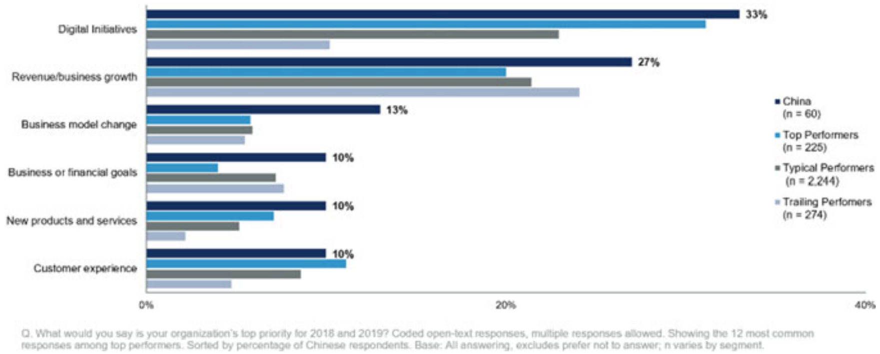

Fig. 7.2 Top priorities for 2018 and 2019 for Chinese CIOs—percentage of respondents. *Source* Chen and Li (2019) at Gartner 2019 CIO agenda

There is no doubt that China has become the world largest digital experiment arena, largely thanks to Chinese digital giants like Tencent's (0700.HK) and Alibaba's (baba.US and 09988.HK) investments in the mobile Internet and payments, such as WeChat pay and Alipay. In addition, phenomenal Chinese digital-born startups, such as DiDi (world's leading ride-hailing service startup), Xiaomi (01810.HK, mobile phone and IoT device manufacturer and service provider), Meituan (03690.HK, food delivery and promotion services), Byte-dance (content and short-form video platform), etc., have creatively invented lots of digital business settings, which have greatly accelerated the development of China's digital business.

Chinese CIOs could be the most anxious ones because Chinese enterprises are rapidly entering a digital maturation phase driven by the highly digitized Chinese customers. Chinese CEOs rank digital business as the No. 1 business priority according to the Gartner survey of Chinese CIOs in 2019 (Fig. 7.2).

7.2.2 *Challenges of Retail Business in China*

The CIOs of China's traditional retail companies have felt the great urgency for digital business transformation because the retail business needs to interact with digitalized consumers every day across all traditional and digital channels. These CIOs encounter the following typical difficulties for digital transformation.

1. The companies have accumulated large amounts of data through many years of business operations. However, the companies cannot even determine the full user profile because the data across channels are quite messy and isolated.
2. The new customer-facing front-end retail applications, such as WeChat mini-programs, third-party online store applications, and live-streaming shopping solutions, have quickly entered the market one after another. Chinese retail

companies are usually not capable enough to self-develop various front-end applications to ride the wave. The increasing number of front-end applications also brings more fragmented data and makes companies' IT system structures more complicated.
3. Front-end retail applications require real-time data for business decision-making, which is not supported by the process-based back-end legacy systems, such as old ERPs.
4. The traditional in-store applications, such as POS (point-of-sales), as its name implies, are mainly designed to record sales transactions. However, the shopping applications lack a powerful digital-based in-store solution to better serve and retain customers, which will enhance customers' overall experiences and increase sales revenues in return. What they need in the digital world is Point of Services, a new generation POS.

In particular, the legacy systems and the insufficient capability to develop digital solutions significantly limit these traditional retail companies' digital business transformation plans. Traditional retail companies have already invested millions of dollars and lots of efforts to build legacy IT systems, such as ERP, WMS, and CRM; and have accumulated valuable business models and supply-chain and organization management processes. They cannot afford the costs and business risks that result from completely abandoning the legacy systems and building new digital systems from scratch. If they do so, such drastic changes would make all the previous IT investments in vain and jeopardize all existing business operations. Moreover, legacy systems still contain valuable core functions and data that are essential for digital business initiatives.

7.2.3 NEXTTAO's Business Target

NEXTTAO is a leading digital technology platform and solutions provider based in Shanghai, focusing on the retail industry for now. With a deep understanding of the industry's problems and business requirements from over one hundred of China's retail companies, NEXTTAO develops a cutting-edge digital technology platform and a set of digital solutions, such as mobile POS, promotion management, and inventory optimization, to help traditional retail companies carry out progressive digital business transformations and innovations while leaving their legacy systems intact. NEXTTAO has successfully implemented its technology platform and applications in quite a few Chinese and globally well-known brands including Starbucks China, BESTSELLER, Peacebird, and Amore Pacific. NEXTTAO also believes that the adoption of its digital technology platform and solutions is a necessary decision for medium and large enterprises in the future. We will elaborate on NEXTTAO's digital technology platform and digital-based solutions in the following sections.

7.3 NEXTTAO's Digital Technology Platform and Solutions

7.3.1 Digital Technology Platform

With the development of digital technologies, retail has adopted increasingly more cross-channels to meet consumers' demands. A traditional IT system is set up based on its predefined functionality, which makes business processes and data flows fragmented and limits a company's business innovation. For the sake of a unified consumer retail experience, it is necessary to consolidate orders, products and inventory so as to smoothly combine online to offline business, and make it possible for consumers to shop anytime and anywhere in any channel and for anything. (Fig. 7.3).

To help retail companies realize unified retail commerce, NEXTTAO develops its own digital technology platform and solutions and integrates them with legacy systems, front-end applications and third-party applications/solutions using APIs (Fig. 7.4). Collectively, each module is essential for an integrated digital business ecosystem for each enterprise to realize its digital ambition. In addition, the components of each module can also be progressively added with great flexibility and dynamics following the roadmap of the company's digital transformation planning and status. For example, we can build just a customer center in DataForce at first and add other centers later on. Another example is that we can roll out digital solutions one by one. We deploy the solutions on Azure first and then on AWS later on.

1. NEXTTAO's **Digital technology platform**, which is named **DataForce**, can integrate with all other modules with APIs. It acts as the brain of whole digital ecosystem, which contains unified data, various business centers and data centers, and algorithms for real-time digital intelligence. It also serves as the hub to share

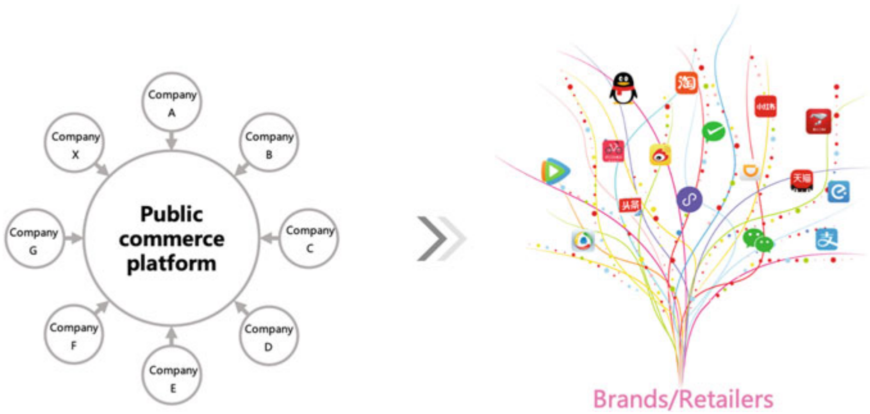

Fig. 7.3 From "Public commerce platform centered" to "Brand/Retailer centered"; Unified Consumer Experiences. *Source* NEXTTAO

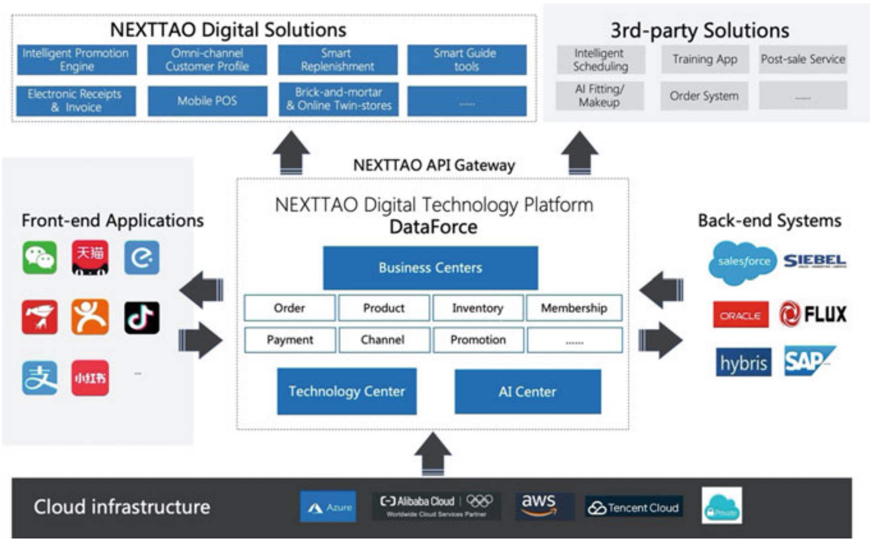

Fig. 7.4 The integral architecture of NEXTTAO's digital technology platform. *Source* NEXTTAO

integrated business capabilities, services and data for external and internal usage among front-end applications and back-end systems.

2. **Front-end applications** refer to various customer-facing applications, especially Internet applications, such as WeChat, Amazon, Tiktok, Alipay, etc.
3. **Back-end systems** refer to traditional IT systems, such as ERP, CRM, HCM, etc.
4. NEXTTAO's **own digital solution** refers to the retail solutions developed by NEXTTAO itself using DataForce.
5. **Third-party solutions** refer to the retail solutions developed by the retail companies themselves or ISV vendors other than NEXTTAO. NEXTTAO's DataForce can serve as an application PaaS platform for those solutions.
6. **The technology center** is a technical layer for the data applications given above. Derived from the industry standard Service Mesh architecture, the technology center here provides full life-cycle management and multi-dimension application/service monitoring for building high-performance and stable services from design-time to run-time. Besides, it also has the built-in capabilities of data replication, hot and cold data governance and holistic data storage, which are fundamental to building every data application. To embrace the eco-system, the technology center is by design programming language independent, organization independent and cloud infrastructure independent. With these capabilities, the ISV partners with different technology stacks can be meshed with each other smoothly to rapidly satisfy the business requirements.
7. **AI center**: After all the data are real-time streamed from front-end applications and back-end systems, DataForce is then capable of leveraging modern AI

algorithms to provide actionable intelligence for retailers. With these business-oriented AI capabilities built into DataForce, NEXTTAO can enable the retailers to practically realize AI's power, such as omni-channel inventory forecasting, dynamic pricing, shopping cart recommendations and eventually supply chain optimization, which has been desired for decades by all companies. As a platform, DataForce is able to adopt new AI capabilities provided by 3rd party vendors, which is ideal for the companies.

8. **The cloud infrastructure** refers to the infrastructure that is used to deploy DataForce and digital solutions, including public clouds such as AWS, Azure, Ali cloud, Tencent cloud, and private clouds implemented for the retail company. This infrastructure is essential to the overall success of digital transformation. A solution that can tackle the fast-evolving business challenges demands a highly elastic computing infrastructure and unprecedentedly open connectivity.

A typical deployment of NEXTTAO DataForce usually consists of the following business centers:

1. **Order Center**: Unify omni-channel orders to enable a retail store to perform sourcing and manage orders from all channels;
2. **Product Center**: Manage online and offline products, including size, attributes, categories, barcodes, prices, sellable status, etc.;
3. **Inventory Center**: Enable retailers to perform smart allocation and replenishment and eliminate insufficient or excessive inventory to maximize inventory value;
4. **Membership Center**: Unify online and offline membership privileges and services and enable precision marketing;
5. **Payment Center**: Unify all retail payment methods, including WeChat pay, Alipay, Union Pay, pre-pay cards, cash, etc.;
6. **Channel Center**: Centralize all online and offline sales and service channels, including store management, POS management, and KPI management; and
7. **Promotion Center**: Unify prices and promotional strategies across all channels, and ensure a consistent consumer experience from all channels.

NEXTTAO also provides a set of digital solutions that run on DataForce. Typical digital solutions deployed are as following:

1. **Intelligent Promotion Engine**: Unify promotional rules, promotional preferences and customer rights so to provide real-time customer verification, promotional rule decisions, and optimal strategy recommendations for online and offline orders and improve the operating efficiency and promotional experience;
2. **Omni-channel Customer Profile** : Unify customer data, rights, and points across multiple brands and channels so as to build a "customer central bank" for intelligent omni-channel marketing and an interactive customer management platform;
3. **Mobile POS**: Provide data-intelligence based mobile applications for stores, help stores to obtain precise customer insights, and refresh the customers' in-store

shopping experience with outstanding services and appropriate recommendations; and

4. **Smart guide tools**: Build real-time and data intelligent shopping guide applications for brands integrated with the WeChat and WeChat@work platform, and enable the in-store workforce to provide 24-h non-stop online service to improve its repurchase rate and operating efficiency.

7.3.2 NEXTTAO's Methodologies for Digital Transformation in Retail Business

NEXTTAO thinks that digital business has significant differences from traditional business, as shown in Fig. 7.5. Therefore, CIOs in the digital world shall have not only in-depth knowledge of digital technologies and solutions, but also the comprehensive understanding of business requirements and the ability to focus on business outcomes. Adopting any digital technology or solution presents great challenges to CIOs and traditional ICT vendors.

Digital transformation is not done just to conduct online business, but also to implement all business online through continuous digital business and an eco-system supported by real-time and data-driven operations to satisfy customers' unified experience at anytime and anywhere. We suggest that CIOs and ICT vendors shall contemplate digital technologies and solutions with business outcomes as a whole by using the following methodologies.

		Traditional IT solution	Digital solution
1	Decision-making basis	Process management and individual experience	Real-time data analysis
2	Key focus	IT Product focus	Customer centered
3	Solution users	Few operating personnel and managers	All company employees
4	Technology/solution development process	Project base and waterfall development process	MVP (Minimum Viable Product) and agile development process
5	System openness	Relatively closed system	Eco-system mindset and open APIs
6	Scalability	Usually scalable through hardware upgrade	Cloud-native elastic architecture

Fig. 7.5 Differences between traditional IT solutions and digital solutions. *Source* NEXTTAO

1. **Think strategically**. Digital business transformation is a holistic corporate-level strategy including a company's middle-to-long term business strategy, IT architecture upgrade, and operational and organizational changes. The successful digital business transformation cases we have seen without exception are all top-down approaches with C-level executives and dedicated digital teams that coordinate corporate resources and push transformation to happen with their best efforts. Only the roles across multiple business lines can often reflect on the re-use of corporate-level capabilities and the design of corporate-level digital architectures. The CIO and ICT vendors shall have comprehensive understandings of the company's digital business ambition and strategy before getting their hands dirty building any digital technology and solutions. ICT vendors also need to equip themselves with business knowledge beyond IT skillsets so that they can deeply engage with senior managers across multiple business lines.
2. **Start with small solutions for the minimum function of the digital technology platform**. The digital transformation process should be progressive and agile since a traditional company is neither prepared nor ready for the complete replacement of existing IT technology and business models. Contrary to the project-based traditional IT total solution development, it is suggested that one MVP (Minimum Viable Product) digital solution be selected as a pilot (Fig. 7.6). The minimum function of the digital technology platform also needs to be installed to ensure the scalability of more digital solutions in the future. By doing so, the traditional company can have a certain digital business rolling out quickly and the company's line of business and IT department can begin to collaborate with each other. Once the MVP receives tangible positive results, the company will gain more confidence and capabilities to roll out more digital solutions on the

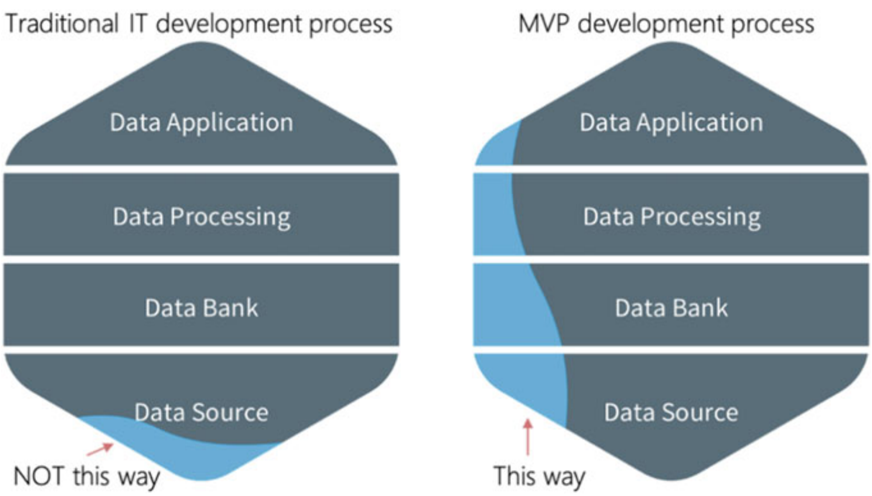

Fig. 7.6 Comparison of a traditional IT solution with the MVP development process. *Source* NEXTTAO

digital technology platform. Such an approach can allow businesses to quickly enjoy the digital benefits without affecting the existing business to the greatest extent.

3. **Set a product roadmap with priorities**. When designing the product roadmap of the digital business transformation, we often feel that there are lots of projects in the pipeline that easily lose focus. NEXTTAO suggests setting project priorities by using some criteria mutually agreed upon with clients. Those common criteria could be (a) business urgency, (b) investment return, (c) transformation complexity, etc. In real cases, most of the traditional companies start their digital transformation projects with customer side solutions, such as digital POS, omni-channel CRM, marketing promotions, and smart shopping guides, which could directly increase revenues and improve customer experiences. We observed that some leading traditional companies began to use digital solutions to enhance their internal operating efficiency, such as through inventory optimization and post-sale service. We further believe that the digital transformation will occur across all supply chain companies in the future, such as agile supply chain collaboration and B2B financing.
4. **Focus on the business result and not technical excellence**. We do not mean to ignore the importance of technology. However, based on NEXTTAO's experience, digital transformation is a very complicated process that requires CIOs and ICT vendors to have excellent capabilities to orchestrate the technology and business values. A common mistake of ICT vendors is that they develop an innovative digital technology but fail to covey it into a meaningful business value to clients. When NEXTTAO meets clients to establish project requirements, it will first ask "what the expected business outcome and operation model?" We believe that a business-driven approach will help NEXTTAO become a reliable high-level digital contributor and assist C-level executives to fulfill their digital transformation blueprints.
5. **Reinforce a customer-centric mindset**. The customer experience is vital in digital business. We can design different digital solutions by tracing the customer life cycle. In a typical consumer journey, how can we turn a potential customer with interest into a brand lover? The IoT technology would provide the measures to increase the attractiveness, and then AI helps to recommend a favorable product at the consumer's convenience. It occurs all along the entire consumer journey (Figs. 7.7 and 7.8).
6. **Consider the eco-system and application as Platform-as-a-Service from Day One**. The digital business transformation process is a long-term journey. Moreover, enterprises usually have multiple vendors for different projects using different programming languages. Based on those situations, NEXTTAO builds its digital technology platform and opens APIs so that all of an enterprise's vendors can benefit from the shared business capabilities, unified data structure and eco-system environment to develop their own applications quickly. It will provide great convenience for an enterprise to manage its vendors on a unified platform and with a unified technical standard.

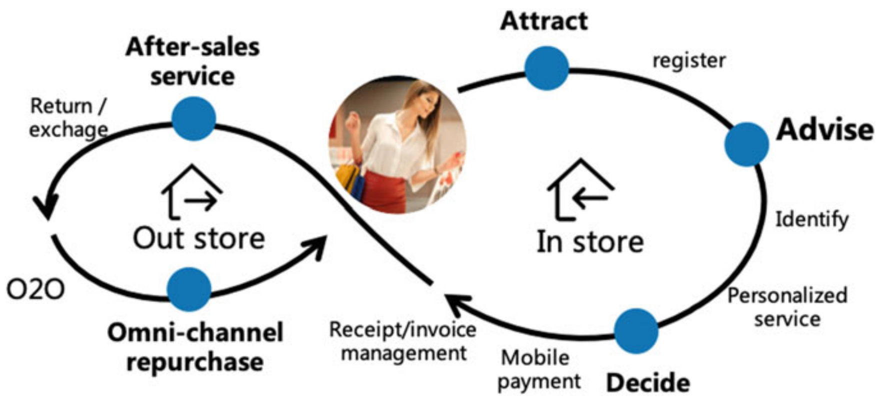

Fig. 7.7 Personalized customer-centric services throughout the customer lifecycle. *Source* NEXTTAO

Fig. 7.8 Digital shopping experience built on new technologies, e.g., AI. *Source* The Internet

7.4 Case—Peacebird Fashion

7.4.1 Introduction of Peacebird Company and Its Digital Business Needs/Problems

Ningbo Peacebird Fashion Co., Ltd. ("Peacebird") is a top China-based consumer-centric fashion brand retailer. The main products of the company include women's, men's and children's clothing. With the mission of "Let Everyone Enjoy the Fun of Fashion", Peacebird aims to be the leading fashion brand for Chinese youth.

As a forerunner of the "Omni-Channel" strategy, Peacebird has been devoting great efforts to both offline and online operations. In 2018, Peacebird generated total annual retail revenue of RMB7.7 bn (USD1.1 bn) and had 4594 brick-and-mortar stores in China (Figs. 7.9 and 7.10).

"Where is the next generation of consumers, we will go there." This was said by Mr. Chen Hongchao, CEO of Peacebird. Focusing on the fashion industry, Peacebird strives to satisfy the increasingly diversified young consumers' fashion and

Fig. 7.9 Peacebird Fashion Show in New York

personalization needs. It has always put the enhancement of the customer experience of consumers as its top priority. However, in the digital retail era, Peacebird has faced increasingly prominent challenges in various areas, such as data unification, omni-channel goods' management, store operations and digital member services.

1. **Data unification:** Peacebird's customer/inventory data in the online and offline channels were scattered in different systems, which were not combined or integrated. Therefore, it was impossible to acquire real-time data to support the front-line data-driven business or quickly launch new digital scenarios such as intelligent fitting rooms, personalized clothing recommendations, etc.
2. **Omni-channel goods' management** : The best-selling goods were out of stock in stores, and the unsold stock piled up. The lack of a data and replenishment model made Peacebird unable to accurately predict the base stock level of each store or conduct efficient and good distribution, replenishment or transfer.
3. **Store operations**: Brick-and-Mortar stores are the main touchpoints directly facing consumers. Peacebird thinks the stores should be transformed into customers' personal exclusive beauty and fashion cloakrooms by providing

Fig. 7.10 Peacebird store

customers with the most intelligent experience and personalized clothing service. Achieving such a goal needs the support of a digital system.

4. **Member services**: Although Peacebird has accumulated a large amount of customer data, it could not achieve refined management and marketing for multi brand and multi-channel members due to the lack of unified customer assets.

7.4.2 NEXTTAO Solutions for Peacebird

To face such great changes and challenges, Peacebird refused to hide in its ivory tower and ignore the world. Starting in 2016, Peacebird partnered with NEXTTAO to deploy its digital technology platform and digital solutions. With continuous dedication, today, Peacebird is acknowledged as one the most innovative Chinese brands that embraces change and digital retail, and has successfully achieved its initial digital transformation. Peacebird's customer repurchase rate has increased by 5%, and the store inventory turnover rate increased by 20% (Fig. 7.11).

NEXTTAO kept communicating with Peacebird to fully understand its problem points and obstacles to digital transformation, and they designed the transformation roadmap together with Peacebird executives, business managers and the IT department. NEXTTAO first helped Peacebird to reform its IT system architecture using the digital technology platform described above. NEXTTAO's DataForce integrated

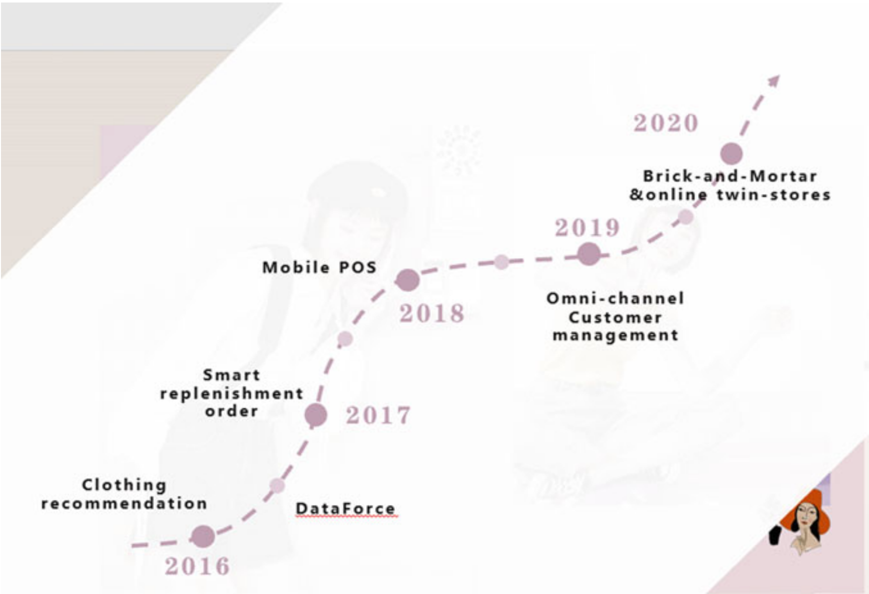

Fig. 7.11 Peacebird's digital platform and solutions roadmap provided by NEXTTAO

approximately 10 systems, including ERP, DRP, finance, SCRM, etc., and developed various core business centers, including the order center, goods center, inventory center, membership center, payment center, channel center, promotion center, etc. In addition to providing a strong technical platform capability for Peacebird, NEXTTAO also helped Peacebird build multiple digital solutions, e.g., mobile POS, face recognition, a smart guide tool, and intelligent distribution and replenishment, to realize is digital transformation capabilities.

In 2019, NEXTTAO helped Peacebird launch an in-depth Member Management project, which provides Peacebird members with "personalized" and "high-quality" fashionable clothing recommendations to improve its sales revenues. In order to achieve the goal of "personalization", NEXTTAO provided accurate member profiles to the in-store workforce by leveraging the capability of the member center in DataForce. This allowed the in-store workforce to accurately predict member preferences and recommend the most appropriate products to members. In order to achieve the goal of "high quality", NEXTTAO leveraged the capability of the product center and inventory center in DataForce to efficiently obtain product introduction materials and inventory status to more effectively improve members' purchase conversion rates.

The outbreak of the coronavirus epidemic in 2020 has had enormous impacts on retail companies including Peacebird. More than 90% of Peacebird's brick-and-mortar stores were closed in late January and Peacebird even prepared for a huge quarterly loss. Surprisingly, the digital capability accumulated over the past four years has played a vital role for Peacebird in this unprecedented situation.

Fig. 7.12 Empty shopping mall during the outbreak of the workforce coronavirus epidemic

With the capabilities provided by the NEXTTAO digital technology platform and digital solutions, Peacebird completed the switch of the sales model and business scenarios from brick-and-mortar stores to various online channels nearly overnight. With the help of the real-time omni-channel member profile, the twin-store solution, the WeChat store, the live-streaming shopping program and clothing recommendations, Peacebird's workforce effectively engaged homebound and bored customers and provided them with appropriate products through brand-new online shopping experiences. Peacebird's women clothing has recorded approximately RMB 8 million average daily revenues in omni-channel during the COVID-19 pandemic, with peak weekly total sales exceeding those of 2019 (Figs. 7.12 and 7.13).

7.4.3 Peacebird Case Study Summary

The Peacebird case gives us two takeaways. First, each enterprise shall begin to build digital capabilities with no hesitation. Traditional enterprises with larger data volumes and more offline legacy systems are suggested to consider the holistic digital business transformation roadmap and adopt digital technology platforms to assist the transformation. Second, digital transformation is more than just technological innovation. The digital transformation is bound to the innovation of business scenarios and the creation of business value. Surely business process scenarios in return will further polish the digital technology platform and inspire more digital solutions.

Fig. 7.13 Peacebird's live-streaming shopping program

7.5 Analysis

1. **What are the human desires, issues in human society or business, and the objective of the utilization of ICT? (needs)**

Digital business has become ubiquitous and it has begun to change everyone's lifestyles. Digital applications bring great convenience for people's daily lives.

They also create new business opportunities for each enterprise to better serve their customers, generate greater economic returns and enhance operating efficiency across the whole industry value chain. We believe that digital technology and solutions that utilize ICT can meet the genuine needs for each personal user, each enterprise and the whole society unanimously. We also see evidence of the urgency since digital transformation has been at the top of the agenda of CIOs globally.

2. **What technologies and functions are utilized in order to solve issues or realize human desires? What is the role of ICT in value creation? (technologies)**

Every customer likes to be treated with privilege and respect. For example, customers in China today are used to shopping anytime and anywhere. Actually, one of the peak times for online shopping is in the late night. However, they still expect the goods to be received next day within 24 h. Therefore, retailers must have the ability to fulfill orders automatically without human intervention. This requires the real-time orchestration of the systems including personalized recommendation (according to the consumers' preferences and privileges), dynamic pricing (according to the level of availability), real-time inventory (according to the location), transportation routing (to deliver within 24 h), etc. Regardless of how the complex computations are triggered, the consumer expects a response within seconds upon clicking in the App. This kind of consumer experience is only achievable through a well-designed digital retail platform as that we discussed above. The cloud-based business technology platform, DataForce, is designed to process vast amounts of data with high concurrent connectivity and a scalable landscape; therefore, it provides the real-time computing of business AI and coordinates the systems with real-time data. With that, customers can be happy shopping, and the retailers win customers' loyalty as well.

3. **What are the value creation methodologies? (value creation)**

What we pursue is not technology excellence itself, but how technology can better enhance business values. The digital technology platform and solutions unlock tremendous amounts of potential regarding data, the cloud, and artificial intelligence in every enterprise. For example, Peacebird adopts NEXTTAO's mobile POS App on DataForce to enable its in-store workforce to better serve customers and improve customer loyalty. It is also found that every enterprise can use digital technologies to increase its internal operational execution and collaborative efficiency across the industry value chain.

4. **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and the ICT system; and what is the relationship among users, ICT providers, and other stakeholders (Collaboration)? (human/business activities)**

With the support of the digital platform, an enterprise can conduct unified management for all ICT solutions, legacy systems, and Internet applications provided by digital giants to provide superior customer experiences via digital intelligence in an agile way. Therefore, a digital platform not only provides a technical solution for an enterprise, but it also helps the enterprise to build a proprietary eco-system to orchestrate all related partners to better serve customers with state-of-art ICT technologies. Digital business transformation will be an exciting and critical process for every enterprise and have a profound influence on human life and the business world.

5. **How have human life, business and society changed? (innovation)**

We are pleased to see that digital technologies are not a niche field of computer science in laboratories nowadays but are making their way into the real world to impact human life and society and create extensive business values. With the unified customer experience and data, the digital platform and solutions will bring more innovation business models and bring better lives to human beings and society. Digital business transformation in the retail industry is a compelling example of the "Democratization of technologies" to create values for each individual user, the workforce and business owners. In Peacebird's case, the digital transformation surely changed the in-store workforce's customer service model and efficiency. The in-store workforce is happy with the trendy tablet POS and increased sales revenues, and customers are happy with the more intimate services and satisfactory products.

7.6 Conclusion

We discussed digital transformation in a retail business with the digital technology platform and solutions and illustrated it with a real case study. It is found that digital transformation is an inevitable move for every retail company to meet customers' requirements and the concept of a digital technology platform will play an important role in it. Also, this transformation is very complicated due to technology platform/solution upgrades and business model renewal. When an enterprise selects the appropriate ICT vendor, it should evaluate the ICT vendor's capabilities in both technology and business understanding. Overall, we believe that the digital technology platform and solutions that NEXTTAO provides will create meaningful business values for each enterprise and greatly change human's lifestyles.

References

Chen O, Li C (2019) 2019 CIO agenda: a china perspective. Gartner 2019 CIO agenda
Lowendahl JM (2019) 2019 CIO agenda: industry insights overview. Gartner 2019 CIO agenda

Part III
Case Studies on Changes of Traditional Businesses and Services (Manufacturing, Agriculture, Transportation and Education)

Chapter 8
Readiness for Digital Innovation and Industry 4.0 Transformation: Studies on Manufacturing Industries in the City of Salisbury

Ke Xing, David H. Cropley, Michelle Leanne Oppert, and Chanvi Singh

Abstract City of Salisbury in South Australia has strong industrial footprint in the manufacturing sectors and sees Industry 4.0-inspired technology advancement and business innovation playing a defining role to reshape the industry structure of the region. This chapter is to present a systematic analysis on barriers and challenges faced by, capability and readiness of, as well as potential strategies for local manufacturing firms (most of which are SMEs) in City of Salisbury in adopting digital innovation toward Industry 4.0 transformation. Key factors analyzed span: (a) Business; (b) Technology; (c) Ills; (d) Supply Chain; (e) Innovation.

8.1 Introduction

The Australian manufacturing sector has been experiencing an increasing pace of transition driven by globalized trade, technological advancement, as well as volatile market demand and supply chains. Although the last two decades have seen a relative decline of manufacturing's share in overall employment, the sector remains a substantial and important generator of economic activity and jobs in Australia, accounting for 26.9% of annual export earnings, 5.7% of GDP, approximately one million employees, and the highest business expenditure on R&D over all industry sectors (AiGroup 2019). While Australia's manufacturing sector is disadvantaged by suffers from high labor costs, geographical remoteness and a relatively small domestic market, the comparative competitiveness of Australian manufacturers is

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dependent on whether and how they can effectively capitalize on the full potential of globalization, digitalization and the increased demand for more tailored and multifarious solutions (CSIRO Futures 2016). Key to achieving such success are efforts by manufacturing firms in engaging with digital technology for value creation through innovative product/service designs and with digital transformation for value capture through innovative business models. It is recognized by both governments and industry that the adoption of *Industry 4.0* within Australia has the potential to significantly improve the capability of Small-to-Medium Enterprises (SMEs) toward advanced manufacturing.

Industry 4.0 is a policy response that was launched by the German government in 2011 in recognition of the profound changes that digital technologies, AI and big data were having on manufacturing firms and the view that this impact would only intensify over time. It aims to drive a transformation of manufacturing through increasing digitalization and strengthening interrelations of products, value chains and business models. The fundamental objective of this initiative is to support the integration of cyber-physical systems (CPS), the Internet of Things (IoT), cloud computing, automation and artificial intelligence (AI), leading to the creation of smart factories.

As the initiative has matured and spread throughout the developed world, Industry 4.0 has become a foundation of digital innovation for the transformation of business models and product/service delivery, not only in the manufacturing sector, but also in the wider economic system. Known also as the *Industry Renaissance* in some countries, and by many other national initiatives (e.g. 'Manufacturing USA' in the United States), the digital transformation of industry is regarded by global business leaders as pre-requisite for improved productivity, improved efficiency, flexibility, agility, improved customer satisfaction, cost reductions, and improved innovation (Lee et al. 2015). Some of the key technologies of Industry 4.0 based on the literature are CPS, additive manufacturing, IoT, cloud computing, big data analytics, simulation and modelling, automation and Industrial Robots, augmented Reality, cybersecurity and several others (Ghobakhloo 2018). Automation in Industry 4.0 enables companies to offer new and better digital solutions to their customers, such as Internet-based services (Dalenogare et al. 2018).

For Australia, embracing digital transformation and innovation is essential for continued economic development, competitiveness and prosperity. Previous research has shown that Industry 4.0 can have an impact on political, economic, social, technical, environmental, and legal factors (e.g. Hecklau et al. 2016). Industry 4.0 represents a shift toward the innovation-oriented economy with knowledge, data and the IoT as its central components (Liao et al. 2017). Organizations are expected to modify business models for their innovation, allowing for a more interactive relationship between the firm and its clients, to better fulfil consumer needs (Ibarra et al. 2018; Morrar et al. 2017). Many companies have also begun to introduce new marketing interfaces and manufacturing processes to the customized needs of the clients who are willing to pay for customized features of their goods and services (Morrar et al. 2017). Whilst Industry 4.0 is expected to bring immense benefits, it also brings many challenges. The main challenge that most stakeholders are concerned with is the cybersecurity risk, given that the IoT is the backbone of Industry 4.0 (Ibarra et al. 2018). The rate of growth of this industrial revolution is exponential, making it difficult to foresee all the benefits, risks and challenges that may result. Current policies and regulations may become redundant due the speed of progress and growth of Industry 4.0, posing a threat to businesses and compelling firms to constantly update their policies and procedures. One of the social challenges of Industry 4.0 is likely to be the job losses resulting from widespread automation of large segments in many industries. While Industry 4.0 can also open the window for new opportunities that may appear in 'high-skilled' categories of employment, a question still remains as to whether these opportunities will meet the supply of labor (Morrar et al. 2017).

A focus on how Industry 4.0 can work for the Australian manufacturing industry is still limited in the extant body of literature. Although it is reasonable to expect that some local manufacturers may have started Industry 4.0-related innovation, mostly in relation to process automation and big data, little is known regarding the patterns, the extent, and the outcomes of their transformation. Furthermore, implementing Industry 4.0 will require coherent digital strategies and data-driven business approaches, flexible production and service provision, strong customization, and cognitive and intelligent support. Both opportunities and challenges associated with digital transformation faced by Australian manufacturing SMEs necessitate empirical studies to shed light on *what to do, how to do it, what hurdles to overcome, and what enabling mechanism need to be provided* for the transition towards Industry 4.0.

Having this in mind, the case study presented in this Chapter is to explore how manufacturers operating in a particular region, i.e. City of Salisbury, in the state of South Australia, consider Industry 4.0 and digital innovation. The investigation was designed to inform current knowledge and practices, identifying capability, readiness, barriers and challenges to the adoption of Industry 4.0 and digital innovation. The context of the case and the methodology of the study are explained in Sect. 8.2, followed by discussions on the results of Industry 4.0 awareness analysis (Sect. 8.3) and of digital innovation readiness assessment (Sect. 8.4). Then, the barriers and the recommendations for changes and actions are reported in Sect. 8.5. The chapter is concluded in Sect. 8.6 with suggestions for further studies.

8.2 Case Context and Methodology

Australia's manufacturing sector is overrepresented with the number of small firms. While most of them operate locally, many have the potential and capability to serve supply chains at the global scale. The manufacturing industry based in the City of Salisbury shares much the same characteristics. The City of Salisbury is a local government area situated on the northern outskirts of metropolitan Adelaide, the capital city of South Australia. It consists of 32 suburbs and covers an area of 158 km^2 (see Fig. 8.1).

Fig. 8.1 Google Map® of City of Salisbury

The region has a strong industrial footprint and a long-term strength in manufacturing. Despite a slight slip in recent years, the sector still represents 15.8% of total local employment (https://economy.id.com.au/salisbury/industry-sector-analysis). Although the City of Salisbury has a diverse industry base, it has been affected by long term structural changes in the Australian economy as well as cyclical downturns. The closure of a major car manufacturer in 2017 has led to the end of mass-production assembly line based automotive manufacturing. This led to multinational component manufacturers leaving the region, smaller firms scaling back or in the case of some recreating themselves. As an example, Salisbury's history and workforce skills in automotive manufacturing are now applied to bus making and the production of the Brabham BT62 supercar. However, the manufacturing sector as a whole remains the most significant contributor to the local economy but it is changing. Path dependency is a term in economics that describes the transition of local economies. Simply stated, the future of a local economy is based on today's skills, infrastructure and capability. City of Salisbury's traditional strengths in defence manufacturing are being applied to space and electronic warfare. Its tradition as a manufacturing region provides the workforce skills for health manufacturing firms to expand and locate. Also, being as the home of South Australia's largest food market forms the base to support the growing food manufacturing sector in the area. As such, transforming traditional manufacturing towards new advanced manufacturing processes is central to the future economic viability for the City of Salisbury. Industry 4.0-inspired technology advancement and business innovation will play a defining role to reshape the existing industry structure of the region and to transition its industrial base towards more value-adding goods and services over time.

For the manufacturing businesses in the City of Salisbury, exploring and adopting new strategies and operations models for Industry 4.0 has become a crucial and urgent need. Understanding the barriers, challenges, opportunities and rewards associated with the transformation to Industry 4.0 will help the City of Salisbury to advocate for the necessary support required by manufacturers and their supply chains in this region and for institutions such as universities to shape the way in engaging with local industries. To accelerate the drive for Industry 4.0 maturity, three fundamental questions must be investigated:

- What factors affect an organization's transformation to Industry 4.0?
- How far along this Industry 4.0 transformation path do organizations in the City of Salisbury sit?
- What changes, support and resources are needed to accelerate and improve Industry 4.0 transformation among manufacturing organizations in the City of Salisbury?

Several studies in the past have measured Industry 4.0, or digital, transformation maturity and the readiness of organizations to adopt Industry 4.0 (e.g. Kopp and Basl 2017; Schumacher et al. 2016). There is, however, a lack of research that addresses the maturity and readiness of organizations within an Australian manufacturing industry context, and the City of Salisbury specifically. To address this gap and to understand the awareness and readiness of manufacturing firms in the City of Salisbury for Industry 4.0, this project has combined both qualitative and quantitative approaches for the investigation.

The case study employed a mixed-methods approach through a process involving two phases of data collection and analysis, i.e. qualitative interviews and a quantitative survey. As depicted in Fig. 8.2, the two phases occurred sequentially after the initial literature review to obtain a thorough understanding of manufacturing firms' innovation capability and readiness, and uncover barriers, challenges and opportunities for manufacturing in the City of Salisbury region. Considering that the emerging literature on Industry 4.0 is still growing, interviews were conducted prior to the survey to uncover a deeper understanding of the local manufacturing sectors' needs

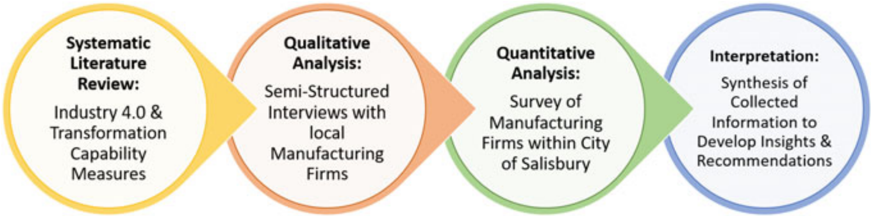

Fig. 8.2 The case study process and methods

and knowledge Industry 4.0. The information collected and analyzed in the interviews was combined with existing literature of Industry 4.0 and existing Industry 4.0 maturity models to develop a quantitative survey instrument. Then, the synthesis of information collected from both phases of analysis was used to develop a set of recommendations for accelerating, supporting, and developing Industry 4.0 maturity for manufacturing firms in this region, and ostensibly, the wider global manufacturing sector.

For the qualitative analysis of the study, firms considered to be manufacturers in the City of Salisbury region were contacted with a request to participate in interviews. Conducted over a period of 12 weeks, this phase of the data collection comprised of face-to-face semi-structured interviews between investigators and interviewees. Individuals participated in the interviews were all part of middle and senior management from local manufacturing firms (see Table 8.1).

The quantitative analysis phase of the study invited senior employees from manufacturing firms in the City of Salisbury region to complete the online quantitative survey distributed on the SurveyMonkey platform. The characteristics of the firms that participated in online survey were representative of the firms that participated in the interviews during the previous phase, including micro businesses (fewer than 5 employees) through to large businesses (200 or more employees).

8.3 Qualitative Analysis on Readiness for Industry 4.0 Transformation

Information gathered from the literature review and existing Industry 4.0 maturity models helped to devise a set of questions that queried interviewees about their knowledge of Industry 4.0 and associated key technological issues, internal and external issues, data analytics and protection, and employees. The questioned were created to align with the five dimensions of Industry 4.0 transformation, i.e. Business, Skills, Technology, Supply Chain, and Innovation, which also represent the five primary Industry 4.0 readiness categories that the project aimed to explore. The format of the interviews was semi-structured with open-ended questions in order to capture other potentially salient information.

Table 8.1 Descriptive information of interview participants

Firm Description	Interviewee Role/s
Food & Beverage	• Engineering Manager
Fashion	• General Manager Supply Chain Procurement • Chief Information Officer
Communications	• Vice President & General Manager • Operations Manager
Electronics	• Operations Manager • Engineering Manager & Defence Liaison • Special Project Officer (I4.0)
Specialised Medical Equipment	• Chief Technology Officer • Manufacturing & Supply Chain Manager
Food & Beverage	• Non-Executive Director
Specialised Equipment	• Chief Executive Director • Sales & Technical Director
Engineering	• Managing Director
Metal Fabrication	• Director
Food & Beverage	• Maintenance Manager • Packaging Manager • Control Systems Engineer • Quality Manager • Technical Brewer • ICT Coordinator
Electronics	• Managing Director • Software Engineer
11 Firms	***23 Interview Participants***

The interviews were analyzed using Braun and Clarke's six-step method of Thematic Analysis (2006, 2013, p. 202). Thematic Analysis (TA) is a simple qualitative method that is useful in research when the participants or groups of the research are relatively homogenous. A deductive approach to TA provided a deeper understanding of the needs of the local manufacturing firms and revealed rich insights into the opportunities, risks, and barriers facing those manufacturing firms for adopting Industry 4.0. The codes for the current TA were predefined. Direct or indirect responses to the interview questions were identified by applying a common understanding of the code and a description of how this would be identified or extrapolated (see Table 8.2).

Once the codes were applied, the investigators followed the steps of TA to uncover the salient themes. Through interpretation and discussion, interrater validity of the themes was established. Table 8.3 presents the eight themes identified from the TA,

Table 8.2 Descriptions of predefined codes for thematic analysis

Codes	Common Understanding	Description
Barrier	Anything impeding, blocking stunting, or stopping	Identified and extrapolated when barriers were mentioned or implied from the interview meaning
Challenge	An issue exists, but can be overcome	Identified when issue discussed could be overcome with knowledge, funding, or skills
Facilitator	Anything that enables, promotes, or helps function	Identified when enablers were present to allow a process or pathway forward
Knowledge	Understanding, lack of knowledge, depth of knowledge	Identified in 3 ways: example of understanding; complete lack of understanding, or the need for more understanding
Motivation	Reasons for going forward or doing something (internal or external)	Identified when interviews revealed reasons for moving forward or not
Opportunity	Possibilities, identified room for improvement	Identified when possibilities were revealed, ideas discussed, or examples of firms expressing reasons for moving forward
Strength	Within a firm or from stakeholders/supply chain	Identified when a factor was presented as a strength to the firm
Weakness	Within firm or from a stakeholder/supply chain	Identified when a factor was presented as a weakness to the firm

each of which includes the number of firms that mentioned this theme, the number of comments pertaining to it, and an illustrative comment.

By analyzing these themes in relation to the TA codes, it was found that the eight themes all pertain to the transformation associated with Industry 4.0 readiness of the participating manufacturing firms. Some themes were identified as, for example, both a barrier and an opportunity, or both a challenge and strength, as indicated by the presence of multiple codes. Furthermore, each theme was considered from the perspective of the five dimensions of Industry 4.0 readiness, as illustrated in Fig. 8.3.

Innovation

Overall, the firms interviewed presented as relatively advanced in terms of Industry 4.0 transformation, appearing to be influenced by their stakeholders' proactive approaches to Industry 4.0 initiatives. Workplace **culture and values** presented as key when discussing Industry 4.0 aspects pertaining to advancements in technology and systems, and associated security threats that could cause friction between policies and employees within firms. For example, some participants expressed concern that employees may not understand the value and reasoning behind any increases in security measures such as restrictions to smartphones in plant environments and the need to frequently change passwords. Poor understanding of the benefits of innovation may lead to employee resistance to change and progression. Meanwhile, some firms have found the adoption of new CPS assists them to be more agile in

Table 8.3 Identification of themes with illustrative comments

#	Identified Theme	# of Comments	Illustrative Quote
1	Return on Investment	10 Firms 44 Comments	*One of the big Industry 4.0 capable solution requires such a major expense and buying across the organisation where the benefits are only clear to certain people.* – 4D
2	Culture & Values	10 Firms 46 Comments	*So, the attitude in terms of embracing is quite important and that's also about how management sell it [Industry 4.0] to everyone.* – 15O
3	Appropriate Digital Systems Software	11 Firms 41 Comments	*One is, perhaps, that there is not necessarily a common standard. There's a number of different types of technology or application who claim to be Industry 4.0 or whatever and not necessarily or directly easy to connect on the same platform. So, it required skills, technical knowledge to be able to have a machine be able to transfer the information to the ERP or to equipment to be able to communicate together. It's getting easier. It's not necessarily fully standardised.* – 6F
4	Knowledge of Industry 4.0	11 Firms 40 Comments	*Well, we need to understand it first, so the biggest barrier is I don't think we understand it yet. So, before we do anything, we need to understand what's possible, how we do it, how are we going about it and things like that. So, I'd start there. Digital manufacturing: we've only just sort of started getting into it and understanding it.* – 15O
5	Strategy to do with Manufacturing Method	11 Firms 37 Comments	*If we want to continue manufacturing in Australia, which we do, which means we want to continue employing people in Australia to do that, then you have to be looking for those methods to change so that people know that to keep doing what we're doing now, to keep doing, to keep manufacturing, we need to be looking at different ways to do that effectively. You've seen so many examples of other companies having offshore and then it all just changes, you know? Whether it's [well-known international brand] or whoever it might be, it just doesn't have that same feel of an Australian made product and therefore the whole sales relationship just changes in the market and we don't want to lose that.* – 6F
6	Management & Leadership	11 Firms 34 Comments	*For us, we're lucky that the, I suppose, corporately in management, that they're supportive [of] us trying to develop an infrastructure that's going to support Industry 4.0. Even though we don't really know what it is going to deliver down the track.* - 18R
7	Security Policies	11 Firms 34 Comments	*So, everything has gone a bit harder or a bit more complex, but we are, you know, it's a real compromise for our IT team to give people enough access so they can do their jobs, but not to make the system vulnerable. It's an ongoing challenge.* – 4D
8	Supply Chain Data	9 Firms 31 Comments	*So, probably the data on finished goods and then getting through these is where we've got a big gap. That will be good. I don't know how to capture that, but that would take someone on site to sort of say 'this is where we've got to go.'* – 13M

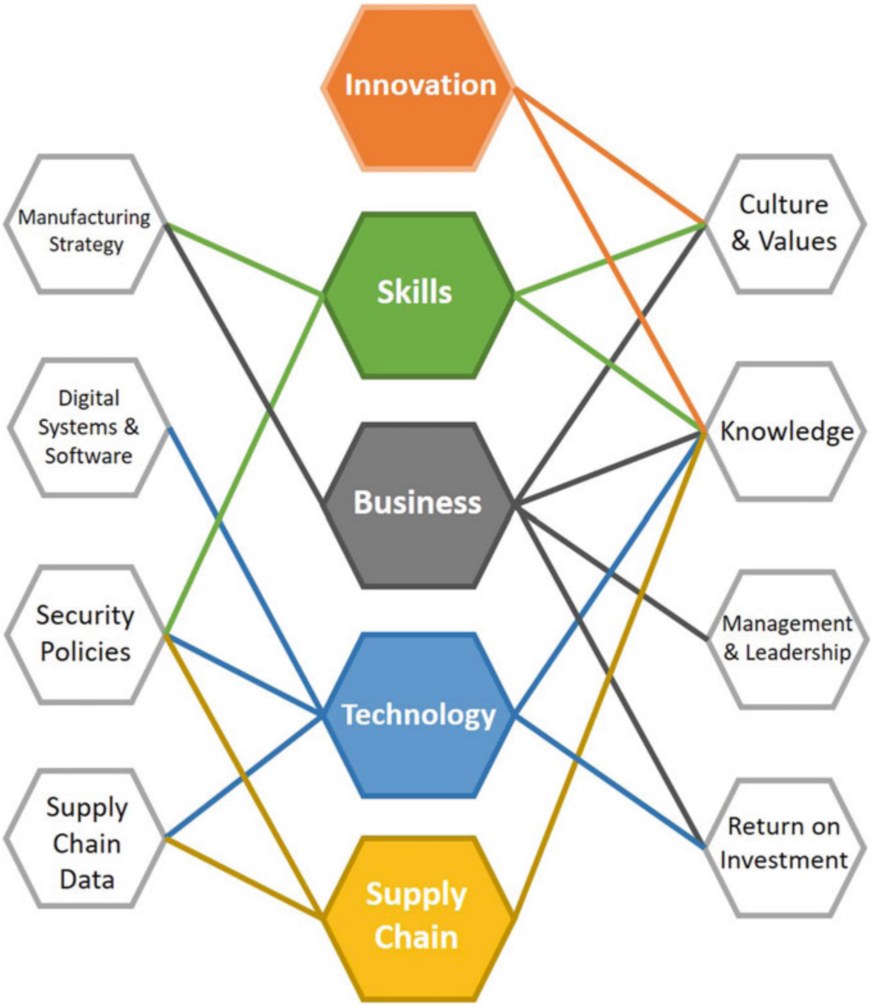

Fig. 8.3 The primary themes and connections with the dimensions of Industry 4.0 readiness

the work environment and locations, for example, by being able to perform their tasks from home or most global locations. Some managers reported that providing a workplace that encourages open discussion and facilitates worker innovation has improved some of their product designs and resulted in better adoption of innovation in the manufacturing environment.

Another facet of innovation challenges to adopting and engaging in innovation was a state of confusion as to what firms need to do in order to transform to Industry 4.0, or why they would need to aspire to do this. Many firms explained that they lack adequate **knowledge** and technical capabilities to identify and acquire new and innovative products or software that would fulfil their Industry 4.0 readiness or progression.

Skills
Finding individuals with the technical expertise to support Industry 4.0 initiatives within companies appears to be a key challenge at most organizational levels. There were frequent comments related to the challenge of recruiting graduate students with appropriate **knowledge** and skills, requiring months of technical training once employed. Additionally, it appears to be equally difficult to afford the competitive salaries for employees with specific technical skills that are required and are often outbid by the Defence sector, to the extent that some firms have taken to poaching employees from other firms. This a threat to some of the firms interviewed and as a result some firms are doing their best to create a positive **workplace culture and values** to both attract and retain skilled employees.

Strategies to do with manufacturing methods for Industry 4.0 transitions included the trade-off between automation and manual operation, loss of employee morale, and potential public backlash at employee redundancies. Many participants expressed a desire to create new roles for employees who have roles that are to be replaced by automation and machines. In fact, some firms reported that employee morale increased in the workplace when employees realize that machines would improve their roles and the work they were now provided with was more interesting and protected against redundancy.

Business
Collectively, while aware of it, the firms did not have a complete understanding of Industry 4.0. Participants suggested that access to examples of Industry 4.0 best-practice would be beneficial and indicated their interest in attending training sessions or events educating them on Industry 4.0 therefore assisting in identifying opportunities for further applications within their firms. Despite a paucity of explicit **knowledge**, the interviews revealed that many firms have begun transitioning towards Industry 4.0 without putting any policies or strategies in place. The impact of this transition with poor **management and leadership** can, and appeared to be, creating some workplace confusion about how the firms are transitioning to the future. Some long-term firm owners or board directors have been accused of viewing Industry 4.0 adoption as a challenge to their leadership or management styles. The highly skilled and experienced participants expressed the desire for their senior manager/s to be willing to listen to ideas and adapt to the changes of Industry 4.0. In terms of family-owned businesses, a characteristic of some of the manufacturers in the City of Salisbury, will mean changing traditional methods of operation that have been successful in the past, but that might not suit the current technological and economic climate. Some firms expressed their desire to remain culturally static and were challenged by attempting to maintain a balance between automation and retaining their workforce. That is, they are satisfied with their **workplace culture** and would prefer it to remain unchanged.

The interview data revealed that manufacturers predominantly see a positive **return on investment** (ROI) in Industry 4.0 applications, but only if the demand for their manufactured products grows. At the times the firms were interviewed, there were limited consumers in a growing marketplace already saturated with mass-produced commoditized products. There appeared limited thinking and understanding on how to using Industry 4.0 as leverage to realign the business model towards building higher profit margins through specialized/customized products. For Industry 4.0 to be integrated into the manufacturing process, a transformation across all aspects of the business is required, which is a significant expense for firms posing challenges in terms of technology cost, implementation, and educating staff on integration and use. Technology related to Industry 4.0 is still relatively expensive and, at this stage, appears to be accessibility only to firms with sufficient economic security and resources to become early adopters. In the interviews, it was suggested that SMEs favor observing what other firms elect to do and then assess the ROI based on that information.

Several firms revealed knowledge of the Industry 4.0 **manufacturing processes** being led by European manufacturers and are attempting to incorporate them. In this case, the **knowledge** of senior management is a key driver for adoption of Industry 4.0 methods in reference to manufacturing. The association of quality Australian-Made products was a reoccurring theme between all of the firms investigated. This was more important to the manufacturers than Industry 4.0 readiness or capabilities. For example, one of the firms designs and hand-tailors luxury fashion products. This firm had previously purchased a laser cutter for patterns and returned to hand-held scissors as the hand cut products were better. This example of handcrafting may be an exception to the rule, but one that should be considered nonetheless.

Technology

Most firms appear to be dissatisfied with their current **digital and software systems**, with a primary challenge existing in regard to finding systems that integrate with each other, are user-friendly and allow easy comprehension of the data collected, acknowledging this is simply due to a dearth of **knowledge** at their end. Irrespective of the size of the firm interviewed, many aspects of the business that had employed new digital systems reported challenges and barriers to linking the multiple systems or identifying a system for the entire firm that meets their needs. The **ROI** of on-boarding new systems including the cost of training staff, is of concern to many firms. Additionally, implementing Industry 4.0 software and machinery revealed issues experienced with international stakeholders; some of their systems are often in different languages and can incur a significant expense to bridge this gap of translation between the interfaces, presenting as another barrier to understanding **supply chain data**.

Supply Chain

Between the firms investigated, there was a paucity of data actively being collected through the supply chains, although the opportunity to do so exists. This could be linked back to **knowledge** of Industry 4.0 because firms are not aware how to collect data from these processes nor how to analyze it, even if the data collected could potentially drive business decisions. No firms had a formal data analyst employed, however one firm was advertising a position for one, as they could foresee the opportunity. Despite the firms' overall lack of knowledge on data analytics and Industry 4.0, a few firms were aware of the benefits of **supply chain data** tracing for quality assurance purposes, for example, tracking of where each ingredient of a product originated from or checking test data of products. The firms were enthusiastic about the quality control they could implement if they were able to track every point or resource along the supply chain from the beginning all the way to the consumer.

Overall, the interviews revealed that the firms who have a significant amount internal Intellectual Property (IP) have been early adopters of advance **security policies,** particularly those firms that operate in the Defence sector, which has a stronger emphasis on partnership and demands for a focus on innovation and capability building driven by supply chain stakeholders. At the time of this study, the Australian Government had instituted the *Essential 8* with three levels of maturity to mitigate cyber security incidents (ASD 2019)—only one firm mentioned knowledge of this initiative. This finding exemplifies the potential lack of information provided to these firms on needs and growth in managing digital assets and data security matter along with adopting Industry 4.0. While there was a breadth of difference on the importance of security policies between the firms investigated, all participants agreed that there is a growing need for security policies to be put in place, particularly with the increase in data collection, use of cloud storage, and the risks of infiltration.

8.4 Quantitative Surveys

Based on the information acquired from assimilation of existing literature of Industry 4.0 maturity, the key themes uncovered from Industry 4.0 readiness analysis, and existing Industry 4.0 maturity models, an online quantitative survey instrument was developed to address the five specific domains of maturity relevant to the adoption Industry 4.0. The questions were designed to probe into the key factors covered in the five domains, defined as:

- **Business**—a range of factors including strategy, models, return on investment (ROI), cybersecurity and corporate social responsibility (CSR);
- **Technology**—including infrastructure, vertical and horizontal integration, ICT platforms, and digital resources;
- **Skills**—spanning leadership and management, soft skills, workforce readiness and change management;
- **Supply Chain**—exploring digital transformation factors in the wider manufacturing environment;
- **Innovation**—including culture, processes, and people.

Each of the five dimensions was assessed at one of five possible *levels of maturity*, ranging from *Very Low* (indicating either that no level of Industry 4.0 maturity could be assessed, or that the maturity was at the lowest possible level), through to *Very High* (defining a level of Industry 4.0 maturity that is consistent with best practice). Responses to the survey questions were captured by using a six-point, Likert-type scale, from "1" (completely disagree) through to "6" (completely agree) with no neutral option. The data obtained were analyzed and converted into the scores of *Industry 4.0 Transformation Maturity Index (I4-TMI)*, with *Median* and *Range* values calculated for each sub-variable listed under the five key variables outlined previously, as presented in Table 8.4.

Figure 8.4 shows the median scores of Industry 4.0 Transformation Maturity against the firm sizes. Based on the data obtained, it indicates that, among those participated in the survey, small firms have medium readiness for Industry 4.0 and medium-sized firms have a higher (i.e. medium-high) readiness for Industry 4.0. While such results appear disadvantaging small firms, these may not serve as the base to extrapolate for general conclusions about the manufacturers in the region, due to limitations in scope and sample size. However, as majority the manufacturing firms in the City of Salisbury are SMEs, this finding does highlight the need for further and broader investigations on relations between "being small" and the readiness for Industry 4.0.

As indicated by the results of Industry 4.0 Transformation Maturity Index, there are some notable strengths in the sample, representing elements that are driving Industry 4 Transformation Maturity in the organizations, and present opportunities for continued growth and exploitation. Overall, however, **Skills**, **Supply Chain** and **Technology** are the three main areas standing out as three main areas of weakness for all firms, providing the greatest opportunities for remediation and improvement.

- Under **Skills**, the main weaknesses are with *Technical Skills* and *Soft Skills. Leadership*, in contrast, emerged as a strength. Firms appear having reasonable levels of confidence in their ability to adapt, and their readiness for changes, which is a promising sign, showing their willingness and potential to transform to Industry 4.0;
- Under **Supply Chain**, the *Skills of Partners* and *Broad Horizontal Integration* are the weakest factors. Although *Technological Advancements* and *Collaboration* may be strengths, there appears to be a lack of a systems approach to foster and leverage innovation for digital integration and more effective/efficient data management across the whole supply chain;
- Under **Technology**, *Vertical Integration*, *Data Analytics* and *IT Digitalization and Interoperability* are all emerged weaknesses. Despite having sound IT infrastructure, competent manufacturing methods and reasonable confidence over own business information management capability, confidence regarding the interoperability of systems and data sharing across production process internally is low;
- Under **Business**, the main, and only, weakness is *Government and Education Support*. This may also correlate with the weaknesses in *Workforce Readiness* and *Technical Skills* observed under **Skills**;

Table 8.4 Industry 4.0 transformation maturity index scores measured

Elements *Category: Business*	1-2 Very Low	2-3 Low	3-4 Medium	4-5 High	5-6 Very High
Strategy				4.3	
Re-thinking/adapting the Business Model				4.0	
Protection of IP & Cybersecurity				4.0	
Corporate Social Responsibility				4.7	
Business culture & Values				4.5	
Government & Education Support			3.4		
Customer Orientation/Individualisation & Data Driven Decision Making				4.5	
Business Score				**4.5**	
Elements ***Category: Technology***	**1-2** **Very Low**	**2-3** **Low**	**3-4** **Medium**	**4-5** **High**	**5-6** **Very High**
Technology & Infrastructure				4	
Vertical Integration			3.5		
IT (End-to-End) Digitalisation & Interoperability			3.3		
Use of Technological Resources & Digitalisation			3.8		
Narrow Horizontal Integration					5.0
Manufacturing Methods				4.0	
Big Data Technologies & Data Analytics (Storage, Management, & Insights)			3.3		
Technology Score			**3.8**		
Elements ***Category: Skills***	**1-2** **Very Low**	**2-3** **Low**	**3-4** **Medium**	**4-5** **High**	**5-6** **Very High**
Leadership					5
Soft Skills			3.0		
Technical Skills			3.3		
Workforce Readiness			3.6		
Adaptability to Change				4.0	
Skills Score			**3.9**		
Elements ***Category: Supply Chain***	**1-2** **Very Low**	**2-3** **Low**	**3-4** **Medium**	**4-5** **High**	**5-6** **Very High**
Collaboration					5.0
Business Model of the Partners*			3.7		
Broad Horizontal Integration (IT & Digitalisation across the Supply Chain from the Initial Suppliers all through to Customers)		2.0			
Technological Advancements of Partners in the Supply Chain*					5.0
Skills of the Partners in the Supply Chain*			3.0		
Innovation in the Supply Chain*				4.0	
Supply Chain Score			**3.3**		
Elements ***Category: Innovation***	**1-2** **Very Low**	**2-3** **Low**	**3-4** **Medium**	**4-5** **High**	**5-6** **Very High**
Environments for Innovation				4.7	
Attitudes to Innovation			3.8		
Processes for Innovation			3.8		
Innovation Score				**4.3**	
Industry 4.0 Transformation Maturity Index			**3.8**		

Note Items marked with an * indicate 'relative to and as perceived by the company

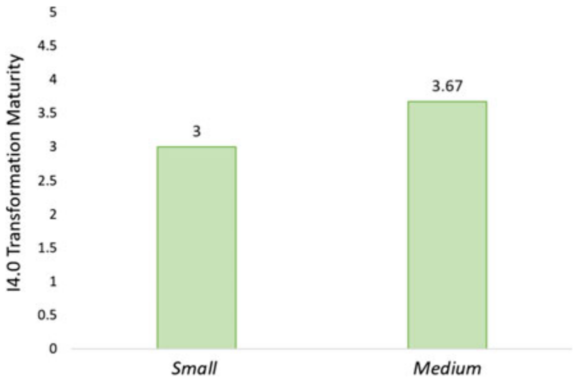

Fig. 8.4 Industry 4.0 transformation maturity versus firm size

- Generally, the results show that small firms appear to struggle the most with Industry 4.0 transformation. Among many contributing factors, **Skills** (particularly Soft Skills) and *Digital Capability* (particularly in managing data for internal and external operations), or lack of them, present as the main impediments to Industry 4.0 transformation.

8.5 Discussion

The results derived from the interviews and survey analysis provide a picture of current readiness and maturity for Industry 4.0 transformation for typical manufacturing firms in the City of Salisbury. The findings help to identify a number of main **barriers** for the manufacturing firms, mostly SMEs, to adopt Industry 4.0 and are used to develop a set of **recommendations** for supporting, developing and accelerating digital transformation of manufacturing firms in this region towards Industry 4.0.

8.5.1 Barriers for Industry 4.0 and Digital Transformation

The information collected through the interviews from manufacturers revealed a strong interest in Industry 4.0—even if their understanding is still limited—and transforming to more digitally innovative pathways to improve their operations and business models. Highlighted in both readiness analysis and maturity analysis are a number of challenges and barriers to successful transformation to manufacturing in Industry 4.0 in the City of Salisbury region. These challenges may be representative of other regions, however the current study specifically aimed to explore a single region to identify support, resources and actions that could improve Industry 4.0

Fig. 8.5 Primary barriers for Industry 4.0 transformation of manufacturing firms studied

maturity in this region; a tailored response to a specific region. In total, six primary barriers are identified, as shown in Fig. 8.5.

Overall, relating back to the key themes identified (see Table 8.3), the firms reported a **general lack of understanding** and explicit knowledge of Industry 4.0 which was compounded by the lack of a succinct and accepted definition of Industry 4.0 in both the literature and industrial domains. Firms are also **wary of engaging in Industry 4.0 transformation**. This could potentially be attributed to their lack of knowledge, but it was identified that there is a general cautiousness among manufacturing firms in the City of Salisbury region with regard to engaging in changes associated with Industry 4.0.

The firms were overall positive about the future of Industry 4.0, it was also evident that they are not sure how this would affect their employees, ROI, and data security. This is exemplified with the firms' **weakness and uncertainty in cyber-security**. Cyber-security was a common concern for all firms interviewed, the firms that completed the survey component reported a belief that their cyber-security capabilities and policy frameworks were sound. The investigators concluded that this issue of cyber-security appears to pertain to the firms' acute awareness and uncertainty over how new ICT and/or CPS under Industry 4.0 will affect their current security measures, how they can/should operate, and whether their current systems could cope with the extra resources required. Paired with cyber-security uncertainty, the firms involved reported **difficulties in integrating different digital systems within and across their businesses**, and this was evident in both the interviews and the survey responses. ITC systems interoperability appears to be a common and significant barrier affecting (as well as affected by) the integration of digital platforms and data management across horizontal and vertical integrations. The challenge of integration is a perceived as a major barrier to the adoption of Industry 4.0, predominantly in how it would impact the supply chain both internally and externally. Overall, the firms involved reported a **lack of resources to support better use of data analytics** and business information capability. Similar to a concern over cyber-security, this can be interpreted as both an awareness of a much higher level of demand imposed by the adoption of Industry 4.0, and a lack of confidence or certainty as to whether the firms could cope with changes and afford the upgrades.

And, finally, a significant challenge for all firms was the **difficulties experienced in accessing relevant training resources for their current workforce or recruiting appropriate technical expertise to support the transformation to Industry 4.0**. The interviews attributed to this issue to factors such as leadership, business culture, government support, remuneration and career attractiveness, tertiary education and professional training, and the socio-economic aspect. The survey analysis revealed concerns over government funding and education support, technical skills of their workforce, workforce readiness for change (skills and mindset) as well as technical skills of supply chain partners. Correlating the findings from both phases, it is apparent that the capability of the workforce (or lack of it) across the manufacturing industry eco-system presents as the most fundamental challenge for Industry 4.0 readiness.

8.5.2 Opportunities and Recommendations

By drawing upon existing literature and Industry 4.0 maturity models, the analysis of the interviews and Industry 4.0 Transformation Maturity Index results also identified opportunities in response to those barriers and challenges for transition toward Industry 4.0 and digitalization. The findings from the case study have led to key recommendations (see Fig. 8.6) to inform relevant stakeholders about what can be done at the organizational level, at the government level, and what role higher education providers can play to support Industry 4.0 readiness and maturity of the industry sector.

Based on the findings from the qualitative interviews and quantitative surveys, *culture change, workforce readiness* and *capability* for digital technology and data security were identified as the key barriers and challenges faced by individual organizations in the City of Salisbury. To overcome these challenges, **senior leaders need to embrace and support digitalization and a culture of innovation within organizations**. This requires senior leadership to view Industry 4.0 and digital innovation an essential, rather than optional, strategic direction for business growth. This can

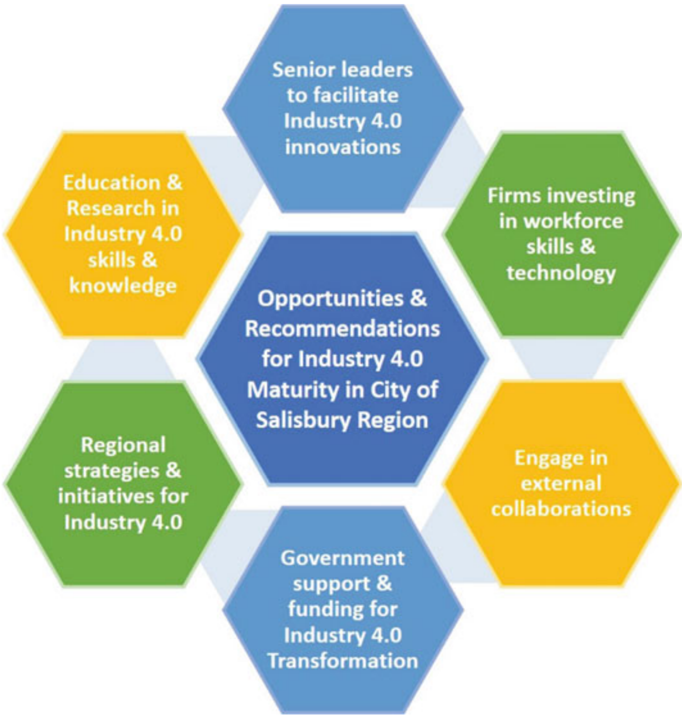

Fig. 8.6 Recommended actions for enhancing Industry 4.0 maturity

be informed by successful examples and best practices. To help firms overcome the inertia of transitioning into Industry 4.0, it is especially crucial to foster improvement of readiness and aptitude for changes. This means that organizations also need to **invest in upskilling their workforces and upgrading digital technology**. This includes investing in IT resources, data analytics, and engagement with universities and professional education institutes to leverage the development of internal capability. Upgrading the workforce should start with fostering cultural changes and overcoming inertia (both organizational and individual) imposed by established habits and legacies. Then, organizations can start introducing specific skills for their employees in relation to digitalization, data capability and security, and business model innovation.

Meanwhile, organizations can benefit by **actively engaging with external collaborations** for peer learning and peer-support by working closely with universities, and government agencies. This can be enabled by taking part in themed workshops, roundtables, forums, Industry 4.0 test labs and hubs, and ‘living lab’ consortia. For the role of universities, the findings from this investigation encourage enhancing **education and research in Industry 4.0-related skills and knowledge**. It is important to develop a suite of case studies and learning resources to support manufacturing

SMEs for their confidence and motivation to develop their own Industry 4.0 initiatives and paths of transformation through learning from peers and examples of 'best practice' relevant to their businesses. It is also recommended that universities establish/enhance an Industry 4.0 focus by including important aspects in their education and engagement programs, within the realms of engineering and business, to create a platform that supports industries, especially SMEs, in developing and testing new technological and business solutions. The role of governments can focus on providing **support and funding opportunities for fostering Industry 4.0 transformation**. These include designing, and advocating for, grant schemes, taxation, and other benefits to incentivize manufacturing SMEs to adapt their equipment, digital technology and business models for Industry 4.0 capability. Also, tailored programs need to be implemented to support manufacturing SMEs to access reskill/upskill training resources and activities for their workforce development.

Furthermore, it is vital for having **regional strategies and initiatives for Industry 4.0** to establish a collaborative eco-system to nurture and facilitate digitalization and business innovation of the manufacturing sector, fostering opportunities for knowledge sharing, for testing and adopting new technology and business ideas, and for developing confidence in Industry 4.0 Transformation. Such strategies and initiatives also need to advocate change and innovation to local firms, at all levels. Innovation associated with business transition toward Industry 4.0 is always risky, and always brings a level of discomfort to firms and to individuals. Supporting the concept of change and innovation in the City of Salisbury—in firms as well as in schools and in the public mindset—will help to position industries and broad communities to embrace the changes that are needed.

8.6 Conclusion

This chapter presents a study exploring how manufacturers operating in the City of Salisbury, South Australia, embrace transition toward Industry 4.0 and digitalization. By employing a combination of literature review, qualitative interviews and analysis, and quantitative survey, the case study was designed to inform current knowledge and practices, identifying barriers and challenges to the adoption of Industry 4.0 and digital innovation. The investigation conducted in-depth analysis on readiness and maturity of manufacturing SMEs for Industry 4.0 transformation on key factors such as Business; Technology; Skills; Supply Chain; and Innovation.

Manufacturing firms in the City of Salisbury region were assessed on a 5-level (Very Low to Very High) Industry 4.0 Transformation Maturity Index (I4-TMI), showing an **overall median maturity of 3.8** (**Medium**). Supported by both qualitative analysis and quantitative evidence, particular weaknesses in Industry 4.0 Transformation Maturity affecting SMEs were identified under the areas Business, Technology, Skills and Supply Chain. As a result, a range of recommendations were proposed to tackle these issues, as a means for accelerating Industry 4.0 transformation in the City of Salisbury.

The recommendations address not only what needs to be done, but also the key stakeholders involved. In general, across different stakeholders, there is a need for a renewed and concerted effort to identify, capture and create synergies across existing initiatives, programs and entities. Creating a strong partnership between local manufacturers, government authorities (both local and state), and tertiary education institutions should be prioritized to enhance the understanding of and the impact of Industry 4.0 on jobs and business growth and to ensure a successful journey in adopting the Industry 4.0 and digitalization for the manufacturing industry and beyond.

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References

Australian Industry Group (AiGroup) (2019) Australian manufacturing in 2019: local and global opportunities. Retrieved from https://cdn.aigroup.com.au/Economic_Indicators/Economic_Outlook/Australian_Manufacturing_in_2019.pdf

Australian Signals Directorate (ASD) (2019) Essential eight explained. Australian Government. Retrieved from https://www.cyber.gov.au/sites/default/files/2020-01/PROTECT%20-%20Essential%20Eight%20Maturity%20Model%20%28July%202019%29.pdf

Braun V, Clarke V (2006) Using thematic analysis in psychology. Qualit Res Psychol 3(2):77–101. https://doi.org/10.1191/1478088706qp063oa

Braun V, Clarke V (2013) Successful qualitative research. A practical guide for beginners. Sage Publications, London

CSIRO Futures (2016) Advanced manufacturing: a roadmap for unlocking future growth opportunities for Australia. Commonwealth Scientific and Industrial Research Organisation (CSIRO). Retrieved from https://www.csiro.au/en/Do-business/Futures/Reports/Advanced-manufacturing-roadmap

Dalenogare LS, Benitez GB, Ayala NF, Frank AG (2018) The expected contribution of Industry 4.0 technologies for industrial performance. Int J Prod Econ 204:383–394. https://doi.org/10.1016/j.ijpe.2018.08.019

Ghobakhloo M (2018) The future of manufacturing industry: a strategic roadmap toward Industry 4.0. J Manuf Technol Manage 29(6):910–936. https://doi.org/10.1108/jmtm-02-2018-0057

Hecklau F, Galeitzke M, Flachs S, Kohl H (2016) Holistic approach for human resource management in Industry 4.0. Procedia CIRP 54:1–6. https://doi.org/10.1016/j.procir.2016.05.102

Ibarra D, Ganzarain J, Igartua JI (2018) Business model innovation through Industry 4.0: a review. Procedia Manuf 22:4–10. https://doi.org/10.1016/j.promfg.2018.03.002

Kopp J, Basl J (2017) Study of the readiness of Czech companies to the Industry 4.0. J Syst Integr 8(3):39–45. https://doi.org/10.20470/jsi.v8i2.313

Lee J, Bagheri B, Kao H-A (2015) A cyber-physical systems architecture for Industry 4.0-based manufacturing systems. Manuf Lett 3:18–23. https://doi.org/10.1016/j.mfglet.2014.12.001

Liao Y, Deschamps F, Loures EDFR, Ramos LFP (2017) Past, present and future of Industry 4.0—a systematic literature review and research agenda proposal. Int J Prod Res 55(12):3609–3629. https://doi.org/10.1080/00207543.2017.1308576

Morrar R, Arman H, Mousa S (2017) The fourth industrial revolution (Industry 4.0): a social innovation perspective. Technol Innov Manage Rev 7(11):12–20. http://doi.org/10.22215/timreview/1117

Schumacher A, Erol S, Sihn W (2016) A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. Procedia CIRP 52:161–166. https://doi.org/10.1016/j.procir.2016.07.040

Chapter 9
Agricultural Business Innovation with New ICT: Case Studies of Fujitsu, Spread and MimosaTEK

Minh Chau Doan and Michitaka Kosaka

Abstract Recently, the world has been faced four big issues: over population, depletion of natural resources, climate change and food wastage. To solve these crises, agricultural business has been globally noticed as an important application field of new ICT such as Internet of Things (IoT) and artificial intelligence (AI). New ICT is expected to solve various issues related to agricultural business, which include increasing yield optimisation, improving crop protection, optimising food supply chains and so on. We conduct three case studies, which are the Fujitsu case (in Japan) as an existing big ICT company, the Spread case (in Japan) as a plant factory venture company and the MimosaTEK case (in Vietnam) as an IoT venture company. We analyse the direction of agricultural ICT and agricultural business innovation in Asia.

9.1 Introduction

Recently, the world has been faced four big issues: over population, depletion of natural resources, climate change and food wastage. To solve these crises, agricultural business has been globally noticed as an important application field of the 3rd generation service innovation using new ICT such as Internet of Things (IoT) and artificial intelligence (AI). IBM explains the reason of this trend as follows:

> By 2024, the Earth's population will total more than 8 billion for the first time in history, adding new stresses on the global supply chain, which is already challenged by a volatile climate and water supply shortages. To meet future food demands, IBM researchers are working on solutions that tap artificial intelligence (AI) and Internet of Things (IoT) and

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cloud-connected devices at every step of the food supply chain. (https://www.techrepublic.com/article/5-ways-ibm-will-transform-farming-by-2024/).

New ICT technologies such as IoT, AI and cloud computing are expected to solve various issues related to agricultural business, which include increasing yield optimisation, improving crop protection, optimising food supply chains and so on.

However, issues on agriculture depend on the characteristics of factors affecting agricultural business, which are climate, crops, farming method and size of farmland. These factors are different in each region and country. Therefore, required solutions using ICT should be optimised to solve issues considering local circumstances. So far, there have been many approaches for solving such agricultural issues from existing big ICT, venture and agriculture-specialised companies. We define "agricultural ICT" as ICT and its solutions to agriculture in this chapter. What kind of approaches are taken to solve agricultural issues in Asia? What direction is agricultural ICT in Asia heading? We provide the answers for these questions through a literature survey and three case studies.

First, we conduct a literature survey of agricultural ICT in Asia and summarise the general trend of agriculture using IoT, AI, cloud computing and smartphones. Also, we introduce IBM's "Watson Decision Platform for Agriculture" as an example of an advanced case. Then, we conduct three case studies, which are the Fujitsu case (in Japan) as an existing big ICT company, the Spread case (in Japan) as a plant factory venture company and the MimosaTEK case (in Vietnam) as an IoT venture company. Finally, we analyse the direction of agricultural ICT and agricultural business innovation in Asia.

9.2 Background: Trends of Agricultural ICT

9.2.1 Survey of Agricultural ICT in Asia

There are many research papers on agricultural ICT in Asia that include IoT, AI, cloud computing, service system architecture on agricultural business and successful examples using ICT.

In China, Fan (2013), Li et al. (2013) and Chen et al. (2014) discussed the applications of IoT and the system architecture of agricultural ICT. Huawei surveyed agricultural ICT and discussed business opportunities from the viewpoint of telecom operators (https://www.huawei.com/-/media/CORPORATE/Images/PDF/v2-smart-agriculture-0517.pdf?la=en). Shi et al. (2019) summarised recent Chinese agriculture using IoT. Wu explained the implementation of IoT into the agricultural industry in China (http://www.fao.org/fileadmin/templates/rap/files/uploads/ESF_Presentations/FAO-ITU_China_Wu_Yin_Final_Revision.pdf).

In Japan, Hori et al. (2010) explained Fujitsu's approach on applying cloud computing to agriculture and its prospects in other fields. Japan's government announced the importance of digital farming as "Digital farming makes agriculture sustainable" (https://www.japan.go.jp/ technology/innovation/digitalfarming.html). Major ICT companies such as Fujitsu (https://jp.fujitsu.com/solutions/cloud/agri/, in Japanese), NEC (https://jpn.nec.com/solution/agri/index.html, in Japanese) and Hitachi (http://www.hitachi.co.jp/products/it/harmonious/cloud/service/agri/index.html, in Japanese) are looking at agricultural business as their major business target.

In India, Choudhary et al. (2016) explained the "Role of Cloud Computing Technology in Agriculture Fields". Patil and Kale (2016) proposed "A Model for Smart Agriculture Using IoT". Mekala and Viswanathan (2017) surveyed "Smart Agriculture IoT with Cloud Computing". Also, an industry and start-up overview of AI in Indian agriculture was reported in (https://emerj.com/ai-sector-overviews/artificial-intelligence-in-indian-agriculture-an-industry-and-startup-overview/).

According to Hori et al. (2010), Fan (2013) and Li et al. (2013), an agricultural ICT system can be described as an operation shown in Fig. 9.1. In the data collection part, necessary data for agricultural business operations are collected through the use of IoT and drones or obtained from other industries' information systems, including sensor data, image data, weather data, food processing information, logistics information and so on. In the processing part of the cloud computing environment, there are three functions for storage, analysis using AI and monitoring. Collected data in the data collection part is stored in the cloud computing environment. These data are used for monitoring and analysis using AI. There are various analyses that use AI for optimising agricultural operations, including work guidance, work plan, correlation analysis, fault detection and so on. The results of the analyses are sent to controllers, farmers or other industries by using IoT, smartphones, or Internet-based communication. This is a type of cyber physical system (CPS).

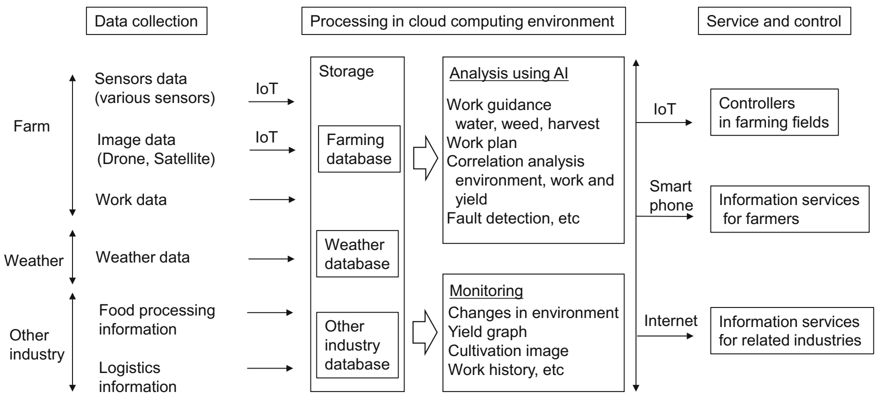


Fig. 9.1 An agricultural ICT system for agricultural operation

9.2.2 IBM's Approach Using AI and Weather Data

IBM is a giant and successful company in the first-generation service innovation and has entered into agricultural business through the development of "Watson Decision Platform for Agriculture" (https://www.ibm.com/downloads/cas/ONVXEB2A). It combines IBM's strong technologies such as weather forecasting from "The Weather Company" (an IBM Group company), AI and agricultural IoT, and supports farmers and agricultural business people to make decisions faster and smarter by providing appropriate information. IBM has expanded its business globally. An outline of this service is summarised as follows in accordance with "Watson Decision Platform for Agriculture".

1. **Objectives of decision making**
    (a) Increased profitability (yielding more bushels or tons of crops per hectare)
    (b) Improved sustainability (crop input optimisation, energy consumption, land and water use, soil conservation, soil carbon content and greenhouse gas emissions)
    (c) Higher quality (increased protein content in barley or sugar content in beets).
2. **Data**
    (a) The world's most accurate weather data
    (b) Soil data such as moisture, nutrient content, fertility and type
    (c) Equipment data gathered from IoT sensors
    (d) Farm practices and workflow data gathered from cooperative growers
    (e) High definition visual imagery from satellites and drones.
3. **AI processing**

    > The Watson Decision Platform for Agriculture applies AI, machine learning, and advanced analytics to this EFR data to extract valuable insights and automatically generate guidance for smarter decisions. A unified dashboard enables growers to easily visualise data and alerts related to critical elements such as weather forecasts, soil conditions, evapotranspiration rates, and crop stress. For example, AI visual recognition of drone-capture footage may be used to automatically identify certain types and severity levels of pest and disease damage. With this field-specific insight, growers can save time and money while reducing the impact on their field by better understanding how and when to spray. (https://www.ibm.com/downloads/cas/ONVXEB2A)

4. **Solutions** (https://www.ibm.com/downloads/cas/ONVXEB2A)
    (a) Improved crop protection by leveraging AI to better understand and proactively alert growers to critical daily crop stress levels, identify signs of pests and diseases and more effectively assess current risk levels of crops.
    (b) Increased yield optimisation with benchmarking and validation against yield models for comparable soil and weather conditions as well as support for better decisions around irrigation, product application and planting/harvesting timing.

(c) Smarter in-season trading with productivity assessments and decision guidance as well as probabilistic weather conditions that feature detailed analyses of sub-seasonal and seasonal forecasts.

IBM's approach to the agricultural business using new ICT technologies is very similar to the agricultural ICT system for agricultural operation shown in Fig. 9.1.

9.3 Case 1: Fujitsu's Agricultural Business

9.3.1 Outline of Fujitsu

Fujitsu was established in 1935. Its consolidated sales amount was 3.95 trillion yen in FY2018 and the number of employees in Fujitsu Group was 132,000 in March 2019. Fujitsu is a giant global company and a total solutions provider in ICT business fields and provides not only various solutions and systems for solving issues in business but also high performance hardware products and electronics devices.

Fujitsu's business consists of three segments: technology solutions, ubiquitous solutions and device solutions. The technology solutions segment conducts B2B and provides services and system platforms globally. The services business covers the IT system business, including consulting, design, application development, implementation, system outsourcing services and system maintenance services. Agricultural ICT business belongs to this business group. The system platform business provides products, including servers, storage systems, middleware software, network products and so on. The ubiquitous solutions segment conducts business of ubiquitous equipment such as personal computers, smartphones and software for mobile devices. The device solutions segment conducts LSI business and electronics parts business. The sales ratio of the three segments is 76% in technology solutions, 12% in ubiquitous solutions and 12% in device solutions.

9.3.2 History of Agricultural ICT Business in Fujitsu

Fujitsu has a long history of agricultural business. Since the early days of computer system business in the 1970s, Fujitsu started its information system business in the food and agriculture field as well as in other business fields such as banking, manufacturing, distribution and transportation. Fujitsu developed an enterprise information system for the Japan Agricultural Cooperatives in the 1970s and started to develop agricultural information systems for agricultural producers.

In the 2000s, computer system environments began changing from server centric systems to distributed systems with networking environments. So, Fujitsu forecasted that all information systems in the future will be connected to computer systems through the Internet, and strongly promoted their business in the food and agriculture, transportation and environmental fields. Today, IoT is accelerating this transformation. In the agricultural business field, Fujitsu started ten experimental farms using new ICT in Japan since 2008, where various sensors were implemented for collecting data and ICT utilisation methodologies were investigated considering optimisation of industry-wide food value chains. Through such demonstration experiments, Fujitsu found that it is important to change agricultural management from personal management on the basis of intuition and experience to scientific management on the basis of data analysis. As a result of such a consideration, Fujitsu developed the service package “Food and Agriculture Cloud: Akisai”, which completely supports agriculture business from agricultural production site to procurement, consolidation and distribution of agricultural products through a cloud computing environment. In addition, Fujitsu aimed to construct a food and agricultural value chain and optimise it by using Akisai in the same way a total value chain in other business fields such as logistics supply is optimised. Akisai was started to provide services from October 2012 and has been used by over 500 customers. Also, Fujitsu has been developing its own experimental farms for promoting food and agricultural value chains in Numazu City (1000-square-metre solar-powered open fields and 350-square-metre house farming) and in Aizuwakamatsu City (a 2000-square-metre completely enclosed plant factory). At these farms, Fujitsu has implemented in-house practices to obtain knowledge on agricultural ICT. Thus, Fujitsu not only promotes agricultural ICT business in Japan but also expands it globally on the basis of sufficient experiences in the agricultural business field.

9.3.3 Issues in Japanese Agricultural Business and Objectives of Fujitsu’s Agricultural ICT Business

1. **Issues in Japanese agricultural business**

Japanese agricultural products are of high quality in terms of taste, shape, safety, etc. and have been providing rich food to consumers. Japan is suitable for the production of a wide variety of agricultural products due to its wide land areas and is effective for creative attractive brands. Therefore, the Japanese government promotes “smart agriculture” for developing its agriculture as a growing industry. However, there are currently three issues in Japan described as follows.

Issue 1: Ageing of Agricultural Producers and a Shortage of Successors
In Japan, there are various problems such as the ageing of agricultural workers, a current shortage of carriers, lack of future successors, skill inheritance and an increase in abandoned cultivation areas. To revitalise agriculture in various parts of Japan and increase profits, policies such as switching to corporate agricultural management, labour saving and yield improvement are required.

Issue 2: Increase in Import Volume, Decrease in Food Self-sufficiency Rate and Necessity of Branding
Import volume of agricultural products from foreign countries increases year by year, and domestic food self-sufficiency rates continues to decline. Moreover, the Trans-Pacific Partnership Agreement (TPP) is expected to import foreign crops and increase exports of domestic crops. To strengthen the competitiveness of Japanese agriculture, agricultural business people should proceed systematically towards appeals of quality and brand, prospects of production, procurement of fertiliser, etc.

Issue 3: Regional Innovation
Agriculture is a key industry in each region. Many players such as agricultural producers, distributors, food industries, retail stores and so on, are involved in the local economy. However, overall cooperation including these players is not strong in Japan. To solve this issue, promoting smart agricultural business is expected through a collaboration of multiple players centred on agriculture as its core.

2. **The objective of Fujitsu's agricultural ICT business**

The objective of Fujitsu's agricultural ICT business is to solve the above issues and make Japanese agriculture more attractive. To achieve this objective, Fujitsu utilises ICT technologies to achieve efficient energy-saving farming, and changes agricultural decision making based on personal intuition and experiences to scientific analysis using various data. For example, fertilisers and pesticides are controlled effectively considering the cost and safety of agricultural products. To increase crop yields, harvest timing and fertilisers are determined in accordance with climate or farmland circumstances. Fujitsu supports highly profitable agriculture business through incorporating management perspectives into agriculture by using ICT technologies.

9.3.4 "Akisai" as a Core of Fujitsu's Agricultural ICT Business and Its Effect

1. **Outline of "Akisai"**

"Akisai", the core of Fujitsu agricultural ICT business, aims at streamlining agricultural management dramatically by using ICT, and contributing to increasing yields, improving quality and branding and saving labour by utilizing agricultural data. Advanced ICT technologies such as IoT and sensors, AI, cloud computing and smartphones are used for collecting various types of data and analysing these data to solve agricultural management issues to expand scale, improve quality and pass on skills to the next generation. The outline of "Akisai" is shown in Fig. 9.2. Fujitsu focuses on agricultural data processing and its utilisation for an effective food and agriculture value chain. The agricultural production management SaaS (Software as a service) and greenhouse horticulture SaaS, which are the main functions of "Akisai", are explained as follows.

Fig. 9.2 Outline of Akisai

2. **Agricultural production management (SaaS | software as a service)**

Agricultural production management in "Akisai" aims at improvement of the following items.

(a) Productivity improvement (yield increase per unit area)
(b) High quality/branding (sales volume and unit price increase)
(c) Cost reduction management (saving energy and resources)
(d) New farming personnel early training (scale expansion).

"Akisai" visualises management, production and quality of agriculture and manages a Plan-Do-Check-Act (PDCA) cycle by analysing planning and results of production, work, harvest and shipment. To execute the PDCA cycle easily, functions in the agricultural production management SaaS are arranged in three categories (Plan, Do and Check) and can be used easily for each usage scene in the PDCA cycle. For example, farmers can analyse various plans before work in the "Planning" phase, and confirm records of data generated daily in the "Recording" and "Confirming" phases. "Akisai" uses smartphones or tablets, and the user interface uses a simple touch panel-type input. With these devices, farmers can easily refer to accumulated work results and sensor data, visualise and analyse these data, and enables them to make accurate decisions in their agricultural business.

3. **Greenhouse horticulture SaaS**

An outline of the greenhouse horticulture SaaS in "Akisai" is shown in Fig. 9.3, where a facility's environmental control box consists of hardware for collecting sensor data or controlling various controllers. The greenhouse horticulture SaaS provides the following cloud services by using various data from the food and agriculture cloud database.

(a) Remote monitoring and control of greenhouses (Fig. 9.4)
(b) Automatic control of equipment in greenhouses under preset conditions

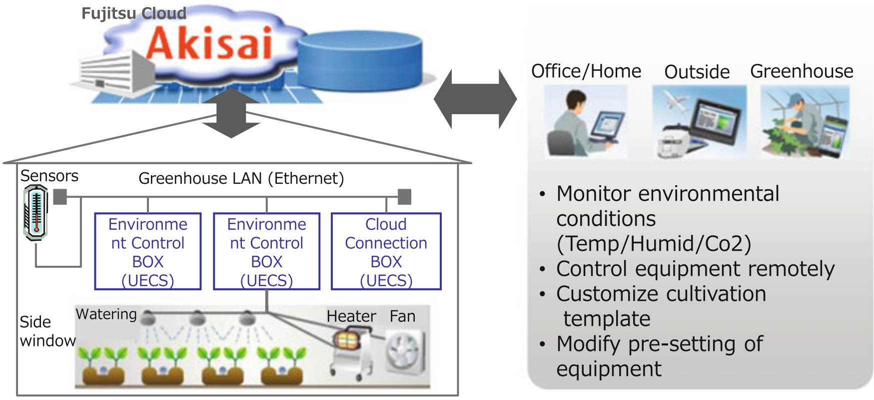


Fig. 9.3 Greenhouse horticulture SaaS in "Akisai"

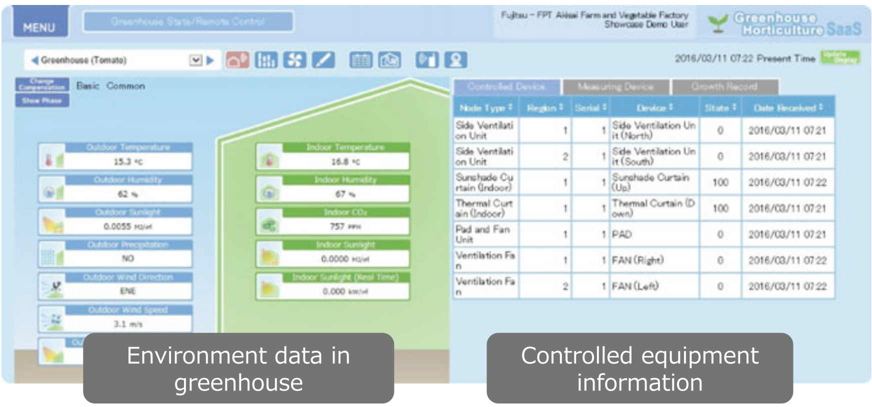


Fig. 9.4 Remote monitoring

(c) Accumulation and analysis of greenhouse environmental data in Fujitsu data centre (Fig. 9.5).

By using these services, farmers can perform necessary tasks in a timely manner and supply stable, high-quality agricultural products through visualisation of production process, remote monitoring of greenhouses and remote control of equipment.

4. **Effect of "Akisai" utilisation**

So far, "Akisai" has had many successful examples of increased yield and improved efficiency. Three examples are described as follows.

(a) In growing vegetables, the cabbage yield was increased by 30% compared to that of the previous year by thorough work during the appropriate period.

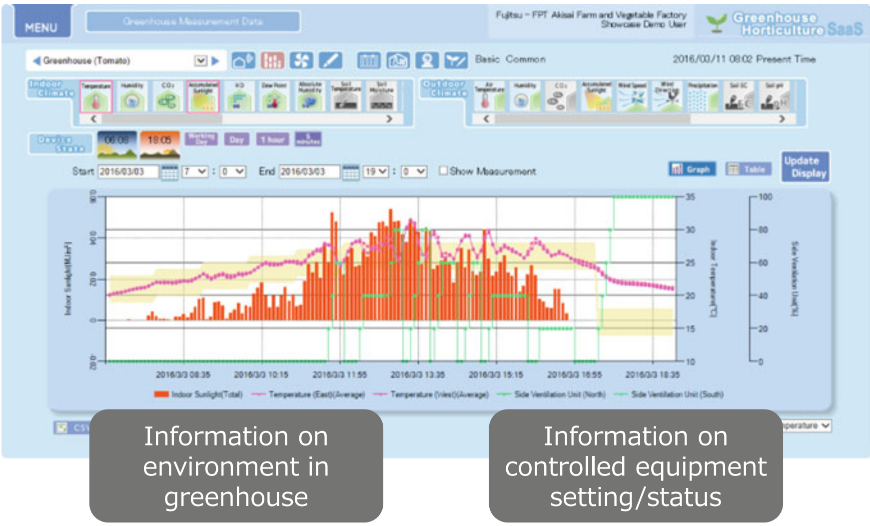


Fig. 9.5 Accumulated data references

(b) In growing rice, the total work time improved by 30% by analysing work time of each step in the rice planting work.
(c) In orange orchards, the yield ratio of oranges with a high sugar content increased from 20% to 40–50% by appropriate timely work.

9.3.5 Smart Agriculture Concept—Future Direction of Japanese Agriculture

1. **Future direction of Japanese agriculture**

Food and agriculture in Japan is now in a period of great change. In the natural environment, "severe climate change" is happening. In agricultural business, business scale becomes large and corporate agricultural management accelerates. Furthermore, players who are different from food and agriculture business are entering into this business so far. Under such business environment, collaborations towards new agriculture begin among various companies by integrating the following knowledge;

(a) Experiences and knowledge in people who have been involved in agriculture and food business
(b) Idea and plans in people who start agriculture and food business
(c) Achievements and research by people who support agriculture and food business from outside.

Fujitsu considers that "diversity", "originality" and "consistency" brought through such collaboration can introduce innovation in future agriculture and food business.

2. **Smart agriculture concept**

Fujitsu is proposing a smart agriculture concept as a new business model aiming at "co-creation". This is because co-creation is indispensable for future business, where new value in the field of agriculture and food business is created by people from various industries and companies. This concept aims to create new agriculture and food business that integrates advanced technologies and business models into each field on the basis of a common philosophy through collaboration among players across industries and businesses. Fujitsu is promoting the commercialisation of this concept as a technology-based agricultural production model that brings together Japan's technological capabilities. Agricultural ICT business including "Akisai" is a part of this business strategy. Fujitsu plans to export the smart agriculture related business in package form (Japan initiative model) in the future.

3. **Iwata model as the smart agricultural business**

As an initiative of this future concept, three companies of different business types, Fujitsu, Orix and Masuda Seed, are collaborating to realise regional innovation focused on agriculture in Iwata City, Shizuoka Prefecture, Japan. This initiative is called "Smart Agriculture IWATA" (SAC IWATA). Figure 9.6 shows the outline of this initiative.

The current status of kale, paprika and tomato in SAC IWATA are shown in Figs. 9.7, 9.8, 9.9, 9.10, 9.11 and 9.12.

Here, business groups across the industry/business fields are collaborating organically and integrating diverse knowledge to create new business models that look over the whole food and agricultural value chain including seeding stations. This project is expected to create strong agricultural business, create a new regional core business and establish regional branding.

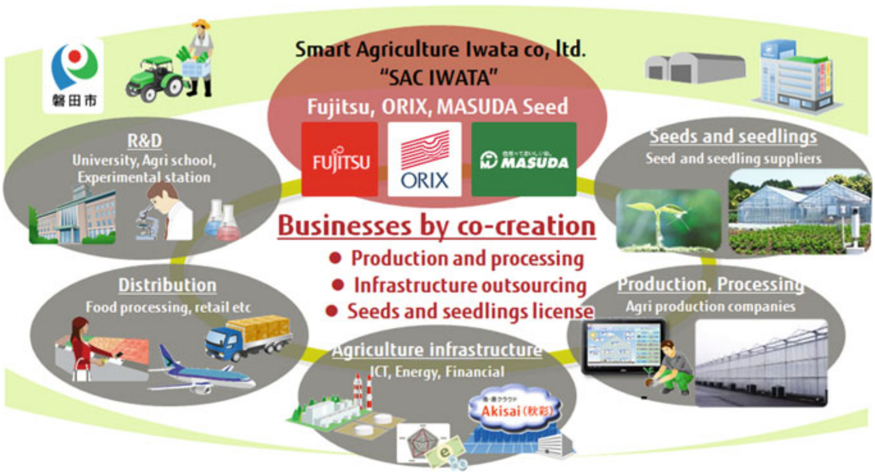


Fig. 9.6 Iwata model of smart agriculture

Fig. 9.7 Greenhouse for kale by soil culture

Fig. 9.8 Greenhouse for kale (inside)

Fig. 9.9 Greenhouse for paprika

Fig. 9.10 Paprika (inside of greenhouse)

9.4 Case 2: Spread's Plant Factory Business (http://www.spread.co.jp/en)

9.4.1 Outline of Spread

Spread is a plant factory business venture established in 2006. Spread operates the world's two largest plants as a single lettuce plant and covers all the elements required

Fig. 9.11 Greenhouse for tomato

Fig. 9.12 Tomato plants in green houses

for commercialisation in-house: production, development, logistics and sales. Spread continues to grow by integrating these functions to build a business system for vegetable products and sales.

1. **Background of establishing Spread**

In the twenty-first century, food shortages has become a big issue due to a global population increase, water shortages and crop damage due to abnormal weather. Also, the use of pesticides and fertilisers has a major impact on people's health and the environment. For this reason, it will become difficult to supply stable food supplies only by agricultural production suitable for the local climate and soil in the future. Moreover, there is a sense of crisis for the decline in agriculture due to a lack of successors due to the ageing problem in Japan. To solve these agricultural issues, Spread's founder proposed a new business, "Artificial-light type plant factory", that enables a stable income without being influenced by external factors such as weather and is an attractive business for the younger generation.

2. **Vision and Objective of the Company**

Spread's corporate vision is to realise a sustainable society where future generation can have peace of mind. To achieve this, the objective of the company is to develop a stable agricultural production system that can supply high-quality and nutritionally rich food to all people and expand this system all over the world.

3. **Spread's approach**

Spread's important mission is to develop sustainable agriculture with a new perspective and "connect" it to the next generation. Spread challenges to resolve agricultural and food issues by considering the following three types of sustainability:

- Social sustainability: stable production of safe food
- Economic sustainability: stable earnings for a secured business
- Environmental sustainability: conservation of global resources and the environment.

9.4.2 History of Spread's Plant Factory Business

Spread built its first plant factory in Kameoka City, Kyoto in 2007 where it produces 21,000 lettuces daily, which was the largest amount in the world. They established their original cultivation technology and production management know-how through repeated trial and error for six years, and achieved profitability in 2013, which was said to be difficult at large-scale plant factories. In 2014, they started a partnership business with a view of expanding the plant factory business globally. Also, pursuing further possibilities of an artificial-light plant factory, Spread started construction of the Techno Farm Keihanna (Fig. 9.13) in Keihanna Science City (Kansai Science City) from 2017, which is the first factory to introduce a state-of-the-art vegetable production system based on the concept of cost reduction and environmental consideration. Spread started shipping products from this factory from November 2018. This factory is the world's largest automated plant factory with the production capacity of 30,000 lettuces daily. Here, advanced technologies such as automated cultivation, water recycling technology, environmental control technology and LED lighting exclusively for plant factories are introduced to achieve larger and more stable production. Furthermore, applications of IoT and AI have been researched to analyse

Fig. 9.13 Techno Farm Keihanna

optimal cultivation environments. Techno Farm Keihanna is positioned as a mother factory of the next-generation agricultural production system *Techno Farm*™, which is aiming for global expansion through franchise and other partnerships.

The produced lettuce is sold to retail stores nationwide under the vertically farmed vegetable brand *Vegetus* (Fig. 9.14). Since lettuce produced in a vegetable factory is

Fig. 9.14 *Vegetus* lettuce

grown in an artificial-light plant factory, it has the following merits;

(a) Since no pesticides are used during cultivation, it can be cooked with confidence.
(b) There is no concern regarding dirt and worms on the outer leaves and core because the vegetables are hydroponically cultivated in a closed plant factory.
(c) There is little waste and you can tear it off by hand, so cooking is easy because the outer leaves can be used.

Spread sells *Vegetus* to about 2500 supermarkets in Japan.

9.4.3 Outline of Techno Farm™

Techno Farm™ is a next-generation agricultural production system that combines Spread's know-how based on 10 years of experience and technological innovation. Such technologies include those for automated cultivation using robotics, water recycling, environmental control, LED lighting exclusively for plant factories and advanced ICT technology such as IoT and AI. The cultivation flow and agricultural production management in *Techno Farm*™ is based on Spread's original know-how. Therefore, the system was developed as a Spread original system with special-purpose products realising this original know-how to reduce operational costs and environmental load. Developed technologies in *Techno Farm*™ are explained as follows.

1. **Automated cultivation technology**

By combining state-of-the-art cultivation and robotics technologies (Fig. 9.15), Spread automated the transplanting of seedlings and panel transportation that had been done manually, and realised unprecedented productivity as a result. Also, Spread made it possible to produce more hygienic and safe vegetables through reducing the number of bacteria and the risk of contamination by keeping the cultivation building unmanned. Furthermore, by minimising the work space, production per unit area has been dramatically improved (Fig. 9.16). In this way, Spread has realised next-generation vegetable manufacturing with the aim of labour saving, efficiency and high quality.

2. **Optimisation of cultivation environment**

Spread developed two important technologies: environmental control that always provides the best conditions for vegetables and water recycling that does not waste any water.

[Environmental Control Technology]
Vegetables are sensitive to slight changes in temperature, humidity, wind direction and carbon dioxide. Especially in vast spaces, the cultivation environment tends to vary. In *Techno Farm*™, the cultivation environment is kept uniform with

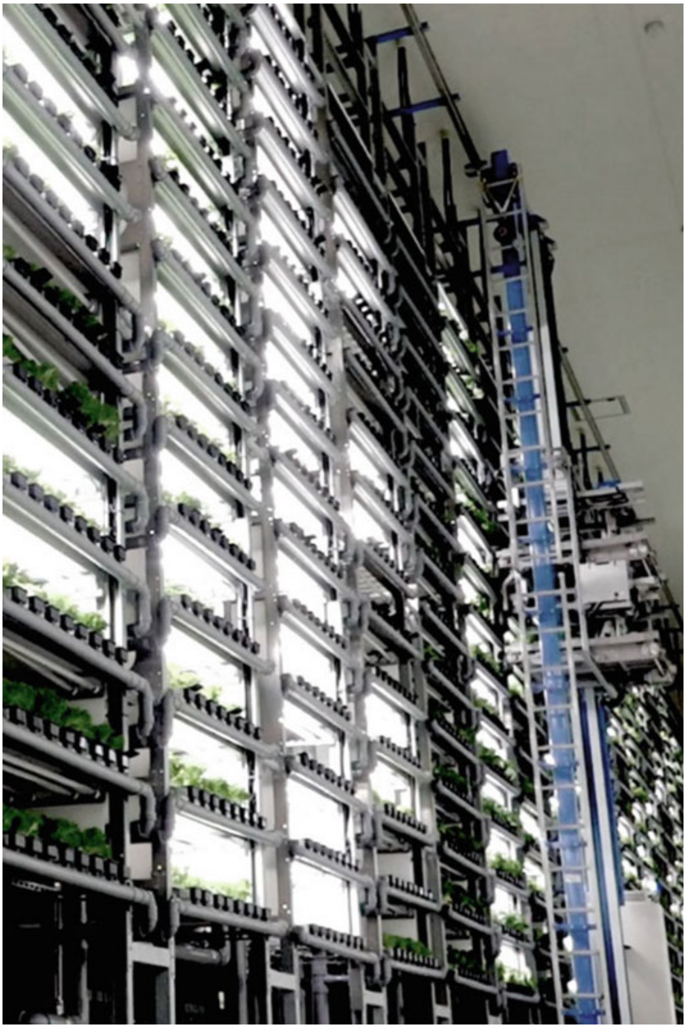


Fig. 9.15 Automation technology

their own air conditioning system to realize large-scale stable production of high-quality vegetables (Fig. 9.17). By using *Techno Farm*^{TM}, vegetables can be produced anywhere in the world from urban areas to cold and tropical areas because the artificial-light plant factory is not affected by the external environment.

[Water Recycling Technology]

Water used for cultivation is reused in the same cultivation space by nano-level filtration technology (Fig. 9.18). In addition, by collecting even the transpiration water from vegetables, 98% of the water used for cultivation can be recycled. As a result, the amount of water required for cultivation could be reduced to about 1/100

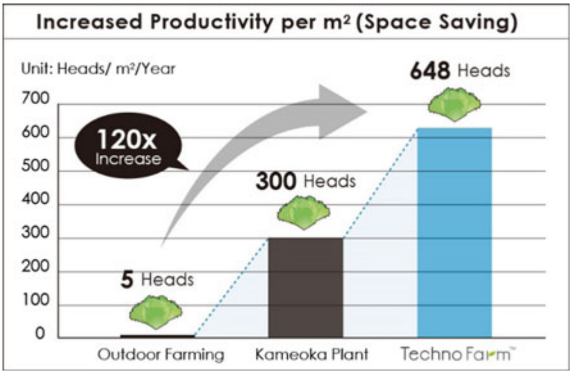


Fig. 9.16 Improved yield

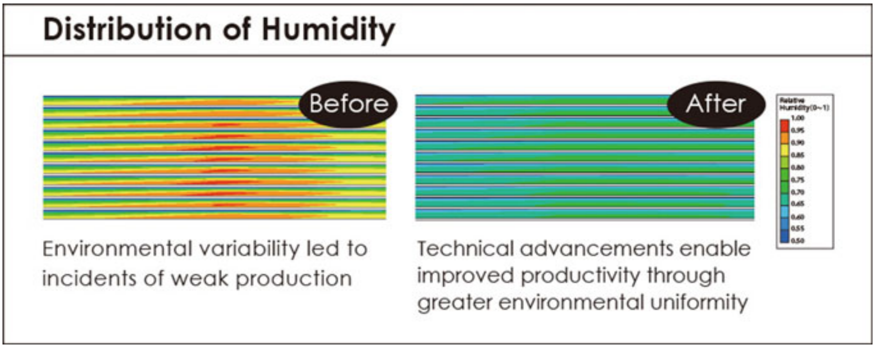


Fig. 9.17 Cultivation environment

compared to outdoor cultivation (Fig. 9.19). It is a new technology that enables agriculture in areas where water resources are scarce and protects the precious Earth resources.

3. **LED lighting exclusively for plant factories**

Spread developed lighting technology that completely eliminated waste as a result of determining the optimal light conditions for growing vegetables in plant factories. By using this technology, Spread succeeded in reducing power consumption by 30% compared to using conventional LED lighting (Fig. 9.20). In addition, this technology can promote optimal growth of vegetables by selecting the optimal wavelength for photosynthesis. Therefore, it reduces the cost of lighting itself and can illuminate vegetables efficiently.

4. **IoT, AI technology**

Based on the idea that ICT technology will accelerate smart agriculture, Spread is actively utilising IoT and AI. By using cultivation data collected by sensors, the optimal cultivation situation is extracted, and advanced production management can

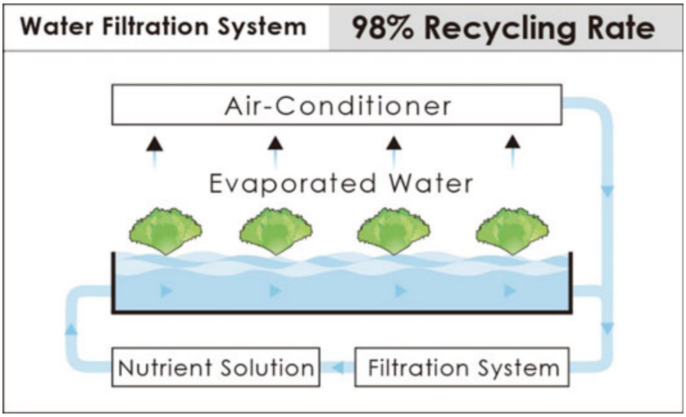


Fig. 9.18 Water filtration system

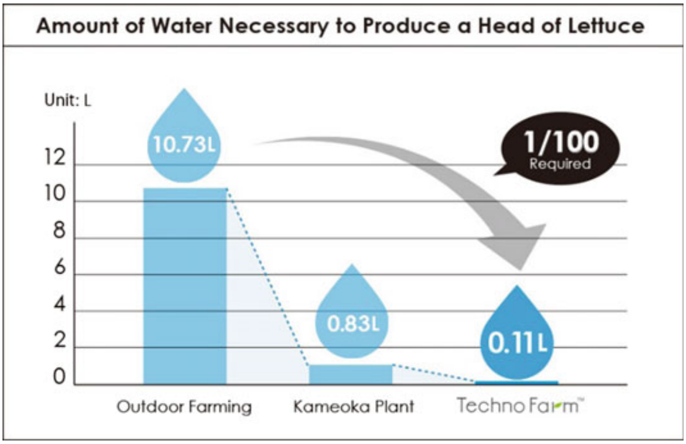


Fig. 9.19 Water recycling effect

be achieved on the basis of yield prediction. Spread is aiming at smart production through analysis accuracy improvement by using big data gathered from each site and sharing the necessary skilled experience for cultivation with the world. With regard to the use of such ICT technology, Spread is conducting joint research with NTT Comware and NTT West. The object of this joint research is to realise more stable production and higher quality through collecting and analysing big data accumulated by Techno Farm Keihanna, and controlling the optimal cultivation environment automatically. In particular, to realise environmental control using AI in an artificial-light type large-scale plant factory, they strive to develop AI that automatically derives optimal solutions for plant growth factors such as temperature, humidity and nutrients. This is a "smarter" factory for efficient cultivation (Fig. 9.21), where AI is

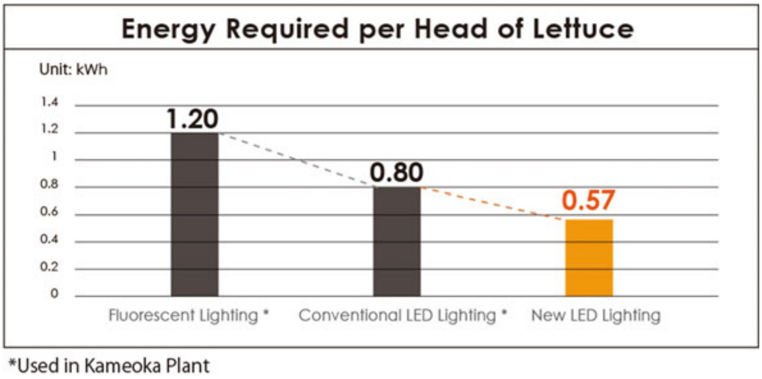


Fig. 9.20 Electric energy consumption per one head of lettuce

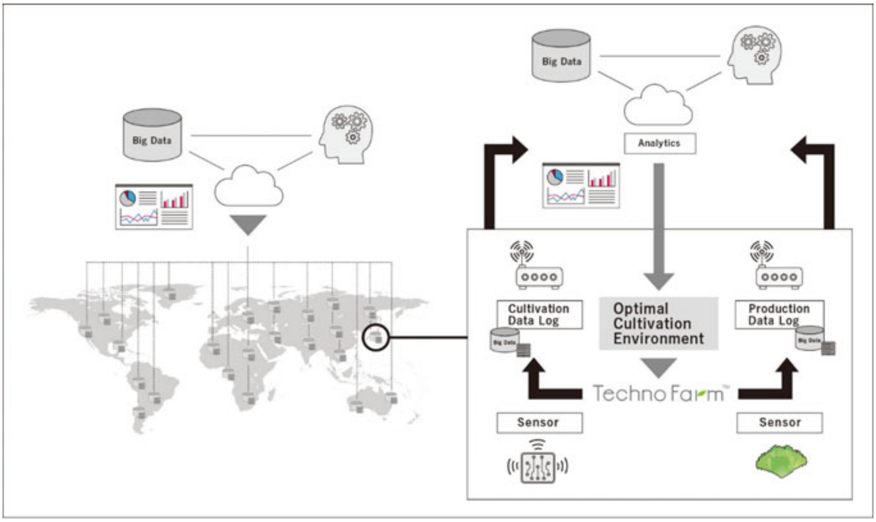


Fig. 9.21 Smarter factory using IoT and AI

learning and corresponding by using collected data in the factory in accordance with the following steps.

Step 1: Collection and accumulation of environmental data and crop data in plant factories (IoT)

Step 2: Analysis of optimal cultivation environment patterns (AI)

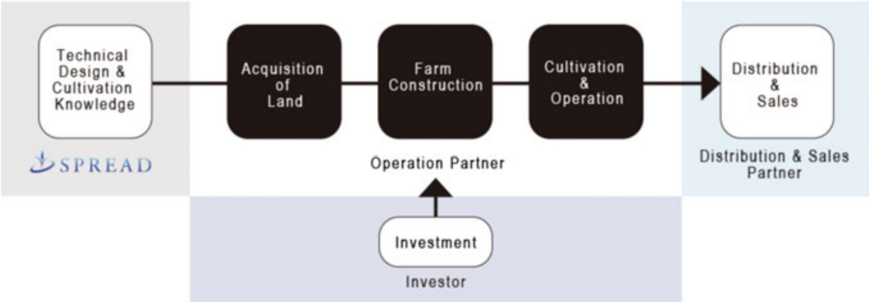


Fig. 9.22 International business model

9.4.4 Business Model Using Techno Farm™

Spread promotes domestic and overseas partnership development as a medium- to long-term initiative after the operation of Techno Farm Keihanna. For this purpose, several partnership models have been prepared including ones for domestic franchises, domestic ownership, agricultural symbiosis, international business, joint research and development partnerships. Partner companies can select suitable partnership models depending on their situations.

For example, in the international business model shown in Fig. 9.22, an overseas partner company and Spread promote joint business through collaboration using *Techno Farm*™. Spread supports the partner company from factory construction to production management by providing design and cultivation know-how. In this business model, Spread establishes a scheme to promote joint business with a wide variety of partners considering characteristics in each region.

9.4.5 Summary of Spread's Plant Factory Business

Spread tries to realise the following innovations by promoting plant factory business.

1. Creation of a new business model that reforms the agriculture business structure. This changes the established standards of agricultural business through alliances with different industries, for example, technological development through collaboration and consortium with business partners.
2. Development of new agriculture production technologies by integrating agriculture and engineering. This includes automated cultivation processes, water recycling and LED lighting exclusively for plant factories.
3. Establishment of a new food supply infrastructure considering the global environment, such as reducing CO_2, recycling water resources, etc.

Such industrialisation of agriculture using ICT may offer solutions to current issues in the agriculture and food industries.

9.5 Case 3: Venture Company of IoT Agriculture in Vietnam: MimosaTEK

9.5.1 Outline of MimosaTEK

MimosaTEK, which provides precision agricultural solutions for farming business in Vietnam, was established in 2014 and has now become one of the best venture companies through five years of continuous development. The company now serves over 300 business customers nationwide. A number of well-known partners and customers to mention include The World Bank (IoT in an agriculture project), TTC Group, Dalat Organik, VinEco, etc. Having the ambition to change the future of Vietnam's agriculture, MimosaTEK's vision is *"MimosaTEK harnesses technology to improve the lives and livelihood of farmers by transforming from experience-based farming into information-driven"* (MimosaTEK2019). As a pioneer of IoT applications in Vietnam's agriculture, MimosaTEK has received significant public interests, and the start-up has won a number of awards such as the Venture Cup in 2015, the Vietnamese round of Seedstars World in 2016 and so on. MimosaTek's new models of IoT applications have been highly appraised by World Bank, the Swedish International Development Cooperation Agency, Securing Water for Food Grand Challenge etc.

9.5.2 Background of Vietnam Agriculture and the Objective of MimosaTEK

1. **Background of Vietnam agriculture**

Vietnam is one of the top agricultural export countries. It is the third biggest in rice export (The world atlas 2017), second biggest in coffee export (The world atlas 2018) and the world's biggest black pepper export (The world atlas 2017). While its government has been pushing for the industry and service sectors to take off, with the goal of become an "industrialised country" by 2020, agriculture still contributed 14.57% of the country's GDP in 2017, exceeding US$34.33B in export revenue (World Bank 2019).

However, throughout their long history, Vietnamese farmers still mainly rely on experience and implement what has been previously been considered the best practices available rather than rely on scientifically-proven methods. Although they have been blessed with such great natural advantages like weather, rich soil and water supplies, the results of yields are not as good as desired. Farming in Vietnam is almost like gambling for farmers: they invest their money, efforts and even their whole working lives just to hope that the crops will be fruitful thanks to nature. As a result, yields' productivity is not consistent or reliable, causing failure and losses for cultivators.

Another characteristic of agricultural production in Vietnam is that it is carried out by small-scale farmers, who do not have the capital to invest in systems that could cost thousands of dollars. Also, farming is still widely regarded as manual labour, and farmers persistently stick to traditional ways of farming.

2. **Objective of MimosaTEK**

The objective of MimosaTEK is to develop “supercharged” agriculture in Vietnam using IoT technologies, which promises to unlock the vast market potentials for Vietnamese products in terms of productivity, quality and market competitiveness. The company aspires to implement precision agriculture in every farm with world-class technology.

One particular example is “precision agriculture”, where most modern technological means are used to optimise farming operations. IoT-based systems, supported by real-time data from sensors and big data analytics, provide farmers with further information regarding all farming decisions not otherwise visible. This helps farmers make better decisions, reduce waste and maximise efficiency (MimosaTEK 2019).

MimosaTEK provides farm management solutions for both smallholder farmers and large agricultural companies in different parts of Vietnam and for different crops. For instance, the solutions are applied for short-day plants such as vegetables and perennial plants such as black pepper, maca and citrus trees. MimosaTEK collaborates with reputable partners in irrigation infrastructure supplies and greenhouse construction to provide complete solutions for our customers. As an AgriTech company, MimosaTEK continues to enhance its solutions and listen to customer needs. Solution optimisation is always at the core of its strategy.

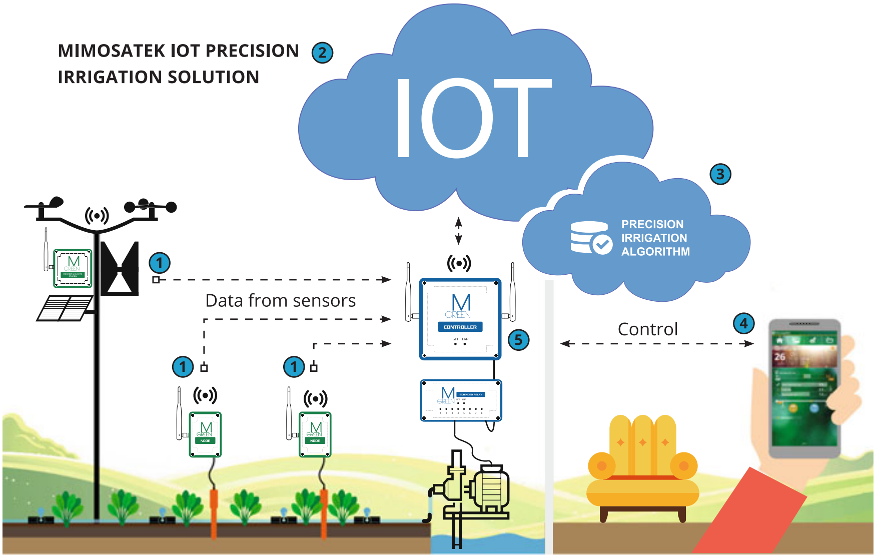
9.5.3 MimosaTEK Precise Agricultural Solutions

1. **Outline of MimosaTEK solution**

The core innovation of MimosaTEK is illustrated in Fig. 9.23. By using sensors that detect weather conditions and water supplies, Mimosa software (now available on mobile devices) can provide farmers with necessary information. All the information regarding weather and soil moisture can easily be tracked on the application. It also gives suggestions for watering or even help irrigate the farm automatically via certain settings. Farmers can apply this solution to optimise irrigation and fertilisation activities on farms.

MimosaTEK solutions brings the following benefits for farmers, traders and governments:

- Farmers can optimise water, electricity and fertiliser usage, achieve optimum crop yield and provide full traceability to their commercial partners.
- Traders can use traceability data of farmers to manage their supply chains and to notify end consumers.



Operating principles of MimosaTEK IoT precision irrigation solution

Fig. 9.23 Precision irrigation solution (MimosaTEK 2019)

- Governments can sponsor technology for farmers, which improves their supply chain management and farming quality in their region. Governments can also use data from weather stations to help local farmers manage their crops more efficiently.

The system operations are as follows:

- The farm or greenhouse is equipped with sensors that track weather conditions and soil moisture. After every five minutes, the data will be updated from the sensors to a centralised management software application.
- A database of plants, including development phase, drainage coefficients, lengths of plant roots, structure of the soil, etc. has already been set up in the software.
- The management software synthesises the original specifications and data from the sensors daily to calculate the amounts of water or fertilisers per day. This information is sent directly to the farmers' mobile phones.
- In addition to knowing the amounts of water or fertiliser needed, the farmers can control irrigation by using a remote irrigation system integrated in the MimosaTEK software. With the remote irrigation system, the water supply is maintained accurately and conveniently.

The success of MimosaTEK solutions enables the company to affirm a 30% reduction in water usage. Moreover, the fertiliser management also helps reduce fertiliser residues that are bad for both plants and consumers. This helps the yields to be productive, minimises possible damages and saves costs for the farmers.

Fig. 9.24 MimosaTEK system's sensors on the farm (MimosaTEK 2019)

2. **Products and solutions**

MimosaTEK offers products such as soil moisture sensors, weather stations, micro-climate sensors (greenhouse only), irrigation controllers, smart automation irrigation and fertilisation systems, MimosaTEK management software and mobile applications. Figure 9.24 shows MimosaTEK system's sensors in a farm.

By using these products, MimosaTEK provides two solutions: which are precision irrigation for smallholder farmers and precision fertigation for medium to large farms. These solutions help farmers manage their yields and crops and provide the following features for agricultural communities in Vietnam.

(a) MimosaTEK's precision irrigation solution has been proven to help save water and electricity usage up to 30%, and to increase crop yield by 25%.
(b) Climatic parameters measured via sensors in MimosaTEK devices help farmers forecast certain conditions that would give rise to the development of harmful insects and diseases.

3. **Development process**

In developing systems and solutions, MimosaTEK has overcome many obstacles both from a knowledge and social perspective. The company has gone through many ups and downs in the research and development of its system to improve its accuracy. The first challenge is that MimosaTEK had no previous experience in farming forecasting or knowledge. Tri Nguyen, CEO of MimosaTEK, met many of the most knowledgeable people in farming. Together, they investigated the environment factors and geological elements that affect plants. However, Vietnamese agriculture generally lacks data collection. While there are plenty of databases on plants and their growth information in developed countries, Vietnam is still behind in gathering such data. Information of plants and their developmental progress have never been collected and recorded accordingly. Therefore, it is difficult to access fundamental information of crops to set up the analysis. MimosaTEK has solved the problems by simulating using the information from the Food & Agriculture Organization (FAO) and from real experiments in the field. Collecting sufficient data for different types of plants is time consuming and expensive. Tri Nguyen and his colleagues have tried their best to develop a system that is suitable for as many plants as possible, widening the horizon for their application in agriculture.

The second challenge is that the farmers, with a long history of working based on experience and senses, are afraid to try new technologies and smart devices. They are hesitant to try alternative solution and are sceptical of the system's ability to succeed. Initially, the farmers believed in their instincts more than the technology. They believe that nothing but their experiences can help them well in the field. Furthermore, the cost of setting up such system is relatively high to many farmers in Vietnam. When MimosaTEK first released their products and service, their sales were significantly under-target. *"We approached the product by inventing features we thought everyone would want, but it was too broad."* explains Lan Anh Le, the COO of MimosaTEK. After communicating with the farmers and extracting useful information, the company realised their problems were as follows:

- MimosaTEK's exhaustive approach was overwhelming for small farms.
- The extensive system means a steep learning curve as well as higher costs.
- In a number of areas, farmers do not have the electrical requirements needed for automated irrigation—to fully adopt the technology, they would have to upgrade their electrical boxes on their water pumps as well.
- Saving water and the environment are not the farmers' priorities at the moment as most of them need the immediate benefits from their investments.

With these revelations, MimosaTEK changed their strategy and approached small farmers by offering prompt and visible benefits, such as how MimosaTEK's solutions can save up to 80% of labour costs, time and even their electricity bills. Finally, MimosaTEK has simplified its product to make adoption easier. *"We've combined previously separate parts of the system into a single product to simplify automation."* And now farmers can ease into the system. "*They can buy the irrigation automation first, since it is the easiest to understand. Then later, after they get used to using data in their farming, they can buy the soil moisture sensors and other greenhouse products. We now take a step-by-step approach,"* explains Lan Anh Le. Moreover, the farmers can now rent the system on a monthly basis to try the technology at an affordable price. When it yields good results, the farmers are likely to choose MimosaTEK as a "must have system" instead of a "useful system" (Fig. 9.25).

The most important change, however, has been in MimosaTEK's mindset. *"We had this great idea and thought the customers would want our products to be more*

Fig. 9.25 Completed solution of MimosaTek for farming

technology-oriented," says Lan Anh. *"But now we're more focused on the farmers' needs. We're transforming the company to become more customer -oriented*."

9.5.4 Summary of MimosaTEK

Over five years of operations, MimosaTEK has steadily developed, following the company vision. So far, MimosaTEK has deployed its solution to more than 300 farms and helped save more than 80 million litres of water. They have achieved the goal of contributing to Vietnam's agriculture. In the era of beneficial start-ups like social network platforms, ecommerce apps and FinTech as leading trends, AgriTech has progressed steadily because of its true nature: innovation for environmental sustainability. It has opened a new chapter of high technological applications in farming, where the farmers now can utilise the available infrastructure and optimise irrigation and fertilisation to ensure fruitful harvests.

9.6 Analysis in Business Innovation with New ICT

We analyse the direction of business innovation on agricultural ICT by comparing the three cases in accordance with the following questions.

1. **What are the needs of people, the issues in society and business and the objective of utilising ICT? (needs)**

Agricultural business has become more important. By 2024, the Earth's population will total more than 8 billion for the first time in history, adding new stresses on the global supply chain, which is already challenged by a volatile climate and water supply shortages. Therefore, there are various issues to be solved in global agricultural business, including increasing yield optimisation, improving crop protection, optimising food supply chains and so on. Additionally, in Japan, there are various problems such as ageing of agricultural workers, current shortage of carriers, a lack of future successors, skill inheritance and an increase of abandoned cultivation areas. In Vietnam, farming is still widely considered to be manual labour, and farmers persistently stick to traditional ways of farming and yields' productivity is not consistent or reliable, causing failure and losses for cultivators. Smart agriculture with new ICT is desired for solving these issues.

2. **What technologies and functions are utilised to solve these issues or realise the needs of people? What is the role of ICT in value creation? (technologies)**

To solve the above issues, a total system optimisation approach, which collects data using sensors, analyses it for optimisation, controls equipment and creates suitable information for decision makers, is conducted in agriculture. This is a type of cyber physical system (CPS). In the data collection part, necessary data are collected through the use of IoT. In the analysis part of the cloud computing environment, AI finds the optimal solutions under the current environment. There are various analyses that use AI, including work guidance, work plan, correlation analysis, fault detection and so on, for optimising agriculture operations. The results are sent to controllers, farmers or other industries by IoT, smartphones, or Internet-based communication. New ICT makes it possible to realise a total system optimisation approach in agriculture business.

3. **What are value creation methodologies? (value creation)**

Value is usually co-created between users and providers. In agricultural ICT business, agricultural knowledge is indispensable for providers to create value with agricultural people by using ICT. The companies in the following case studies made efforts to obtain sufficient agricultural knowledge for value creation.

Fujitsu has been developing its own experimental farms for promoting food and agricultural value chains in Numazu City (1000-square-metre solar-powered open fields and 350-square-metre house farming) and in Aizu-Wakamatsu City (a 2000 square-metre completely enclosed plant factory) and has conducted in-house practices at the farms to obtain knowledge on agricultural ICT. On the basis of such activities, Fujitsu promotes value co-creation with customers.

Spread built their own plant factory in Kameoka city, Kyoto in 2007 where they established their original cultivation technology and production management know-how through repeated trial and error for six years. Spread built Techno Farm

Keihanna, which is the first factory to introduce a state-of-the-art vegetable production system based on the concept of cost reduction and environmental consideration. Spread started shipping products from this factory from November 2018. Thus, Spread has developed its own knowledge on agriculture and food supply chains through trials in their own factories.

In Vietnam, MimosaTEK had no previous experience in farming forecasting or knowledge. There are many people possessing the best knowledge in farming regarding environment factors and geological elements that affect plants. However, Vietnam's agriculture generally lacks the means to collect data. Therefore, it is difficult to access fundamental information of crops to set up the analysis. So, MimosaTEK solved the problems by simulating using the information from the FAO and from real experiments in the field. Collecting sufficient data for different types of plants is time consuming and expensive. MimosaTEK have tried their best to develop a system that is suitable for as many plants as possible, widening the horizon for their application in agriculture.

Thus, the companies in these cases have developed their own agricultural knowledge for creating values using new ICT.

4. **What is the relationship between human/business (including employee, organisational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**

Co-creation and collaboration are indispensable for future ICT business. The companies in the following case studies provide evidence.

Fujitsu proposed a smart agriculture concept as a new business model aiming at "co-creation" because co-creation is indispensable for future business, where new value in the field of agriculture and food business is created by people from various industries and companies. This concept aims to create new agriculture and food business integrating advanced technologies and business models in each fields on the basis of common philosophies through the collaboration of players across industries and businesses.

Spread promoted domestic and overseas partnership development as a medium- to long-term initiative after the operation of Techno Farm Keihanna. For this purpose, several partnership models have been prepared, including ones for domestic franchises, domestic ownership, agricultural symbiosis, international business, joint research and development partnership. With regard to the use of ICT technology, Spread is conducting joint research with NTT Comware and NTT West. The object of this joint research is to realise more stable production and higher quality through the collecting and analysing of big data accumulated by *Techno Farm*™.

MimisaTEK is also growing up as a solution provider through the co-creation with farmers as follows; *"We've combined previously separate parts of the system into a single product to simplify automation. And now farmers can ease into the system. They can buy the irrigation automation first, since it is the easiest to understand. Then later, after they get used to using data in their farming, they can buy the soil moisture sensors and other greenhouse products. We now take a step-by-step approach."*

5. **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

Agricultural ICT innovates food supply chains with agricultural products and productivity of those products in the following case studies.

Fujitsu aims to create new agriculture and food business that integrates advanced technologies and business models, and promotes the commercialisation of this smart agriculture concept through an initiative project "SAC IWATA" where Fujitsu, Orix and Masuda Seed are collaborating to realise regional innovation focused on agriculture in Iwata City, Shizuoka Prefecture, Japan.

Spread tries to realise the food supply chain innovation through (1) the creation of a new business model that reforms the agriculture business structure, (2) the development of new agriculture production technologies, including automated cultivation processes, water recycling and LED lighting exclusively for plant factories and (3) the establishment of a new food supply infrastructure considering the global environment such as reducing CO_2, recycling water resources, etc.

MimosaTEK innovates Vietnamese agriculture from being instinct-oriented to technology-oriented to improve yield productivity and crop protection.

9.7 Conclusion

We discussed agricultural ICT from the viewpoint of business innovation with new ICT. The major success factor is the total system optimisation approach in agricultural business using new ICT technologies, which collects data using IoT and sensors, analyses it using AI for optimisation, controls equipment by IoT and creates suitable information for decision makers using smartphones. In addition, food value chain optimisation under a cloud computing environment is promoted through collaboration among different industrial stakeholders. The agricultural industry is a very important business sector in the twenty-first century, and new ICT is expected to play an important role in the development of innovative agricultural business.

References

Chen S, Xu H, Liu D, Hu B, Wang H (2014) A vision of IoT: applications, challenges, and opportunities with China perspective. IEEE Internet Things J 1(4):349–359

Choudhary SK, Jadoun RS, Mandoriya HL (2016) Role of cloud computing technology in agriculture fields. Comput Eng Intell Syst 7(3):1–7

Fan TK (2013) Smart agriculture based on cloud computing and IOT. J Converg Inf Technol 8(2)

Hori M, Kawashima E, Yamazaki T (2010) Application of cloud computing to agriculture and prospects in other fields. FUJITSU Sci Technol J 46(4):446–454

Li M, Zhu Z, Chen G (2013) Information service system of agriculture IoT. Automatika, J Control Meas Electron Comput Commun 54(4):415–426

Mekala MS, Viswanathan P (2017) A survey: smart agriculture IoT with cloud computing. In: 2017 international conference on microelectronic devices, circuits and systems (ICMDCS)

Patil KA, Kale NR (2016) A model for smart agriculture using IoT. In: International conference on global trends in signal processing, information computing and communication, pp 543–545

Shi X, An XS, Zhao Q, Liu H, Xia L, Sun X, Guo Y (2019) State-of-the-art Internet of Things in protected agriculture. Sensors 19:1833–1857

https://data.worldbank.org/indicator/NV.AGR.TOTL.CD?locations=VN&view=chart. Retrieved Mar 2019

http://www.fao.org/fileadmin/templates/rap/files/uploads/ESF_Presentations/FAO-ITU_China__Wu_Yin__Final_Revision.pdf

https://e27.co/7AgriTech-startups-asia/. Retrieved Mar 2019

https://MimosaTEK.com/en/. Retrieved Mar 2019

https://www.cbinsights.com/research/agriculture-tech-market-map-company-list/. Retrieved Mar 2019

https://www.worldatlas.com/articles/the-american-food-giant-the-largest-exporter-of-food-in-the-world.html. Retrieved Mar 2019

https://www.worldatlas.com/articles/the-world-s-largest-exporters-of-coffee.html. Retrieved Mar 2019

https://www.worldatlas.com/articles/the-world-s-top-black-pepper-producing-countries.html. Retrieved Mar 2019

https://www.worldatlas.com/articles/top-rice-exporting-and-importing-countries.html. Retrieved Mar 2019

Chapter 10
Aiming to Realize a Smart Society and Seamless Mobility with ICT: JR-EAST's Challenge for Business Innovation

Masahiko Suzuki

Abstract The East Japan railway company (hereafter JR-EAST) is the largest railway company in Japan. Social infrastructure service has progressed according to the progress of ICT. JR-EAST provides a railway transport service, which is among the important social infrastructure services, and has continued provide innovation in transportation services for customers and improvement in its work process by utilizing ICT such as the internet, IoT, and AI. This chapter introduces the history of innovation and future development with ICT and reviews progress in terms of service by ICT. JR-EAST has long contributed to society through its railway transport service and continues to realize business innovation, seamless mobility and convenience through its railway transport service by ICT.

10.1 Introduction

The East Japan railway company (hereafter JR-EAST) is the largest railway company in Japan. Social infrastructure service has progressed according to the progress of ICT. JR-EAST provides a railway transport service, which is among the important social infrastructure services, and has continued provide innovation in transportation services for customers and improvement in its work process by utilizing ICT. ICT itself has progressed through the accelerating speed of developing technologies, such as computers, online processing, the internet, and smartphones. JR-EAST has enhanced transportation services by utilizing ICT, such as the internet, IoT, and AI. Railway service, a social infrastructure service, is carried out safely and accurately every day by operating a huge infrastructure, rolling stocks, grand facilities, and operating staff organically. ICT can manage these resources as a system effectively, so railway operators can achieve many innovations, such as providing higher-quality transport service, realizing efficient communication with customers, creating new services and achieving a higher level of maintenance.

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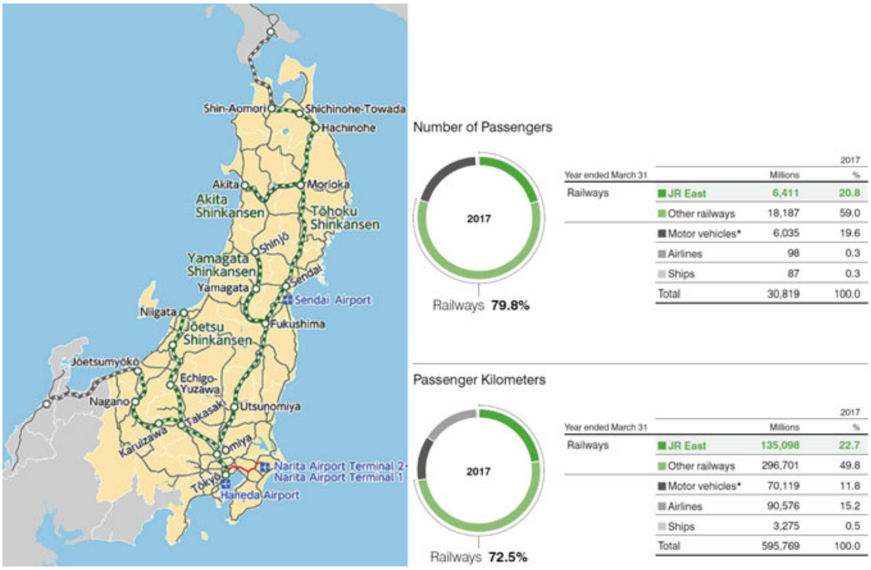
In this chapter, we focus on JR-EAST, which provides many services related to transportation. This chapter introduces the history of innovation and future development with ICT and reviews progress in terms of service by ICT. JR-EAST has long contributed to society through its railway transport service and continues to realize business innovation, seamless mobility and convenience through its railway transport service by ICT.

10.2 JR-EAST's Company Profile and Management Strategy

10.2.1 Company Profile of JR-EAST

JR-EAST is a Japanese railway company that was established in 1987. Among the railway companies in Japan, JR-EAST is the largest, and it belongs to the largest class in the world. JR-EAST's operating line is over 7400 km (including the 1200 km Shinkansen high-speed train), transporting 17 million passengers per day (Fig. 10.1). The operation area crosses the Tokyo metropolitan area, Tohoku area and Koushin-etu area. The operating line consists of 5 lines of Shinkansen (1194.2 km) and 66 conventional lines (6205.5 km). The conventional lines mainly take on the role of transportation in the Tokyo metropolitan area and intercity transportation. Shinkansen mainly



Operating area (JR-EAST(2020-3)) Passenger data (JR-EAST(2019-1) p.44)

Fig. 10.1 Operating area and passenger data of JR-EAST

Fig. 10.2 Pleasure Train "GENBI SHINKANSEN" (JR-EAST 2020-2)

takes on the role of intercity transportation end-to-end in the JR-EAST operating area. Approximately 12,000 trains are operated with 53,200 staff every day.

JR-EAST provides many characteristic transport services, including the following:

1. Service providing more convenience to passengers through operation among different lines, such as Shinkansen and conventional lines (Akita Shinkansen, Yamagata Shinkansen), and through services such as the Ueno-Tokyo line and Shonan-Shinjuku line.
2. Service providing more luxurious service via the "Gran class" (like first-class air travel).
3. Service providing pleasure and entertainment, such as "GENBI SHINKANSEN" (Fig. 10.2) and "Resort Shirakami."

These transport services have increased the value of movement itself. JR-EAST expands various railway transport services to increase the attractiveness of rail travel by keeping up with its customers' variety of needs and habits.

Additionally, JR-EAST has carried out various businesses other than its railway business. These businesses have been carried out under the following policy: "From the provision of services with railway infrastructures to the introduction of new values to society, focusing on the affluence of everyone in their daily lives." (JR-EAST 2019-4, p. 2-1).

- IT, Suica business: "Suica service" (Fig. 10.3), "Shopping point service," "Credit card."
- Distribution, service business: "In-station (eki naka) commercial facilities" (Fig. 10.3), "Convenience store business," "Beverage business," "Advertising business," "Sports, leisure business," "Location service," "Property license business."
- Real estate, hotel business: "Development of shopping center," "Office building business," "Housing business," "Hotel business."
- International business: "Technical support for overseas railway construction project (e.g., Joining high-speed railway project between Mumbai and Ahmedabad in India)."

Suica (JR-EAST (2019-1) p.39)

ecute (JR-EAST (2019-1) p.38)

Fig. 10.3 Image of lifestyle service

10.2.2 Management Strategy of JR-EAST

Since its establishment, JR-EAST has been striving to realize safe and convenient railway service. As a result, the number of railway accidents has been halved, and the railway network including high-speed train (Shinkansen) lines has expanded. JR-EAST takes pride in its social trust. JR-EAST thinks that through setting "Trust" as its base, it will be able to create new value by integrating various technologies developed inside JR-EAST and introduced externally (open innovation) (Fig. 10.4).

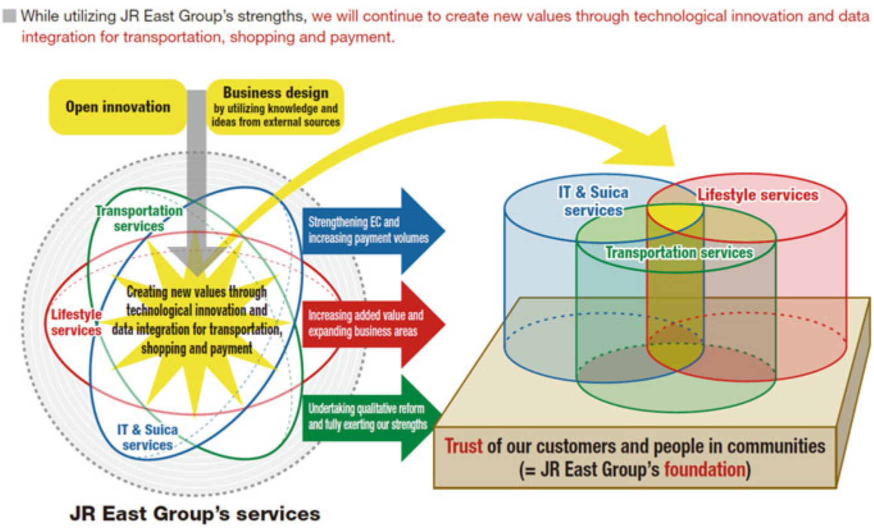


Fig. 10.4 JR-EAST Group's strengths (JR-EAST 2019-4, p. 4-2)

10.3 Service Revolution for Social Infrastructure Service by ICT

In this section, we investigate how social infrastructure is revolutionized and progressed by ICT, using Japanese railways and JR-EAST as the case study.

10.3.1 Direction of Service Revolution by ICT for Social Infrastructure Service Providers

ICT has made human activities more convenient in many ways and has provided new functions never been seen. We think these two characteristics have improved the service level of social infrastructure from two points of view: "Contact with customers" and "Progress in efficiency for maintenance/development of infrastructure." We put each ICT technology in the plane of two axes (Fig. 10.5). We can see that each technology can enhance two characteristics in each different ratio. For example, "Process integration" is relatively effective to maintain/develop a provider's infrastructure, and "Smartphone" is more effective to close the gap between providers and customers.

Social infrastructure service providers need many infrastructure resources when providing services. In the 1870s, the dawn of railway history in Japan, almost all operations depended on human activity. Since then, operation mechanization has progressed such as through signal control (1856), automatic vehicle couplers (1925), centralized train control (CTC) (1936) and programmed train control (PTC) (1964) (Matsumoto 1992). Because the operation area of the Japan National Railway covered the entire nation, railway companies prepared the communication network to communicate between adjacent stations and between offices in the region.

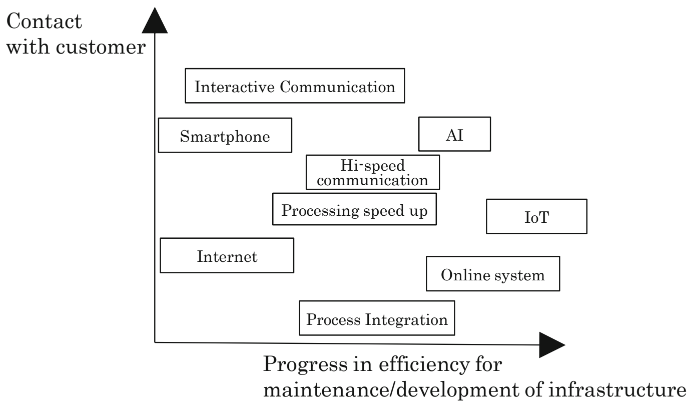


Fig. 10.5 Progression of service by ICT (from the viewpoint of 2 axes)

The introduction of these systems contributed to efficient and safe train operation directly, contributing to satisfy customers' growing needs and expanding the railway network. Because social infrastructure services should cover a wide service area, the provider had to a build smooth communication method between regions. In addition, the infrastructure placed in various regions must be managed from a control center. The following three systems are indispensable for a railway transport service: (1) communication between adjacent stations to operate trains safely, (2) a centralized system to control signals of the railway, and (3) an online purchase system that facilitates Japan-wide train reservations. Therefore, application of ICT was inevitable, and railway transport service providers actively applied ICT in the 1960s. This was approximately 30 years earlier than other organizations' application of ICT.

The Following sections introduce some topics of ICT applications to the railway business. Such examples have realized improvement in train operation and customer satisfaction. In other words, ICT greatly contributed to progress in the two axes of Fig. 10.5.

10.3.2 Overview of History in Upgrading Railway Transport Service by ICT

Table 10.1 shows three phases of a representative ICT system used to upgrade a railway operation service.

1. COMTRAC, MARS in Phase 1 (1960s–1970s)

Although the system in phase 1 was built and introduced in the 1960s, in the era of the Japan National Railway (hereafter JNR) before JR-EAST was established, both were advanced cases of ICT introduction prior to not only the Japanese railway field but also Japanese society. In Sect. 10.3.3, we explain in detail these cases that contributed to improved service.

2. ATOS, Suica service in Phase 2 (1990s–2000s)

Table 10.1 Phase of service upgrades by ICT in JR-EAST (including the era of former organization)

Phase	Phase 1	Phase 2	Phase 3
Category/Period	1960s–1970s	1990s–2000s	2020s–future
Progress in efficiency for maintenance/development of infrastructure	COMTRAC (COMputer aided TRAffic Control system)	ATOS (autonomous decentralized transport operation control system)	"Smart maintenance"
Contact with customer	MARS (magnetic electronic automatic seat reservation system)	Suica service (contactless IC card type ticket)	Service using IoT, AI, smartphone

These large-scale, complicated systems were developed and introduced after JR-EAST was established. The company has realized a dramatic improvement in train transport service.

We explain these systems in Sect. 10.3.4.

2. Smart maintenance, service using IoT, AI, and smartphones in Phase 3 (2020s-future)

These are now under study/development or have just been introduced to maintain infrastructure and improve service in the future. Japan will soon enter an era of low birthrate and aging. Therefore, it likely will become difficult to maintain/manage social infrastructures and service levels. To mitigate these situations, applying IoT, AI and smartphones will become increasingly important. We explain these cases in Sect. 10.4.

10.3.3 COMTRAC, MARS in Phase 1

These systems were developed and installed in the 1960s and 1970s, the era of JNR. In the 1950s, the needs for railway transport continuously increased in Japan. Therefore, many limited express trains with reserved seating increased, and high-speed train (SHINKANSEN) operation between Tokyo and Shin-Osaka started in 1964 when the Tokyo Olympics were held. In these situations, new systems with ICT were inevitable for efficient transportation. Under this business environment, COMTRAC and MARS were developed as the representative systems in phase 1.

1. COMTRAC (COMputer aided TRAffic Control system)

Railway business in the United Kingdom started in 1825. In Japan, railway business started 50 years later, although remarkable progress was subsequently achieved. In 1964, the Tokaido Shinkansen line opened. The operation speed of Shinkansen was 200 km/h, and Shinkansen reached from Tokyo to Shin-Osaka as the highest-speed train in the world. The number of train operations was over 700 per day. All trains running between Tokyo and Shin-Osaka were controlled by a central train control center in Tokyo. Soon after Shinkansen opened, the staff's heavy load of route control operations led to serious problems due to the increase in train operations. In addition, it was thought that the number of trains would increase explosively when the Tokaido Shinkansen route to the Sanyo Shinkansen line opened in 1972. Therefore, JNR developed a computer system for executing train control. In March 1972, the COMTRAC system began operation. COMTRAC's functions include not only automatic train control but also train scheduling, rolling stock operation and driver operation (Fig. 10.6).

One characteristic function of this system is its sophisticated human–machine interface. Usually, train control can be executed automatically according to a predetermined train schedule. However, in a case when a train is delayed or suspended,

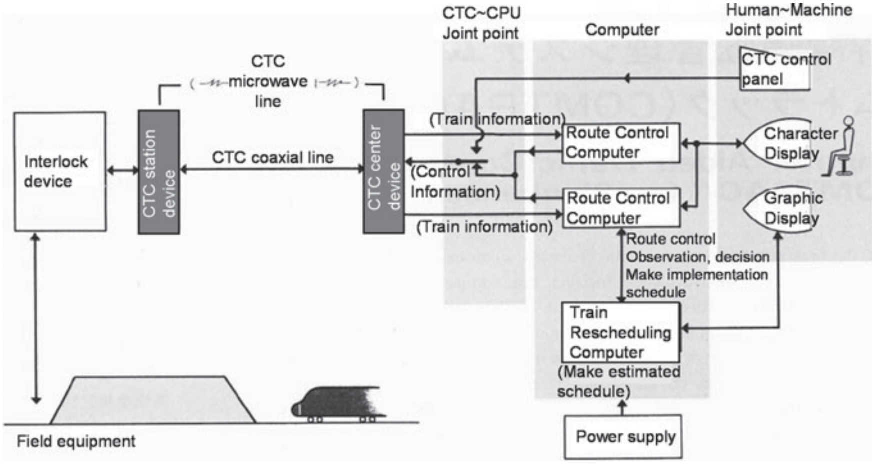


Fig. 10.6 System structure of COMTRAC (translated from Okamoto et al. 1972)

railway staff must change the order of trains and suspend train operation manually. Even if a computer can reschedule and predict a better answer, humans (railway staff) ultimately must decide how to reschedule comprehensively. To make communications between computers and railway staff smoother, the graphic display terminal (GD) was developed.

COMTRAC has been upgraded over time through some replacements. The technology was migrated to the SHINKANSEN control system developed for the Tohoku/Jouetsu Shinkansen line, Kyusyu Shinkansen line, and Hokkaido Shinkansen line according to the expanding Shinkansen business area.

2. MARS (Magnetic electronic Automatic seat Reservation System)

In the 1950s, railway transport service was predicted to expand, so railway service providers considered various improvement plans. Among them, the need for a seat reservation system was very strong. Previous seat reservation procedures depended on reception by telephone and reservation books on rotary tables at ticket centers, thus requiring a human interface. Because of the increase in reservations, the required complicated work caused the existing infrastructure to reach its limit. Therefore, customer service levels decreased with increasing waiting times to reserve seats for customers and increasing workloads of the staff. This was the reason for the anticipated need for the new system.

In 1960, by actively applying electronic computers, which had entered practical usage, JNR developed an online real-time seat reservation system (MARS: Magnetic electronic Automatic seat Reservation System), which could service four limited express trains. MARS became a top candidate for the largest class of online real-time processing systems using electronic computers in Japan. Therefore, MARS has a big footprint in Japanese computer history.

At first, MARS's reservation capacity was approximately 2000 seats per day. Through the improvement of the system, its capacity expanded to 200,000 seats per day in 1970. The system was soon able to handle 100% of reserved seats provided by JNR. As MARS continued to be upgraded, its capacity has reached 1 million seats per day (Subcommittee of MARS 2013). Its system structure continued to be upgraded considering customers' needs. At first, the terminals to access the MARS system were placed only in stations and tour offices, so only related staff could access the system. In 1975, the system was upgraded with the capacity to reserve seats via telephone by customers themselves. In the 2000s, terminals on which customers could directly reserve seats and issue tickets were released and placed in stations. Several railway providers including JR-EAST have implemented an internet-based seat reservation service. JR-EAST provides the "eki-net ("eki" means station)" service (https://www.eki-net.com/pc/personal/yoyaku/wb/Common/ReserveTop/ReserveTop.aspx).

At first, the main objective of MARS was to reduce the workload of the staff and increase the number of transactions. After that, MARS continued to be upgraded by ICT to meet customers' needs for reservations.

10.3.4 ATOS, Suica Service in Phase 2

1. ATOS (Autonomous Decentralized Transport Operation Control System)

In JR-EAST's operation area, the Tokyo metropolitan area is the most important. In this area, there are many railway lines, and the population expects high-frequency train operation. For example, on the Yamanote line (loop line), which has 30 stations, trains go around in approximately one hour. A train reaches a given platform every 3 min.

Previously, train control was carried out by the station staff, which was a very heavy load. In addition, information transmission among the control staff, station staff and maintenance staff depended on oral communication by telephone. Several accidents occurred because of miscommunication between staffs. Once a train left a station, the station staff could not easily determine its precise current location. Therefore, sometimes a station staff had trouble informing passengers of the status of a train delay or suspension. The train operation in the Tokyo metropolitan required modernization. Train control systems using ICT were also applied to rural lines with fewer trains. However, everyone thought that the systemization of train control could not be realized in the Tokyo metropolitan area because of the limitations of computers at that time.

Through further progress of ICT over the years, the train control system for the Tokyo metropolitan area, named "Autonomous Decentralized Transport Operation Control System (ATOS)," was installed on the Chuo line initially. ATOS expanded over the managed area gradually. In 2019, ATOS controlled 6000 trains per day on 24 railway lines (1313.5 km). Figure 10.7 shows the structure of the ATOS system. The daily schedule is downloaded to each station device to control the trains. The

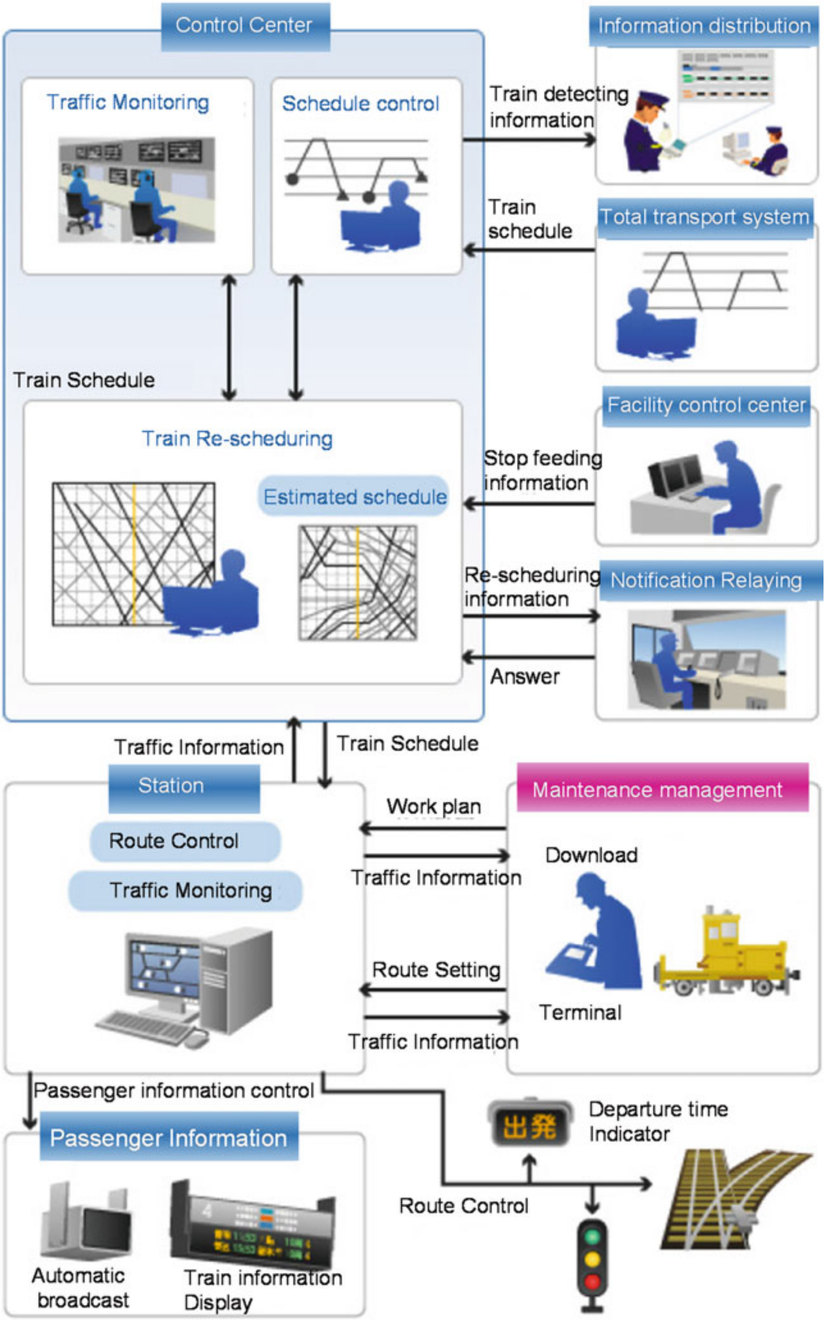


Fig. 10.7 Structure of ATOS system (translated from JR-EAST 2020-1)

station device controls signal equipment after checking related conditions for safety and moving motor point machines.

When ATOS was installed, daily train operations could not be suspended. In addition, it was impossible to apply ATOS to all railway lines in the Tokyo metropolitan area simultaneously. Therefore, ATOS was designed based on the "Autonomous decentralized system" concept (Matsumoto 1992). ATOS as an autonomous decentralized system has both a single-station mode and a central online mode. ATOS now controls all railway lines by switching between these modes (Fig. 10.8). ATOS expanded its operating area without suspending transport service. The concept of an autonomous decentralized system is also applied to ensure operation continuity in the case of maintenance and fault tolerance in the case of system error. ATOS also provides train positioning information to smartphones, which contributes to increased customer service (see Sect. 10.4 for details).

2. Suica service (Super Urban Intelligent CArd)

The Suica service is JR-EAST's novel service centered on contactless IC cards. Suica is a proximity-type contactless IC card. The basic function of Suica is to admit a passenger through a ticket gate in a station by touching the Suica card to the gate. In advance, digital currency is stored in the Suica card. Suica service began in 2011. Unique passenger ID, amount of digital currency, record of usage, departure/destination/validity period (commuter pass) and other data are stored inside the Suica card.

When a passenger touches a ticket gate, the required digital currency according to the used section is automatically withdrawn from Suica. If the data in Suica change after going through a ticket gate or in some way, the changed information is transmitted to a central server via the station server. Finally, the central server can hold all data of all issued Suica cards (Fig. 10.9). By 2019, more than 75.9 million Suica cards had been issued (JR-EAST 2019-1). Among the specifications of contactless IC cards, one of most important in contrast to railway tickets is "High-speed processing when going through a ticket gate." In Japan, the number of passengers who pass through ticket gates is 60 per minute during morning rush hour. Development staffs carried out many field tests by trial and error to overcome these conditions. As a result of testing and technical research, they considered the detection area of radio waves output from the ticket gate and invented the ideal movement of "Touch and Go" when passengers go through ticket gates using Suica (Shiibashi 2008; Shiibashi et al. 2006).

Stored digital currency in Suica has been used not only for railway tickets but also electronic money since March 2004. Applications have explosively spread to in-station stores, stores in the city, and bus/taxi fares. As mentioned before, the central server contains all Suica IDs, so reissuance of Suica is possible (stored values can be restored), enabling Suica cards to be used as security ID cards for entering buildings. Furthermore, mutual use of IC cards between transport service providers that issue the same kind of contactless IC card as Suica began in March 2013. In October 2019, mutual use of IC cards was available in 255 transport service providers. Once customers take a Suica card in hand, whether they want to ride several transportation

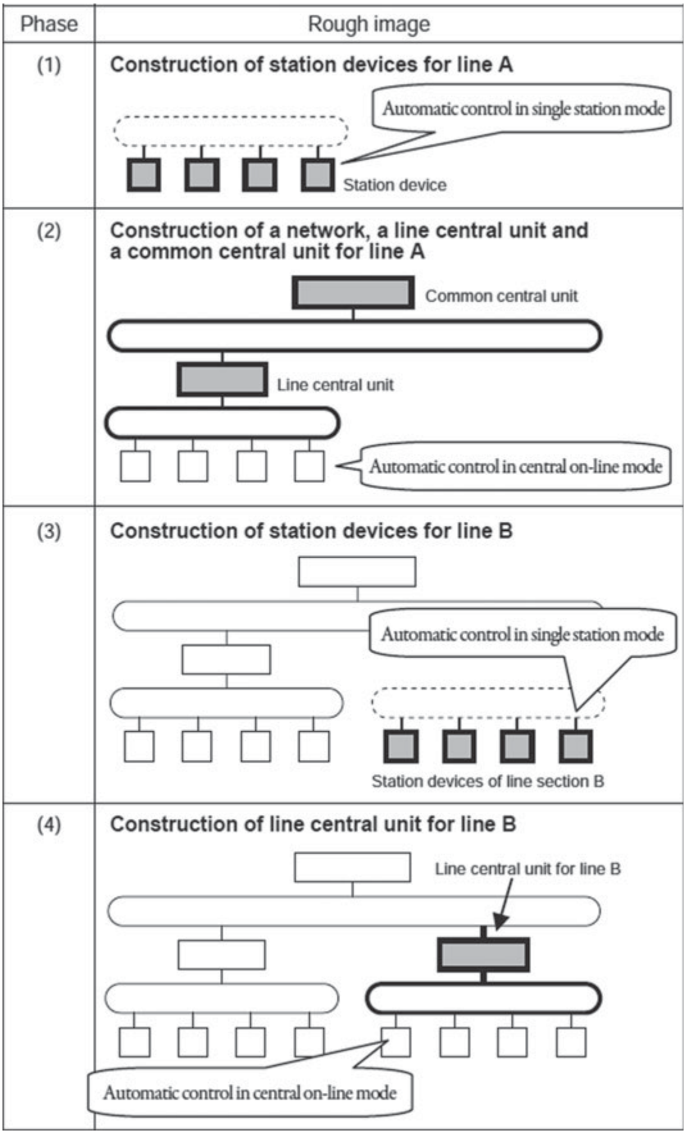


Fig. 10.8 Outline of step-by-step construction (modified from Ito 2011)

modes or make a purchase, they can go from departure to destination using only Suica. From the customer viewpoint, seamless service by Suica has been achieved and found to be very convenient for a customer's daily life.

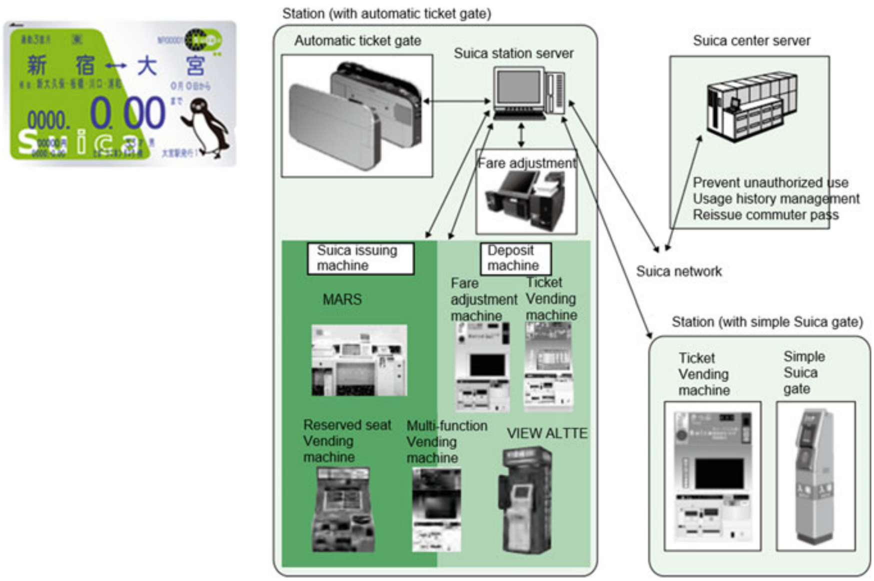


Fig. 10.9 System structure of Suica service (translated from JR-EAST 2019-2, p. 69)

10.4 Realizing Smart Infrastructure Management in Age of IoT, AI in Phase 3

In Sect. 10.3, we introduced ICT systems that have already been developed, installed and applied in practical business. In this section, we describe some ICT applications under development or at their starting point in JR-EAST. The first topic is "Smart maintenance," which emerged in the 2010s and whose concept is to manage maintenance of huge volumes of infrastructure using IoT and AI. The other topic is the establishment of new interaction between providers and customers using new digital devices such as smartphones.

10.4.1 Smart Maintenance (Utilizing ICT Mainly for Employees)

"Smart maintenance" is an integrated concept covering innovation in maintenance of high-quality railway transportation service. Development staffs of JR-EAST aim to realize improvement of maintenance through developing new methodologies, systems and rules to execute appropriate maintenance for rolling stocks, rail facilities, civil structures, electric facilities, and signal and communication facilities.

The important keyword is CBM (Condition-Based Maintenance). JR-EAST aims to change its maintenance paradigm from the traditional TBM (Time-Based Maintenance), which involves predetermined intervals of inspection/maintenance, to the novel CBM in which appropriate inspection/maintenance timing depends on the condition of the facilities (Fig. 10.10). By executing CBM, it is expected that the maintenance workload and lifecycle cost will be reduced. In the future, the low birthrate and aging in Japan will lead to a decrease in customers and maintenance staffs. JR-EAST would like to overcome these problems via smart maintenance.

As mentioned before, there are various types of facilities to execute railway transport service. The mechanism of degradation, means of determining the state of degradation and decision criteria of maintenance are different among facilities. Therefore, JR-EAST must apply the appropriate type of ICT according to each facility. JR-EAST already started to research and develop smart maintenance for several facilities. The smart maintenance effort for equipment in signal facilities is explained as follows.

Figure 10.11 shows the research on detecting abnormalities in a signal bond, which is a part of train detection facilities named track circuits. The methodology of the abnormality detection process consists of (1) pattern recognition by investigating images of signal bonds and (2) abnormality detection by comparing a target image and a previous image. To improve detection ability, JR-EAST installs many images into the system for learning.

JR-EAST is researching and developing CBM for other facilities, such as rolling stocks, rail facilities, overhead lines, and tunnels. JR-EAST aims to change the maintenance methodology from direct-view inspection by maintenance staff to CBM with ICT, such as IoT and AI. Inspection by a system is superior to inspection by humans in terms of frequency, although the range of inspections is limited to gathered images. Therefore, CBM is expected to overcome the labor shortage in Japan and be able to execute inspections of the same quality.

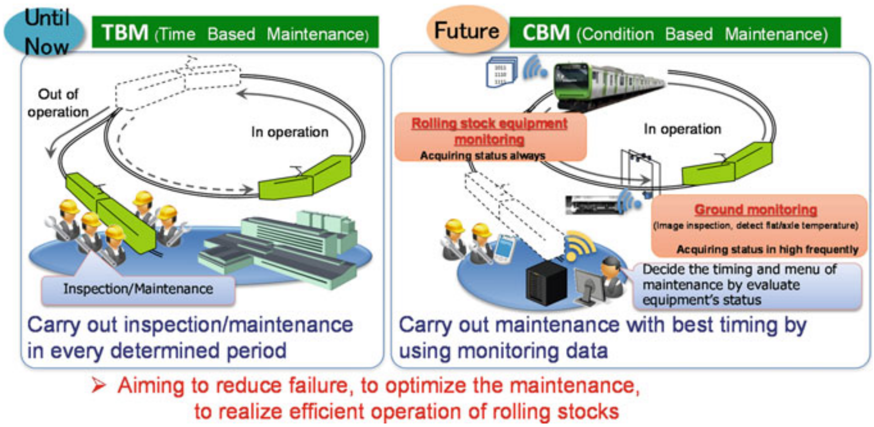


Fig. 10.10 Smart maintenance image for rolling stock (translated from Anami 2019)

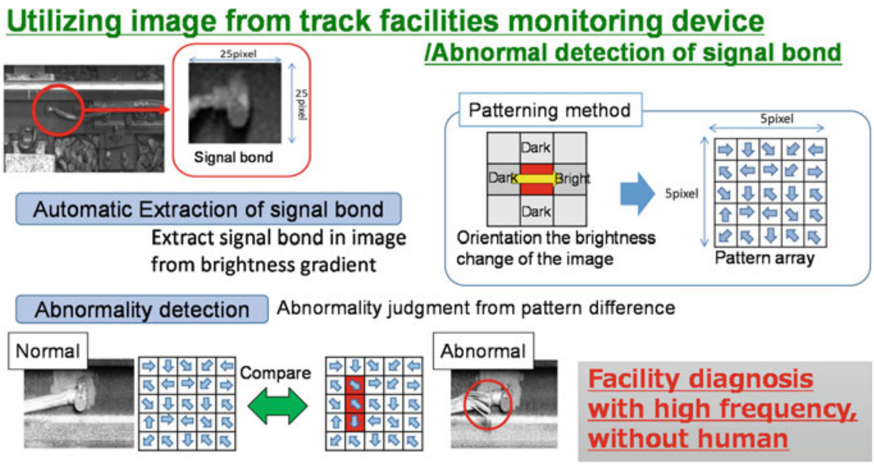


Fig. 10.11 Smart maintenance image for inspection of signal bond (modified from Kudo et al. 2017)

10.4.2 New Service by Using Smart Devices

1. JR-EAST app

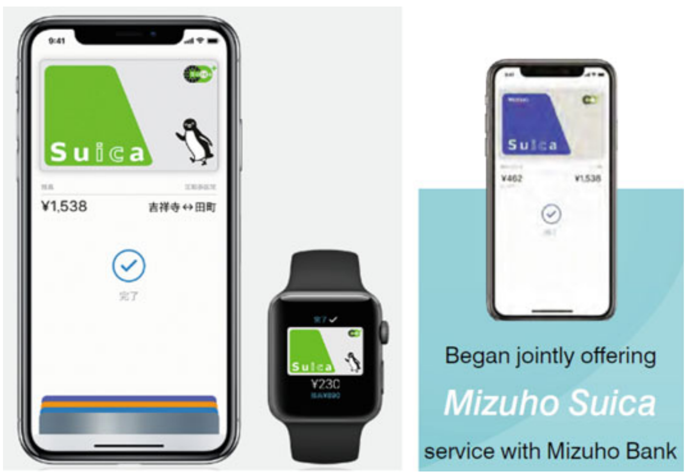
The JR-EAST app is an application for smartphones (Fig. 10.12). In addition to offering train operation information and route finding functions, it can display the position of a train within a railway line. Smartphone users can obtain train information in detail without going to the station. As mentioned in Sect. 10.3.4 (1), previously, detailed information on train locations could be seen by only a few railway employees. Therefore, few customers could know the train operation status until they reached the station. This was a cause of high loss in customers' opportunity cost.

When the internet became popular, various types of route finding applications were released. Advanced customer needs shifted the use of transport service, which was made possible by receiving updated train information. From the viewpoint of railway service providers, the most important objective is to maintain precise train operation according to a predetermined schedule. However, schedule disturbances cannot be eradicated because unexpected accidents due to bad weather or external causes are inevitable. Considering this situation, customers need to determine appropriate countermeasures based on precise information on train operation status. The JR-EAST app by ICT will fulfil this need for each customer.

2. Suica on Apple Pay, Mizuho Suica

In a new service, Suica can be integrated into smartphones, and the user can use the smartphone as Suica. Digital currency charges can be completed online, thus realizing seamless movement. This service was established by collaboration with Apple Pay and Mizuho Bank, which is one of the biggest Japanese banks (Fig. 10.13). Smart-

Fig. 10.12 Image of JR-East application (JR-EAST 2019-3)



(JR-EAST (2019-5)) (JR-EAST (2019-1)p. 4)

Fig. 10.13 Collaboration between smartphone and Suica

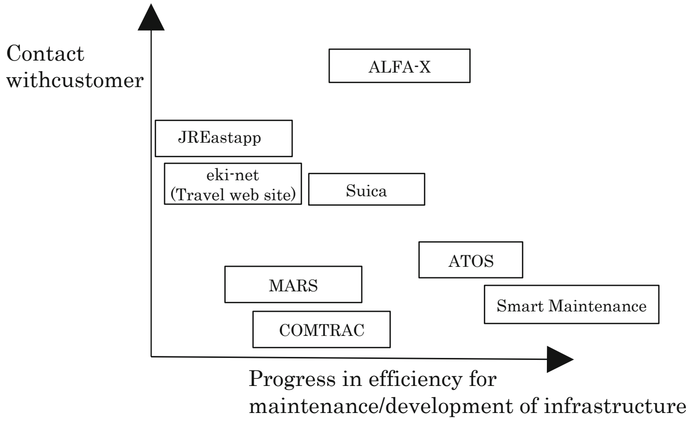


Fig. 10.14 Position of each development in JR-EAST and JNR

phone integration is necessary for citizens' lives, and Suica can promote customers' seamless movement before and after using a train.

10.5 Considering Innovations in Social Infrastructure with ICT

10.5.1 Direction of Innovation in Social Infrastructure

Figure 10.5 can be revised as Fig. 10.14 considering the services described in Sects. 10.3 and 10.4.

The characteristics of each service are different, so the contribution ratio between the horizontal axes and the vertical axes also are different. In addition, "ALFA-X" (JR-EAST 2018) is a nickname for the next-generation rolling stock of Shinkansen, which is under testing. ALFA-X is under research and development. The concepts of ALFA-X are (1) the pursuit of further safety and stability, (2) the improvement of comfort, (3) the improvement of environmental performance, and (4) innovation in maintenance. These concepts include both directions shown in Fig. 10.14.

10.5.2 Innovation of Social Infrastructure with ICT Considering B to B to C

As mentioned before, JR-EAST's innovation with ICT can solve problems of both customers and providers, thus providing new value. In social infrastructure service, the infrastructure tends to influence the service process. For this reason, it is important to analyze social infrastructure service as a “B to B to C” business structure. The first “B” is a provider, and the second “B” is an employee (customer of the provider). To fulfill customers’ needs and increase service value, the second “B” is very important.

Suzuki (2019) described these structures of social infrastructure as “SISLA (Social Infrastructure Service Level Agreement) (Fig. 10.15).

SISLA is an extended concept from the Service Level Agreement (SLA) (Uchikawa et al. 2006), which is usually used in the information service business. In providing social infrastructure service, it is difficult to facilitate direct interaction between customers and providers. The SISLA concept is proposed based on the following analysis. Similar to SLA, there exists a predetermined service level (SISLA) between providers and customers. Therefore, the providers strive to keep the service level, and the customers use the service with trust. In the SISLA concept, customers agree to use social infrastructure service at a predetermined level despite the lack of direct interaction with providers.

JR-EAST’s cases in Sects. 10.3 and 10.4 can be described by applying the SISLA model as illustrated in Figs. 10.16, 10.17, and 10.18.

Interesting characteristics are revealed by explaining the cases of JR-EAST’s innovation with ICT using the SISLA model. In social infrastructure service with both external service (B to C) and internal service (B to B), common characteristics of ICT applications can generate business innovation according to the concept that “fullness of internal service brings fullness of external service.” ATOS and Suica service have characteristics such as high-speed data processing, so they contribute not only to internal service but also to external service. One of the major criteria for judgement on the installation of each system is whether the system can improve and enrich internal service. Through analyses of JR-EAST’s cases, it is suggested that improvement of the internal service level brings improvement of the external service level. Customers’ needs for transport service have changed from “Basis and necessities of life for moving” to “Moving in concert with daily life: don’t delay, don’t waste time, feel free to move, move with fun.” Various types of ICT satisfy these customer needs. ICT can expand and improve the quality of transport infrastructure service.

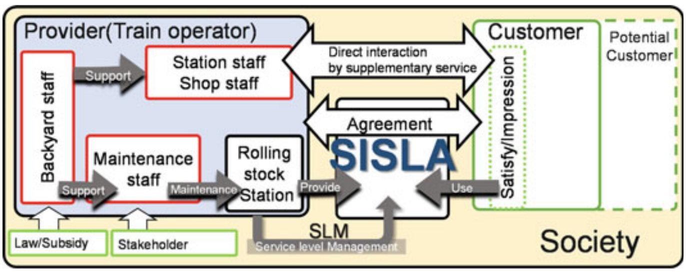


Fig. 10.15 SISLA model (Suzuki 2019)

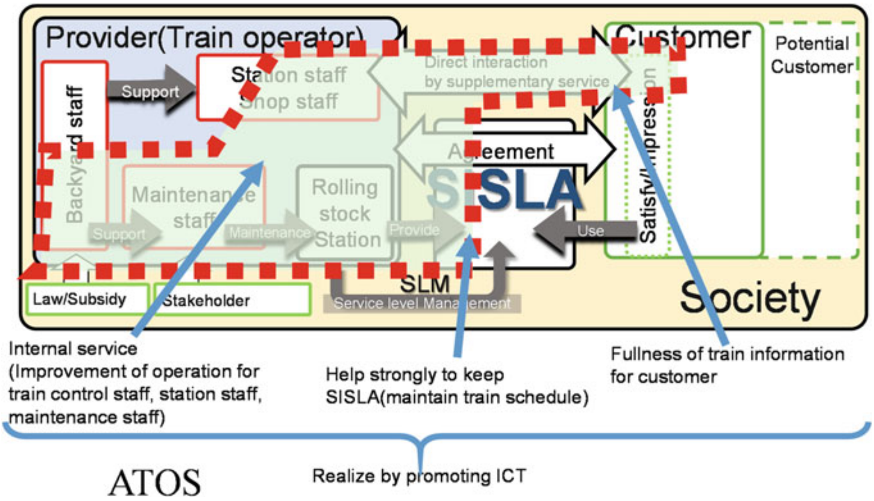


Fig. 10.16 Explanation of ATOS improvement in SISLA model

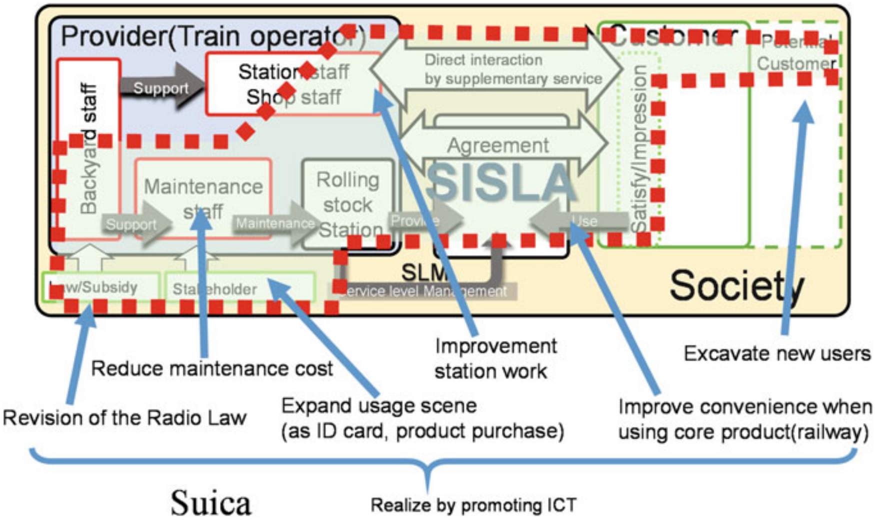


Fig. 10.17 Explanation of Suica improvement in SISLA model

10.6 Analysis of Business Innovation with ICT in JR-EAST

Through analyses of JR-EAST's transport service, we have the following answers for the given five questions on business innovation.

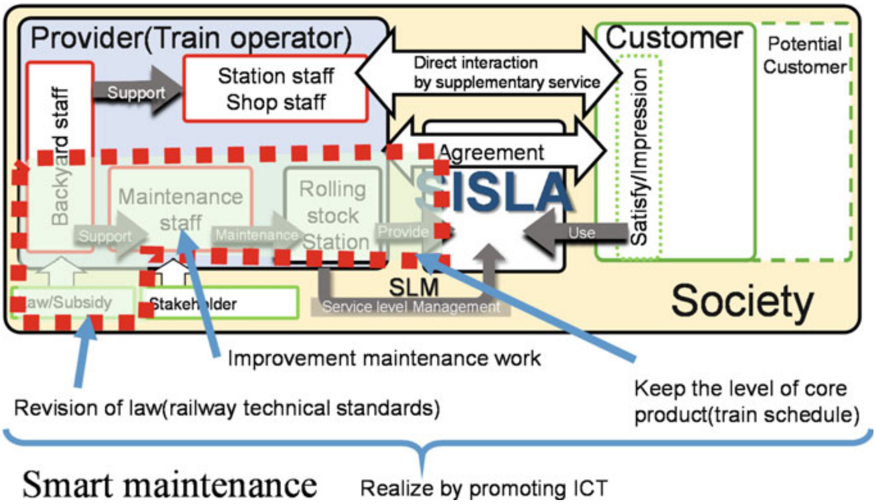


Fig. 10.18 Explanation of smart maintenance improvement in SISLA model

1. **What are the human desires, issues in human society or business, and objective of utilizing ICT? (needs)**

Common needs in all cases are both customer needs and employee needs. Customer needs for social infrastructure are “Existence as a basis for fundamental life” and “Existence that can be used in safety and in relief.” JR-EAST’s case of service improvement by ICT realized “Safety and relief in railway transport service.” The major trigger of installation in each case is employee needs. Employee needs are management of a huge volume of infrastructure to remove human-centered operation. In JR-EAST’s cases, the company must solve specific needs, such as “High-speed transaction to calculate complex fare adjustment,” “Train operation for large-scale railway line network in the Tokyo metropolitan area” and “Change maintenance methodology based on feeling and experience of veterans.” To solve these needs, JR-EAST needed high-speed data processing and communication technology. The emergence of ICT in the 1990s provided the ability to solve these needs.

2. **What technologies and functions are utilized to solve problems or realize human desires? (technologies)**

In a railway network, many trains must be operated on various railway lines on a precise schedule. Previously, railway network operation was human centered. To systemize railway networks, large-scale, real-time and online specifications were needed. MARS and COMTRAC, built in the 1960s, were among the earliest systems that fulfill these specifications in Japan. Once the systems were started, they could not be stopped because JR-EAST cannot suspend transportation service. Therefore, in the ATOS and Suica systems, JR-EAST installed the concept of an autonomous decentralized system to realize partial maintenance/replacement. In addition, in the

Suica system, the company installed high-speed transaction technology of contactless IC cards to realize many passengers' passage through the ticket gates. Furthermore, for smart maintenance, which will expand in practical use through cutting-edge ICT, JR-EAST aims to realize frequent data gathering by IoT and maintenance decisions by AI, which is superior to human capacity.

3. **What are the value creation methodologies? (value creation)**

Business innovation, such as COMTRAC, MARS, ATOS, and Suica, provided new value to employees. They systemized human-centered work and yielded maintenance savings. Furthermore, to customers, they spread new value, such as safety, relief, and convenience. ICT gave providers new business opportunities. In the Suica service, JR-EAST expanded the function of stored digital currency to use in shops as electronic money. In ATOS, JR-EAST provided customers with detailed train information for timely and appropriate decision-making. In smart maintenance, the benefits reach not only employees by realizing optimized maintenance but also customers by expanding train operation times and the number of trains. ICT closed the gap between railway service providers and customers and reduced lag in communication.

4. **What is the relationship between human/business (including employees, organizational culture, and leadership) activities and the ICT system, the relationship among uses ICT provides, and other stakeholders (collaboration)? (human/business activities)**

ICT improved the environment of information sharing between service providers and customers and made the sharing process smooth. In addition, ICT shrank the barrier for customers who use the railway transport service and shrank the barrier between railway transport service and other services. Suica is different from the former magnetic-type tickets. When customers want to go through a ticket gate, Suica, a contactless IC card, can be used without leaving the customer's hand or even the customer's bag. ATOS reduced the opportunity cost of customers by providing detailed and appropriate train information. Smart maintenance will provide qualitative innovation for maintenance work. Public perception of maintenance work on railways is not that good because the work tends to be performed at night, the work field is mainly outside, and the work may be dangerous. However, smart maintenance may erase these negative impressions.

5. **How have human life, business or society changed? (innovation)**

There is no doubt that the core product of railway transport service is "Moving." Moving facilitates human encounters, creation of new communities, and creation of new business. From the viewpoint of innovation, railway transport service is the basis of innovation. JR-EAST's cases improve service quality and value in railway transport service by promoting customer use of the railway. ATOS realized business innovation by applying a full-time, fault-tolerant, autonomous, decentralized system. ATOS works behind the scenes to provide a consistent, safe, stable railway transport service daily. Suica created a new social infrastructure in which seamless payment can be available to the whole society. Moving is valuable and definitely will not cease if communication methods such as the internet and smartphones become even more popular. Railway transport service is one of the best social infrastructure services to realize moving whenever customers want to move. Railway transport service may activate other social infrastructure services and customer actions. Social innovation should be the goal in the contribution of social infrastructure service.

10.7 Conclusion

ICT has evolved social life in various ways. The cases of social infrastructure service with ICT have the same trends as other services for social life. In this chapter, we introduced JR-EAST as a leading provider of railway transport service in Japan. JR-EAST moved forward the innovation of work via ICT and thus improved service to customers. Facing social realities such as the low birthrate and aging in Japan, JR-EAST has shown its future direction in its management vision "MOVE UP 2027." JR-EAST, setting "Trust" as its base, aims to create new value. One of its concrete goals is to execute business innovation by "Taking initiative in seamless mobility and realize stress-free moving" (Fig. 10.19). JR-EAST is trying to provide a railway-centered new lifestyle, with keywords "Making cities more comfortable," "Making regional areas more affluent" and "Developing businesses for the world." Mobility is one of the most important parts of service, referred to by the keyword "MaaS." Therefore, to realize a sustainable society, ICT must play an important role.

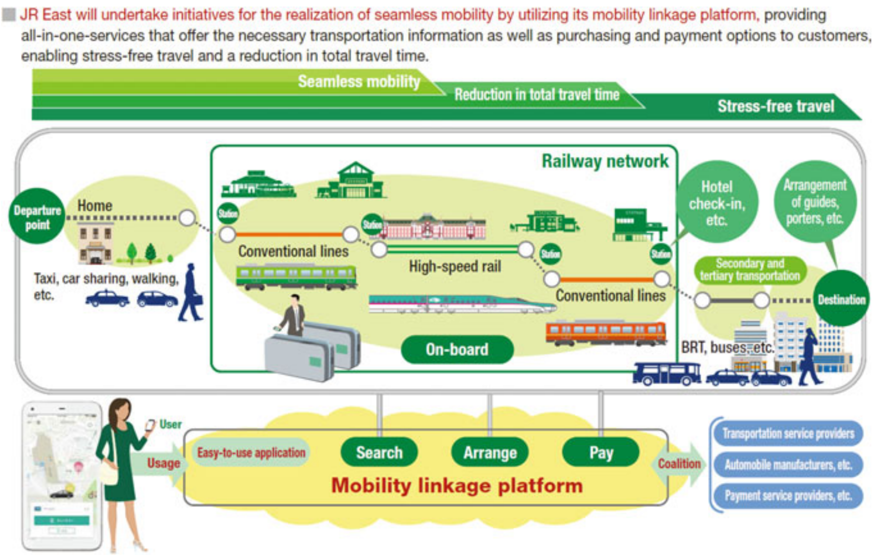


Fig. 10.19 Realization of seamless mobility (JR-EAST 2019-4, p. 10-2)

References

Anami T (2019) Status of initiatives for smart-maintenance. JR East Tech Rev 62:5–10. East Japan Railway Company (in Japance)

East Japan Railway Company (JR-EAST) (2018) Sustainability Report 2018, East Japan Railway Company, https://www.jreast.co.jp/e/environment/pdf_2019/gri_contentindex2019.pdf, p 13. Accessed 2020/2/5

East Japan Railway Company (JR-EAST) (2019-1) Annual Report 2019, East Japan Railway Company, https://www.jreast.co.jp/e/investor/ar/2019/index.html, pp 4, 38, 39, 44. Accessed 2020/2/5

East Japan Railway Company (JR-EAST) (2019-2) Company Handbook 2019, East Japan Railway Company, p 69

East Japan Railway Company (JR-EAST) (2019-3) JREAST app, East Japan Railway Company, https://www.jreast-app.jp/. Accessed 2020/2/9

East Japan Railway Company (JR-EAST) (2019-4) JR East Group Management Vision 'Move UP' 2027, https://www.jreast.co.jp/e/investor/moveup/, pp 2-1, 4-2, 10-2. Accessed 2020/2/5

East Japan Railway Company (JR-EAST) (2019-5) Suica: Apple pay, East Japan Railway Company, https://www.jreast.co.jp/appsuica/. Accessed 2020/2/5

East Japan Railway Company (JR-EAST) (2020-1) ATOS, https://www.jreast.co.jp/newtech/tech06_main.html. Accessed 2020/2/5 (in Japanese)

East Japan Railway Company (JR-EAST) (2020-2) GENBI SHINKANSEN, East Japan Railway Company, https://www.jreast.co.jp/e/joyful/genbi.html. Accessed 2020/2/5

East Japan Railway Company (JR-EAST) (2020-3) Route maps, East Japan Railway Company, https://www.jreast.co.jp/e/routemaps/byline.html. Accessed 2020/2/5

Ito K (2011) Development and update of ATOS, JR East Technical Review, No. 20, pp 52–55, East Japan Railway Company, 2011.4 (in Japance)

Japan Railway Electrical Engineering Association (2001) My company: Railway Information Systems Co., Ltd. Railw Electr Eng 12(10):85–86

Kudo Y, Suzuki M, Kobayashi T (2017) Study about abnormal detection of a signal bond for track circuits. In: Proceedings of Railway Engineering 2017, 2017, 0018

Matsumoto M (1992) Electric Railway, Morikita-syuppan, pp 30, 223, 252–257, 1992.4 (in Japanese)

Okamoto M, Imaki M, Titose S, Ihara H, Kubo Y, Takahasi T (1972) Computer aided traffic control system "COMTRAC" for SHINKANSEN. Hitachi Rev 54(8):70 (in Japanese)

Shiibashi A (2008) Suica changes the world—lifestyle innovation driven by JR East-. Tokyo-shimbun Press (in Japanese)

Shiibashi A, Usuki D, Sugiyama Y, Mori K (2006) An application of autonomous decentralized architecture to an IC card ticket system. In: Proceedings of IADIS international conference applied computing 2006, 2006, pp 107–114

Subcommittee of MARS (2013) History of development of MARS. Japan Railway Electrical Engineering Association, p 8 (in Japanese)

Suzuki M (2019) A proposition of service evaluation model for social infrastructure service and A case study in transportation service: SISLA evaluation model induced by SLA concept. Doctoral thesis, Japan Advanced Institute of Science and Technology, 2019.9

Uchikawa K, Mizuki M (2006) The book which helps you understanding the basics and mechanism of ISO 2000 well (in Japanese), Shuwa System Co., Ltd, pp. 35–53, pp. 138–144

Chapter 11
Effect of New ICTs on Vocational Education in China: A Case Study of Wuxi Vocational Institute of Commerce

Jinfang Cai and Xian Qian

Abstract ICTs are redefining almost everything of human activities, including life, work, and even relationships. In modern education, they are main driving forces to the transformation and expansion of education in terms of methodology and content. Vocational education, as an important style of education, particularly relies on ICTs due to its specialties in the large number of candidate students, importance of experiences in practice, and requirement-oriented training. New ICTs are leading to innovations of vocational education from various aspects, which breeds high-quality online education service which is cost-effective and thus affordable and available to more learners. In this study, we take higher vocational education in China as an example to study the effect of new ICTs on the education. By conducting a comprehensive case study on a Chinese vocational institute, we reveal from service science perspective some fundamental findings that we believe are instructional and helpful to guide ICT-driven innovations in vocational education.

11.1 Introduction

News ICTs are leading to drastic change in education, too. In the past decades, ICT, particularly the Internet, has made online learning (Anderson 2008) and distance education (Keegan 2013) possible. They are considered as auxiliary education forms for those who cannot get educated in traditional manners. However, the emergence of new ICTs such as 4G/5G wireless communication, mobile computing, cloud computing and virtual reality are causing revolution to traditional education in schools. For instance, MOOC (Massive Online Open Courses) (Pappano 2012)

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is becoming a modern learning way which is affordable and flexible for anyone to enroll.

Besides open learning platforms like MOOC, education identities are trying to introduce new ICTs to reform their own education contents and forms according to their characteristics to achieve high-quality teaching and learning (Abbott 2003). Higher vocational education, as a kind of higher education which provides practical experience in a particular occupational field, as agriculture, home economics, or industry, is experiencing a dramatic reform to teaching and learning as affected by new ICTs (Latchem 2017).

The book (Latchem 2017), *Using ICTs and Blended Learning in Transforming TVET*, edited by Colin Latchem, comprehensively summarizes the ways in which ICTs are applied to the transformation and expansion of traditional technical and vocational education and training systems. A new learning model called *blended learning* originated in such transformation and expansion. It both integrates e-learning into traditional classroom methods and independent study to create a new hybrid teaching methodology. In blended learning model, new ICTs are playing crucial role to enable individuals and communities to access information, share experiences and ideas, and learn knowledge and skills. Many innovative applications of ICTs in vocational education have been initiated all over the world. For instance, low-cost tablets are adopted in Philippine for online and blended learning in remote classrooms (Lumagbas et al. 2019). In Germany, the concept of Vocational Education and Training 4.0 (Pfeiffer 2015), which advocates learning through virtual environments such as online report book, knowledge network of the graphic arts and mobile knowledge database, is proposed in accord with the fourth technology-driven industrial revolution called Industry 4.0.

11.2 ICT-Based Vocational Education in China

The development of ICTs also leads to dramatic transformation of vocational education in China (Schulte 2015). There are 170 million young people between the age of 18 and 24 who need to be skilled for employment, while brick-and-mortar institutions do not have the capacity to enroll all of them to get trained in campus. Moreover, conventional vocational education suffers low quality due to many issues such as low teacher-student ratio, uneven distribution of resources, big gap between teaching content and practical requirement. Introducing ICTs into vocational education can effectively solve these issues to improve the education quality.

The ICT-based vocational education in China is developed in a top-down manner, in which the government plays a dominant role in the development (Wu 2014). The concept of ICT-based vocational education was first officially proposed by the government in 1998, when the Ministry of Education (MoE) made a policy to promote computer and multi-media aided teaching methods in vocational education. From 1998 to 2018, the government has released more than 85 national policies to accelerate and deepen the reform of vocational education in accordance with the

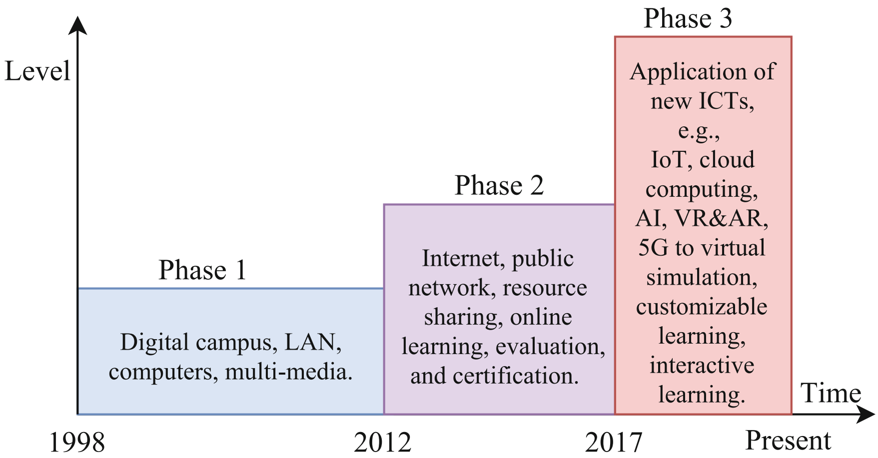

Fig. 11.1 The three-phase development of the ICT-based vocational education in China

development of ICTs. Among these policies there are three landmarks dividing the development of the ICT-based vocational education into three phases, as shown in Fig. 11.1. Below we briefly explain each phase in terms of the main ICTs used and the specific targets to achieve.

The first phase is about the origination of the ICT-based vocational education in 1999, when the MoE released a policy to advocate the development of Local Area Network (LAN) in campus for the purpose of both administration and education. Such network integrates various services such as VOD (Video on Demand), multi-media teaching network, library administration. This phase is featured by campus digitalization, which typically includes the setup of local area network, multi-media classrooms, and computer lab. Due to high cost of ICT equipment and facilities in that time, such resources are usually very limited and thus cannot be used prevalently in teaching and learning. Compared with teaching, administration was significantly improved by ICTs.

In 2012, the government released a guidance for the development blueprint of ICT-based vocational education, as a part of the country’s 12th Five-year Plan. The main characteristic of development is to bridge the distance among vocational education institutions by the Internet and develop an integrated multi-purpose public network for resource sharing, online and distant training, evaluation and certification. The prevalence of the Internet in this period makes it possible for both instructors and learners access online resources nation-wide. A survey shows that by December 2015 the number of Internet users in China reaches 686 million, 50.3% of the population. This causes drastic change to traditional teaching and learning for vocational education. For instance, blended learning and flipped classroom become common ways in vocational training schools.

The third phase begins from 2017 with the maturity and affordability of many new ICTs such as the Internet of Things, cloud computing, mobile computing, virtual reality and augment reality, and 5G technology (Zhao and Jiang 2019). In 2017, the government made a policy to emphasize the development of virtual simulation platforms, customizable online learning systems and mobile learning systems for vocational education. Such innovations in vocational education help learners get involved in workplace environment to gain real experience of their future work, which is particularly useful to those special cases such as clinic nursing. AI technologies help learners to engage into learning activities more interactively communicating with instructors as well as robotics and AI-embedded equipment.

11.3 A Case Study on WXVIC

Wuxi Vocational Institute of Commerce (WXVIC) is a provincial public institute founded in 1965, aiming at training skilled service-oriented workers and technicians in the field of marketing, manufacturing, and servicing. The institute is located in Wuxi, a city in southern Jiangsu province, 135 km by car to Shanghai. Wuxi is a regional business hub, attracting world-wide investment to extensive manufacturing and large industrial parks devoted to new industries. Benefiting from the strong industry background, WXVIC plays an important role in training skilled workers for local factories and companies.

In the institute there is a comprehensive set of 41 majors, ranging from business commerce to automobile and information technology. Among these majors, Business Commerce is one of the featured majors. As of January 2020, the university has enrolled 14,000 full-time students. Among its 800-member faculty, 250 are full-time professors and 500 hold master or Ph. D diploma. In 2019, the Business Commerce major of the institute was enrolled by the MoE in the *Construction plan of high-level vocational colleges & specialties with Chinese characteristics*. The plan aims to accelerate the development of several representative vocational colleges to a higher level with special budget and policy support.

As a 55-year-old vocational institute, WXVIC is both a witness and participant in the transformation and expansion of vocational education from conventional mode to ICT-based mode. Besides, it also plays a leadership role in this transformation and makes a great achievement in the reform. From 2016 to 2019, WXVIC has won three straight first-place awards in the nation-wide ICT-based teaching contest, demonstrating its strength in the innovation of education with ICTs.

The transformation of the ICT-based education in WXVIC basically follows the three-phase evolution in accord with government policies, as mentioned in previous section. As of December 2019, the institute has developed a completely digitalized campus with a high-performance cluster computing center for network service, high-speed wireless network covering every corner of the campus, a unified authentication system to access the resources on both local and public networks, and a data center for data collection, storage and analysis. More than 200 multi-media classrooms are constructed with a capacity of 10,000 students. Particular, there are 40 multi-purpose classrooms supporting video and audio conferencing, chat, and webinars across mobile, desktop, and room systems. Such fundamental ICT facilities drastically change the way of teaching, learning and campus administration.

Powered by the ICT facilities, the institute has developed a blended teaching and learning platform called E-Classroom, which integrates several online teaching and learning services. The platform unifies the advantages of both conventional teaching and online teaching, so that students can attend to classes in rooms as normal, and meanwhile they can learn online using their mobile devices such as smart phones and tablets anywhere and anytime. On the platform there are over 1000 high-quality video courses available to the students. Two were selected as best online courses and publicly available on the national MOOC platform, and 78 courses won provincial level awards. The average number of online students every day is around 8000, which means half of the students take the online courses every day. The average time spent on the online courses by each student is around 2 h one day.

11.4 E-Classroom Education Platform in WXVIC

We surveyed the E-Classroom education platform by on-site inspection into the facilities and face-to-face with the practitioners involved. We also attend to some representative lectures to gain the first-experience of learning on the platform.

11.4.1 Overview of the Platform

Figure 11.2 shows the main facilities, technologies and practitioners of the E-Classroom Education Platform. It is a local information ecosystem which integrates various systems with 24 $\times$ 7 nonstop services for teaching, learning and administration. Since online courses usually rely on videos, audios and online software, these data must be stored on the server and easy to access. To meet such requirement, the institute builds a high-performance sever and data center to support highspeed Internet access and massive data storage. Many Wi-Fi routers are setup at public area in the campus so that users can connect to the Internet conveniently. They can also access the Internet by 4G and 5G data roaming services provided by network carriers at reasonably low cost. These ICT infrastructure and facilities make it possible to teach on learning online.

The E-Classroom Education Platform is built on the top of a network service called Fanya, an online teaching and learning system developed by a Chinese IT company Chaoxing. The company is well-known in China for its digital library business, and shares 30% market in this field. Fanya is a prototype system providing fundamental functions. Besides basic teaching and learning functionalities, the latest 5.0 version of the system introduces AI and Big Data technologies for data visualization, teaching and learning evaluation, and personal testing, etc.

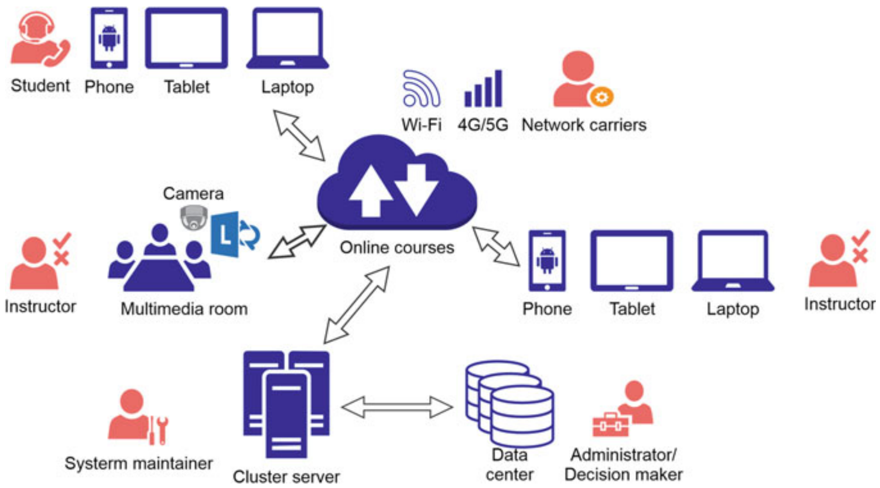

Fig. 11.2 The framework of the E-Classroom Education Platform: facilities and practitioners

The E-Classroom Education Platform is a secondary development product based on the requirements and characteristics of the institute. As shown in Fig. 11.2, it supports indoor teaching, mobile learning, and administration. At classroom, instructors can access online teaching resources such slides, videos, and textual documents. Meanwhile, the teaching can be recorded and uploaded to the cloud so that learners can review on mobile devices such as smart phones, tablets and laptops whenever they need. Meanwhile, instructors can manage the online course resources using mobile devices, make assignments and exercises on the platform. Correspondingly, students can submit reports and chat online to ask and answer questions using the system. The system can tack the activity of students, which can be used to evaluate their performance.

11.4.2 Operation Process of the Platform

The platform provides a user-friendly web-based interface for creating, managing and subscribing online courses. We take two main functionalities of the platform as examples to demonstrate its operation process. One example is about how an instructor sets up a course on the platform and teach the course on mobile devices. In another example, we explain how a student learns an online course, does assignments and tests on the platform.

11.4.2.1 Setting up and Teaching an Online Course

An instructor can set up a new online course using either his or her personal computer or mobile devices such as tablet and smart phones. As example we present the process of setting up and lecturing a course using smart phones. The platform provides dedicated apps for both iOS on Apple devices and Android OS.

Figure 11.3 shows four main snapshots of the apps. First, an instructor logins the app using his or her faculty identity and credential. The top page shows the recent courses the instructor visited and also the links of teaching resources, mini programs, and some sources created by other instructors. Instructors can follow the guide step-by-step to set a course on this page, and upload corresponding resources used in the course.

The second snapshot shows the message center where instructors can communicate with learners online. It is an instant message exchange system so that they can chat interactively to ask and answer questions, and discuss problems.

The third snapshot represents a note page, where instructors can take note during teaching online. There are two types of note, private and public. Private notes are only accessible to the owner, while public notes are available to all the participants of the course. They can also comment on the note for discussion.

The last page shows a mirror screening function of the app. It can seamlessly transfer all the content from a smart phone to a computer which only needs to be connected to the Internet. One can access all the resources of the source by opening the web address as shown in the page in a web browser. The four digits below the web address are passwords for accessing the course. Anyone who knows the password can join the course by opening the web page in a web browser. Usually, instructors send the password to students in the message center so that they can login the course with it. This technique is called screen mirroring, which is particularly useful to both online and in-class teaching. In online mode, everyone who logins the course with the password can watch the same content on the screen as the instructor is showing.

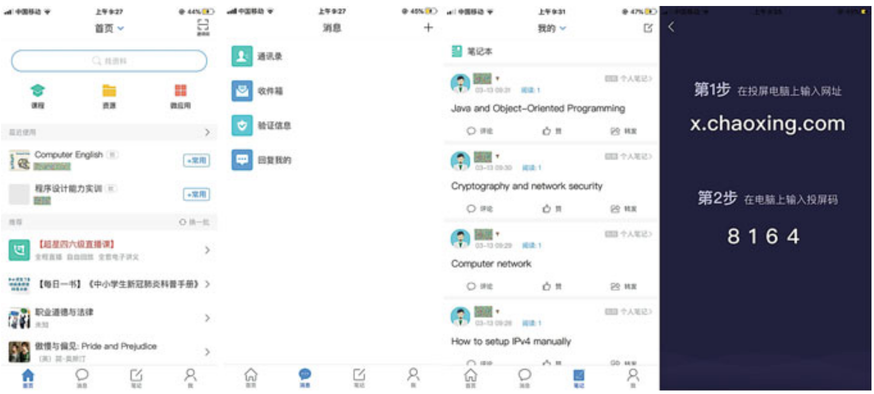

Fig. 11.3 Snapshots of teaching online on mobile phones on ECEP

Students can follow the instructor's explanation while watching the demonstration. In in-class mode, instructors can use this function to project the content to a big screen and teach in front the students.

11.4.2.2 Registering and Learning an Online Course

Student can learn an online course in two ways. The first way is to register the course and learn by themselves to watch the videos, PowerPoints, and other documents that are uploaded in advance by the instructor. They can access the course on either personal computers or mobile devices. The only prerequisite is that the device must be connected to the Internet and a web browser is installed.

The second way is that students learn online with instructor teaching simultaneously. In the previous section, we have explained how an instructor start teaching online by the screen mirroring technique. Once students get the 4-digit password, they can see the same screen that the instructor is showing from his side. The first snapshot in Fig. 11.4 shows an example. Students can also access the resources of the course and other functionalities on the platform such as discussion panel, quick note, and cloud drive, as shown on the second snapshot in the figure. The third one shows all the lessons of the course. Students can click on the link to view the corresponding content. Students can ask questions while learning the course by write them down on the discussion panel as shown by the last snapshot. Any other participant including students and the instructor can see the question and answer it by replying the message. They can also do online exercise and quiz similarly.

By the screen-mirroring technology, the platform setups a virtual classroom on the Internet. In the virtual classroom, instructors teach courses, handout assignments

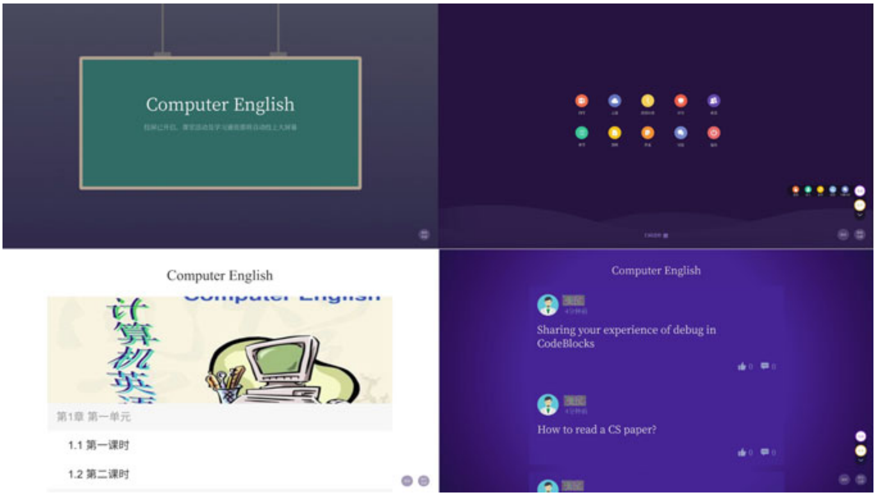

Fig. 11.4 Snapshots of learning online on laptops on ECEP

and exercises, and organize test and quiz as they do in physical classrooms. It is not restricted by location and capacity. Students from different places can join the course online simultaneously without the limitation of capacity, and it would not cause extra burden to instructors.

11.4.3 Feedback from Instructors and Students on ECEP

After two-year development, ECEP has become a stable and reliable platform that the institute is now heavily relying on it for most of the teaching and learning activities. We collected feedback from the instructors and learners in the institute on their experiences of teaching and learning on the platform. The collected feedback is positive. Both the two sides, i.e., instructors and learners, agree with the necessity of using the platform and think it significantly improves the teaching efficiency and quality. To learners, it becomes more convenient to access the online courses and learn according to their pace and progress.

An instructor whom we interviewed is teaching a course about *Introduction of Automobile Mechanisms*, a compulsory course to teach students basic knowledge about the principles of automobile mechanisms. The instructor thinks that the effect of using the platform in teaching is very positive.

> In the course I need to show students the interior of cars to help them understand the principles that how they operate. I teach in a blended way. I put slides and videos on the platform in advance, and explain to students and answer their questions in class. In conventional teaching approach, I have to draw on whiteboard or just describe using language. It is sometimes too abstract for students to understand well. Now in my online course, I prepared corresponding images and videos which I always show in class and meanwhile explain face-to-face. The visualization is apparently easier for students to understand. Another advantage is that I do not need to repeatedly prepare teaching resources, which drastically saves a lot duplicate effort. From administration point of view, the online course helps the communication between students and I. They can use the online discussion function to send me messages to ask questions when they learn online. Compared with face-to-face manner, the online discussion is not restricted by physical places and time. Students are very active online.

Figure 11.5shows a snapshot of a video used in the course. The video demonstrates by animation the operation principle of windshield wiper in automobiles. By watching the video, it is very easy to understand how a windshield wiper is driven by a device inside the car and how the force is transmitted. Compared with traditional textual description, the advantage of videos is apparent in its straightforwardness and informativeness.

Besides specialized courses as aforementioned, the courses for common knowledge are also ideal candidates that can be delivered online. Such courses are usually compulsory, and therefore the number of students who take the courses is usually must larger than that of specialized courses. In traditional teaching, students have to be divided into several small classes due to the capacity of classrooms and guarantee of teaching quality. Instructors need to repeat the same content several times for

Fig. 11.5 A snapshot of a video to teach the principle of windshield wiper (Taken from the ECEP official website http://WXVIC.fanya.chaoxing.com/)

all classes, which requires duplicate teaching effort. However, online courses can effectively solve the issue.

We interviewed a lecturer who is teaching a course *Introduction to Computers* for all first-year students except those from the School of Art Design and the School of Digital Media. The objective of the course is to teach student basic computer skills such as operating systems, network management, office software, and Internet. Students are not required any prerequisites to learn the course.

> We have six lecturers to teach the course. Nevertheless, we are facing hundreds of students. It is big burden if we teach face-to-face in the traditional manner. Although we can directly demonstrate computer skills in front of students, we have to repeat them to each class. Such on-site demonstration is quickly gone. If a student misses one step, he or she may not be able to follow next steps. After we put the courses on the platform, we flipped the teaching approach in that we required students learn online before class and in class we are responsible of answering the questions raised by students. The flipped approach is more effective than the traditional one. We avoided the repeated demonstration which is not innovative at all. Meanwhile, we are now having time to improve ourselves so that we are capable of handling those strange questions that students may raise in class about the problems they encountered when learning by themselves online.

From students' perspective, they prefer the online learning style to the traditional way for many reasons. One is that the young generation is used to online learning. Mobile devices such as smart phone, tablets and electronic readers already become their necessities in everyday life. They do not confine themselves only in classrooms to learn any longer. Instead, they prefer to learn in their own style from various medias such as the Internet, intern and observation.

> I prefer to learn on the platform because I can learn with my own pace. Whenever I have problems during learning, I can try to solve it by searching for solutions on the Internet or keep it temporarily and ask later in class. Sometimes, I may come up with a solution before the class, which I think I learn more than simply asking for answers from teachers. Another reason is that it is difficult to get concentrated to follow teachers 45 min in class, and consequently I may miss a lot. By online learning, I do not have such issue. I can repeatedly learn those that are difficult to me until I fully understand it. Another advantage of online

learning is that I am not learning right in front of teachers. I become more self-disciplined and self-motivated to learn.

From the feedback of both instructors and students, it can be concluded that teaching and learning on the platform is favorite way to them and online learning has incomparable advantages such as convenience, cost-effectiveness, flexibility and reproduction, thanks to the revolutionary progress of ICTs.

11.4.4 Problems and Solutions

In the development of ECEP, the institute also experienced many technical and methodological problems when promoting the application of the platform.

11.4.4.1 Quality Guarantee

The first methodological problem with the platform is how to guarantee the teaching and learning quality. There have been well-established criteria of evaluate the quality of a traditional teaching and learning effect. By contrast, teaching and learning on ECEP is still considered as auxiliary means. There is no standard to evaluate the effect and guarantee the quality.

As the advantages of online education are clear, its weaknesses are also apparent and might result in low education quality. For instance, the platform gives students freedom of deciding when they are prepared to open their computer to start learning. This feature is essentially a double-edged sword. Self-motivated students benefit from it, while those who are not interested in the course may never learn it online. Although the new technology allows instructors to track each student's learning activities online, the tracking mechanism can be easily cheated and thus cannot be considered as a deterministic factor for evaluation.

Another weakness of online learning is that learning in virtual reality may widen the gap between the knowledge that students learned and the capability that they use it to solve practical problems. Such capability is particularly necessary to technical and vocational education. Both theory and practice are equally important to students, while practical experiences is hardly gained from online learning. Therefore, one cannot purely rely on online platform to achieve high-quality learning.

To guarantee the education quality, the institute has made many attempts to integrate traditional approach and the ICT-based approach. Students are asked to learn online by themselves before class, and on class instructors give them some test and exercises to examine their learning effect and meanwhile train their capability of applying what they learn. They call such form *flipped classroom*, a kind of blended teaching approach which have been proved effective to solve the issues of ICT-based education.

There are also other machine-based auxiliary approaches which are helpful to guarantee the quality of online learning. For instance, AI-based approaches are introduced in the latest version of the ECEP system. The system can automatically analyze the learning habit of each student, and gives them advises and reminders based on their habit. Meanwhile, when the system detects exceptions such as intensive learning in a short time or no activity online for a long time, it will report to instructors. These auxiliary approaches can help instructors collect basic information on students' learning progress, the time spent on the course and their performance.

11.4.4.2 Performance

Performance of the platform is another problem that directly affects the quality of online learning. In the earlier phase, online learning was not widely accepted by both teachers and students due to the low performance of the system caused by low bandwidth capability and less user-friendly interface. The low-speed Internet usually took much time for learners to stream a video from servers. Online streaming is stopped and buffered, which heavily affected learners' feeling and caused frustration. Another result due to the low speed of the Internet is the quality of video has to be reduced in order to make the size of video reasonably small to download or stream. Moreover, before the prevalence of mobile computing, the system was simply a BS (Browser and Server) web application which can only be accessed by computers. It caused extra cost for instructors and students in order to access the system.

The solution to the performance issue of the system is straightforward, i.e., to upgrade hardware facilities and improve the user interface of the system. The drastic progress of hardware technology makes the affordability of high-performance devices and services. The hardware performance and Internet bandwidth by 4G and 5G technologies are no longer problems. As for the software, because there are many mature software products developed by professional IT company, a cost-effective solution is to purchase such product and customize it by secondary development according to the institute's concrete requirements.

11.4.4.3 Security, Privacy and Data Abuse

As an ICT application, ECEP also faces the some common technical and ethic problems of ICT products such as security, privacy and data abuse.

The ease of accessing the Internet increases the risks of outside attack to electronic systems. Such systems are become vulnerable to get attacked. Data leakage or system crash due to attack is not tolerable when thousands of users are teaching and learning on the system. Particularly, the system and network must be ensured safe when students are having online testing.

> Although there is no general solution to the security problem, our institute have adopted some strategies to protect the system to some extent. For instance, we introduced VPN (Virtual Private Network) technology to prevent malicious login from outside. Each system user, e.g.,

instructor, student and administer, is issued a unique account. Anyone who tries to access the system must be authorized by our authorization system based on the industry-standard protocol OAuth 2.0. Besides, instructors are not recommended to upload those documents and videos used for internal teaching to the platform. Online testing is usually organized using local network service which is disconnected from outside.

Besides security, user privacy and data abuse should not be neglected. For instance, participation rates and reaction times of students are often recorded by the platform for further data analysis. It also occurs to instructors. The system may collect the online activities of instructors to evaluate their teaching performance. Students and instructors may feel offended if their data is abused without their permission and authorization. What the institute can do to protect user privacy and their private data is to access the authorized data and let users know the risk of sharing unauthorized data in publish. However, these efforts are still quite limited. Relevant regulations and laws by the government are desired to solve the problem.

11.5 Values and Value Co-creation

New ICTs are redefining the education approach. For instance, Apple, as an innovation pioneer, has launched Apple Distinguished Educators (ADE) program since 1994 to promote the application of Apple technology to transform teaching and learning. Two decades later, state-of-the-art ICTs such as mobile devices, high-speed wireless transmission and renaissance of Artificial Intelligence, gradually clear the obstacles in ICT-based evolution of education. ICT products specialized to education are booming. Teaching and learning with ICTs are the trend of the new education form.

11.5.1 Values of ICT-Based Vocational Education

From service point of view, ICTs create new education values that transitional approaches cannot produce. They main include the abilities of learning on demand and learning in virtual reality, and the digitization of learning resources. Figure 11.6 shows three main values of new ICTs-based education.

11.5.1.1 Learning on Demand (LOD)

ICT-based education makes it possible for students to learn on their demand, which is becoming a new learning style among the youth. The notion of LOD was first proposed in 1998 by Trondsen Eilif and Vickery Kent in their work (Trondsen and Vickery 1997), where it was defined as *a model that reduces knowledge acquisition time, cuts travel costs for both students and teachers, lowers off-the-job related expenses, reduces classroom overheads and lowers materials expense.* A feature

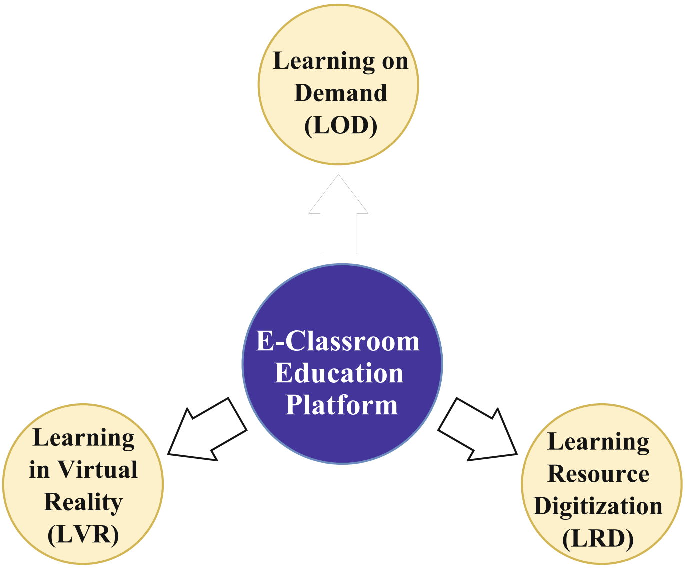

Fig. 11.6 The values created by ECEP

of LOD is that it emerges with the advent of the Internet (Trondsen and Vickery 1997). Online learning have all the characteristics that LOD features, and thus online learning is also considered as a concretization of LOD (Elaine and Jeff 2010).

One main feature of learning on demand is that learners can learn based on their real demands and with their own pace, as we learned from the survey. The learning quality in this way is usually better than the one of learning at fixed time and place due to the individual difference. Particular to vocational training, students usually need to learn practical skills that are used in special environments. The effect of learning in such the right environment would be better than the one of learning in a common classroom. Online learning breaks the limitation of time and location so that students can learn on the occasion when they need corresponding knowledge to solve problems at hand.

Another feature of learning on demand is that it does not require burdensome investments due to light dependence on physical space and human resources. Consequently, it cuts the cost of learning. The reduction of learning cost makes it affordable to more people, and meanwhile encourages government and enterprises to invest in education with lower risk.

11.5.1.2 Learning in Virtual Reality (LVR)

Another value of ICT-based education is that teaching and learning can be conducted in virtual reality. The notion of learning in virtual reality (LVR) was first proposed by Bricken (1990), and in his work he described a blueprint where the teacher can create a programmable environment where students can gain immediate sense of words and pictures to enhance their feeling, understanding and skills during learning. Follow-up studies showed the possibility of learning in virtual reality with the progress of information technology (Mills and Madalena 1999; Bossard et al. 2008; Greenwald et al. 2017) and evidences are found to the equivalence effect of learning in both real world and virtual reality even for complex spatial tasks such as route learning (Lloyd et al. 2009; Bertram et al. 2015).

Learning in virtual reality for vocational education and training is particularly useful because the knowledge that learners need to learn is usually specialized and learning in specific environment is desirable to help learners link what they learn to the real-world problems (Schank 1997; Bacca et al. 2015). Apparently, it is almost impossible for institutes to setup a real training environment for each specialized course. New ICTs make it possible to produce virtual environments. Compared with real teaching environments, virtual environments have the following advantages:

1. They are cost-effective to setup and consequently lower the cost of learning, which further attracts more investment from both government and enterprises and makes the learning affordable to more people.
2. They are easy to access e.g. on the Internet or specific software, and can be reproduced whenever needed, which give learners more practice opportunity to enhance their knowledge.
3. They can easily enumerate and simulate various scenarios and even create some rare cases which are good to enrich learners' experiences.
4. In the case that the real training environment is dangerous, virtual environment can avoid the risk of physical harm and safety hazards to learners, particularly those unsophisticated ones.

The above advantages of virtual learning environment make it an ideal solution to meet the needs of teaching and learning of specialized skills. The application of virtual environment to vocational teaching and training impels governments and enterprises to start new education projects and businesses. For instance, India government launched *MoVE* (Mobile vocational education) project for rural India (Akshay et al. 2012). Malaysia initiated m-learning (Mobile learning) program since 2011 (Abd Rahman et al. 2011). Germany developed several ICT-based projects such as BloK (The Online Report Book), WDB (The Mobile Knowledge Database for the Plastering Trade), and online portal *foraus.de* to provide online teaching and learning service (Hartel 2017). Learning in virtual environment also leads to innovation of learning approach. Blended learning has gradually become a popular way for the young generation to gain special training (Sahin 2010).

11.5.1.3 Learning Resource Digitization (LRD)

ICT-based revolution of vocational education also drives the reform of the pedagogical content and resources. Digitization is main trend of the reform (Leonard 1999).

That is, knowledge needs to be digitized to meet the requirement of ICT-based education. Although traditional paper books are still the mainstream for in-class education, various forms of resources for teaching and learning such as eBooks, audio books and videos are invented and becoming popular among the youth (Merga 2014). The digitization of pedagogical contents are natural product of ICT-based revolution of education, and in turn drives the progress of the revolution, because these new forms of learning resources are more suited to ICT-based education than paper books.

Although it is controversial to argue either paper books or digital books are better than the other as it basically depends up personal preference, advantages of digital learning resources are still obvious and dominant (Rojers 2015).

- Faster to spread. With the progress of communication technologies, it takes less time to download a video of large size from the Internet. Digitized pedagogical contents including eBooks and even high-definition videos can be downloaded fast or even read and watched online.
- Cheaper to reproduce. A digital document can be easily reproduced by simple copy and paste operation on computers with very little cost. This feature lowers the cost of producing digital document, and consequently makes digital documents affordable to more people.
- Easier to store and manage. Digital documents can be stored on hard disk permanently, which only takes a very small physical space. Using database technologies, they can be stored in a database system which provides efficient functions to access.
- More straightforward to understand. Digital audios and videos are more straightforward to understand than textual documents for the feature of audiolization and visualization, which are more natural to human's sense.

The ICT-based revolution on education accelerates the digitization of the resources related to teaching, learning and testing. The digital contents for building online courses on either public MOOC platforms or private internal teaching systems are *live knowledge* in that it is self-explainable and self-interpretable. Although knowledge digitization suffers copyright and intellectual property issues, it has become an unavoidable trend in this knowledge and information society, which makes knowledge more manageable and sustainable (Carrillo et al. 2009, 2010).

11.5.2 Value Co-creation Model

From service science perspective, the essence of traditional vocational education is a process of value co-creation by knowledge transmission and specialized training of skilled workers. Instructors and learners are main contributors in this process. Learners are not only passive recipients but also co-creators because they collaborate with instructors together for high-quality education service (Cai et al. 2018).

In ICT-based education, the contribution of online service providers should not be neglected because their technical supports and ICT software and hardware products

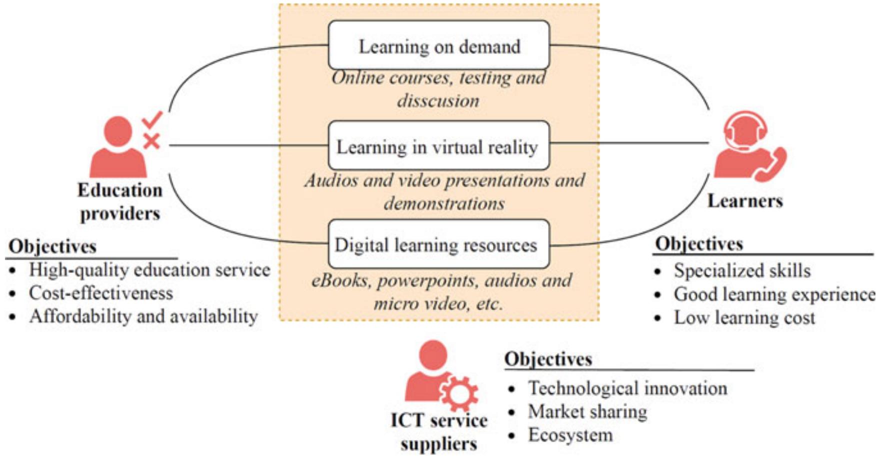

Fig. 11.7 Value co-creation model of ICT-based vocational education

are fundamental and necessary to the new education. The values of the new education include not only those of traditional education but also the new values as discussed in the previous section. They are co-created by the collaboration of education providers, learners and ICT service providers. Figure 11.7 shows a value co-creation model of the ICT-based vocational education.

- *Education providers*. The objective of education providers is to present high-quality and cost-effective education service which is affordable and accessible to more young people who wants to get educated for their career development. They deliver the service aided by ICT devices and systems to lower the cost and improve the availability and meanwhile guarantee the education quality.
- *Learners*. The objective of learners is to acquire professional knowledge and specialized skills from the education with good learning experience and low cost. They expect to study independently with their own pace and at their favorite environment.
- *ICT service supplier*. The objective of ICT service suppliers is to provide innovative ICT products and services to both education providers and learners by which they can make commercial profits. They expect their products and services are competitive for big market share and try to develop exclusive ICT ecosystems and users' brand loyalty.

The objectives of the three parties are consistent and profitable to each other, which is the foundation of close collaboration among them. For instance, ICT service suppliers make financial gain by selling their products and services to both education providers and learners, and meanwhile they can collect feedback and data from users for product and service improvement and innovation. Education providers can do live teaching online and share digital resources such as slides and videos on the Internet for learners to access on their demand. The new teaching method meets the requirements of modern vocational education from education providers' side, such as the reduction of cost and availability without time and location restrictions. Learners' participation is also important to the co-creation of the values. They are both beneficiaries of the education by enriching themselves with new knowledge and practitioners who make contributions with new skills. Their interaction with instructors is also helpful to the innovation of teaching. As consumers, learners also make contributions to the improvement of ICT products and services by sharing their experience and comments to the supplier.

11.6 Analysis

In this section, we analyze the business innovation with new ICTs in the field of vocational education from five dimensions, i.e., objectives, technologies, methodologies, relationships of all stakeholders, and effects.

(1) **What are human desires, issues in human society or business, the objective of utilization of ICT? (needs)**
The main objective of utilizing of new ICTs in vocational education is to meet the desires of both education providers and learners, which are to provide (*resp.* receive) high-quality, affordable and easily accessible education services.

(2) **What technologies and functions are utilized in order to solve issues or realize human desires? What is the role of ICT in value creation? (technologies)**
New ICTs that have emerged and commercialized are now being gradually applied to vocational education. Typical technologies include 4G/5G wireless communication, mobile computing, cloud computing, virtual reality and augment reality, and artificial intelligence more recently. Corresponding hardware and software products and services are developed by professional providers.

(3) **What are value creation methodologies? Consider optimization of total system, industries or companies' collaboration, value co-creation between providers and users. (value creation)**
New ICTs break the physical limitation to teaching and learning and breeds a new online mode, which makes use of various digital resources such as video, audio, eBooks, and PowerPoints for knowledge transmission. Teaching can be delivered by live broadcasting or requesting on demand. A blended mode by integrating both online and offline modes is prevalent in practice.

(4) **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and ICT system, the relationship among users, ICT providers, and other stakeholders (Collaboration)? (human/business activities)**
New ICTs redefine the relationships among three stakeholders including education providers, learners and ICT service providers in vocational education.

Besides conventional teaching and learning relationship between education providers and learners, they are both users of ICT service providers. Meanwhile, ICT service providers are also contributors to and beneficiaries of high-quality education service.

(5) **How human life, business or society have changed? (innovation)**
The introduction of new ICTs has significantly transformed and expanded conventional vocational education by drastically reducing its cost, improving its availability and accessibility. It is redefining a new approach of knowledge transmission, which is not limited by cost, physical location and time. Knowledge is becoming cheaper and easier to access and more concrete and direct to learn than the past.

The above business innovations with new ICTs accelerate the transformation and expansion of vocational education in various aspects. Everyone involved in this transformation and expansion is beneficiary. Knowledge is more easily spread and delivered, which lowers learning cost while improving learning experience and effect. New values of vocational education are co-created by education providers, ICT service vendors, and even learners.

11.7 Conclusion

ICTs are redefining almost everything of human activities, including life style, working, and even relationship. Teaching and learning, as essential activities, are the most effective means of the continuation and evolution of human civilization and knowledge transmission for human enlightenment and specialization. In modern education, ICTs are the main driving force to the transformation and expansion of education in terms of methodology and content. Vocational education, as an important style of education, particularly relies on ICTs due to its specialties in the large number of candidate students, importance of experiences in practice, and requirement-oriented training.

This work briefly overviewed the three-phase development of the ICT-based vocational education in China, and presented a case study as a representative example of the current progress. State-of-the-art technologies and products such as cloud computing, 5G, and apps for mobile devices are introduced into the education, which significantly improves the teaching quality and learning experience of online education. Aided by ICTs, education providers save duplicated effort on in-class teaching, and focus themselves on creative work such as producing high-quality textbooks, teaching videos and documents. The cost of education is reduced. It is more affordable to the youth and easier to access thanks to the new ICTs. Meanwhile, vocational education is no longer a non-profit activity but instead a market full of business opportunities because of the introduction of ICTs. More and more investments from society and government are attracted to vocational education, which would further accelerate its development and evolution.

References

Abbott C (2003) ICT: changing education. Routledge

Abd Rahman R, Hashim M, Hisyam M (2011) Mobile learning in Malaysian technical and vocational education (TVE): a qualitative case study

Akshay N, Sreeram K, Anand A, Venkataraman R, Bhavani RR (2012) Move: mobile vocational education for rural India. In: 2012 IEEE international conference on technology enhanced education (ICTEE). IEEE, pp 1–5

Anderson T (2008) The theory and practice of online learning. Athabasca University Press

Bacca J, Baldiris S, Fabregat R, Graf S et al (2015) Mobile augmented reality in vocational education and training. Procedia Comput Sci 75:49–58

Bertram J, Moskaliuk J, Cress U (2015) Virtual training: making reality work? Comput Hum Behav 43:284–292

Bossard C, Kermarrec G, Buche C, Tisseau J (2008) Transfer of learning in virtual environments: a new challenge? Virtual Real 12(3):151–161

Bricken W (1990) Learning in virtual reality. University of Washington

Cai J, Sun M, Kosaka M (2018) Perceiving learner as value co-creator in older adult education: from both theoretical and practical perspectives. Asia Pacific J Educ Taylor Francis Online 38(4):565–581

Carrillo FJ, Metaxiotis K, Yigitcanlar T, Mohamed M, Murray A, Mohamed M (2010) The role of information and communication technology (ICT) in mobilization of sustainable development knowledge: a quantitative evaluation. J Knowl Manage 13(5):271–286

Carrillo FJ, Mohamed M, Stankosky M, Mohamed M (2009) An empirical assessment of knowledge management criticality for sustainable development. J Knowl Manage

Elaine A, Jeff S (2010) Learning on demand: online education in the United States, 2009. ERIC

Greenwald S, Kulik A, Kunert A, Beck S, Frohlich B, Cobb S, Parsons S, Newbutt N (2017) Technology and applications for collaborative learning in virtual reality. pp 719–726

Hartel M (2017) Germany: BIBB. Using ICTs and blended learning in transforming TVET, p 59

Keegan D (2013) Foundations of distance education. Routledge

Latchem C (2017) Using ICTs and blended learning in transforming TVET, perspectives on open and distance learning. UNESCO, Commonwealth Learn

Leonard DC (1999) The web, the millennium, and the digital evolution of distance education. Tech Commun Q 8(1):9–20

Lloyd J, Persaud NV, Powell TE (2009) Equivalence of real-world and virtual-reality route learning: a pilot study. Cyberpsychology Behav 12(4):423–427

Lumagbas JJ, Smith W, Care E, Scoular C (2019) Tablet computers in Philippine public schools: school-level factors that influence technology management and use. Tech Pedagogy Educ 28(1):73–89

Merga MK (2014) Are teenagers really keen digital readers? adolescent engagement in eBook reading and the relevance of paper books today. Engl Aust 49(1):27–37

Mills S, Madalena M (1999) Learning through virtual reality: a preliminary investigation. Interact Comput 11(4):453–462

Pappano L (2012) The year of the MOOC. The New York Times 2(12):2012

Pfeiffer S (2015) Effects of industry 4.0 on vocational education and training. Institute of Technology Assessment, Vienna

Rojers PJ (2015) Higher education book publishing—from print to digital: a review of the literature. Publ Res Q 31(4):264–274

Sahin M (2010) Blended learning in vocational education: An experimental study. Int J Vocat Tech Educ 2(6):95–101

Schank R (1997) Virtual learning. A revolutionary approach to building a highly skilled workforce. ERIC

Schulte B (2015) (Dis) Empowering technologies: ICT for education (ICT4E) in China, past and present. Chin J Commun 8(1):59–77

Trondsen E, Vickery K (1997) Learning on demand. J Knowl Manage 1(3):169–180
Wu D (2014) An introduction to ICT in education in china. In ICT in education in global context, Springer, pp 65–84
Zhao Y, Jiang Z (2019) Bridging the gap: ICT and OER for equitable and quality rural education in China. In: Ministerial forum, p 175

Part IV
Case Studies on New Businesses with Mobile Devices and Internet

Chapter 12
Mobile Payment Innovations in China: China UnionPay's Practice and Experience

Quan Sun, Yongkai Zhou, and Tao Tang

Abstract The popularization of mobile internet has given rise to the demand for flexible and convenient payment methods. For China, it is necessary to keep pace with or even lead the trend of innovation and development in the age of mobile payment. From the perspective of systems engineering, this chapter introduces the research and practice of China UnionPay's mobile payment project. The general requirements and core engineering problems of the mobile payment project are summarized based on the analysis of the characteristics and engineering difficulties. Integrated innovation of technologies is introduced to resolve the contradiction between ease-of-use and security. Rapid iterative development process is adopted to improve the product release efficiency as well as user experience. The launch of the mobile payment project also opens the window to coordinate the whole payment industry for upgrading and quality-improving.

12.1 Introduction

The popularization of the mobile internet has greatly shaped everyone's daily life. This process is an opportunity for the payment industry to upgrade and reform, but it is also a challenge. The demand for flexible and convenient payment is more pressing than ever before. Mobile payment is rapidly emerging as a new form of payment along with the payment of chip cards and online payments. These diversified payment innovations lay the foundation for 'internet finance'.

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After more than ten years of rapid development, the bankcard industry has experienced the switch from magnetic stripe cards to chip cards and from physical bankcards to virtual bankcards. The service provided by bankcards is moving in the direction of increasing security and convenience. The focus of the bank card industry has shifted from merely cross-bank switching to the adoption of innovative payment technology to promote the development of the whole industry chain.

From a historic view, China's bankcard development can be classified into 3 stages. In the era of magnetic stripe cards, China was learning from international bankcard organizations (Zhu 2000, Zhang 2013). In the era of chip cards, China was developing these in parallel with the main participants in the world. In regard to the age of mobile payment, it is necessary for China to keep pace with or even lead the trend of innovation and development worldwide (Chai 2015). The ongoing and predicted trends in transaction amounts and growth rate of China's mobile payment market are shown in Fig. 12.1. The large-scale application of mobile payment offers a good chance for the entire industry chain to upgrade their legacy devices and improve quality. Such improvements would also help to accelerate the transformation from an extensive to an intensive economic growth mode.

The next-generation mobile financial platform will play a key role in China's financial payment system. From the system engineering perspective (Xuesen 1982), the mobile payment system is huge and highly open, extending to all social industries. Furthermore, it is also a complex system with distinct characteristics of systematicness, dynamic interrelatedness and economy (He et al. 2013). In the process of managing the mobile payment project, many of the problems encountered not only relate to technical engineering but also to financial, social, and even legal issues, which make the system highly complicated (Chai and Sun 2016). Furthermore, the mobile payment system does not exist in isolation. We have to think about how to best integrate it into the existing stably running payment system rather than rebuild a totally new system. This calls for a series of engineering methodologies to help solve these complicated problems. The resulting methods can be applied to manage innovation requirement analysis and to optimize the research, analysis, design and implementation of the project (Liu et al. 2016).

On December 12th, 2015, based on years of in-depth investigation and elaborate prearrangements, China UnionPay (CUP) issued its own brand of mobile payment, 'QuickPass', together with dozens of China's top banks (Fig. 12.2). The launch of QuickPass represents a key milestone of the mobile payment project, and it has proven to be suitable for China's actual conditions. In this chapter, we will introduce China UnionPay's research and practice on the system engineering management of the mobile payment project.

The rest of the chapter is organized as follows. Section 12.2 will introduce China UnionPay's business situation. In Sect. 12.3, the general requirements and objectives for the mobile payment project will be summarized. In Sect. 12.4, the development of the mobile payment project will be introduced. Section 12.5 will analyze the adoption of new technology into the mobile payment project and its impact. Section 12.6 will finally discuss the direction of business innovation with a new ICT product in mobile payment.

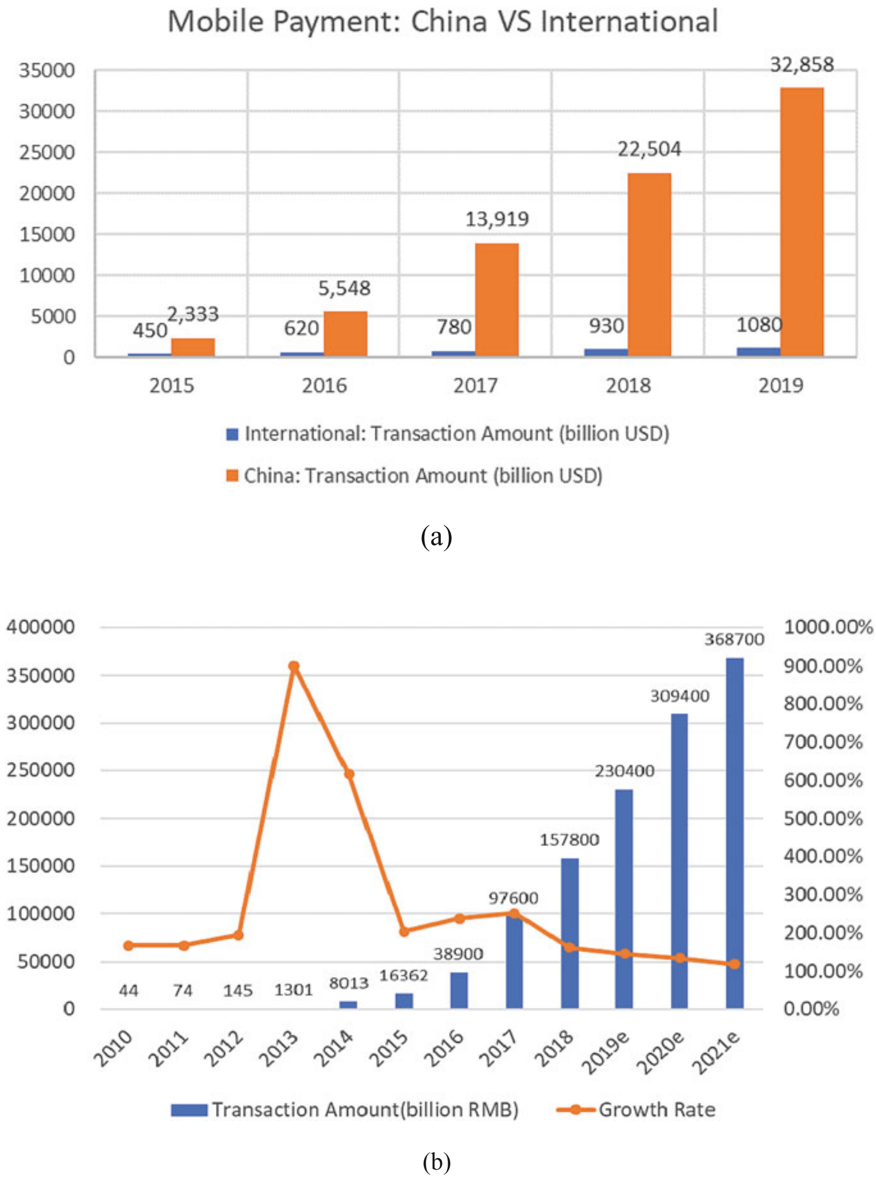

Fig. 12.1 Mobile Payment Development in China. **a** Transaction Amount (Yuguo wang 2019) **b** Transaction Amount and Growth Rate (Chinabgao 2019)

Fig. 12.2 UnionPay mobile QuickPass product

12.2 China UnionPay's Business Situation

12.2.1 Introduction of China UnionPay

China UnionPay is a financial services corporation headquartered in Shanghai, China. Founded on March 26, 2002, China UnionPay became a leading bankcard association in both domestic and international markets. It is also the only interbank network in China that links all the automatic teller machines (ATMs) of all the banks throughout the country. It is also an electronic funds transfer at point of sale (EFTPOS) network and is the largest card payment organization (debit and credit cards combined) in the world, ahead of Visa and Mastercard, offering mobile and online payments based on the total value of the payment transactions. More than 7 billion UnionPay bankcards can be accepted by tens of millions of merchants in 170+ countries and regions around the world. Some UnionPay credit cards are also affiliated with American Express (AmEx), MasterCard, or Visa, and they can be used abroad as American Express, MasterCard, or Visa credit cards, respectively. UnionPay is also the first financial-level preauthorization service for secured transactions in China. The system allows payment for online shopping at any merchant that accepts UnionPay. In 2019, the number of cross-bank transactions of CUP reached 147.8 billion, with a total amount of 189.4 trillion yuan.

12.2.2 Mobile Payment Service of China UnionPay

With the implementation of China's inclusive finance and tax-fee reduction policies, customers' disposable income has increased significantly, and as payment scenarios have widened, mobile payment products have been more convenient to use by consumers. With the rapid development of mobile payments, China UnionPay has devoted efforts to participate in this field. Several products have been carried out by China UnionPay on mobile payments, such as QuickPass, UnionPay APP, and mobile POS (point of sale).

QuickPass is a contactless smart card feature similar to MasterCard's PayPass or Visa's payWave, which enables offline contactless payments with mobile devices such as mobile phones, bracelets, watches, etc., and supports QR (Quick Response) code payment and remote online payment. It uses NFC (near field communication) and token technology to support small-amount payments. At present, QuickPass is supported by most digital wallet providers, such as Huawei Pay, MI Pay, OPPO Pay, vivoPay, Apple Pay, Samsung Pay, and Meizu Pay Currently, QuickPass is widely used in many supermarkets and fast food stores.

The UnionPay APP is an entry platform for mobile payments developed by various commercial banks and UnionPay. Consumers can bind bankcards through this APP, manage various types of bank accounts and use the mobile payment services and the other services provided by various banks. By the end of 2019, the total number of registered users exceeded 250 million, and the UnionPay APP became a major APP in mobile payments.

The mobile POS (Fig. 12.3) is a mobile multifunctional collection product based on a mobile phone smart terminal developed for merchants. Merchants can receive orders on the mobile phone by using the mobile POS without needing special external POS equipment.

(a) QuickPass

(b) UnionPayAPP

(c) Mobile POS

Fig. 12.3 Mobile payment service provided by China UnionPay

12.3 The Requirement and Objective for Mobile Payment Innovation

12.3.1 Market Requirements and Engineering Problems

Compared to a traditional bankcard payment, a mobile payment brings about the following changes in terms of its representation form:

(1) **On the client side**

The most notable change is that the physical bankcard is no longer the only payment carrier and will be gradually replaced by mobile terminals. The mobile terminals involved may vary greatly, and the most frequently used is the mobile phone. Recently, wearable devices have also been developing rapidly. Under the mobile scenario, the behavior of mobile terminals tends to be much more unpredictable, making it difficult to locate and identify the cardholders.

(2) **On the acceptance side**

Traditional payment terminals (POS) will also be replaced with mobile payment terminals, e.g., mobile POS. In this case, the increased mobility may degrade the controllability of the terminals. Currently, in China, the charging of interchange fees depends on the scope of business. Compared to the traditional static scenario, it is much easier for a low fee-rate mobile POS to be used in a high fee-rate business service, which is the so-called 'POS shifting' problem. This would violate the current regulations and pose a great challenge to risk management.

(3) **On the backend**

Improvements are also needed to adapt that backend to the highly mobile payment scenario, although these changes are not as apparent as those of the frontend. The risk management system should take more factors (such as device name and location) into account so that the potential risks can be evaluated from a more comprehensive perspective (Cai et al. 2016). Furthermore, the backend system should also provide a set of uniform interfaces for the mobile terminal platforms to register and access.

As a large engineering system, mobile payment projects require top-level design with overall optimization. The general design is important to a system and can best embody the innovation of engineering intelligence. The design should comply with the internal development trend of modern financial services. The bankcard information system in the mobile finance age can then be built based on it, which is key to the success of the bankcard industry.

Before that, the engineering problem has to be clearly stated. From the features and status of mobile payment analyzed in Sect. 12.2, the core engineering problems of the mobile payment project can be summarized as follows:

ISSUE 1: How to efficiently design and develop mobile payment products with the lowest reconstruction cost, subject to financial security and compliance requirements?

ISSUE 2: How can industry chains cooperate to establish a mobile payment ecosystem?

12.3.2 Two Main Objectives: Balance and Coordination

The mobile payment system is a complex system. Many factors need to be taken into consideration during the engineering process. These factors are usually interrelated, and some of them are even contradictory. Therefore, CUP has needed to make considerable efforts to balance and coordinate the contradictions encountered in the whole mobile payment system project.

12.3.2.1 Comprehensive Balance

To address the first issue of engineering problems, a comprehensive balance is introduced and implemented in the project to ensure high efficiency and low cost.

(1) **Balance between convenience and security**

For the financial industry, funding safety is the greatest concern. However, the demand for diversified payment experiences has brought big challenges to funding safety. With the advent of the mobile internet, many innovation payment methods have appeared, such as square bankcard readers, barcode payments and voice payments. Unfortunately, many of them are high risk options. Therefore, the mobile payment system to be designed should meet the requirement of financial funding security. Furthermore, the development and release process should be accelerated to meet mobile users' rapidly changing demands.

(2) **Balance between innovation and regulation**

Mobile payment will undoubtedly involve many innovations. The nature of mobile payment is still financially inherent, and the credit and risk attributes of finance have never changed. The key to financial innovation lies in risk control, and security is always the first concern. Therefore, regulation plays an essential role in mobile payment. It serves as a key point to properly treat the role of information technology in the process of implementing the mobile payment project.

(3) **Balance between data utilization and privacy protection**

The usability and security are usually thought to contradict each other. Apart from the funding security mentioned above, payment information protection is also very important to cardholders as well as the whole payment system. It should be ensured that no sensitive payment information is leaked to the nonfinancial organization or intercepted by any third parties.

12.3.2.2 Integral Coordination

To address the second issue of engineering problems, the methodology of integral coordination is accepted and applied by the whole bankcard industry to establish a mobile payment ecosystem.

(1) **Coordination of upstream and downstream in the industry**

The bankcard industry is the basis for financial payment, which involves 4 large industries: the financial industry, manufacturing industry, service industry and information industry. The mobile payment project covers the main participants, such as banks, mobile phone manufacturers, telecom operators, and mobile payment terminal manufacturers. It would take monumental efforts to coordinate all of the above parties and balance their interests.

(2) **Coordination of international standards and domestic standards**

Traditionally, the bankcard industry tends to design products in accordance with international standards. Faced with severe cyber network security situations, China has turned to developing its own standards as a way to realize technical independence and controllability. How to integrate domestic standards, especially cryptography algorithms, into the new generation of mobile payment systems should also be seriously considered.

12.4 Development of an Innovative Mobile Payment

12.4.1 Major Mobile Payment Services

We mainly provide two kinds of mobile payment services, i.e., NFC (near field communication) payment and QR code payment.

12.4.1.1 NFC Payment

The core idea of the QuickPass NFC solution is a 'bankcard simulation', that is, the mobile terminal acts as a virtual bankcard to access the payment network. Such a design has several advantages:

(1) **Financial security**

The core idea of simulating the bankcard in mobile terminals limits the financial functions of mobile terminals to a minimum level. The essence of the solution is 'one account, multiple payment carriers'. Once the information of the entity bankcard inputted by the user passes the validation of its issuing bank, the bankcard can be virtually provisioned into the secure element of the mobile terminal. The virtual

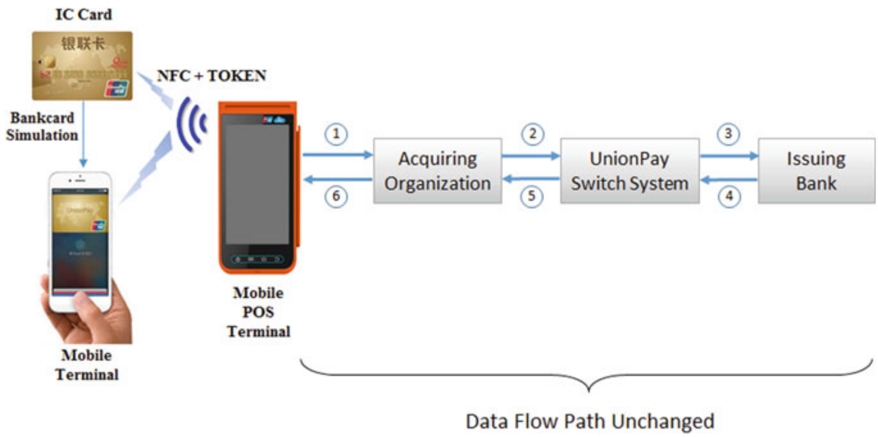

Fig. 12.4 Illustration of 'Bankcard Simulation' in QuickPass design

card shares the same bank account with the original bankcard and can be used in the scenario of near field payment or mobile online payment. The data flow of each payment transaction is exactly the same as that of using a real bankcard, i.e., the acquiring organization delivers the transaction information to the issuing bank via the intermediate bankcard organization, who finally processes the settlement of the funding, as shown in Fig. 12.4.

The platform of the mobile terminal itself is not a payment organization, and no extra financial accounts are allowed to deposit the funding. In this way, the overall financial payment system is still kept as the original 4-party mode, which has been shown to be stable through numerous decades of operation. Therefore, theoretically, QuickPass tends to be more secure than most of the OTT (over the top) solutions since OTT operators usually become directly involved in the financial service by setting up extra financial accounts and depositing customers' payment funding, which complicates the whole financial system and could bring more potential risks.

(2) **Low reconstruction cost**

Theoretically, by following the idea of bankcard simulation, the reconstruction effort of the project only exists in the mobile terminal part. This limits the project scope to a minimal effort. However, in actual practice, we have also modified the backend system to provide a uniform interface and enhance risk management. However, the modification is relatively slight compared to reconstructing a totally new platform. Generally, the overall engineering cost can be greatly reduced, making it possible for QuickPass products to be publicly available in a relatively short time.

By following the idea of a 'bankcard simulation', the focus of the mobile payment project will be on the mobile terminal part. In the design of QuickPass, the communication between the mobile terminals and the POS is through NFC, which is a wireless protocol for short-range communication. Another reason to adopt NFC is that it is already the standard for the chip card. To transparently simulate the bankcard and

Fig. 12.5 UnionPay QR code

interact with existing NFC-enabled POS terminals, an intuitive practice is to adopt the same communication protocol for the mobile terminal. This also helps to reduce the reconstruction cost and reuse the existing payment infrastructure.

12.4.1.2 QR Code Payment

As a new form of payment, QR code payment was first introduced and promoted by some third-party payment organizations due to its convenience and simplicity. During the process, many security issues have appeared, raising some public concerns. After a rigorous demonstration analysis and dedicated regulation design, China UnionPay recently officially issued UnionPay QR code payment standards, including ‘China UnionPay QR code payment security standard’ and ‘China UnionPay QR code payment application specification’ (Fig. 12.5). These 2 documents define and regulate the mode of QR code payment based on the UnionPay bankcard.

Unlike the QR code payment scheme offered by third-party payment organizations, UnionPay’s scheme is strictly based on bank accounts and adheres to the 4-party mode of the existing bankcard system. The difference between the UnionPay QR code payment and the physical bankcard payment only lies in the information exchange mode. There is no financial risk caused by extra financial accounts that deposit customers’ payment funds. Furthermore, the commercial bank can also obtain consistent and complete payment information.

Compared with the traditional bankcard-based face-to-face payment method, QR code payment as a mobile internet-based payment mode faces completely different risks. These include faked binding in the bankcard-binding stage, QR code leakage, faked QR code risk, and APP account theft in the payment stage. To handle these new forms of risks, China UnionPay has formulated a set of risk prevention and control strategies:

(1) Establishing business and risk rules based on the 4-party mode. The 4-party mode involves bankcard associations, bankcard issuers, bankcard acquirers and merchants. Therefore, business rules, such as the division of responsibilities and profit distribution, should be considered in an integrated way. At the same

time, risk rules, such as risk prevention, real-time monitoring and postdisposal, should be handled uniformly.

(2) The adoption of the token technique to avoid leakage of APP and recipient account information.
(3) Helping the participants to carry out risk monitoring towards the stage of bankcard binding and the stage of payment by taking advantage of the factors reported by the cooperation agencies. The goal is the real-time or quasi-real-time interception of high-risk transactions.
(4) Enhancing the rapid risk linkage mechanism with business participators through cargo interception and delayed settlement to alleviate the losses. On the other hand, to eliminate the concerns of users, we introduce the mechanism of in-advance risk compensation, providing both a convenient and a secure payment experience.

12.4.2 Difficulties of Development

(1) **Technical Difficulties**

The top technical difficulty in the project is how to provide convenient payment services in a secure mode. Managing security issues throughout the whole project poses great challenges. Security here may involve the safety of individual financial accounts, communication security, privacy protection, state financial security and national information security, all of which are central to the financial system and can never be compromised (Hong et al. 2016).

(2) **Engineering Difficulties**

The mobile nature of such payments may bring many uncertainties to the whole system. The engineering difficulties of mobile payment projects include demanding timelines and few use cases. Worldwide, mobile payment is still in its infancy. Even in developed countries, there are no large-scale application experiments. Almost no cases can be referenced. On the other hand, the demand is so pressing that the whole project has to be implemented and tested within a relatively short period. The traditional development process is no longer suitable for rapidly changing demands (Hong et al. 2016)

(3) **Marketing Difficulties**

The bankcard industry involves long industry chains, which makes coordination and cooperation complicated. The bankcard industry is the basis for financial payments, which, as stated above, involves 4 large industries: the financial industry, manufacturing industry, service industry and information industry. The mobile payment project covers the main participants, such as banks, mobile phone manufacturers, telecom operators, and mobile payment terminal manufacturers. It would take huge efforts to coordinate all of the above parties and balance their interests. China UnionPay as a traditional payment organization, which means that when launching some innovative services, the firm needs to adapt with more flexible and pragmatic measures while also maintaining the bottom line of security compliance.

12.4.3 Process of Developing a New Service and New Business

(1) **Adopting a rapid iterative development process to improve product efficiency and user experience.**

In the era of mobile internet, good mobile applications usually place great emphasis on user experience and quick release to satisfy the expectation of end users and take the competitive initiative.

Under such circumstances, we have adopted the mechanism of 'user experience-based rapid iteration' to develop the QuickPass products. Compared with the traditional waterfall software development process, such an agile software development focuses on rapid iteration and user experience feedback. This means that the initial software product is no longer fully complete and flawless. Instead, it can be gradually improved through each rapid iteration period and via user feedback. The iteration process is shown in Fig. 12.6.

In fact, the user experience and the process of rapid iteration are complementary to each other. On the one hand, rapid iteration promotes product online efficiency, which satisfies the expectation of end users. On the other hand, the feedback of user

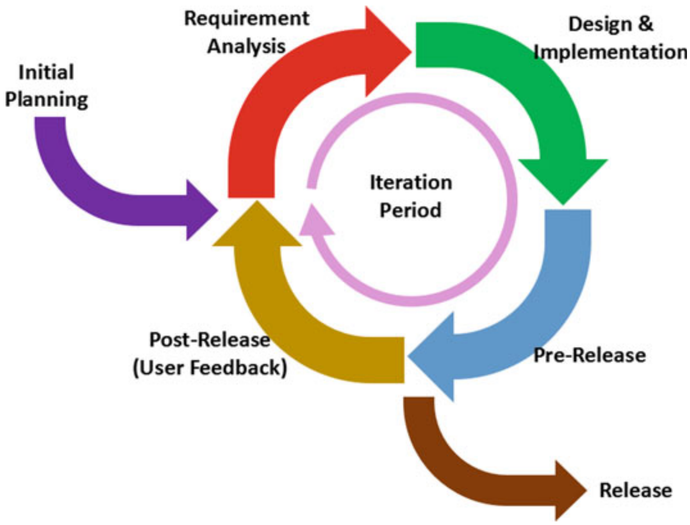

Fig. 12.6 Development process of rapid iteration

experience helps the iteration process to gradually improve the quality. In the practice of QuickPass product release, we have set up the following two objectives:

(1) Ensure product quality before online deployment. At the stage of design and development, this quality assurance follows the rigorous process of user investigation, design specification drafting, and testing to ensure the product quality.
(2) Improve user experience via feedback and rapid iteration. After the release of an iteration, feedback is collected through end users' reports and expert analysis to explore the problems of the current release. Improvements can then be made accordingly to continuously enhance the product experience.

The detailed mechanism is concluded in Table 12.1.

After the adoption of the 'user experience-based rapid iteration', the release period of QuickPass application has been shortened from 7 months to 4 months, and the development process is still under improvement. To date, QuickPass has successfully launched 3 rounds of iterations since its first release in Dec. 2015.

(2) **Developing standards first to coordinate the industry chain**

As introduced in Sect. 12.3.2, the mobile payment project involves a long industry chain. China UnionPay as a central switching point must take the responsibility of coordinating each of the parties in the industry chain. The method adopted is to develop mobile payment standards first and to gradually generalize the standards to the whole industry chain. From 2002 to 2005, China UnionPay had already set up a relatively complete standard system for bankcard payment, covering magnetic stripe

Table 12.1 Mechanism of user experience-based rapid iteration

Objective	Stage	Actions
Ensure product quality before online deployment	Requirement analysis	Establishment of QuickPass sample user database
		QuickPass end user requirement investigation
	Design	Formulation of QuickPass product design specification
		Expert analysis of QuickPass UI design
	Pre-release	Testing and validation
Improve user experience via feedback and rapid iteration	Post-release	Expert analysis of released QuickPass products
		Checking for the enforcement of the UI design
		Volunteer testing and feedback
		Questionnaire investigation and feedback
		Hotline and complaint feedback

bankcards and integrated circuit bankcards. However, in new scenarios of mobile payment, the technical standards must be transformed from the basic channel access interface to a synthesized platform, covering mobile phones, smart cards, application software, secure elements, payment terminals, and system interfaces.

Accordingly, China UnionPay has organized all parties in the industry to discuss the solutions and standards for mobile payment, including the token technique and HCE (Host-based Card Emulation). We also cooperate with the manufacturers to develop related products and promote the innovative development of the payment market.

For commercial banks, China UnionPay has provided a uniform interface through its trusted service module (TSM) platform. Banks can develop the accessing system accordingly by referring to the standard interface. Currently, most of the statewide commercial banks have accomplished the reconstruction to adapt to the TSM interface, and regional banks are also launching the development project, which greatly improves the standardization level.

For mobile phone manufacturers, the recommended configuration is NFC communication modules embedded with SE chips. The uniform TSM interface has provided great convenience for the mobile phone terminal to access the payment network. Once the terminal connects to the TSM network, the issuing service of all banks can be achieved, including the binding of existing bankcards and issuing of new bankcards in real time. For other terminal companies, such as wearable device manufacturers, the processes are almost the same as those of mobile phone manufacturers.

In 2012, after the establishment of mobile payment standards, all industrial parties made great investments, and the industry chain gradually formed. It is a favorable opportunity to actively promote the establishment of an open and mutually beneficial cooperation mode and a harmonious and standard mobile payment industry chain. In the future, with the advance of the technical standards requirement on the security level, China UnionPay will continue to upgrade security mechanisms under the support of all parties in the industrial chain to guarantee the high security level of QuickPass products.

Under the leadership of the People's Bank of China, China UnionPay has taken into consideration both the industry demands and the requirements of the information security project launched by the National Development and Reform Commission. The security architecture and testing mechanism have been gradually established according to the standard requirements, covering mobile terminals including SD cards, SIM cards, wearable devices and NFC-enabled mobile phones. Under the framework, security mechanisms have been enforced in all of the QuickPass products, which laid a good foundation for the application and large-scale promotion of the products.

(3) **Protection of Payment Privacy Data**

In the era of mobile internet and big data, a large amount of user data is considered a considerable treasure. However, this would also make it more likely for user data to be illegally collected or improperly processed. Events of large-scale data leakage have been frequently reported during the past several years (Lu et al. 2016).

Under this circumstance, people are showing growing concern about the security of their personal data. In the case of mobile payments, payment data are essential to user privacy. We have fully realized this problem at the beginning of the design and placed great emphasis on the protection of payment privacy data. The principle is that users' sensitive data can only be processed and recorded by the authorized financial institution, who should promise to take the responsibility of protecting these data from unauthorized access. Nonfinancial organizations should not be capable of interpreting these data or be allowed to store them.

The method is to first classify all of the involved data to identify which kind of data is private and which can be properly presented. Processing and storage requirements are then set up according to the data security level. Specifically, the data involved in mobile payments are classified into the following 3 categories: bankcard data, presentational data and transaction data. To be specific:

(a) **Bankcard data** refer to the basic information of a bankcard, which is usually printed on a physical bankcard. It includes the bankcard number, valid date and CVN2 (Card Verification Number in UnionPay standards, usually 3–4 digits printed on the back of bankcards, which is the same as Card Validation Code CVV2 in Visa standards or Card Validation Code CVC2 MasterCard standards). Users need to input such data during the stage of 'card binding'. The data will be transmitted to the bank side via the mobile platform for identity validation under user acknowledgments, approval and confirmation. Meanwhile, the mobile platform is not allowed to store any of these data.
(b) **Presentational data** are the content shown on the APPs of the mobile terminals. These data are provided by commercial banks or China UnionPay, such as the last 4 digits of the bankcard number and card art. They are used to help users view and check the information or state of the virtual card binding.
(c) **Transaction data** refer to the payment data during each transaction. Scenarios include online and offline payment. For offline mobile payments, the flow of transaction data is exactly the same as that of chip cards, which directly connects to China UnionPay's switching network without intermediately passing through the mobile platform. The transaction data in the online mobile payment scenario refer to the payment data generated during online shopping by using the APPs of authorized merchants. The APP first delivers these data to the SE (secure element) embedded in the mobile terminal, which will encrypt the data by using the encryption key issued by banks. The encrypted data are then delivered to the authorized merchants via the mobile platform and continue the subsequent processes. In this way, it can be ensured that the mobile platform only sees the encrypted data, therefore protecting the user's payment information.

12.5 New Technologies in Mobile Payment

New technologies are adopted and implemented in the mobile payment system in the form of integrated innovation and independent innovation.

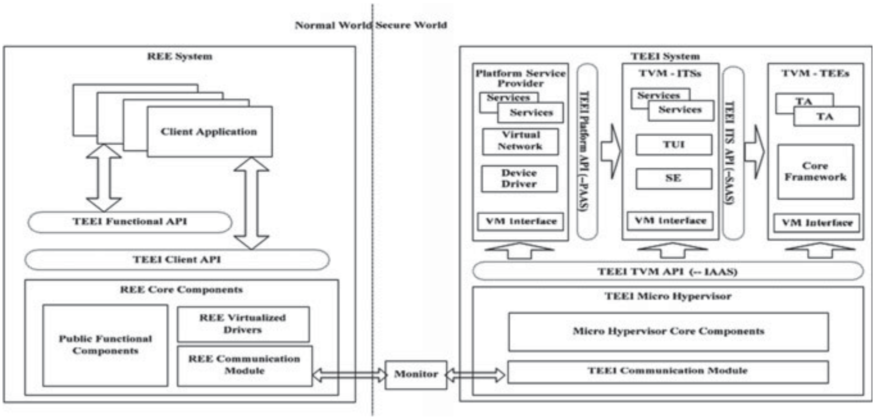

Fig. 12.7 The system architecture of TEEI

12.5.1 TEEI Technology

Trust Environment Execution (TEE) is the trusted computing mechanism implemented in the ARM (Advanced RISC Machine) chip. For mobile payment applications, the most sensitive code of payment logic is switched to the TEE zone so that it can be separated from the other nontrusted code. This can effectively prevent the original code from being illegally modified, thus greatly improving the trustiness of the payment application. In short, the application of TEE technology can realize the following security functions: trusted computing, data encryption, system protection, secure input, and secure storage. Typical security mechanisms include the control over the APPs on the mobile terminal to access the secure element, the control of the on-off switch of the NFC communication, and the presentation of a secure password input panel free from illegal sniffers. China UnionPay also proposes the TEEI (TEE integration) solution, which can be considered the virtualization of TEE infrastructure. The system architecture of TEEI is shown in Fig. 12.7, which makes it possible for multiple trust applications to share one TEE zone without interfering with each other (Chai et al. 2014).

12.5.2 Tokenization Technology

On the bankcard side, tokenization technology has been adopted and developed to protect payment transactions from fraud and sensitive data from leakage.

(1) **TOKEN** is a secure transmission technique developed specifically for NFC mobile payment. Before transmission, the sensitive payment information, such as bankcard number and PIN (Personal Identification Number) code, is first transformed to a TOKEN string. To the nodes in the transmission path, the

TOKEN is just a meaningless string, and it can only be decoded at the bank side. This protects the sensitive information from being observed by third parties.

(2) **HCE** stands for Hybrid Card Emulation, which is the software architecture that provides exact virtual representation of chip bankcard, which makes the 'virtual bankcard' proposal practical. Its security is based on the TEE implementation. HCE is implemented on mobile terminals without secure element function support.

(3) **SE** stands for secure element, which is a hardware implementation of a tamper-resistant platform capable of securely hosting applications and their confidential data. eSE (embedded SE) embeds the SE chip into the NFC communication module. Its security level is higher than HCE and is the most recommended configuration for mobile terminals. In mobile sensors, SE is usually integrated into the subscript identity module (SIM) card or smartphone.

(4) **TSP** means trusted service platform, which is set up to handle the mobile payment transaction. It works together with the Token mechanism, which transmits the payment token rather than the bankcard number for payment validation. China UnionPay's TSP can support 4 typical scenarios defined in the EMVCo reference architecture: online merchant, digital wallet, NFC payment and QR code payment, which can cover most attested online and offline payment scenarios. China UnionPay's TSP can also facilitate services such as the control of Token usage, credit level assessment, and dynamic transaction risk assessment. In China, TSP platforms are typically operated by bankcard associations such as UnionPay and large banks such as ICBC (Industrial and Commercial Bank of China).

The integration of the above technologies enables mobile terminals to provide express payment services at a guaranteed security level.

12.5.3 Biometric Technology

(1) **Face recognition**

Face recognition is a biometric recognition technology for identity authentication based on the features of a person's appearance. The significant feature of the technology is that it can prevent the leakage of personal information and use noncontact methods for identification for mobile payment. During the transaction, consumers only need to face the camera of the mobile devices, and the system automatically takes pictures, scans the consumer's face, and compares the image with the information stored in the database. Face recognition technology is used in face recognition POS. Some face recognition POS equipment of China UnionPay is shown in Fig. 12.8.

(2) **Trajectory recognition**

Trajectory recognition is implemented on the mobile POS to prevent unauthorized bankcard acceptance. Different bankcard acceptance behaviors show different

Fig. 12.8 Face recognition POS

motion patterns of POS terminals. Therefore, a neural network algorithm is used to distinguish the abnormal behavior of unauthorized transactions from normal behavior. If a POS terminal moves in abnormal patterns, then the transactions generated by the POS will be cancelled.

(3) **Voice recognition**

Voice recognition technology is used on POS to accept bankcards based on voice commands. Therefore, bankcard transactions can be performed based on the dialog between the customers and POS. Voice recognition is essential in self-service scenarios.

12.5.4 Risk Management Technology

For the risk management system, a framework consisting of **risk prevention, real-time monitoring, and postdisposal** is set up for the mobile payment platform, as shown in Fig. 12.9.

(1) **Risk prevention**

Risk prevention mainly focuses on the stage of bankcard binding. Most of the identified cases of mobile payment fraud take place at this stage. Multiple-factor authentication is adopted to validate the operation of each bankcard binding process. Mechanisms include SMS (short message service) validation, PIN code verification, and real-name matching. Furthermore, to adapt to the mobile scenario, information such as mobile device name, SIM, IMEI (International Mobile Equipment Identity), MAC (Media Access Control Address) and terminal location are collected and introduced into the risk management system. Such context information can effectively improve the risk management system. In the future, chip card validation will be introduced by scanning the real chip card through the NFC link when a user registers a mobile simulated card.

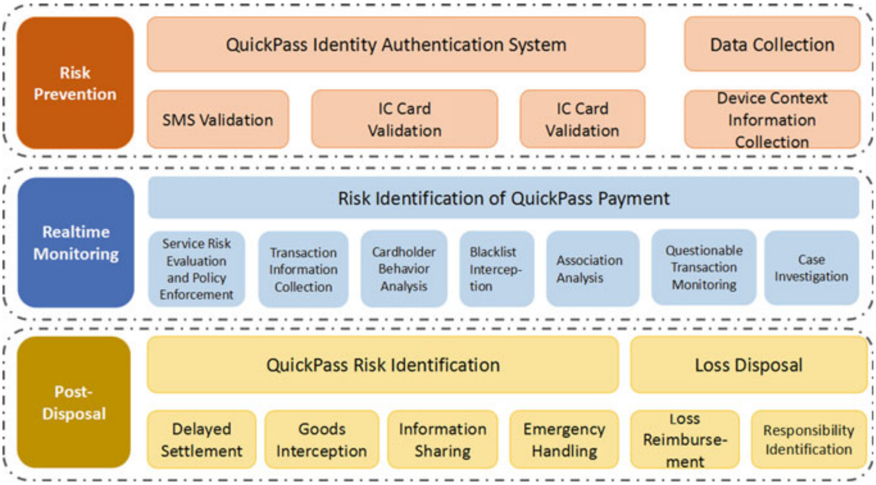

Fig. 12.9 Framework of QuickPass risk management system

(2) **Real-time risk monitoring**

Real-time risk monitoring addresses each of the payment requests. Big data technology is adopted to synthetically evaluate the trustiness of a transaction from multiple sources of data. An interactive linkage mechanism is set up among China UnionPay, issuing banks and acquiring banks to jointly handle risk monitoring, cardholder service and merchant management. By taking advantage of the historical data and in-depth association analysis of transaction behavior, the risk management system of China UnionPay is able to monitor each of the mobile cross-bank transactions in real time and attempt to cut off fraudulent transactions. The model of the risk monitor system can persistently evolve and self-improve according to the fraud being detected.

(3) **Postdisposal**

Postdisposal handles the fraudulent transactions being reported. In the scenario of QuickPass, the fraud losses can be minimized through the mechanisms of joint bankcard risk prevention. Actions such as delayed settlement for questionable mobile transactions and the interception of the goods in transit will be taken once the online or offline fraud mobile payment is reported. Under the circumstance of small-amount mobile payments, most banks tend to adopt an active reimbursement policy to compensate for the fraud loss, which leverages the concern of cardholders and helps to populate the QuickPass service.

12.6 Business Innovation with New ICT in Mobile Payment

We analyze the direction of business innovation with the new ICT in mobile payments by answering the following five questions.

(1) **Business Needs: What human desires and issues in human society or business are the objectives of the utilization of ICT?**

The major human desires for mobile payment are user experience. Compared to traditional bankcard payments, users require maximum convenience when completing the payment process. Furthermore, all kinds of equipment can be used as payment terminals. The notable new value created by the mobile payment project is that it achieves both ease-of-use and security, which greatly satisfies human desires for mobile payment. With the development and promotion of the Mobile QuickPass product, it is now very convenient for people to enjoy the payment service in a variety of scenarios with only a mobile phone or some other mobile equipment devices.

(2) **New Technologies: What technologies and functions are utilized to solve issues or realize human desires?**

As introduced in Sect. 12.5, new technologies are utilized in mobile payment products. On the client side, TEEI technology is used to ensure the transaction security of mobile payments. On the bankcard side, tokenization technology is used to protect payment transactions from fraud and sensitive data from leakage. On the backend, many risk management technologies are used to identify and prevent risky transactions. During human interactions, biometric technologies are widely used on mobile and POS terminals.

(3) **Value Creation: What are the value creation methodologies?**

The main methodology for value creation is through the innovation of technology integration and the innovation of industry coordination.

(a) **Innovation of technology integration**

QuickPass mobile payment services achieve both ease-of-use and security through the integrated innovation of technologies. Through technical innovation, it has been shown that the security of the entire mobile payment system can be comprehensively improved. Therefore, ease of use and security are not always in conflict. This is the most important discovery in the practice of the project. A set of innovative security enhancement measures have been integrated and adopted to meet the requirements of quality and security compliance, covering both the frontend and backend of the mobile payment system. China UnionPay has carried out a series of technical integrations involving information collection, information transmission and information processing. Emerging technologies such as cloud computing, big data, artificial intelligence, terminal security techniques and blockchain have been properly applied, as shown in Fig. 12.10.

(b) **Innovation of industry coordination**

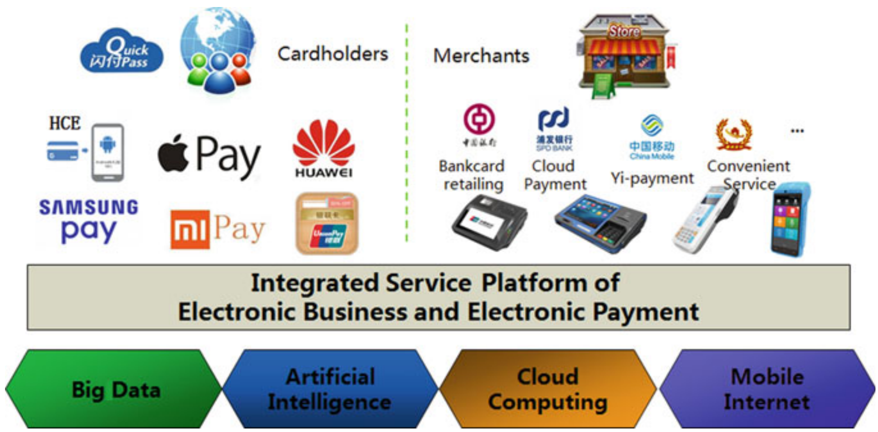

Fig. 12.10 The frontend and backend upgrading of payment system

The mobile payment project involves coordination among several large industries, including banks, telecom operators, and mobile phone companies. It requires powerful management intelligence to integrate all parties to cooperate and balance the different interest preferences of each other.

From the overall perspective, the bankcard organization plays a special role in the coordination of different industries. It should take the responsibility of investigating the trend of the innovation of the information industry and exploring the solution towards win-win cooperation. The mobile payment project represents the concentrated application of high technology in the financial industry, which is also the source of engineering and technology innovation. During the process, the project calls for close communication with related international standard organizations, industry alliances, and research organizations to learn the advanced management and operation experience to gradually improve the ability of innovation and development.

(4) **Human/Business Model: What is the relationship between human/business (including employees, organizational culture, leadership, etc.) activities and ICT (Information and Communications Technology) systems, as well as the relationship among users, ICT providers, and other stakeholders (Collaboration)?**

The variance development of the ICT system has brought great convenience to the lifestyles of consumers and businesses. Among them, the development of 4G and 5G network technologies has made it faster for people to obtain information. The way to obtain information has changed from paper and computer equipment to mobile equipment. Thus, the consumption and payment habits of consumers have gradually changed, which breaks temporal and geographical restrictions. The large changes include the transition from offline to online shopping for consumers and increasingly online operations for businesses. The changes in the relationship between activities and ICT systems have also greatly promoted the development of mobile payment services and scenarios.

(5) **Innovation Result: How has human life, business, or society changed?**

(a) **Changes in human life**

The payment style of human life has been significantly impacted in China with the popularization of mobile payment. Most people do not have to carry cash or credit cards and can enjoy convenient financial services anywhere and anytime. Even in underdeveloped regions, such as rural areas, pastures and mountains, mobile financial services can be provided locally with 3G or 4G networks. More than half of all payment transactions are conducted with mobile phones.

(b) **Changes in the business model**

The technological innovation of ICT has greatly promoted the change of production methods and production relations and created many new business modes. Specifically, mobile payment technology innovation has directly changed the transaction methods of enterprises and then reshaped the business modes of enterprises. The arrival of mobile payments will reshape the offline business model, and the importance of geographical location in traditional offline business modes has gradually weakened. The business mode of mobile payment focuses on payment methods, payment security mechanisms, and expanding payment markets and scenarios.

(c) **Changes in the ecosystem**

Based on the change in business modes, mobile payments also promote the innovation of payment ecosystems. First, mobile payment creates a closed-loop development of business services. Businesses will attract new users as well as keep old users by various allowances and activities in the closed-loop ecosystem of mobile payments. Second, the data created from transactions will strongly support the new ecosystem of mobile payments. Businesses can improve the perception of user needs by using the accumulated data from consumers and find a new transaction ecosystem through accurate secondary marketing.

12.7 Conclusion

Mobile payment is a new financial product and service based on business innovation with new ICT. New technologies such as TEEI and tokenization, new methodologies such as comprehensive balance and integral coordination, and new business models such as NFC payment and QR code payment have been integrated and implemented in the product. A new ecosystem has been built up with great business success in China, and people can enjoy secure and convenient financial services in both developed and underdeveloped regions. The financial service of mobile payments has become an essential part of inclusive financial systems.

References

Cai Z, Zhang F, Chen D (2016) Information system development risk management of commercial banks. China Machine Press

Chai HF (2015) Research and practice on the engineering management method of financial informatization project. Front Eng Manage 2(2):165–172

Chai HF, Sun Q (2016) Research on the giant and complex financial information system engineering management from the perspective of meta-synthesis methodology with the bank card information exchange system engineering as a sample. Front Eng Manage 3:404

Chai H, Lu Z, Meng Q, Wang J, Zhang X, Zhang Z (2014) TEEI—A Mobile Security Infrastructure for TEE Integration. In: 2014 IEEE 13th international conference on trust, security and privacy in computing and communications. Beijing, pp 914–920

Chinabgao (2019) Volume of mobile payment market. http://www.chinabgao.com/k/yidongzhifu/36463.html

He J, Wang M, Wang Q (2013) Status quo and development of China's engineering management. High Education Press, Beijing

Hong Q, Lin Y, Niu X (2016) Information security technology and management system in banking. China Machine Press

Liu Q, Meng Q, Yao D (2016) Banking information system construction in the era of globalization. China Machine Press

Lu G, Chen S, Wang L (2016) Data governance of commercial bank. China Machine Press

Wang YG (2019) Global mobile payment market transactions will reach USD 1.08 trillion in 2019, with over 60% of e-commerce traffic coming from mobile terminals. Available at https://www.cifnews.com/article/43298

Xuesen Q (1982) A study of system engineering. Hunan Science and Technology Press

Zhang Q (2013) People first, innovation and development. The golden card project's contribution to the construction of new four modernizations. Performance report on the 20-year implementation of golden card project

Zhu R (2000) Accelerationg of the construction of government information netowrk. Zhu Rongji On the Record 4:21

Chapter 13
Value Co-creation Between Stakeholders in Malaysia's Automotive Aftermarket E-commerce Industry: A Case Study of Sparke Autoparts

Norani Nordin, Mohd Faizal Ahmad Zaidi, Noorulsadiqin Azbiya Yaacob, Michitaka Kosaka, Michael Tio, and Shaun Li Yeoh

Abstract Sparke Autoparts Sdn. Bhd. (Sparke) is a start-up E-commerce company co-owned by PKT Logistics Group Sdn. Bhd. (PKT) and Baturu Information Technology Co. Ltd. (Baturu). Sparke is an industrial internet company specialising in automotive parts (autoparts) aftermarket sourcing, supply, transactions and services for the passenger and commercial vehicle markets. Its fully integrated Business-to-Business (B2B) service platform is the first in Malaysia, forming a closed loop of autoparts trading services from parts search, quotation, payment and delivery. Its industry-leading online platform solution is expected to make Sparke a leader in transforming and consolidating the traditional, fragmented autoparts industry in Malaysia. As the company is implementing a new business model that has the potential for disruptive innovation in Malaysia's autoparts industry, this case study could give benefits to researchers and practitioners. The value co-creation between the various stakeholders—platform and service provider (Sparke), sellers (suppliers and stockists), and buyers (car and truck workshops) is an interesting relationship to be

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studied, especially on learning how to overcome the many challenges and barriers in introducing the new business model which shows great promise in addressing the various issues that are currently plaguing the traditional way of business in Malaysia's autoparts industry.

13.1 Introduction

Using Information Communications Technology (ICT) in E-commerce is having great impacts on various business sectors, especially the electronics, food and beverage and consumer goods industries. In China, there are many examples of successful business that make large profits rapidly using E-commerce, most notably Alibaba, Taobao and WeChat. Incidentally, automotive aftermarket E-commerce is a relatively new but lucrative market segment not only in China but also most of South-East Asia. The entire autoparts aftermarket for both passenger and commercial vehicles in Malaysia is estimated to be worth about RM18-20 billion (MITI 2020).

PKT Logistics Group Sdn. Bhd. (PKT), which is a leading logistics company and that deals with the storage, transport and distribution of autoparts in Malaysia, had the vision of being the first to implement E-commerce in the automotive aftermarket industry in Malaysia. Thus PKT, together with Baturu Information Technology Co. Ltd. (Baturu), established a joint venture company in the form of Sparke Autoparts. Sparke is an industrial internet company specialising in automotive parts (autoparts) aftermarket sourcing, supply, transactions and services for the passenger and commercial vehicle markets. Its fully integrated Business-to-Business (B2B) service platform is the first in Malaysia, forming a closed loop of autoparts trading services from parts search, quotation, payment and delivery.

As the company is implementing a new business model that has the potential for disruptive innovation in Malaysia's autoparts industry, this case study could give benefits on business innovation to researchers and practitioners. The value co-creation between the various stakeholders—platform and service provider (Sparke), sellers (suppliers and stockists), and buyers (car and truck workshops) is an interesting relationship to be studied, especially on learning how to overcome the many challenges and barriers in introducing the new business model which shows great promise in addressing the various issues that are currently plaguing the traditional way of business in Malaysia's autoparts industry. A model is developed to show the knowledge sharing and value offering between the stakeholders in order to create new service ideas.

The outline of this chapter is as follows. We describe the general trends of automotive aftermarket E-commerce, the situation in China and Malaysia that paved the way for PKT Logistics and Baturu Technology to form a joint venture and co-create Sparke. The chapter ends with the discussion on value co-creation between the stakeholders and the identification of what benefits and advantages that it brought to its stakeholders using IoT technology.

13.2 Outline of the Automotive Aftermarket

13.2.1 General Trends of the Automotive Aftermarket

According to Global Industry Analyst, Inc. report, the global automotive aftermarket is projected to exceed US$1.0 trillion by 2022, driven by the increasing average age of vehicles and the number of vehicles operation. Ipsos Business Consulting (2016) predicted there are three major trends to shape the automotive aftermarket for the next 20 years comprise of diverging market growth across borders, digital demand for instant, connected and transparent buying experience from consumers and the rise of the next generation of automotive Do-It-Yourself (DIY) consumers. These new trends actually will reshape the way stakeholders need to think of how business in the automotive aftermarket is conducted and value is created.

13.2.1.1 Definition and Business Situation of Automotive Aftermarket

To give a general definition, the aftermarket is defined by goods or services that is used with the main product or acquired after buying the main product (Shapiro and Teece 1995). It is also interchangeably referred to as aftermarket support or aftersales products and services which are activities related with primary products such as spare parts and services after initial sale of a product (Cohen et al. 2006; Chinnam et al. 2009). An important part of the aftermarket business in any industry is related to aftersales services. In automotive industry, the Automotive Aftermarket is described where all the vehicle parts, chemicals, equipment, and accessories are manufactured, distributed, retailed and installed after the sale of the automobile by the original equipment manufacturers (OEMs) to the consumers (Fast Forward Advisor 2018). In other word, Automotive Aftermarket contain all activities related to maintaining a car after its initial sale and until the end of its lifecycle after the sale by the original equipment manufacturer (OEM) to the consumer.

The automotive aftermarket is experiencing a very dynamic phase in its development with the rise of many startups and digitalisation trends. Based on "E-commerce Automotive Aftermarket—Market Analysis, Trends, and Forecasts" published by ResearchAndMarkets.com in 2019, E-commerce automotive aftermarket market worldwide is projected to grow by US$157.2 Billion, driven by a compounded growth of 22.8%. Thus, concerning on its current business situation, the sales amount of new cars has become gradual and the business for automotive aftermarket is expected to grow steadily. The continuing growth of automotive aftermarket means that parts manufacturers and related business such as automotive logistics may slightly change their business from business operations for new car sales to optimising their supply chain in the aftermarket such as repair and maintenance. In such business situations, synergy between stakeholders in this area might create a win-win situation. Also, digitalisation through E-commerce initiatives across the industry provides a great influence on the market.

13.2.1.2 The Automotive Aftermarket E-commerce

Economic, legal, societal, and technological factors and the trend for globalisation have created a very competitive business environment. These business environment changes impact the manner in which companies operate, and as a result, many firms have restructured their business processes as well as their E-commerce initiatives. E-commerce will allow aftermarket players to further increase the automotive aftermarket's value as connectivity helps them move closer to the end customer and generate big data. Moreover, the automotive aftermarket is undergoing dramatic changes with evolving customer expectations, acceleration of technological innovation, and shifts in competitive power. Global information company, the NPD Group 2017 found that about 14% of buyers in the automotive aftermarket make purchases online. Buyers turn to online communities and reviews, among other digital platforms, as a way to improve their purchasing decisions. Hedges & Company consumer surveys revealed that the buyers will do online research from four sources that are online search (74%); autoparts retailer websites (73%); manufacturer websites (57%) and automotive forums (47%) before they make purchase online. This evidence further highlight that online platforms have gained attraction among the E-commerce automotive aftermarket buyers.

(1) **Trends of Automotive Aftermarket E-commerce**

New business model for automotive aftermarket is the automotive aftermarket E-commerce. Electronic commerce (EC) itself refers to using the Internet and intranets to purchase, sell, transport, or trade data, goods, or services (Turban et al. 2012). EC offers numerous benefits to all participants that allow organisations to go into remote and global markets for both selling and buying at better prices. In addition, organisations can speed time-to-market to gain competitive advantage. They also can improve the internal and external supply chain as well as increase collaboration.

The electronic market is the major venue for conducting EC transactions. An e-marketplace (also called e-market, virtual market, or market space), is an electronic space where sellers and buyers meet and conduct different types of transactions (Turban et al. 2012). The functions of an e-market are the same as those of a physical marketplace; however, computerised systems tend to market electronic markets much more efficient by providing more updated information and various support services, such as rapid and smooth executions of transactions.

The rise of automotive aftermarket E-commerce across automotive industry means that parts manufactures must keep up with advancements in distribution. According "E-commerce for Automotive Aftermarket" report, in China, the automotive aftermarket E-commerce started new business model with ICT specifically by using E-commerce is expanding its business all over the world:

> "The global E-commerce automotive aftermarket was worth $32.7 Billion in 2016 and is expected to rise at a phenomenon pace of 24.2% CAGR (compound average growth rate) for the forecast period between 2017 and 2025. The rise of the digital world has been transforming the ways products and services are consumed in the global automotive aftermarket. Nowadays, consumers have more channels to shop around. As buyers continue to be more

demanding, seeking different region-specific features as well as an element of uniqueness to emphasize differentiation and individual taste and status, E-commerce as a direct venue to customers becomes a dominant channel for manufacturers, shop owners and dealers to reach out to the market across borders."

(2) **Automotive Aftermarket E-commerce Platform**

What is the automotive E-commerce? There are two types of E-commerce, which are Business-to-Business (B2B) E-commerce and Business-to-Customer (B2C) E-commerce. According to "The Boom of China's Automotive Aftermarket is Imminent" by Ipsos Business Consulting (2016) analysis, the traditional business flow for route-to-market structure of automotive aftermarket business can be described as Fig. 13.1, where B2C E-commerce only is positioned in the business flow.

The evolving business for route-to-market structure of automotive parts in Fig. 13.2, shows the position of B2B E-commerce channels that have become an emerging trend for autoparts suppliers to achieve parts distribution efficiency. B2B E-commerce platforms are expected to shape the parts distribution landscape by conveniently connecting parts suppliers with 1st tier distributors and workshops. The merits of B2B are to improve parts distribution efficiency, to enlarge parts distribution coverage especially in areas where parts suppliers do not have a strong presence, and to obtain first-hand information on market demand so as to streamline new product development and optimise inventory management.

(3) **Players in the B2B and B2C automotive aftermarket**

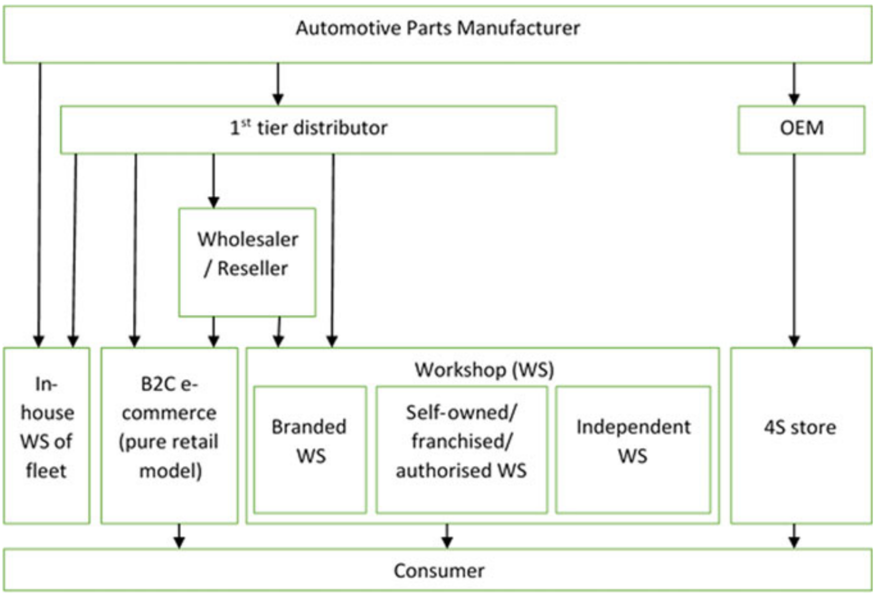

Fig. 13.1 Traditional flow for route-to-market structure of automotive parts (referred: *The Boom of China's Automotive Aftermarket* by Ipsos Business Consulting (2016))

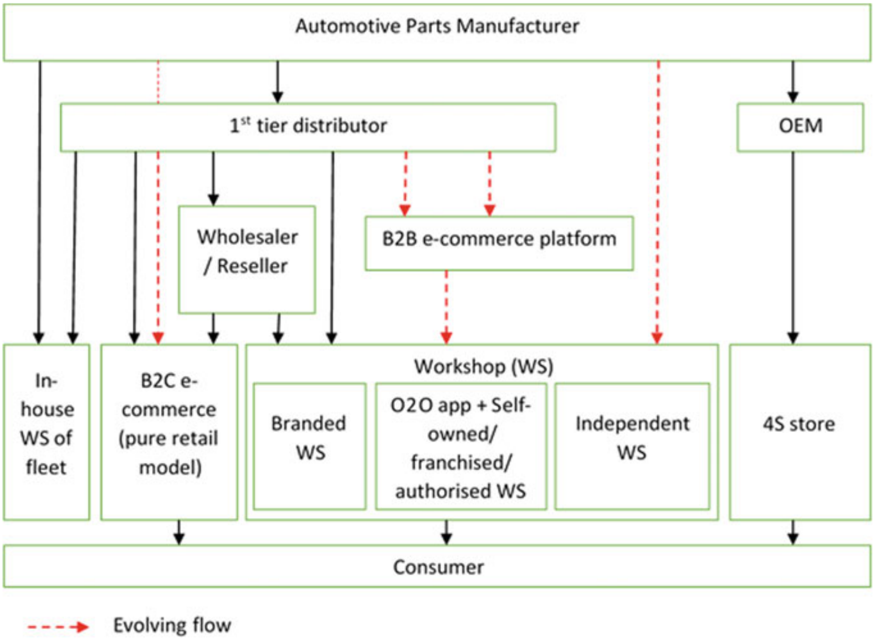

Fig. 13.2 Evolving flow for route-to-market structure of automotive parts (referred: *The Boom of China's Automotive Aftermarket* by Ipsos Business Consulting (2016))

Table 13.1 summarises product/service offering and key advantage of B2B and B2C players in automotive aftermarket. Price transparency and online service with IT platform are major characteristics except branded workshops as a traditional offline model. They improve market efficiency and customer experience using ICT. Especially, in B2B platforms, advantages over the traditional distribution models are:

(i) Optimise parts distribution efficiency through advanced database and intelligent enquire/order dispatching systems.
(ii) Offer value-added services (e.g. big data analysis, faster delivery, micro credit, sharing technical knowledge) to workshops.
(iii) Enlarge geography and category coverage of parts distribution, combining own warehousing and shipping capacity with own or third-party logistics services.

(4) **Workshops' concerns and B2B platforms' contributions in the B2B E-commerce process**

The entire process of B2B automotive aftermarket E-commerce consists of four sub-phases which are pre-sale service, ordering and payment, logistics and after-sale service. In each phase, each stakeholder's concerns, solutions and support are summarised in Table 13.2. Online platforms provide systems and services with suppliers' support to address the needs and expectations of workshop customers. In the pre-sale service phase, the platform has an online autoparts catalogue that utilises

Table 13.1 Product/service offering and key advantage of B2B and B2C players

	Product/service offering	Key advantage
B2B E-commerce	Operate platforms that purchase from parts manufacturer/distributor and sell to workshops	• Price transparency in B2B market • Larger geographical coverage, with faster delivery than traditional distributors/wholesalers • Customer analytics driven by big data
Branded workshop (Traditional offline model)	Offer offline repair/maintenance service to consumers	• More standardised repair & maintenance service compared with traditional independent workshops
B2C E-commerce (Retailer)	Sell parts to consumers online without offline service	• Price transparency in B2C market
O2O Platform	Sell parts to consumers online and appoint specific workshops (self-owned or franchised or authorised) to offer offline service	• Price transparency in B2C market • More standardised repair & maintenance service compared with traditional independent workshops

Table 13.2 Stakeholders concerns and contributions in the B2B E-commerce process (referred: *The Boom of China's Automotive Aftermarket* by Ipsos Business Consulting (2016))

B2B e-commerce process	Concerns by workshops	B2B platforms' practice	Suppliers' support
Pre-sale service	▪Parts quality and authenticity ▪Difficulty finding a clear match between parts and car type	▪Parts tracking system, endorsement from OE parts suppliers ▪Internal database to help streamline parts searching/matching process	▪Help B2B platforms to improve the accuracy of parts database and fight counterfeiting
Ordering and payment	▪Complex payment process ▪Cash flow pressure would require credit terms	▪B2B online payment systems to simplify payment process ▪Cooperate with financial companies to provide solutions on cash flow	▪Offer better credit terms to B2B platforms
Logistics	▪Concern over delivery time: 97% of workshops expect parts to be delivered within 12 hours	▪Cooperate with logistics partners to offer efficient parts delivery services ▪Own regional parts centers or share warehouses with local partners	▪Offer agile logistics solutions to cater to B2B platforms' logistics requirements
After-sale service	▪Concern over quality of after-sales service and warranty related aspect	▪Develop teams to improve after-sales services ▪Offer standardized warranty terms to increase platform credibility	▪Offer technical support/training to help improve B2B platforms ▪Optimize warranty process

a smart search algorithm to quickly and accurately look for parts' pricing and availability in the entire database. In the ordering and payment phase, an online payment gateway is used for easy and secure payment. Cooperating with financial organisations to offer value adds such as lines of credit, rebates or point rewards systems helps to relieve cash flow pressures. In the logistics phase, the platform conscripts logistics partners and/or 3rd party couriers to offer fast and efficient delivery services.

This is very important because generally speaking, 97% workshops expect parts to be delivered within 12 h of ordering. Lastly, in after-sale service phase, the platform must have a responsive customer service team to deal with any post-sale enquiries including requests for return or exchange and warranty claims.

13.2.2 Automotive Aftermarket E-Commerce in China and Malaysia

"Auto aftermarket is a general term of a series of transactions related to usage and service of vehicles after they are sold. It includes maintenance, auto spare parts and the corresponding financial and insurance service system" (Shen 2015, p. 1425). Previous studies have shown that car repair and maintenance is not as profitable as in the past. In the near future, firms will have to adjust their business model in order to maintain competitiveness with emerging opportunities under new economy. As a result, automotive aftermarket manufacturers and services providers have to use a new entrepreneurship model with online business, where E-commerce is the important element of new economy (Aboltins and Rivza 2014). Currently, B2B E-commerce (or e-hubs) is increasingly adopted by automotive firms in the western countries to reduce cost. However, to success with B2B E-commerce, automotive firms must understand not just the benefits but also the barriers, including supply topology, buyer-supplier relationships, leadership, and the threat of disbenefit from e-hubs (Howard et al. 2006). Therefore, knowing how automotive aftermarket E-commerce can benefits both autoparts manufacturers and consumers is important since B2B can be influenced by the relationship between customer loyalty and commitment (Roghanian and Gheysari 2013).

13.2.2.1 Activities of Automotive Aftermarket E-commerce in China

The annual growth of China new car sales is around 20% and will continue to grow in the future. In term of aftermarket parts, more than 40% of consumers prefer OEMs parts, where the critical success factors of aftermarket parts are contributed by competitive price, brand recognition, efficient supply chain, channel relationship, and penetration on chained repair shops (Brekelmans and Chen 2016). Despite of slower growth rate, vehicle sales in China will continue to increase up to 24 millions by 2020. At the same time, consumers in China have also considered used cars as a good alternative to the new one, and have turned to digital media to get information about cars (Gao et al. 2016). In addition, a survey has found that where consumers in China have sought information about cars with digital media, and they also expressed their interest in a wide range of maintenance and other automotive services (Gao et al. 2016).

Meanwhile, based on the Ipsos Business Consulting's report, the value of automotive aftermarket segment in China will reach USD214 billion by 2020, with more than 90 million out of warranty vehicles on the road. In order to capture the opportunities, autoparts manufacturers have to develop a new strategies with evolving distribution channel. Due to evolving channel, autoparts are now distributed to independent stores and end consumers via B2B and B2C E-commerce respectively. Unfortunately, the current automotive aftermarket industry is not well developed. Due to venue and fund limitations, an online platform is needed to solve the problems as this will not only increase the profits of manufacturers and dealers, but also benefits the car owners (Shen 2015). Despite of that, E-commerce players that focus on autoparts in China, such as Tuhu and JD.com are giving convenient to consumers to purchase parts online and install them at third party workshops. Since the percentage of car owners in China preferring independent aftermarket parts is expected to increase from 65% in 2017 to 80% by 2022, it seem that automotive aftermarket with E-commerce will continue to grow. However, issues such as lack of capability of last mile delivery, and financing to service shops need to be overcome by the E-commerce players (Russo et al. 2017).

According to the "E-commerce Automotive Aftermarket Report—Global Forecasts 2026", China is leading the Asia Pacific automotive aftermarket E-commerce. In addition, from a digital landscape, China has four companies in the top 10 technology companies worldwide, and has 731 million of internet users. Even Alibaba's sales on a single day in 2016 was worth USD 17.8 billion (Russo et al. 2017). This shows that China is well equipped with digital technology that is accessible by many of its population. As a result, China is becoming the leader of automotive aftermarket E-commerce in the region.

13.2.2.2 Activities of Automotive Aftermarket in Malaysia

Automotive has becoming the most significant contributor to Malaysia economic growth (Mamat et al. 2014). In relation to the automotive aftermarket in Malaysia, the National Automotive Policy (NAP) 2020 has listed two related objectives, which is (1) to increase exports of vehicles, automotive components, spare parts, and related products in the manufacturing and aftermarket sector, and (2) to increase the participation of competitive native Malay companies in the domestic automotive industry, including in the aftermarket sector. Besides of these objectives, NAP 2020 has established four roadmaps and three blueprints, in which one of the roadmaps is focusing on the automotive aftermarket. This suggests that, automotive aftermarket sector is being emphasised by the Malaysia government. In fact, NAP 2020 is targeting about 46,000 jobs by 2030 for the aftermarket sector. This target is however lower than the original target of 80,000 jobs in reflection of the current challenges. Therefore, sustainable manufacturing principles should be applied in the Malaysia automotive manufacturing industry (Kasava et al. 2020). An automotive study in Malaysia has found that despite the numbers of complaints and dissatisfaction of service quality, overcharged fees and fake parts were frequently reported in the mass media; it appears that it was not as serious as perceived by the public. Meanwhile, consumers are aware of the importance of scheduled maintenance and maintained their vehicles at general workshops (Wahab et al. 2017). In Malaysia, tire and tint are the most popular items for modification or retrofitting, which is then followed by wheel, engine, and brake. In term of the cost, most of the spending are placed on the engine (Jawi et al. 2017). According to NAP 2020, an international cooperation in the development of global automotive industry is needed to enable Malaysia to become a leader in automotive industry within ASEAN region. Hence, in term of automotive aftermarket industry, Malaysia needs to cooperate with China to introduce E-commerce automotive aftermarket business.

13.3 Sparke Autoparts: Joint Venture Company by PKT Logistics and Baturu Technology

13.3.1 Outline of Sparke Autoparts

Under the business situation of B2B automotive aftermarket E-commerce in China and Malaysia, which is explained in the Sect. 13.2, Sparke was established in January 2019. This is a joint venture company between PKT Logistics in Malaysia and Baturu Technology in Guangzhou, China. It was developed as a B2B E-commerce platform for automotive parts in the aftersales market, essentially an online conduit between spare parts suppliers and car workshops. Its business was officially launched on 9 September 2019. Concerning the relationship between PKT Logistics and Baturu Technology, PKT is the leading automotive logistics company in Malaysia, in charge of all front-end operations and provides the manpower and logistics resources for this business. On the other hand, Baturu Technology, which currently is the leading B2B autoparts e-commerce platform in China, provides all the back-end IT systems, programming and code-based resources for the platform. This relationship can be shown in Fig. 13.3.

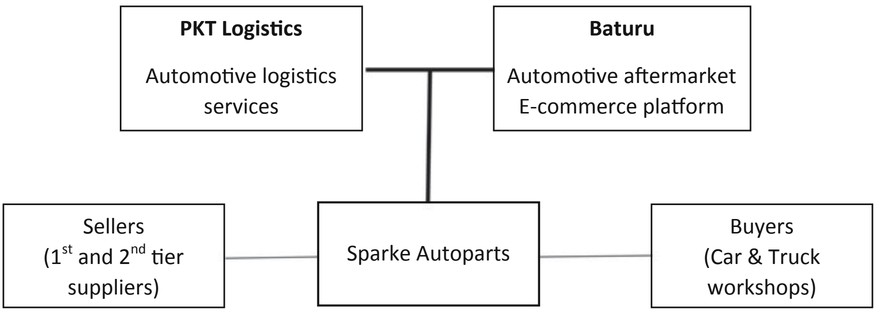

Fig. 13.3 Sparke as a venture company by PKT Logistics and Baturu Technology

Sparke's customers are all car workshops and insurance panellists in Malaysia which specialise in passenger vehicles (such as cars, 4WD, MPVs) and commercial vehicles (such as buses, trucks and lorries). Conversely, the sellers are the first and second tier aftermarket distributors of autoparts who indirectly connect with the buyers via the platform. Sparke strategically chooses its suppliers so that it can have up to 95% parts coverage, and its number of workshop customers grows every week. This is very significant to the Sparke as a new entrant in Malaysia's aftermarket market.

Currently, the automotive aftermarket industry for passenger vehicles in Malaysia is estimated to be worth approx. RM9-10 billion, however the industry is very fragmented. Therefore a lot of inefficiencies and grey areas exists in the market, for example unlicensed parallel importers, fake/imitation products, bribery and corruption. These problem could lead to lack of transparency and credibility which open to the manipulation of price and quality. Thus, the objective of the new Sparke e-commerce platform is to overcome the afore-mentioned problems. The new system which is disruptive to the current market, aims to simplify and provide transparency on the transaction for both suppliers and customers in the automotive aftermarket.

(1) **Sparke's E-commerce platform**

Sparke's E-commerce platform is based on electronic marketplaces and exchanges. E-marketplace is an online market, usually B2B, in which buyers and sellers exchange good or services (Turban et al. 2012). There are three main functions of the e-market: (1) matching buyers and sellers; (2) facilitating the exchange of information, goods, services, and payment associated with the market transactions; and (3) providing an institutional infrastructure, such as a legal and regulatory framework that enables the efficient functioning of the market. The functions of an e-market is similar to those of a physical marketplace. However, computerised systems tend to make e-market much more efficient by providing more updated information and diverse support services to buyers and sellers.

In general, there are seven components of e-marketplaces; customers, sellers, products and services, infrastructure, front end, back end and intermediaries. In this sub-section, the discussion of Sparke E-commerce platform is based on the seven components of e-marketplace as mentioned. Figure 13.4 shows the Sparke E-commerce platform.

As mentioned in previous sub-section, the *sellers* participated in Sparke E-commerce platform consist of first and second of automotive aftermarket distributors. While the *customers* of Sparke are the workshops and insurance repair shops. The type of *products* selling through the platform are the automotive parts of passengers and commercial vehicles. These products can be categorised into three categories: Original, original equipment (OE) and replacement equipment (RE). The *infrastructure* of the Sparke E-commerce platform includes electronic networks, hardware and software. As the platform is fully developed by Baturu Technology, the Sparke E-commerce platform is hosted by AliBaba cloud computing service (Aliyun).

In the e-market place, *front end* is the business area which customers interact including the website and application interface, electronic catalogue, a shopping

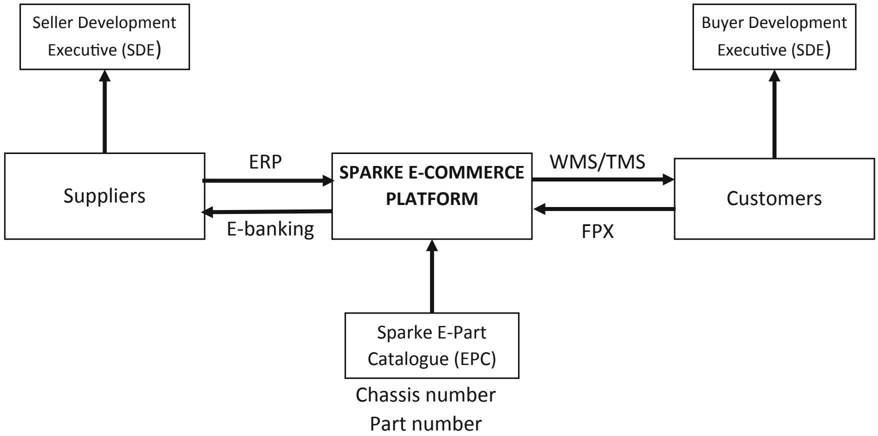

Fig. 13.4 Sparke's E-commerce platform

cart, search engine and payment gateway. The *back end* of the Sparke E-commerce platform is the activities that support online order fulfilment, inventory management, facilitating supplier transactions, payment processing, packaging and delivery. The discussion on the purchasing process of Sparke E-commerce platform which involving the front end and back end will be in the next sub-section.

Concerning the IT system, Sparke's platform consists of six different subsystem which fully integrated. Each subsystem specifically designed to meet the needs and demands of a particular stakeholder. The subsystems are shown in the Table 13.3. However, due to the confidentiality, the details of the subsystems could not be revealed in this chapter. Sparke Autopart E-commerce platform is almost similar to other B2B E-commerce platform. However, Sparke platform has an element of value added where it has sales executives to assist in building the market further. Furthermore, all the process like storage, delivery, handling and retail exchange to customers are done by Sparke.

(2) **Purchasing process in Sparke E-commerce platform**

Table 13.3 Subsystem in Sparke platform and its stakeholder

	Sparke subsystem	Stakeholder
1.	Enterprise resource planning (ERP)	Seller
2.	Electronic parts catalogue (EPC)	Customer
3.	Warehouse management system (WMS)	PKT
4.	Payment gateway or financial process exchange (FPX)	Customer
5.	Transportation management system (TMS)	PKT
6.	Sparke platform (website and mobile application)	Customer

This section explains on the purchasing process of Sparke E-commerce platform as shown in Fig. 13.5. If there is a problem with a car, the car owner needs to go to the workshop. The mechanic will looks at the car and identify the problem, before he identifies the part needed to repair the car. Traditionally, the workshop will send the enquiry via social network service (SNS) to five or six sellers that it has regular connections with. To submit the enquiry, the workshop will give the chassis number and the part number which the workshop found after searching the manual catalogue. The chassis number is an identifying code for a specific automobile. The chassis number is a unique vehicle identifier which composed of 17 characters (digits and capital letters). Each letter and number provides specific year, make, model, engine size and manufacturer. After the information is given to the sellers, the workshop needs to wait for quotation. The supplier who quotes the fastest, has the part available and the cheapest price will usually win the order. Although this method can be considered effective, it is not efficient because of potential delays, human errors in sending information, wrong parts delivered and no quality checking.

Therefore, to address these potential flaws, the Sparke E-commerce platform was created, now with a website and mobile application. To order the required part, the workshop first needs to register on the platform and will be given a free business account. Then the workshop need to key in the chassis and part numbers in the Electronic Parts Catalogue (EPC) system. This EPC is a cloud-based catalogue and online brochure developed by Sparke based on car brand, model and parts name. The EPC is also linked to the seller's Enterprise Resource Planning (ERP) where the seller will upload their available parts and pricing into it. When the workshop types the required information, the system will automatically search from the seller's ERP on the available stock. If the part required matches, the price, quantity and quality will appear on the customer's screen. Based on the workshop requirement, he will choose which seller to buy the part, and the part will be dropped in the e-shopping cart for the payment process through payment gateway or Financial Process Exchange (FPX).

After payment confirmation, the chosen seller will gets a notification from the platform on the required part. Then, the seller will pick, pack, double check and then send the ordered parts to Sparke's warehouse. Next, Sparke will deliver the part to the workshop after the order and parts quality are verified. The last-mile delivery is done by Sparke or through a 3rd party courier.

13.3.2 Outline of PKT Logistics and Impacts of Automotive Aftermarket E-commerce on PKT's Business

PKT Logistics has a significant role of establishing this venture company. The logistic company PKT knows the automotive business situation and has customer base in Malaysia, and carries out automotive logistic business with smart warehouses, which is an essential part in automotive aftermarket E-commerce business. Also, the current

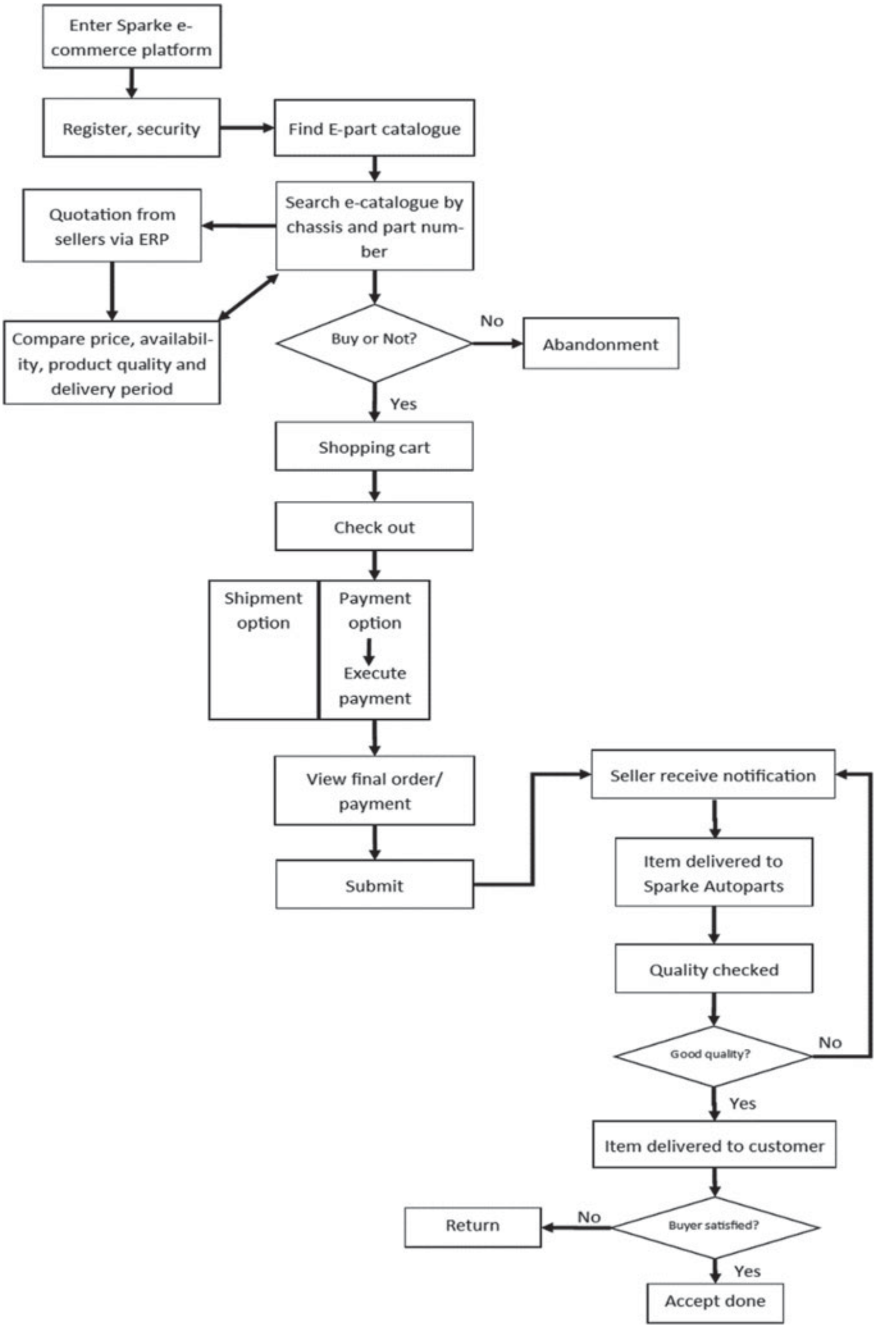

Fig. 13.5 Purchasing process in Sparke E-commerce platform

CEO of PKT, Dato Michael Tio has interests on value co-creation with new ICT in his business such as Facebook community. He introduced E-commerce platform with new ICT and expands PKT's business from the traditional automotive logistics to B2B automotive aftermarket by using E-commerce platform. This is a right approach in Malaysia automotive business environment explained in Sect. 13.2.2. Here, we explain outline of PKT Logistics and its business and impacts of automotive aftermarket E-commerce on PKT's business.

(1) **Outline of PKT Logistics and its Business**

In 1974, Dato' Tio Sook Keo founded a trading company called Port Klang Trading in Shah Alam, Malaysia. The company was renamed and is operating today as PKT Logistics Group Sdn Bhd. PKT is currently considered a leading logistics company not only in Malaysia but also in the Asia Pacific region. To reach this position, PKT had to differentiate itself by changing its business philosophy from the standard to the service concept perspective. In doing this, they are strongly committed to providing a total logistics service-based solution to customers through mutual cooperation among stakeholders. The services include end-to-end design, implementation, and operation of logistics solutions in freight forwarding, customs brokering, contract logistics, haulage, and distribution management for large and medium-sized national and multinational companies (Business Times, Oct 25, 2016). The leadership of Dato Michael Tio (DMT), Group Chief Executive & MD of the company, was behind this change and the eventual success of PKT. Now, PKT is a limited company (Sdn. Bhd.) and ranked fifth in Malaysia in the logistics service industry including automotive logistics. PKT has expanded its business with international collaborators. PKT has also started another joint venture with Massa Logistics and Okamoto Logistics Co., Ltd. to become an automotive specialist.

PKT is operated by over 900 energetic employees who are eager to manage almost 200 hundred high-profile customers such as Kia Motors, Hyundai Motor Company, Mitsui O.S.K. Lines, Ltd. (MOL), Mazda Logistics Co., Ltd. (Malox). In this, to manage the all business aspects, PKT developed its physical infrastructure as well such as the company built new advanced generation warehouse called 'The 12 Waves'

One Auto Hub

One Auto Hub is a 2,000,000 sq.ft. commercial development by PKT Logistic Group in Batu Kawan, Penang. Located in the fast-growing Batu Kawan Industrial Area, this development comprises a few commercial components, which includes The 12 Waves, The Ship Campus, The Lighthouse Lodge, The Automotive Boulevard, The Mangrove Walk and The Andaman Wharf as shown in Fig. 13.6. One Auto Hub is slated to emerge as one of the largest automotive logistics providers in the country to cater to the needs of the automotive industry under the purview of the Northern Corridor Implementation Authority.

(2) **Impacts of Automotive Aftermarket E-commerce on PKT Logistics business**

Fig. 13.6 PKT Logistics's One Auto Hub

PKT Logistics has been the market leader in automotive logistics in Malaysia for more than 40 years. PKT also is known as the preferred regional logistics service provider for automotive principals, franchises, distributors and original equipment manufacturers (OEMs). However, PKT has diversified its business range to other market sectors such as food and beverages (F&B), fast-moving consumer goods (FMCG), and education. This strategy is aimed at getting PKT to be listed at Bursa Malaysia and achieve RM1billion (USD230 mil) revenue by year 2020.

Therefore, by having Sparke, it gives PKT a complimentary divergence of automotive vertical. Through Sparke, PKT has control and influence on the automotive aftermarket industry. This is because the suppliers and customers of Sparke has very little or nothing to do with PKT. The company needs to search for its own suppliers and customers. Thus, it can be said that Sparke is completely a new business segment that PKT has not ventured into before.

13.3.3 Outline of Baturu Technology

PKT partner for establishing Sparke is Baturu Technology Guangzhou, China. Baturu is a successful company of B2B automotive aftermarket E-commerce in China. The company has enough experience on this business and has enough IT technologies for smart e-marketplace. We explain the outline of Baturu Technology using information on its Website.

Founded in 2013, Baturu provides the broadest on-line offering of autoparts products in China by leveraging its independently developed autoparts database, trading system and supply chain, covering maintenance parts, wearing parts, mechanical parts and collision parts. Its industry-leading online transaction solution is expected to make Baturu a leader in transforming and consolidating the traditional, fragmented autoparts industry in China. The platform currently covers 180+ mainstream car brands, 200,000 car models (95% of all car models in the domestic market), 200 million order matching stock and 5,000,000+ sellable SKUs. With the help of its unique supply chain from virtual stock to transfer warehouse and offline store, Baturu has built a service network of over 100,000 car repair shops in China.

Now, Baturu Technology is an industrial internet company specialising in automotive aftermarket transactions and services. Baturu's Autoparts Shop is a B2B service platform focusing on the whole vehicle trade in China, forming a closed loop of autoparts trading services from parts search, quotation, payment, to delivery. In 2015, it held a "Series A financing round" led by Qifu Capital, while its "Series B round" attracted investment from Huachuang Capital and Eastern Bell. "*The support of Warburg Pincus will further enhance our operational and offline delivery capabilities, laying the foundation for continued expansion in China*," said Zeng Wangui, founder and CEO of Baturu. "*Our immediate focus is on smooth operation and market expansion with the recent launch of the South China central warehouse and distribution centre*."

13.3.4 Significance of Venture Business by Logistics Company and E-Commerce Platform Company in the Automotive Aftermarket E-Commerce

We evaluate this venture company's activity from the viewpoints of win-win relationship.

[Win-Win relationship]

The venture company "Sparke" is the result of win-win relationship between PKT Logistics and Baturu Technology. Two companies have the following needs and requirements about B2B automotive aftermarket E-commerce.

PKT Logistics' needs and requirements : PKT wants to expand their business from the traditional automotive logistics to the automotive aftermarket depending on shifting market needs in Malaysia. In order to capture new market of automotive aftermarket, PKT consider to start B2B E-commerce business as successful cases of B2B automotive aftermarket in China. In order to do that, it is necessary to have a nice B2B E-commerce IT platform and know-how of Chinese B2B automotive aftermarket business. Baturu Technology has both capabilities required by PKT.

Baturu Technology: As explained in Sect. 13.2.2, Chinese E-commerce companies generally want to expand their business activities from China to other country. It is easy to export IT-base E-commerce platform. However, it is difficult to make successful business considering local business situations. Therefore, Baturu wants to collaborate with a real automotive logistics companies which have enough know-how of automotive logistics with warehouse and customer base in the target countries. PKT has such capabilities required by Baturu. Futhermore, PKT is the best partner that Baturu could find due to the availability of Chinese-speaking employees in PKT. Due to the reason, Malaysia is Baturu's first international market and PKT is its first international partner.

Thus, each companies' needs and requirements are matched. As the result of win-win collaboration, Sparke was established as the joint venture company by PKT and Baturu in the current automotive aftermarket business situation.

13.4 Value Co-creation Between Stakeholders of the New IoT Service

13.4.1 Value Co-creation in B2B Collaborations

According to Vargo and Lusch (2008), customer in the service-dominant logic is always a co-creator of value where both customer and the service provider are involved in value-creating process. Customers can engage in dialogue with suppliers during each stage from product design to product delivery. Usually the supplier will make a value proposition, and the customers actualise the value by using the offer of the supplier (Valjakka et al. 2012). Therefore, there are more opportunity for supplier and customer to create value through customized, and co–produced product and services.

In context of B2B, in designing its value offering, the company needs to gives a significant attention to interpreting and responding to what value it perceives customer are looking for (O'Cass and Ngo 2012). By doing it better than competitors, the company can obtain an advantage. This can be done if the firm could understand the customer expectations and transform these expectations into a bundle of value deliverables in the form of product advantage (product performance value) and relational advantage (relationship and co-creation value).

Service value depends on the relationship between the service and its situation. As suggested by Kosaka et al. (2012), there are four steps for service value co-creation in B2B collaborations: knowledge sharing in collaborations, identification of the service field, knowledge creation for the new service idea, and implementation of the new service idea. These four steps in the service value co-creation process can be described in a two-dimensional plane as shown in Fig. 13.7 and known as KIKI model. In step 1, the collaborators in service value co-creation process understand and share the objectives of the collaboration. Therefore the collaborators share the knowledge and information related to the objectives. For step 2, the service field is identified between providers and recipients. Both parties will investigate the services or products needed and also the service support required. Step 3, is where knowledge creation for the identified service of the service field is done and designed. New knowledge for service

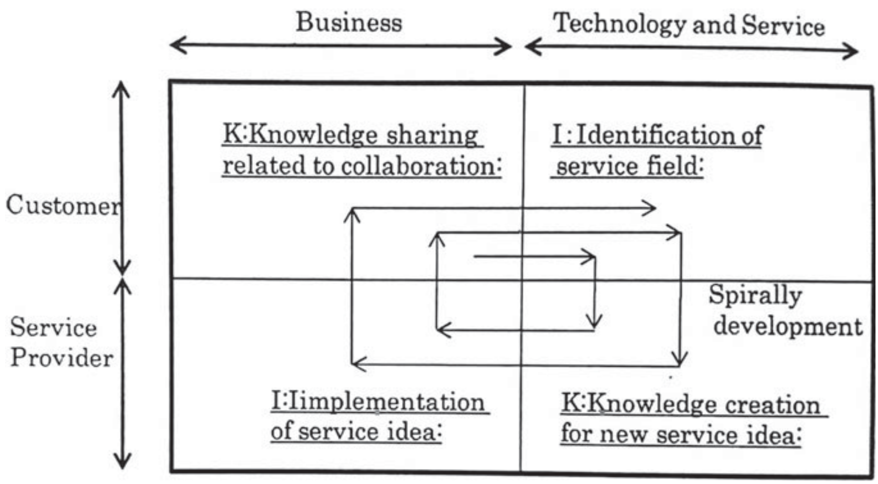

Fig. 13.7 KIKI Model (referred: Kosaka et al. 2012)

is created by combining various service ideas and technologies. Finally, in step 4, the new service idea is implemented by considering the business model. Collaborators of the service value co-creation process will evaluate the new service idea and further service enhancement is done for more improvement. KIKI model has a structure similar to that of the well-known SECI model of the knowledge creation process. The knowledge creation of SECI model consists of four modes i.e., socialization, externalization, combination and internalization.

13.4.2 Model of Value Co-creation Using New IoT

With the current progress of the Internet of Things (IoT), consumers are now becoming even more "connected, informed, and active" and they can "access information on firms, products, technologies, performance, prices, and consumer actions and reactions from around the world" (Prahalad and Ramaswamy 2004, p. 4). As a result, IoT is getting increasingly important to the companies due to intensified consumer power with the rise of internet and social media to co-create value in new products and services (Labrecque et al. 2013).

IoT can enhance value co-creation activities through "an open and comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data and resources, reacting and acting in face of situations and changes in the environment" (Madakam et al. 2015, p. 165). It enables virtual connection and networking of the objects that happen at anytime and anywhere, e.g., at home and office (Gubbi et al. 2013). It has many potential uses, either for industry- or user-specific applications to enhance consumers' values via device-to-device, and

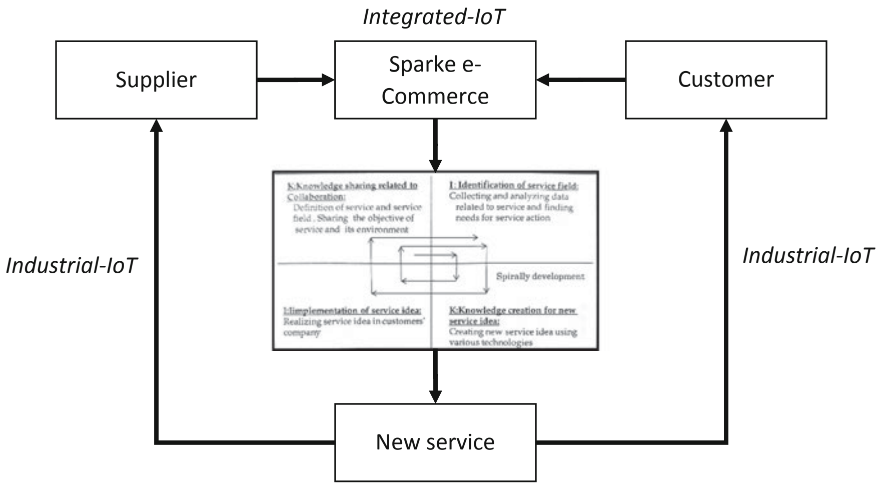

Fig. 13.8 A model of B2B value co-creation with IoT for new service

human-to-device interactions (Lee and Lee 2015). Hence, IoT can be a good platform for active interaction and collaboration in B2B platform. The companies can use IoT to perform business activities within and between functional areas. The firms can also use IoT to interact and collaborate with suppliers, partners, and distributors.

In the context of Sparke, the B2B IoT system is the Sparke E-commerce platform. The system has integrates the supplier and customer collaboration. However, from the system, by going through the value co-creation process as illustrated in KIKI model, a new service could be developed. This new service will served the supplier and customer in Industrial-IoT. Figure 13.8 demonstrates IoT as a mechanism of value co-creation for new service in B2B platform. In this model, the Industrial-IoT gives benefits in mass-customization, defect free operations and zero downtime. As a result, the Industrial-IoT could improve the company's performance in quality, delivery speed, dependability, flexibility and reduced cost. Whereas, for Integrated-IoT, the system manages to predict the customer's behavior, demands and trend. Therefore, the system can be utilized to plan for capacity, supply network, process technology, and product development and organization.

13.5 Analysis of Business Innovation

Based on case study analysis, we answer the following five questions.

(1) **What are the needs of people, the issues in society and business and the objective of utilising ICT? (needs)**

In Malaysia, automotive aftermarket business is growing, where efficiency is required in business. However the current autoparts industry for passenger and commercial vehicles is very fragmented. Therefore a lot of inefficiencies and grey areas exist in the market. The objective of the new system is to improve the business efficiency and credibility in automotive aftermarket industry.

(2) **What technologies and functions are utilised to solve these issues or realise the needs of people? What is the role of ICT in value creation? (technologies)**

IT platform system for E-commerce in the Internet environment is introduced. Then, Sparke' platform consists of six different subsystems such as ERP, EPC, WMS, payment gateway, TMS and Sparke platform (website and mobile application). Each specifically designed to meet the needs and demands of a particular stakeholder through adapting local market needs into the system.

(3) **What are value creation methodologies? (value creation)**

The method of value co-creation in Sparke is the Sparke E-commerce platform. The system which is incorporates the elements of IoT and Artificial Intelligence (AI) has creates the values for both its suppliers and customers. As Sparke E-commerce platform system is still developing, the interaction and knowledge sharing with its stakeholders is encouraged. The process of value co-creation is similar to the steps of KIKI model. Sparke as the owner of the system will gather all the information and a weekly online discussion is arranged with Baturu IT specialists to solve the issues raised by the stakeholders.

(4) **What is the relationship between human/business (including employee, organisational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**

The venture company "Sparke" is the result of win-win relationship between PKT Logistics in Malaysia and Baturu Technology in China. PKT wants to expand their business from the traditional automotive logistics to the automotive aftermarket depending on shifting market needs in Malaysia. PKT consider to start B2B E-commerce business by collaborating successful companies of B2B automotive aftermarket in China. Baturu wants to collaborate real automotive logistics companies which have enough know-how of automotive logistics with warehouse and customer base in the target countries. This is one of such global collaboration examples.

(5) **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

The automotive aftermarket E-commerce is emerging business field. The ICT technology utilised here basically allows for more transparency and efficiencies business in the automotive aftermarket business areas. It changes businesses by removing obstacles and inefficiencies in the traditional offline method of conducting transactions.

13.6 Conclusions

In this chapter, we have analysed the value co-creation between Sparke Autoparts and its stakeholders through a new ICT service known as Sparke E-commerce platform. Sparke Autoparts which is a joint venture company from PKT Logistics (Malaysia) and Baturu Technology (China) has introduced a new ICT system that disruptive to the current automotive aftermarket industry. This system which is integrated with the elements of e-commerce, IoT and AI technologies has creates a mutual benefit to its parent companies in terms of revenue creation and new market penetration. Furthermore, the system also acts as the active link of the collaboration between Sparke's suppliers and customers, hence new services could be developed and implemented. From this disruptive innovation system, there are measurable changes and benefits that the automotive aftermarket industry is experiencing especially to B2B players. The system also is expected to shape the parts distribution landscape especially parts distribution efficiency and coverage, which offers value-added services to the workshops and influences more agile logistics solution.

References

Aboltins K, Rivza B (2014) The car aftersales market development trends in the new economy. Procedia-Soc Behav Sci 110:341–352

Brekelmans M, Chen KY (2016) China's automotive aftermarket: a strategic opportunity. China Bus Rev

Business Times http://bloomberg.com/research/stocks/private/snapshot.asp?privcapId=50275851. Retrieved on Jan 25, 2020

Chinnam RB, Huisingh D, Subramoniam R (2009) Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs. J Clean Prod 17(13):1163–1174

Cohen M, Agrawal N, Agrawal V (2006) Winning in the aftermarket: from the May 2006 Issue. Harvard Business Review. Retrieved from https://hbr.org/2006/05/winning-in-the-aftermarket

Deliverable 1.1 Market segmentation for CPS technology. The Platforms4CPS. Retrieved from https://www.platforms4cps.eu/fileadmin/user_upload/D1.1_Market_segmentation_for_CPS_technology.pdf

Hedges and company releases annual online auto parts forecast: online sales to break $10B in 2018. PR Newswire. Retrieved from https://www.prnewswire.com/news-releases/hedges–company-releases-annual-online-auto-parts-forecast-online-sales-to-break-10b-in-2018-300649342.html

E-commerce automotive aftermarket—market analysis, Trends, and forecasts. ResearchAndMarkets.com. Retrieved from https://www.businesswire.com/news/home/20191011005237/en/Global-E-Commerce-Automotive-Aftermarket-Market-Analysis-Trends

Fast Forward Advisors (2018) Ecommerce for automotive aftermarket. Retrieved from https://fastforwardadvisors.com/news/ecommerce-for-automotive-aftermarket/

Gao P, Sha S, Zipser D, Baan W (2016) Finding the fast lane: emerging trends in China's auto market. McKinsey and Company

Gubbi J, Buyya R, Marusic S, Palaniswami M (2013) Internet of Things (IoT): a vision, architectural elements, and future directions. Future Gener Comput Syst 29(7):1645–1660

Howard M, Vidgen R, Powell P (2006) Automotive e-hubs: Exploring motivations and barriers to collaboration and interaction. J Strateg Inf Syst 15(1):51–75

Ipsos Business Consulting (2016) The boom of China's automotive aftermarket is imminent. Retrieved from https://www.ipsosconsulting.com/insights/publications/the-boom-of-chinas-automotive-aftermarket
Jawi ZM, Solah MS, Ariffin AH, Shabadin A, Ali A, Osman MR, Wong SV (2017) Automotive consumerism: a study of car user's practices & behaviour in Klang Valley, Malaysia
Kasava NK, Yusof NM, Saman MZM (2020) Sustainable manufacturing application in malaysian automotive manufacturing. Int J Bus Technol Manage 2(1):34–39
Kosaka M, Zhang Q, Dong W, Wang J (2012) Service value co-creation model considering experience based on service field concept. In: Icsssm, vol 12. IEEE, pp 724–729
Labrecque LI, vor dem Esche J, Mathwick C, Novak TP, Hofacker CF (2013) Consumer power: evolution in the digital age. J Interact Market 27:257–269
Lee I, Lee K (2015) The Internet of Things (IoT): applications, investments, and challenges for enterprises. Bus Horiz 58(4):431–440
Madakam S, Ramaswamy R, Tripathi S (2015) Internet of things (IoT): a literature review. J Comput Commun 3(05):164
Mamat TNAR, Saman MZM, Sharif S (2014) The need of end-of-life vehicles management system in Malaysia. Adv Mater Res, vol. 845. Trans Tech Publications Ltd. pp 505–509
MITI (2020) National automotive policy 2020 (NAP 2020), Ministry of International Trade and Industry
O'Cass A, Ngo LV (2012) Creating superior customer value for B2B firms through supplier firm capabilities. Ind Mark Manage 41:125–135
Prahalad CK, Ramaswamy V (2004) Co-creation experiences: the next practice in value creation. J Interac Market 18(3):5–14
Roghanian P, Gheysari H (2013) Commitment and customer loyalty in business-to-business context. Commitment 5(19):156–164
Russo B, Zhang J, Tang J, Hu P (2017) Rising opportunities in China's automotive independent aftermarket. Gao Feng Advisory Company Limited
Shapiro C, Teece D (1995) Systems competition and Aftermarkets: an economic analysis of Kodak. Antitrust Bull 39:135
Shen Y (2015) Design of a hadoop based data platform for auto aftermarket. In: 2015 international conference on management, education, information and control. Atlantis Press
Turban E, King D, Lee J, Liang TP, Turban D (2012) Electronic Commerce 2012: a managerial and social networks perspective
Twelve Percent of U.S. Consumers Making Automotive Purchases Buy Online. The NPD Group, Inc. Retrieved from https://www.npd.com/wps/portal/npd/us/news/press-releases/2017/twelve-percent-of-us-consumers-making-automotive-purchases-buy-online/
Valjakka T, Mäkinen S, Lehtonen A (2012) Opening company boundaries for collaborative business model renewal. In: 13th international CINet conference: continuous innovation across boundaries
Vargo SL, Lusch RF (2008) Service-dominant logic: continuing the evolution. J Acad Mark Sci 36(1):1–10
Wahab MA, Jawi ZM, Hamid IA, Solah MS, Latif MM, Isa MM … Hamzah A (2017) Automotive consumerism in Malaysia with regard to car maintenance. J Soc Automotive Eng Malays 1(2)

Chapter 14
e-Service Innovation Through Malaysian Consumer Perspectives: Case Studies of e-Hailing and e-Hypermarket

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Abstract In recent decades, Malaysian Internet usage has rose rapidly. Malaysia Internet penetration rate has achieved 80% or equivalent to 26 million Internet users. With the rapid growth of the internet usage in Malaysia, consumers are now starting to purchase product and services via online medium. This chapter focuses on how Malaysian consumer value online services as alternatives of getting service. The chapter begins with the current trends of e-service in Malaysia. Two online services, e-hailing and e-hypermarket will be discussed. The gathered consumer value will help industry in providing better e-service.

14.1 Introduction

Internet penetration in Malaysia has reached almost 140%. According to Kemp and Moey (2019), 80% or equivalent to 26 million Malaysian between the ages of 16

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and 64 are already shopping online. Following the global trend, more Malaysians are also shifting to mobile. Malaysians boast one of the highest mobile penetrations in the world at 85.7%. Other than buying on marketplaces and e-commerce stores, according to Bain & Company, about a third of Malaysians prefer buying informally through social media websites such as Facebook and Instagram. This is the reason why social commerce is thriving in Malaysia (Lim et al. 2016).

Malaysian government for years has provided many initiative and plans to achieve a high-income nation goal by year 2020. This include transforming service industries from traditional counter-service to online commerce or e-commerce through Malaysian Economic Transformation Programme (ETP) (Handley 2016). One of the key initiative is the Virtual Mall project. This project aims "to grow the internet-based retail market, taking advantage of higher disposable income of the Malaysian population, better broadband services, and the proliferation of mobile devices in the country" (PEMANDU 2014). This initiative is supported by the National e-Commerce Strategic Roadmap, which has six prime goals:

- Increase seller adoption of e-commerce;
- Accelerate adoption of e-procurement by businesses;
- Remove non-tariff barriers (domestic e-fulfillment, cross-border e-commerce, e-payment, consumer protection);
- Realign existing economic incentives;
- Make strategic investments in key e-commerce firms; and
- Promote Malaysian businesses to increase cross-border e-commerce.

According to the Consumer Barometer by Google in 2017, Malaysians are most likely to buy flights, hotels, music, ground travel and clothing and footwear online. This means that not all products will see online sales (Muda et al. 2016). A study conducted by Rakuten in 2010 (Rakuten 2012) found that 71% of Malaysian online shoppers tend to regret their online purchases, 48% were dissatisfied due to mismatched expectations, 29% were disappointed with the poor product quality and 30% of Malaysians failed to complete their online purchases. Therefore, maximizing the effort in doing promotion and provide good customer service can help in improving the online shoppers interest in online shopping (Fauzi et al. 2018).

This chapter discusses on the innovation of service in Malaysia from the traditional approach to the use of technology in providing the services online. In short online service is refer as e-service. We reviewed previous research works and statistics from reliable media sources. We also discusses on two online services studies which are the e-hailing and e-hypermarket. These two services have now become the lifestyle of Malaysian.

This chapter begins with an outlook of the current state of e-commerce in Malaysia and presenting the top e-commerce players in Malaysia. This is followed by two case studies on e-service innovation which are the e-hailing and e-hypermarket. Then, an analysis of the business innovation of these two e-services will be discussed. The chapter ends with a conclusion.

14.2 E-Commerce in Malaysia

Online system has been a great boom in usages since the introduction of e-commerce which allows users to perform online transactions at anyplace and anytime. It is described as activities of buying, selling and trading products or services via the usages of electronic devices such as computer or smart phone with internet. The online transactions could be varied from paying a bill to buying grocery. In modern days, more merchants are hosting their own online platform to provide online services when the mobile commerce is growing.

The Malaysia e-commerce market revenue is reported to amount to USD 4337 million in 2020 (Statista 2020). The market is expected to grow with an annual growth rate of 8.4% (until 2024). To give you an idea of how far Malaysia's e-commerce has come, Table 14.1 shows a timeline of some of the most important e-commerce site launches (and closures).

Some international and local e-commerce players have shaped the e-commerce scene in Malaysia. These internet businesses have pushed their ways to penetrate the Malaysia market, challenging their business norms. The presence of strong players such as Lelong.my, Fashion Valet.com, Mudah.my and Lazada on the online market-place is an evidence that e-commerce in Malaysia is accelerating. Functionality, authority, and attractiveness are the three important quality of the e-commerce web

Table 14.1 Malaysia e-commerce scenes

Year	Site launches
2004	**eBay** launches eBay Malaysia
2007	**Lelong.my** is launched as pioneer Malaysian platform
2010	**FashionValet.com** is launched by Vivy Yusof and Fadza Anuar
2011	**Mudah.my** is launched
	Groupon launches in Malaysia by acquiring Groupsmore
2012	**Lazada** and **Zalor**a are launched by Rocket Internet as a business-to-consumer e-commerce marketplace
	Carousell a consumer-to-consumer marketplace is launched
	Rakuten Malaysia marketplace is launched by Rakuten Japan
	Hermo.my is launched
2013	**GemFive** is launched by GuoLine eMarketing
2015	**11Street.my** launched by 11Street Korea
	Shopee is launched as mobile-first business-to-consumer and consumer-to-consumer e-commerce marketplace
2016	**Rakuten** shuts down
2017	**Fave** launches, rebranded from **Groupon**
	GemFive shuts down

Source statista.com

Table 14.2 Top 10 e-commerce websites in Malaysia

Ranking	e-commerce website	Online traffic in thousand clicks
1	Shopee	28,920
2	Lazada	18,940
3	Lelong	1903
4	Zalora	1430
5	GoShop	1028
6	PG Mall	863
7	eBay	725
8	ezbuy	517
9	Hermo	469
10	Sephora	377

Source statista.com

pages (Wei et al. 2018), and these are the reasons why some of these e-commerce players still exists until today.

In Malaysia, online marketplace dominates the e-commerce space, with local branded e-commerce websites trailing behind. Malaysia e-commerce market has been growing rapidly because of its fast-growing economy and advanced infrastructure for digital technologies (Muller 2019). Table 14.2 shows the top 10 e-commerce websites ranking in Malaysia as of the fourth quarter of 2019 where we can see Shopee is leading other e-commerce sites with almost 29 million clicks.

The environment in Malaysia is ready for e-commerce growth. Internet and mobile penetration in the country is one of the highest in Southeast Asia and the logistics and legal infrastructure is prepared to take on a high volume of daily orders.

14.3 A Case Study of E-Hailing in Malaysia

14.3.1 Outline of E-Hailing Service in Malaysia

Prior to the emergence of e-hailing services, customers will need to call a taxi either from the road, or book a taxi from the taxi call center to get somewhere (Ruangkanjanases and Techapoolphol 2018). Technological advancements in the transport industry have led to the change that customers no longer need to call taxis by the road and simply use e-hailing services to book online transportation and make various travel-related choices (Wan Mohamad et al. 2016). Technological advancements in the transport industry have made e-hailing services available 24 h and accessible to customers.

The emergence of e-hailing has led to the evolution of the transportation industry around the world especially when Uber was introduced in 2009 and Lyft in 2012, and has made e-hailing services continue to grow, become popular, and gain more attention from the customers (National Association of City Transportation Officials 2016). The evolution of e-hailing services began in urban areas as urban dwellers were exposed to technology and infrastructure development. However, today, e-hailing services have also expanded widely as the number of internet users is increasing (Sakaran et al. 2018). According to Flores and Rayle (2017), e-hailing services are known as online travel booking services. E-hailing is defined as an ordering process for booking vehicles online using computers or mobile devices such as mobile phones. E-hailing is a system that allowed customers to choose and use e-hailing services to reach their desired destination (Shaheen et al. 2017). Then, the driver is allowed to identify the given location of the customer and to take the customer to his or her destination. Through the system, customers can book online trips and pay the trips either by cash or online transactions. E-hailing is a travel service for individuals that helps customers to book travel just at their fingertips.

In Malaysia, e-hailing services began when Uber was introduced in January 2014 and Grab in May 2014 (Arman 2017). The Government of Malaysia has made e-hailing services as one of the legal services of law enforcement (Nazura et al. 2017). Provisions for the government to regulate e-hailing service operations were realized after the Public Transport (Amendment) 2017 and the Commercial Vehicle Licensing Board (Amendment) 2017 were passed in the House of Representatives on July 27, 2017 (Parlimen Malaysia 2017). The e-hailing service is listed as one of the legal services of Malaysian public transport through the statement of the Minister in the Prime Minister's Department of Malaysia (Nazura et al. 2017). The e-hailing services that attract customers in Malaysia include Uber, Grab, MyCar, Dascee, Riding Pink, Eevom as well as taxi services which are also categorized as e-hailing services namely Sunlight Taxi, EzCab, Comfort Taxi and Easy Taxi (Khan 2017).

While e-hailing services are growing rapidly and becoming customer choice today, e-hailing services also face issues and challenges in customer satisfaction. Customer satisfaction with the systems is important for e-hailing companies, as companies need to develop strategies to provide the latest technology and accessible systems to attract customer. This issue clarifies that customer satisfaction with the e-hailing system needs to be identified. Furthermore, the use of e-hailing services is also restricted to older generations as they choose traditional taxi services without the need for any internet technology. The older generation is the less educated generation of technology. Thus, it is difficult to use e-hailing as system requires customer to understand the functionality of the systems and technologies used to obtain the services (Vivoda et al. 2018).

However, e-hailing has many advantages such as in reducing the travel cost and waiting times (Flores and Rayle 2017). With e-hailing, customers do not have to carry a cash as payment can be made automatically by connecting e-hailing with a credit card. Personal details of customers and drivers are also recorded through the system to prevent any crime (Flores and Rayle 2017). The e-hailing service not only changed the structure of the transportation industry but also changed the way people lived their lives. In the future, conventional transport companies planning to change to the e-hailing system may refer to the technological structure provided by the e-hailing company to advance the public transport industry in Malaysia.

14.3.2 E-Hailing Satisfaction Model

The customer satisfaction model of e-hailing services in Malaysia is designed based on the concept of co-creation value. The DART model (Prahalad and Ramaswamy 2004) was used as a key factor in the measurement dimension to identify the customer satisfaction factors with the integration of SERVQUAL model (Parasuraman et al. 1988), Ojasalo model (Ojasalo 2010) and Silalahi model (Silalahi et al. 2017). Dialogue, access, risk assessment and transparency factors in the DART model were used to study the importance of co-creation value in e-hailing services, which is the interaction between e-hailing companies and customers. Figure 14.1 shows the conceptual model for customer satisfaction of e-hailing services.

The definition of dialogue, access, risk assessment and transparency based on the original definition of Prahalad and Ramaswamy (2004) have been refined and customized for e-hailing services as validated by the experts. Table 14.3 shows the definition of dialogue, access, risk and transparent factor for e-hailing.

Three models of user satisfaction which are the SERVQUAL model, the Ojasalo model and the Silalahi model are integrated into the DART model to be sub-factors of the dialogue, access, risk and transparent factors. Table 14.4 shows the definition of sub-factors corresponding to the dialogue, access, risk and transparent factors.

The study is conducted on e-hailing services operating in Malaysia. The study population is a community of e-hailing users in Malaysia who are registered customers of e-hailing services. E-hailing customers in Malaysia are identified through the presence of e-hailing service customers on social media sites such as

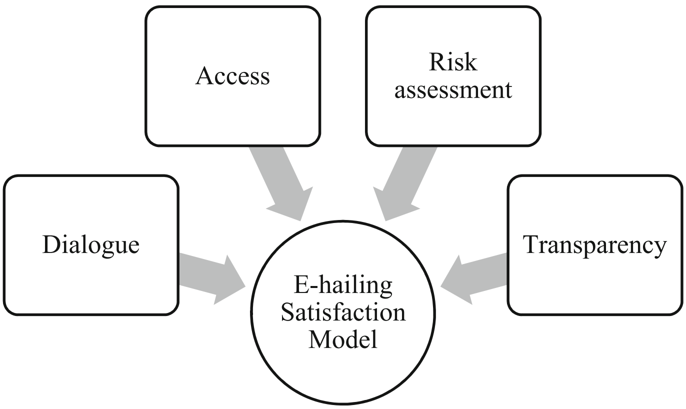

Fig. 14.1 The conceptual model for customer satisfaction of e-hailing services. *Source* Idros (2019)

Table 14.3 The definition of factors for e-hailing

Factor	Definition
Dialogue	Two-way communication and interaction that occurred between the company and e-hailing customer to understand customer's emotions, experiences, issues and solve e-hailing matters together using various method of communications
Access	The company displays useful information by providing an accessible interactive website or apps as a platform for e-hailing customers to access information and service in the easiest way
Risk	The company will notify e-hailing customers about the potential risks before, during, and after using e-hailing and customers must be well prepared to deal and bear the risk if they want to continue using e-hailing
Transparency	Trust that has been established between customer and e-hailing company to protect customer's data privacy and ensure that the company will deliver trusted information

Source Idros et al. (2020)

Facebook, Twitter, Instagram and Whatsapp. 251 respondents are involved in the e-hailing customer satisfaction survey. The number of respondents involved exceeds the specified sample size. The questionnaire is divided into three sections: Part A for respondent demographics, Part B for determinant factors of customer satisfaction and Part C for customer satisfaction. Demographic information is based on gender, age, e-hailing application are used, the period to registered users and frequency of use. Part B focuses on customer satisfaction factors that include dialogue, access, risk and transparency. While, Part C focuses on overall customer satisfaction, which is to measure customer satisfaction through the positive experience of respondents after using e-hailing.

The results show that there is a significant relationship between the four factors namely dialogue, access, risk assessment and transparency with the customer satisfaction towards e-hailing services. Among all four factors, transparency is the most influential factor in customer satisfaction with e-hailing services. Research findings on factors affecting customer satisfaction have helped e-hailing companies provide high quality services and devise strategies for maintaining customer satisfaction for the services.

The study indicates that co-creation values of dialogue, access, risk assessment and transparency is indeed affecting the customer satisfaction of e-hailing services. Overall, dialogues can influence the customer satisfaction of e-hailing services with the presence of two-way communication between e-hailing companies and customers. Access also affects the satisfaction of e-hailing service customers with the availability of e-hailing services. Furthermore, risk assessment affects customer satisfaction when the customer is ready to continue using e-hailing after learning about the potential risks. Finally, transparency can affect the customer satisfaction of e-hailing services as e-hailing companies strive to protect the safety and privacy of customers. Implementation of dialogue, access, risk assessment and transparency in

Table 14.4 The definition of sub-factors

Factor	Sub-factor	Definition
Dialogue	Empathy	The company pays attention to understand the specific needs of the customer
	Personalization	The company gives individualized attention to answer customers' question and comment
	Responsiveness	The company provides fast feedback to assist customers through various communication channels
	Communication	The company communicates with the customer in a language that is easy to understand
	Contact	The company offers many communication channels that allow interactivity to build a close relationship with the customer
	Interactivity	The company provides communication method to build a close and interactive relationship with customers
	Perceived website innovativeness	The company allows the customer to give innovative feedback regarding experience using the service
Access	Tangible	The company provides an accessible platform such as a website or apps for all customers
	Ease of use	Customers can search for anything related to service easily with navigation provided
	Website design	Websites or apps that have a user-friendly design with easy access
	Information	The content displayed in the system is useful for the customers
	Content adequacy	The content provided is complete regarding the materials and services offered
	System availability	The system is accessible at any time without system failure
	Accessibility	Customers have the opportunity to access information about service anywhere without any problem
Risk assessment	Perceived risk	Customers are aware that the system is likely to experience a failure which ultimately leads to loss

(continued)

Table 14.4 (continued)

Factor	Sub-factor	Definition
	Perceived cognitive	Customers are aware of service flow that help them to predict the implications aftermath for service usage in the future
Transparency	Assurance	Knowledge and credibility of the company that will inspire customer's trust
	Trust	The customer has a firm belief about the transaction process provided
	Reliability	The company promised the customers by delivering the service accurately and consistently
	Security	Customers' confidence that all the steps that they take throughout the system are free from harm without any doubt
	Privacy	Customer trust that the company will work to protect the customer's personal data
	Content usefulness	Information provided is based on trusted sources
	Punctuality	Service will deliver at the designated time as promised
	Billing	The company provides detailed information about the price that can be trusted by the customer

Source Nur Athirah Nabila et al. 2020

services has led to increased customer satisfaction which has also led to the growth of e-hailing business.

The e-hailing satisfaction model is in line with the government's policy of making e-hailing one of the public services in Malaysia and operating legally under the Public Transport (Amendment) Bill 2017 (Parlimen Malaysia 2017). The study also measures the level of customer satisfaction of e-hailing services in Malaysia through the value of the customer satisfaction index as the improvement in the quality of e-hailing services leads to improved quality of public transport in Malaysia. E-hailing companies can also identify weaknesses and improve services through the discovery of the value of the customer satisfaction index. In this regard, the study could also be a reference for the other transport companies in the future in order to keep pace with the development of the Malaysian transport industry.

14.4 A Case Study of E-Hypermarket in Malaysia

14.4.1 Outline of E-Hypermarket in Malaysia

Weld Supermarket was introduced in Malaysia in 1963 and it was the first modern retail concept (Kaliappan et al. 2009). Meanwhile, the first hypermarket that was introduced in Malaysia was Makro in 1993 (Lee 2004). The concept of online grocery shopping started in Malaysia in the mid-2000, pioneered by humble names like PasarBorong Online, SubangGrocer.com, CGdeMart.com and Citrasspicemart.com (Zaini et al. 2011).

These days, Malaysian e-grocers such as redtick.com, presto.com, food-world.com.my and doorstep.com, are among the current players in Malaysian online grocery business. For the time being, all of these online retailers deliver all year round across the Klang Valley using a fleet of lorries and vans. This area is focused based on the fact that it has the highest percentage of people connected to the Internet and computer-savvy people in Malaysia (Sandhu et al. 2011).

Online hypermarket shopping system or e-hypermarket is an online system that allows users to purchase grocery items from the hypermarket store via the internet using any electronic devices ranging from computer to handheld mobile devices. It enables users to conduct shopping activities via electronic devices at any time via the usages of internet network without having to spend hours in the local hypermarket store (Yeganegi and Elias 2016). It enables users to conduct shopping activities via electronic devices at any time via the usages of internet network without having to spend hours in the local hypermarket store.

Euromonitor International in its latest report dated April 2014 has recorded 13.5% in the value growth of grocery category in 2013, while others such as beauty and personal care (9.4%), consumer electronics and video games hardware (17.3%), apparel and footwear (23.7%), consumer healthcare (12.4%) and media products (10.5%). However, although there are few online grocery players in Malaysia, none is prominent as no online grocers register any significant sales performance in 2010 (Euromonitor International 2018).

April 2013 has marked the introduction of e-hypermarket by Tesco Stores (Malaysia) Sdn. Bhd. It is further reported that the local e-hypermarket is expected to continue to face challenging conditions in the short-term forecast period as players are now taking the wait-and-see approach, depending on the success of Tesco. Other reasons that limit the customers' willingness to shop online are; customers still picked up products from physical stores where they could choose their preferred items and some of them believed that physical stores offer more promotions than the online shopping channel (Lim et al. 2016).

Consequently, the e-hypermarket concept appeals to mainly the young and tech-savvy customers who enjoy the convenience of not having to rush to the shops to pick up their groceries after work. However, this will remain a complement to the country's grocery retailing landscape since online shopping for grocery items is still in an infancy stage in Malaysia (Euromonitor International 2018).

14.4.2 The E-Hypermarket User Acceptance

Yeganegi and Elias (2016) have conducted a study to understand the customer shopping behavior when purchasing their grocery online (or e-hypermarket behavioral intention) using mobile devices. In order to understand the customer shopping behavior, a model was constructed which based on Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al. 2003) with addition of three new factors. The three new factors are perceived cost, perceived trust and word-of-mouth (WOM).

The proposed model consists of six independent factors and two dependent factors. The independent factors are performance expectancy, effort expectancy, social influence, facilitating condition, perceived cost and perceived trust. The dependent factors are behavioral intention and word-of-mouth. Figure 14.2 is the mobile commerce online shopping system (MOSS) model.

According to Yeganegi and Elias (2016) these independent and dependent factors are the most suitable factors that can explain the acceptance of the user when using a mobile application for buying goods online from the hypermarket. The definition of the factors and suggested measurement items are explained in Table 14.5. These definitions are taken from Venkatesh et al. (2003), Mayer et al. (1995), Wang and Yang (2005), Baraghani (2008), and Ong (1982).

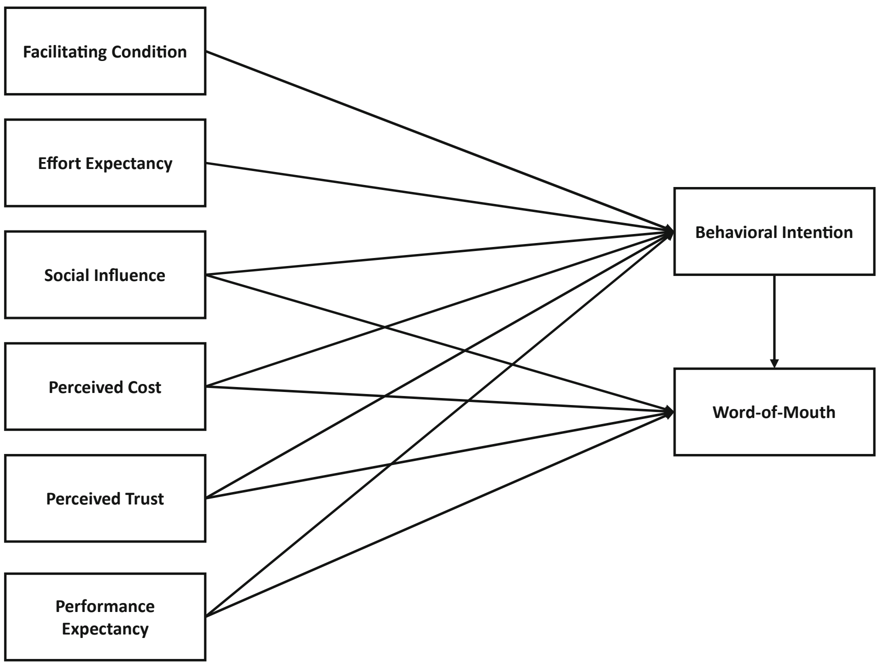

Fig. 14.2 MOSS model. *Source* Yeganegi and Elias (2016)

Table 14.5 Factors and definition

Factor	Definition
Facilitating condition (FC)	Facilitating condition refers to the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system
Effort expectancy (EE)	Effort expectancy refers to the degree of ease associated with the use of the system
Social influence (SI)	Social influence refers to the degree to which an individual perceives that important others believe he or she should use the new system
Perceived cost (PC)	Perceived cost refers to the degree in which an individual would use the service when it required less cost and less effort
Perceived trust (PT)	Perceived trust refers to the willingness of a person to be accepting the action of another person based on the belief that that person would perform an action that important to the trust or irrespective of the ability or control the other person
Performance expectancy (PE)	Performance expectancy refers to the degree to which a person believes that application of a system could improve his or her job performance
Behavioral intention (BI)	Behavioral intention is the indication of how far a person willing to exert effort to perform a particular action
Word-of-mouth (WOM)	Word-of-mouth refers to the exchange of information orally between sender and receiver regarding the purchase of services or goods

The study is conducted with a hypermarket shoppers who are randomly selected at the hypermarket and have used mobile commerce (m-commerce) for online shopping. 500 questionnaire are distributed at a hypermarket with 400 returned questionnaire, which brings to 80% response rate. A five-point Likert scale, ranging from "strongly disagree" to "strongly agree" is used to measure each of the items of the constructs. There are two sections in questionnaire. The first section focuses on the demographic data which are gender and age of the respondents. The second section contains the measurement items of all eight factors. The measurement items for each factor are shown in Table 14.6.

Results as shown in Table 14.7 have indicated that the independent factors have positive significant effect on both dependent factors. This means that any improvement on facilitating conditions, effort expectancy, social influence, perceived cost, perceived trust and performance expectancy will increase the level of behavioral intention to use online hypermarket shopping system and vice versa. Similarly, any improvement on social influence, perceived cost, perceived trust and performance expectancy will increase the level of WOM and vice versa. The study also found that there is a significant role of behavioral intention to use as an important predictor of WOM activity. Those who have a high level of intention to use are more engaged in WOM activities.

Table 14.6 Measurement items

Factor	Measurement
Facilitating condition (FC)	Gain access to the necessary resources, knowledge, information and support
Effort expectancy (EE)	Easy to understand, easy to use system
Social influence (SI)	People influence
Perceived cost (PC)	Save cost, free, transparency
Perceived trust (PT)	Secure, personal information protection, valid, legal
Performance expectancy (PE)	Benefits, speed and productivity
Behavioral intention (BI)	Intend to use
Word-of-mouth (WOM)	Recommendation, advantages, share experience

Table 14.7 Hypothesis test results

	Mean	S Dev	FC	EE	SI	PC	PT	PE	BI	WOM
FC	3.53	1.02	1							
EE	3.58	1.14	.497*	1						
SI	3.18	1.04	.472*	.380*	1					
PC	3.53	1.03	.335*	.476*	.274*	1				
PT	3.03	1.05	.358*	.397*	.334*	.457*	1			
PE	4.00	1.23	.463*	.522*	.298*	.386*	.208*	1		
BI	2.58	1.44	.568*	.538*	.470*	.502*	.429*	.524*	1	
WOM	3.55	1.03	.521*	.506*	.506*	.485*	.434*	.456*	.722*	1

*Significant at $p < 0.01$

The findings from the study have many implications for both marketers and mobile system developers. It is clear that performance expectancy is an important variable affecting the intention to adopt m-commerce by customers. In addition, performance expectancy plays an important role in stimulating positive WOM recommendation. Thus, m-commerce users are influenced significantly by their perceptions about the performance of m-commerce and the benefits of using it. Therefore, marketers for m-commerce should persuade customers about the advantages of m-commerce and the developers should emphasize on how to improve the performance and productivity of the m-commerce.

The study also showed that cost plays a vital row in behavioral intention and positive WOM recommendation. User would expect lowest cost or cost free service from a system. So, marketer must know how to market the system so that shoppers could feel that the system is free to use and they can save their shopping cost via the system.

Finally, trust plays significant role in positive WOM recommendation. Although performance expectancy and social influence are important in motivating positive

WOM in m-commerce, the trust concept will also play an important role in increasing participation in WOM recommendation. Understanding the influence of trust on the acceptance and use of m-commerce is essential to the success of m-commerce. Therefore, marketers should consider the trust issue as well as usefulness and social influence in building and advertising m-commerce.

14.5 Analysis of Business Innovation with ICT

We analyze the direction of business innovation with new ICT in e-commerce in Malaysia through answering the following five questions.

(1) **What are the needs of people, the issues in society and business and the objective of utilizing ICT? (needs)**

In line with technological developments, e-hailing services are among the services that use technology to provide convenience to customers. However, e-hailing needs to know the extent to which users are satisfied with the services provided. Customer satisfaction is important and has an impact on the success of a service. Customers today are better informed, aware of their needs and have a clear idea of the product or service they want. Customer satisfaction with e-hailing services is crucial to helping e-hailing companies provide a quality, responsive and interactive travel booking system.

Despite reported advantages of e-hypermarket, there are still huge number of people who are not using the online system. A survey conducted by Nielsen (2015) reported that while a quarter of global respondents are e-hypermarket and 55% are willing to use it down the road, 61% reported that they still find grocery shopping at the store to be an "enjoyable and engaging experience." Nearly as many as 57% said that retail grocery shopping is a "fun day out for the family". However, it is with no doubt certain shoppers are more likely to choose the Internet than others. Therefore, besides understanding what the customer wants, engaging the customers in using the technology and to ensure that the technology is used properly becomes a challenge to both the grocery retailer and the technology developer. This can be achieved by creating more appealing e-hypermarket system that is highly reliable and trustworthy for the customers. The customers too would expect their shopping experience is at least similar to the physical store, especially access to information, convenience, breadth of product selection and sustainability.

(2) **What technologies and functions are utilized to solve these issues or realize the needs of people? What is the role of ICT in value creation? (technologies)**

In a simple business context, online system with online transaction is part of e-commerce. It is described as activities of buying, selling and trading products or services via the usages of electronic devices such as computer or smart phone with internet. The e-hailing system should have a communication channel that facilitates the interaction between the customer and the company that creates the concept of co-creation to enhance customer satisfaction. This on the other hand could help any e-hailing companies to identify their strengths and weaknesses and find ways to improve the quality of their e-hailing services.

Meanwhile, the e-hypermarket is an online system that allows customer to purchase grocery items from the hypermarket store via the internet using any electronic devices at any time via the usages of internet. With this online service, customer can save more time buying their grocery from home rather than going out to the local hypermarket store. Mobile devices such as smartphone or tablet as well as network access to conduct transactions which involve the exchanges of value, information, and products are the important technological factors.

(3) **What are value creation methodologies? (value creation)**

The customer satisfaction model of e-hailing services in Malaysia is designed based on the concept of co-creation value. The development of co-creation value model for e-hailing can identify the relationship between companies and customers to help increase customer satisfaction. In order to identify factors that influence customer satisfaction, the DART model developed by Prahalad and Ramaswamy (2004) was used as a key factor in the measurement dimension. Customer satisfaction models namely the SERVQUAL model, the Ojasalo (2010) model and the Silalahi et al. (2017) model were subsequently matched to the factors of dialogue, access, risk assessment and transparency of DART model. All factors have functionality towards the quality of the transport services and appropriate to the context of the e-hailing. The use of the DART model is in line with the study of customer satisfaction. The dialogues, access, risk assessment and transparency factors in the DART model have broad character and are appropriate for studying the importance of co-creation value in e-hailing services, which is the interaction or relationship between e-hailing companies and customers.

In the case of e-hypermarket, the study was conducted directly with the customers. E-hypermarket value were identified based on the customer satisfaction of the service provided by the grocery retailer and their shopping experiences. The MOSS model helps in understanding the behavior of the customers. The factors in the model can indicate the state of the m-commerce adoption. Although the study was conducted only with the customer, getting feedback on the customer experience is important. Understanding the customer value will help creating better product and service offerings for superior customer experiences. This study underscores the importance of intangible knowledge as well as tangible aspects for creating highly value outputs.

(4) **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**

In e-hailing, the results show that the factors of dialogue, access, risk assessment and transparency in the e-hailing customer satisfaction model, in fact, affect the customer satisfaction of e-hailing services. Dialogue factor can affect customer satisfaction of e-hailing services with the existence of two-way communication relationships between e-hailing companies and customers. Access factor can also influence the satisfaction of e-hailing service customers with the availability of e-hailing services. Furthermore, risk assessment factor can influence customer satisfaction when customers are ready to continue using e-hailing after learning about the potential risks. Finally, the transparency factor can influence the customer satisfaction of e-hailing services as e-hailing companies strive to protect the safety and privacy of customers

Marketers need to consider the importance of social influence and word-of-mouth recommendation in e-hypermarket adoption since these two variables show an important level of relationship with intention to use m-commerce. Therefore, identifying opinion leaders is a key strategy for marketers in order to obtain advantage from these influential groups. If marketers can find the opinion groups that influence many customers, and use those to communicate the advantages of m-commerce, this will probably encourage more customers to use m-commerce. Every level of users in any online grocery retailing plays an important role in a success of m-commerce.

(5) **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

The e-hailing customer satisfaction model in Malaysia has a positive impact on e-hailing companies in identifying customer satisfaction factors. E-hailing companies need to ensure that dialogue is always available in the service by providing a variety of communication channels to facilitate communication between customers and e-hailing companies. In addition, e-hailing companies need to ensure that access is always available in the service by providing complete and useful information access to e-hailing. However, for risks assessment, e-hailing companies need to constantly ensure that customers are prepared to face potential risks. At the same time, e-hailing companies also need to develop strategies to reduce the risk of system failures in order to give customers confidence. E-hailing companies also need to ensure that transparency is always available in the service by keeping customers' personal data secure and providing reliable information. Implementation of dialogue, access, risk assessment and transparency in e-hailing services has led to increased customer satisfaction which has also made the e-hailing company business thrive. In addition, the development of the customer satisfaction model of e-hailing services is in line with the government's policy of making e-hailing one of the public services in Malaysia and operating legally under the Land Public Transport (Amendment) Bill 2017 (Parlimen Malaysia 2017).

The MOSS model can be translated into a framework which can be used as a guideline for retailing businesses who which to conduct their business using mobile application as the platform. This will also revolutionized the retailer's business model. The model helps grocery retailers, marketer and system designers to understand their customer shopping behavior. In the future, providers can make improvement and create a better online shopping experience for their customers.

14.6 Conclusion

This chapter has discussed the transformation of service from the traditional counter service to the online service in Malaysia. We can see the increasing trend of businesses converting to technology for providing better service to their customers. The emergence of these online services as early as mid-2000 has changed the businesses in Malaysia to be more efficient and effective. Two online service innovations which are e-hailing and e-hypermarket are greatly accepted by Malaysian consumer. With strong support from the government of Malaysia that provides sustainable plans and incentives given to businesses, together with the continuous strong pushes given by the customers, no doubt that these actions will influenced the businesses in Malaysia to move ahead through high intense of competitions both locally and internationally.

References

Arman A (2017) Regulating Uber and Grab drivers. New Straits Times, 20 August 1

Baraghani SN (2008) Factors influencing the adoption of internet banking. Lulea University of Technology

e-commerce Malaysia Outlook. Retrieved 12 Jan, 2020, from https://www.statista.com/outlook/243/122/ecommerce/malaysia

Euromonitor International (2018) Hypermarkets in Malaysia. Retrieved 12 Jan, 2020, from https://www.euromonitor.com/hypermarkets-in-malaysia/report

Fauzi MWM, Omar MK, Aziz RA, Zainal Abidin MAH (2018) Factors influencing online buying behaviour of generation Y. Int J Bus Econ Law 17(1):1–9

Flores O, RayleL (2017) How cities use regulation for innovation: the case of Uber, Lyft and Sidecar in San Francisco. Transp Res Procedia pp 3760–3772

Handley H (2016) An Introduction to e-Commerce in Malaysia. ASEAN Briefing. Retrieved 24 Feb, 2020, from https://www.aseanbriefing.com/news/an-introduction-to-e-commerce-in-malaysia/

Kaliappan SR, Alavi R, Abdullah K, Zakaullah MA (2009) Spillover effects of foreign hypermarkets on domestic suppliers in Malaysia. Int J Retail Distrib Manag 37(3):226–249

Kemp S, Moey S (2019) Digital 2019 spotlight: Ecommerce in Malaysia. Retrieved 23 Feb, 2020, from https://datareportal.com/reports/digital-2019-ecommerce-in-malaysia

Khan KU (2017) Rideshare/e-hailing in Malaysia. Slaid. Funkada, Malaysia

Lee C (2004) Centre on regulation and competition: Working Paper Series. Competition Policy in Malaysia, Centre on Regulation and Competition, vol 68, pp 1–29

Lim YJ, Osman A, Salahuddin SN, Romle AR, Abdullah S (2016) Factors influencing online shopping behavior: the mediating role of purchase intention. Procedia Econ Fin 35:401–410

Mayer RC, Davis JH, Schoorman FD (1995) An integrative model of organizational trust. Acad Manag Rev 20(3):709–734

Muda M, Mohd R, Hassan S (2016) Online purchase behavior of generation Y in Malaysia. Procedia Econ Fin 37:292–298

Muller, J. (2019). Top 10 e-commerce sites in Malaysia Q4 2019. Retrieved 3 Apr, 2020, from https://www.statista.com/statistics/869640/malaysia-top-10-e-commerce-sites/
National Association of City Transportation Officials (2016) Ride-hailing services: opportunities & challenges for cities. NACTO June 1–11
National eCommerce Strategic Roadmap. Malaysia Digital Economic Corporation (MDEC). Retrieved 21 Feb, 2020, from https://mdec.my/about-malaysia/government-policies/national-ecommerce-roadmap/
Nazura Ngah O, Mohamad HF, Rosli FA (2017) RUU sahkan khidmat e-hailing, Uber, Grabcar lulus. Berita Harian, 27 Julai: 1
Nielsen (2015) The future of Grocery: E-commerce, digital technology and changing shopping preferences around the world. The Nielsen Company April 2015
Idros NANBM (2019) Model Kepuasan Pengguna Perkhidmatan E-Hailing Berasaskan Nilai Cipta-Sama. M.Sc. Thesis. Universiti Kebangsaan Malaysia
Idros NANM, Mohamed H, Jenal R (2020). The use of expert review in component development for customer satisfaction towards E-hailing. *Indonesian Journal of Electrical Engineering and Computer Science*, Vol. 17(1), pp. 347–356
Ojasalo J (2010) E-service quality: a conceptual model. Int J Arts Sci 3(7):127–143
Ong WJ (1982) Orality Nd Literacy. Methuen & Co., Ltd., New York
Parasuraman A, Zeithaml VA, Berry LL (1988) SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. J Retail 64(1):12–40
Parlimen Malaysia (2017) Rang Undang-Undang Akta Pengangkutan Awam Darat (Pindaan). Fasal 30 Pindaan Jadual Pertama Akta 715. 15(2017):1–22
PEMANDU (2014) Annual report 2014 review. Prime Minister's Department
Prahalad CK, Ramaswamy V (2004) Co-creating unique value with customers. Strategy Leadersh 32(3):4–9
Rakuten (2012) Rakuten, INC. Retrieved 12 Jan, 2020, from Rakuten, INC: https://global.rakuten.com/corp/news/press/2012/1031_01.html
Ruangkanjanases A, Techapoolphol C (2018) Adoption of e-hailing applications: a comparative study between female and male users in Thailand. J Telecommun, Electron Comput Eng 10(1):43–48
Sakaran SS, Noor Harifah Mohd, Eboy OV (2018) Socioeconomic factors that affect usage of Grabcar services in Kota Kinabalu city, Sabah. Malays J Bus Econ 5(2):65–77
Sandhu MS, Sidique S, Riaz S (2011) Entrepreneurship barriers and entrepreneurial inclination among Malaysian postgraduate students. Int J Entrep Behav Res 17(4):428–449
Shaheen S, Chan N, Rayle L (2017) Ridesourcing's impact and role in urban transportation. ACCESS Magazine July: 1–9
Silalahi SLB, Handayani PW, Munajat Q (2017). Service quality analysis for online transportation services: case study of GO-JEK. Procedia Comput Sci pp 487–495
Statista (2020) eCommerce Report 2020: eCommerce Malaysia. Retrieved 21 Feb, 2020, from https://www.statista.com/outlook/243/122/ecommerce/malaysia#market-marketDriver
Venkatesh V, Morris MG, Davis GB, Davis FD (2003) User acceptance of information technology: toward a unified view. MIS Q 27(3):425–478
Vivoda JM, Harmon AC, Babulal GM, Zikmund-Fisher BJ (2018) E-hail (rideshare) knowledge, use, reliance, and future expectations among older adults. Transp Res Part F: Traffic Psychol Behav 55:426–434
Wan Mohamad WNAAB, Fuad AFM, Shahib NS, Azmi A, Kamal SBM, Abdullah D (2016) A framework of customer's intention to use Uber service in tourism destination. Int Acad Res J Bus Technol 2(2):102–106
Wang HI, Yang HL (2005) The role of personality traits in UTAUT model under online stocking. Contemp Manag Res 1(1):69–82
Wei CY, Fauzi ISM, Thenmoley R, Elhussein ESE, Asirvatham D (2018) E-commerce adoption and analysis of the popular e-commerce business sites in Malaysia. Bus Econ J 9(2):1–6

Yeganegi R, Elias NF (2016) Measuring the user acceptance on online hypermarket shopping system based on UTAUT model. Int J Manag Appl Sci 2(2):6–9

Zaini ZMM, Ramli N, Ghani FA, Samsudin A, Hamid M, Jusoff K, Ngali N, Rahmat N, Khalid K, Musa M (2011) Online grocery shopping: the affect of time availability on Malaysian consumer preferences. World Appl Sci J 12:60–67 (Special issues on service sector transforms the economy)

Part V
Case Studies on New Application Fields with New ICTs

Chapter 15
Networked Coordination to Facilitate Secondhand Electronics Recycling and Exchange: A Case Study on Aihuishou

Xuefeng Chen and Zixiao Ji

Abstract Aihuishou is the biggest digital device recycling and exchange company in China. It has full coverage of the secondhand value chain, dealing with more than 10 million used smartphones and laptops every year. Unlike other recycling firms, AHS not only collects and holds inventory, but also develops its own testing, grading and exchange platform that has redefined how value is created in the secondhand industry. All participants can easily sell or bid for secondhand devices at the best price on the platform. The platform applies algorithms and robotic testing facilities to ease such transaction process.

15.1 Introduction

The importance of the recycling and circulation management of post-use consumer electronics has been growing. With the worldwide mass production and mass consumption of digital devices—smartphones, tablets, laptops, digital cameras, earphones, drones—the number of obsolete and discarded items increases annually, leading to a greater need for proper recycling and circulation services, particularly in China, a country with large household spending power. Each year more than 400 million phones become outdated in China. It is evident that a vast majority of these used phones end up left in people's desk drawers, not in the standardized recovery network, resulting in idle resources and environmental issues.

Aihuishou (AHS or the company), whose Chinese characters mean "love recycling", has successfully discovered a way to scale up its operations to become China's largest smartphone recycler and a leading global transaction platform for all categories of used digital devices. The company has strengthened its service relationship

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with customers and small businesses in the value chain through a unique omni-channel collection strategy while continuously investing in advanced pricing, testing and grading technologies on its transaction platform. The company currently employs more than 4000 employees to provide recycle services in all major Chinese cities and operates a centralized testing and "productization" process in seven cities. Because used phones are compact in size, standardized in type and relatively high in salvage value, AHS has also been able to open overseas branches in Hong Kong and the United States while working with investee affiliates in India, Indonesia and Brazil to collectively engage in global procurement, provide customized quality testing services, and meet sales and distribution needs.

This chapter outlines how AHS gradually became a category-defining business leader by applying the latest technological developments to facilitate the circulation of secondhand electronics. The chapter examines the mechanism and the revenue model of PJT Marketplace (this platform is named Paijitang, or PJT Marketplace; in Chinese, "Paijitang" means "the best place for trading all sorts of devices"), which is an ICT-enabled exchange platform, and its affiliated robotic testing center. It also explains how AHS was able to change the industry in which it competes in a systematic and predictable way; why and how AHS sought to transition from a self-run recycling model to a third-party service platform; and how the constant stream of data created by platform interactions and transactions can be exploited by machine-learning algorithms to make pricing and bidding suggestions smarter, thus making the value chain smarter. AHS management conducted a full review of the company's business model and ICT technology stack from the perspectives of the second growth curve (Foster 1988; Handy 2016) and the aggregation theory (Thompson 2015) to illustrate how AHS created its differentiated business model of commoditized service offerings, including the following:

(1) quality grading and price benchmarks that AHS built up through its proprietary recycling business
(2) digitization of business actors and things that enhances trust in secondhand dealing
(3) core capabilities of supply-and-demand matching and a robotic testing process
(4) machine-learning algorithms that help find and determine the right price

…

and its value creation method, i.e., how commoditized service offerings help reduce industry-wide transaction costs, how the AHS service network was upgraded to a professional exchange platform, and how this platform reshaped the company's links with business actors (e.g., recyclers, suppliers, resellers, service providers, smartphone brands, carriers) to make deals easier to complete.

15.2 Development of the Aihuishou Company

The development process of the company (Fig. 15.1) has been based on meeting

Fig. 15.1 Aihuishou company development process

client needs through self-run recycling shops and an aggregated service network. This service network emerged and evolved gradually under the application of the IoT, data analytics and pricing technologies. Unlike other recyclers, whose businesses are structured through vertical integration and emphasize linear control, AHS has developed an industry coordination network that generates positive externalities. AHS believes in the principle of collective improvement, and as the coordinator of this orchestration, it can benefit from the network in the long run.

AHS has accumulated a solid record of experience over the past decade. At its outset in 2011, AHS recycled phones through its website and other local shops while developing its own quality standards and testing facilities. Based on the initial recycling bulk, in 2014, the company expanded its coverage and opened self-operated recycling shops in popular shopping malls and began providing trade-in services on the Internet platform of e-commerce giant JD.com [NASDAQ:JD]. This omni-channel collection strategy quickly demonstrated its feasibility and enabled the company to begin collaborating with phone and home appliance chain retailers in 2016. In 2018, the company launched PJT Marketplace, which enables all parties, including former competitors, to migrate online and conduct transactions under AHS's quality certification rules. Since 2018, the company has gradually shifted its strategy from being a proprietary recycler to being a third-party transaction enabler with respect to both the digitized transaction process and robotic testing and storage, and this transition has helped the company open a larger total addressable market.

After an evolution of nine years, in 2019, AHS generated a total gross merchandise volume (GMV) of more than 2 billion US dollars and had come to annually recycle or facilitate recycling transactions regarding over 10 million units of digital devices, most of which are smartphones, tablets and laptops. The company's advance to its market-leading position can be divided into three major phases. This chapter primarily focuses on the evolution of phase 2 and phase 3.

(1) **Phase 1**: the scene-driven period—operating a first-party (buy-and-sell) recycling service independently, followed by coverage of a wider channel and a strategic partnership with JD.com
(2) **Phase 2**: the opening-up period—from proprietary to platform, empowering all business actors in the secondhand value chain to achieve more

(3) **Phase 3**: the aggregation period—going forward, the company is exploring more innovative growth curves based on the AHS platform's capability to expand its service scope.

(1) **Phase 1: scene-driven period**

Founded in 2011, AHS was one of the first companies to apply internet methodology to the traditional recycling field in China. At the time, consumers were transitioning from the 2G feature phone to the 3G smartphone in China and many other areas worldwide; the increasing global shipments of new smartphones—717 million in 2012, a 45% increase compared with 2011 (IDC, 2012)—had brought a similar magnitude of rapid growth in outdated phones, in which residual value remained. A niche but nevertheless attractive market for recycling and circulation emerged with a large development potential.

AHS entered the market at this time when consumers were underserved. Customer experiences differed sharply due to the lack of an established recycling network. Traditional recyclers typically came from socially disadvantaged groups. They operated their businesses on low budgets and only worked to support their families. A small recycler usually collected phones from the doorstep of a telecom shop with little knowledge of condition and price before testing them manually and reselling them to known dealers. Customers complained about the haggling experience, opaque pricing, spam and even fraud that occurred in such informal recycling services. Because there was no benefit to be gained from sales growth in services provided by small recyclers, telecoms, smartphone brands and retailers also had negative experiences. No single recycler was large enough to cope with a networked trade-in program.

AHS entered the secondary market, introducing a guaranteed recycling service at a reasonable price, a considerate recycling experience, and data-cleaning services that enhanced trust. A proprietary buy-and-sell mode secured control over the entire process from marketing, testing and recycling to distribution. Additionally, the use by AHS of its own working capital prompted a cost-effective approach—the company had to acquire new customers and convert their transactions at low cost. Early efforts included attempting to generate sales leads from online forums and the offline device market. Soon, company management realized it was the scene that could best provoke the customer's recycling desire as opposed to advertising. That is, the right time for recycling an old phone is when someone is trying to obtain a new one, and the right place to offer conversion is where customers with such old-for-new intention gather.

To attract offline customers, AHS cautiously tested the unit economics of opening shops in different scenes, such as campuses, business districts, and community shops, before making its final decision—to largely deploy new shops in shopping malls. Shopping malls in China are centralized locations in a town that attract young people to shop, dine and entertain themselves, in upscale cinemas and hair salons, for example. In essence, a shopping mall is a lifestyle ensemble and a local social network. When people were enjoying their leisure time in the shopping mall, it was much easier and more natural for AHS employees to introduce customers to recycling services in exchange for money, credit, or a new phone. To open up such a large

Fig. 15.2 AHS recycling shops in shopping malls in China

number of self-run recycle shops in shopping malls was risky, but logically, it make sense. The shops (Fig. 15.2), decorated in a yellow theme color, were eye-catching both for shopping mall customers and destination customers diverted from JD.com and conveyed a vivid brand image.

AHS aimed to maximize the utilization of existing offline service facilities through an omni-channel approach, i.e., by diverting customers' recycling inquiries from all scenes to the closest AHS shops (Fig. 15.3). One of the largest sources of recycling orders was JD.com and its secondary exchange affiliate Paipai. AHS chose to work with JD.com after it had become the largest online retailer in the digital categories and displayed significant interest in introducing phone recycling and trade-in programs to stimulate new device consumption. In addition, AHS broadened its recycling business coverage, working with the official online malls of major phone brands, including Huawei, Samsung and Xiaomi, to launch customized recycling services. A third online recycling customer source was AHS's own transaction scenes, including the AHS website, its mobile application, and its official accounts on WeChat and

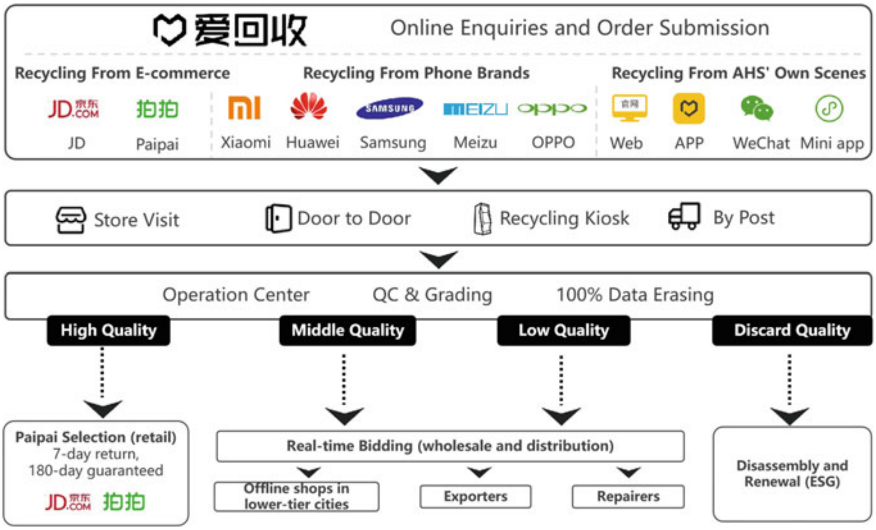

Fig. 15.3 How AHS operates self-run recycling businesses across scenes

miniapp (plug-ins on WeChat that enable AHS to run testing and recycling enquiries on WeChat).

For this retail-style recycling business, ICT applications enabled an evolutionary approach. For one, the application programming interface (API) facilitates the seamless coordination of online orders from the online e-commerce and official websites of smartphone brands with the offline shop network of AHS. Thus, all online recycling service queries can be answered in a timely fashion and delivered through AHS shops in major cities. Through the jointly developed API, AHS can use a standard toolkit to inquire and interact smoothly with JD's customers and recycle orders. Once the online order is placed, the system automatically asks for the location of the customer and guides the customer to the nearest AHS shop to receive services. The system also tracks the entire testing and service process at the storefront for customer review. The data accumulated through the system—after being processed with machine learning—results in a knowledge creation loop of precise demand recognition and a quick response to customer preferences.

In addition, the emergence of the internet of things (IoT) promises to support offline operations. IoT sensors can help digitize the physical retail space and generate data in real time. AHS independently developed an IoT-based system that monitors each shop's daily operations, enabling the service standard established by headquarters to be fully implemented by local AHS shopkeepers. Shopkeepers are conveniently equipped with visual dashboards on their tablets, which helps them find data report necessary for their shops and customized guidance on sales enhancement. When information and instruction are transmitted digitally with clarity and immediacy, the shop network can respond with confidence. Overall, this technology enriched the scalability of recycling services, thus enabling AHS to open more shops in China.

Another key factor for the self-run phase was securing the source of goods. The autoalarm function embedded in the monitoring system ensures that fraud or agent problems, such as bypassing orders, can be perceived and reported to headquarters, which ensures in turn that each shop operates efficiently. In essence, the monitoring system digitizes the physical space—the shop—making it "online visible" and data-driven instead of requiring hierarchical management and shop inspection. It is hard to imagine how the company could manage its shops and their nationwide coverage cost-efficiently and effectively without being able intelligently connect with and supervise them through this IoT-based system.

(2) **Phase 2**: **opening-up period—the birth of PJT Marketplace**

AHS became an established participant in China's phone recycle industry in 2017. That same year AHS further evolved a disruptive solution providing services to all members of the industry, including former competitors. This third-party transaction and supply chain platform was named Paijitang, or PJT Marketplace. The birth of PJT Marketplace marked a fundamental transition from a solely buy-and-sell approach to an intelligent open-to-all transaction infrastructure. PJT Marketplace was separated from the proprietary business as an online marketplace for sellers and buyers in the supply chain. Both sides pay a commission, normally ranging from 1 to 3%, for advanced testing, grading and distribution services.

In the early days of forming the network, PJT offered a free-admission policy that successfully reduced the entry barrier for participants interesting in trying the system and/or operating. In the further evolution of the network, individual information on both sides of a transaction was hidden, and only products that had been subjected to PJT grading were shown. In accordance with PJT Marketplace standards, all products that have been sold are mandatorily sent to centralized operation centers—there are 7 in Mainland China and Hong Kong—for testing, grading, and pricing before being placed on the virtual racks for bidding. A unified grading standard and unified processing capabilities ensure all interactions and transactions are completed online while enabling the platform to guarantee service quality. A small commission fee was charged to sustain system operation.

With its advanced testing and grading standards, PJT Marketplace reduces unnecessary transaction conflicts while enhancing trust on both the seller's and buyer's side. For sellers, with PJT Marketplace, they can have access to a large range of buyers globally rather than only a small number of local buyers. This wide access to buyers could significantly help sellers increase their attainable sales because the platform removes additional markup by dealers and distributors. Additionally, the flexibility feature of the platform—the minimum bidding cart can be 1 unit—enables competitive bidding for every stock holding unit. Notably, quality certificates issued by PJT Marketplace transform nonstandard recyclables into standardized secondary products in fixed grades. This approach significantly smoothens circulation. In fact, 95% of the products tested by PJT Marketplace are sold by bidding within three days—arguably the fastest turnover in the secondhand industry.

For buyers and exporters, with the help of PJT Marketplace, the procurement of goods can be better coordinated with their own sales dynamic because they can bid on customized items at any time of the day at fair prices. The products they successfully bid for will be shipped with guaranteed quality grades. In addition, buyers who purchase goods at PJT Marketplace enjoy the "cut-the-middlemen" benefit compared with their offline counterparts. With the help of the platform, purchasers can expand their sourcing networks through access to a wide range of products across China and beyond.

The transaction volume on PJT Marketplace (or the B2B business) has increased from a very small amount to more than 3 billion RMB in GMV in 2018, and the volume for 2019 was more than double that of 2018. The fast expansion and monetization of PJT Marketplace reveals that technology-enabled network collaboration is more scalable than traditional linear business. Motivated by self-interest, business actors have participated in the network and increased the overall prosperity of the platform. With its abundant information and transaction flow, the market-oriented network can to a certain extent "automatically" correct errors, and business actors can find an efficient path through the network.

(3) **Phase 3**: **aggregation period—the expansion of PJT Marketplace**

By 2019, PJT Marketplace was well recognized as a place for pricing and for trading. It enables personal and small companies to cooperate online to perform business activities more efficiently than any other organization can through vertical integration. Fed by large volume of data generated from real-time transactions, the pricing algorithm is becoming increasingly accurate and risk-averse, which also contributes to the margin stability of the self-run recycling business. PJT Marketplace was developed according to the needs of business actors. As the network aggregated and diversified, it began to expand into an ecosystem of comprehensive services in response to client needs—from introducing new transaction scenes to providing advanced functions and transaction tools.

A "servitization" trend has naturally emerged as management has sought to leverage the scale of and data accumulated on PJT Marketplace to achieve incremental improvement. As it grew in complexity, PJT modularized many of its functions into "service containers" to which small businesses could subscribe and to satisfy pay-as-you-go requirements. One important development was to thoroughly open PJT's grading standards and upgrade one service center into an automated service center for third-party business actors. The center's services include testing certificates, inventory management and sale on consignment. In addition, for those participants who perform well on PJT Marketplace but are unqualified for the loans required to expand their operations, the platform intends to offer lending services based on the creditworthiness of sellers and buyers, which has already been tested algorithmically according to their transaction records.

During the aggregation period, the company is employing disruptive measures to acquire new customers and business actors to further expand the network effect. Embedded with the state-of-the-art testing and pricing software, the company is introducing two new types of IoT device.

【An automatic recycling kiosk】

The first is an automatic recycling kiosk (Fig. 15.4) with patented diagnostics solutions. These kiosks can be placed in all types of shop to help third-party shopkeepers quickly launch their own trade-in services even if the shopkeeper knows little about recycling. The kiosk prices each individual's device based on model, condition and current market resale value. After automatically providing testing, pricing, recycling and credit payment, the kiosk temporarily stores the phones before they are shipped downstream for reexamination and distribution services provided by PJT Marketplace.

【DeviceHero: a portable testing gadget】

The second new IoT device is a portable testing instrument (Fig. 15.5) named "DeviceHero". Anyone can buy a DeviceHero at an affordable price and quickly use it without prior knowledge to detect major smartphone models. Thus, anyone—such as an owner of convenience store or a repairman—can start a small recycling business among his acquaintances at any location. Both new IoT devices help the platform build business relations directly with end users, which will enlarge the monetization base and increase data input to enable the transaction algorithm to become smarter.

Fig. 15.4 AHS-designed automatic recycling kiosk for the retail channels of phone brands

Fig. 15.5 DeviceHero: a portable testing instrument that enables everyone to recycle

Penetrating core transaction scenes is another key driver for enlarging service scope. Figure 15.6 depicts synergy creation between PJT Marketplace and Paipai. In mid-2019, AHS acquired Paipai—China's largest secondary B2C platform, a

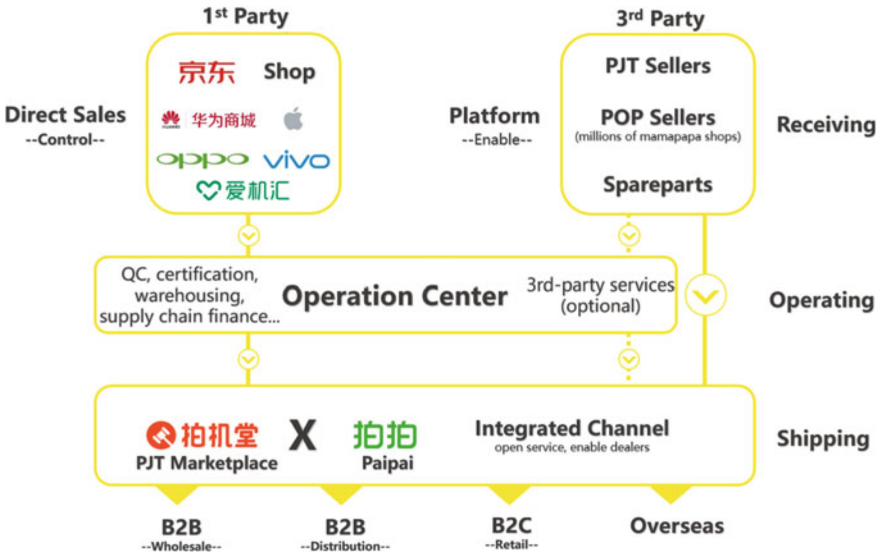

Fig. 15.6 Synergy creation between PJT Marketplace and Paipai

subsidiary brand of JD.com—and entered into a five-year exclusive partnership with JD.com. In this way, the selling and shipping platform acquired another important transaction scene for direct retail. Paipai is a third-party retail platform. The merger between the two platforms has motivated more retail business actors to participate, fostering closer coordination and the emergence of the innovative business model shown in the diagram. After testing by an AHS operation center, a storage pool fuels both PJT Marketplace (B2B) and Paipai (B2C) with a unified quality control and coordinated selling network, enabling business actors to independently choose faster turnover through B2B or higher margin through B2C.

15.3 Background of Forming a Networked Business

(1) Background of networked coordination

AHS was founded with a mission to not only become China's largest recycler but also to reduce waste by prolonging the use of electronics products while extending global circulation to locations where devices are in short supply. To achieve its mission, the company must become impactful and defensible to the maximum extent. In recent years, the network effect emerged as a strong defense for vertical technological companies. In a typical two-sided service network, one additional user slightly enhances the service network for the other users. This phenomenon can continue aggregating, similar to a rolling snowball. Once one service network takes the lead and begins to self-reinforce, its smaller competitors find it substantially harder to narrow the gap.

One paradigm that has guided AHS's transition is the S-shaped growth curve, as described by Handy (2016). The S-curve reflects that every company has a life cycle. A company is an organization of internal resource management and external coordination. To produce products and services that meet the requirements of the target market, the orchestration of production resources occasionally requires adjustment. Handy closely examined companies that enjoyed long-term success and found that these companies did not just continue to climb the current growth curve although their core businesses were still growing. For managers, the problem that must be recognized is that determined steps towards change must be initiated while the first curve remains underway. Continuous investment in new techniques and new services is equally if not more important than the optimization of the existing successful business. Reinventing the business model and organizational form can help a company find new niche markets that offer rapid expansion and far fewer competitors. At the same time, history and tradition can be confining as well as assets. Because every growth curve peaks at a certain point and then starts to decline, it could be dangerous if a company becomes complacent and refuses to innovate and change. An eventual decline is inevitable. The secret to continued growth is to initiate and invest in the second curve before the first one peaks, while the company still possesses abundant resources, including money, time, energy and buffer, to withstand the temporary nosedive that will occur during the early investment period of the second S-curve.

(2) **AHS's successful approach**

This section explains why AHS adopted an approach different from that of other recyclers in 2017, when its recycling business increased at a high double-digit rate and recorded a five-year high. Remarkable changes, including the launch of PJT Marketplace at the year's end and the fundamental transition from a buy-and-sell model to an open platform, were implemented after in-depth management discussion. Although the self-run recycling shop business in major shopping malls had achieved a satisfying performance with respect to revenue and this success encouraged the firm to continue with the status quo, the management perceptively realized that in the years to come the number of self-run shops could reach saturation level, particularly in large cities, such as Shanghai and Beijing. Although the ceiling for the domestic recycling market was far from reach, the growth speed was largely determined by the annual number of newly open shops. Thus, the magnitude of AHS's self-run services was largely restricted by shop location. To sustain a healthy same-store growth economics, the number of shops must increase modestly in a linear fashion.

Meanwhile, the penetration rate of secondary digital service recycling remained low. A larger addressable market existed offline in lower-tier cities across China. The recycling market is fully dispersed, and the customer's need for recycling is difficult to efficiently cover through self-run shops because of management ineffectiveness and diminishing return on initial investment. The status of an earlier business formation, 1688.com—an online yellow pages website for procurement needs within the Alibaba business ecosystem—implied that even a giant company cannot take full control of all of the "capillary vessels" of business activity, as Zeng (2018) argued, and Alibaba was initially forced to rely on network coordination since it lacked the time, skills, and investment resources to create the required capabilities in-house. Chinese companies are better positioned to take advantage of network coordination, combining business actors seamlessly across the internet versus building up independently.

Although giant networks, such as Taobao and WeChat, had already become unshakable in China, fortunately, PJT Marketplace was established in an era when the "industrial internet" was still new. Most Chinese industries—including secondhand electronics—have very weak infrastructure with no dominant firms, and there is room to reconstruct an entire industry with the help of ICT and AI. In contrast, companies in the United States and Japan have generally already integrated the value chain as a result of advanced management and knowledge creation. However, in China, a business venture can expand its service coverage by using small businesses as agents to reach end customers. With improving operation efficiency and client satisfaction, a networked platform can further enable new participants to enter and start their own recycling businesses providing modularized services. It has been observed that for reasons of efficiency sellers have felt it necessary to move more offline business features online to better coordinate and optimize business activity, although many of these sellers are inexperienced with doing business online. Eventually, a networked platform can generate profit through this incremental value creation.

15.4 Development of the PJT Service Offering Platform and Its Role in the Networked Recycling Business

15.4.1 PJT Service Offering Platform

(1) **Outline of complete system**

The PJT service offering platform (Fig. 15.7) was generally evolved from the AHS self-run recycling business because the self-run businesses had established testing and circulation benchmarks referred to by other business actors and because the testing redundancy of the self-run businesses needed to be utilized. This approach resulted in the complete opening of AHS's backend capability to form a service offering platform. The PJT service offering platform basically consists of two independent but seamlessly coordinated systems. One is an online transaction platform (PJT Marketplace) developed and operated by AHS that focuses on creating network coordination between business actors while using data generated from real-time transactions among those business actors to optimize the PJT grading standards and pricing matrix. The other is offline automated operation centers that focus on cost-efficiency in the device testing process and economies of scale. The online marketplace and the offline operation centers represent the two cornerstones of the smart B2B commerce business.

(2) **Process of developing the PJT service offering platform**

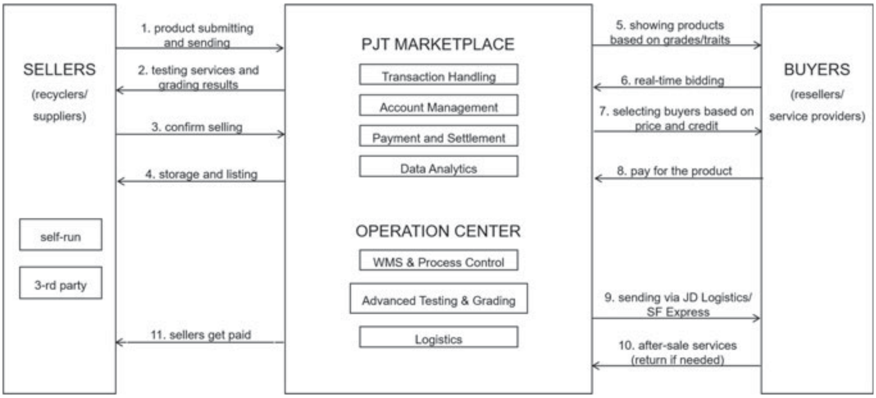

Fig. 15.7 PJT service offering platform and transaction process

The networked business platform was not planned meticulously but grew in the manner of a gradual evolution. Indeed, AHS initiated the formation of such exchange platform, but more importantly—at the early stage, AHS-certified products recycled from self-run shops attracted a critical group of professional buyers, and those buyers made the quick start of a two-sided platform possible. PJT Marketplace also inherited the AHS quality inspection process and upgraded it into 36-grade quality certification standard. This development has lowered the transaction cost across the entire industry to an acceptable level. That is to say, objectively, AHS's proprietary business acted as a medium through which suppliers and purchasers could find one another. The trust generated by AHS's standardization and quality assurance attracted more buyers to procure products from AHS instead of sourcing in the local market. With more interested buyers, certain resellers along the value chain asked AHS if they could send products to AHS for testing and consignment sale. This practice became the prototype of a centralized collaboration network. Leveraging the access to those buyers, the company began to extract value from upstream third-party suppliers. Suppliers competed to make their products more attractive with respect to platform rules regarding larger shipments and faster turnover. This development improved the quality of and access to supply, while buyers competed against one another to bid for the products.

It is worth highlighting how effective linkages between participants were found and strengthened in the forming of the network. Traditionally, in online search engines or yellow pages, the network relied on a wide spread of information and each individual's own value discovery, which was highly time-consuming and invited a large number of spammers. There was no unified standard system or intermatching mechanism. Users had to rely on a peer-to-peer relationship or use a recognized agent for endorsement.

A platform business requires three pillars for smooth circulation to occur and aggregate: digitization, standardization, and AI.

【Digitization】 The first stage in developing an online trading platform is to digitize the traditional network and its components, including nodes (i.e., participants, such as consumers, things, decks, sellers, buyers) and links (i.e., connections and potential sales leads among nodes). Consumer internet applications, such as WhatsApp or WeChat, digitize their participants and serve as a communication tool. However, such applications are highly inadequate for small businesses that wish to operate their entire business online, including management of the trading, logistics and receivables process. A genuine digitization of the transaction process can lower the entry barrier and thus bring a large number of marginal nodes (i.e., small businesses) online, such as recyclers and local resellers, while creating equal opportunities for them to do business. Tools and mechanisms provided by PJT Platform also address challenges facing sellers desiring to build their online businesses completely from scratch. For the first time, these groups can gain full access to other business participants. Digitization also provides more information and interaction, which means increased closeness and durability as well as enhanced business activities among participants.

【**Standardization**】 After digitization, the second stage is to standardize the circulation pathway and the transaction rules for all participants. Participants who fail to observe such rules are punished according to platform standards. A set of unified transaction standards gradually replaces manual checking, experience-based grading, and disputes regarding quality. Standardization enhances multisided trust on the platform with commonly recognized and predicable product and service offerings, i.e., commodities. For example, in PJT Marketplace's transaction rules, based on brand, in-use time, exterior condition, interior functions, and downstream market demand, millions of stock keeping units (SKUs) in all categories of digital device are categorized into 36 levels and sent for bidding. This advanced grading system will be further subdivided into a range of more narrowly defined levels to guarantee testing objectiveness for each product. Overall, the standardization method helps eliminate information asymmetry and fraud in bidding and delivery by spurring participants to do business in an honest and trustworthy way.

【**Artificial Intelligence** 】 The third stage is the application of artificial intelligence through recasting the standardization and interactive business activities in the form of algorithms and robotization, which creates a virtuous loop of self-optimization and thus greatly enhances working efficiency. As is well known regarding algorithms, data generated from real-time processes represent a new means of production and can adjust the production process itself. As transaction volume on PJT Marketplace increases, data from recycling, testing, circulation and consumption activities accumulate and are subjected to AI analytics. The operation automation is achieved through machine-learning algorithms that enhance coordination and benefit each link in the value chain. For example, frontline innovation by recyclers and resellers in response to client procurement needs is quickly captured in the deal flow. Based on digital trends and error flags, AHS programmers can correspondingly adjust functionalities and apply usable add-ons to facilitate new market-driven initiatives. In addition, more data input into the algorithm makes the system smarter, enabling it to offer a specialized dashboard for active participants. AI also reads customer reviews algorithmically and provides recommendations for suppliers. In fact, the PJT Marketplace functions as a competent business assistant for recyclers and resellers to achieve better inventory management and enable them to seize the right business opportunity.

With respect to robotization, AHS has solidified its accumulated knowledge in platform services and grading methods in the form of a large-scaled operation center in Changzhou, Jiangsu Province, and this operation center is equipped with AHS-developed automated facilities (Fig. 15.8). Traditionally, it is feasible for a reseller to inspect all products if their numbers are limited to tens or hundreds per day. However, this approach no longer functions for a networked platform because of the scalability. AHS was the first to introduce the testing and grading work flow in the form of assembly line. Each worker was in charge of a specific part, which could create a certain degree of knowledge accumulation. In fact, this industrialized process was limited by its weak linkage with the online transaction data flow. In addition, it was inadequate to increase testing capability in a nonlinear manner. After two years of research and experiment, a robotic testing model was proven effective by virtue

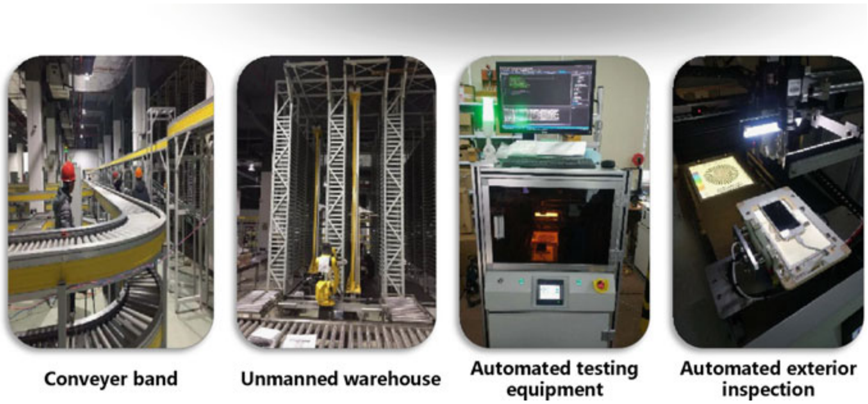

Fig. 15.8 Automated facilities in the AHS Changzhou operation center

of its scalability and accuracy in handling SKU management and high productivity without stopping. The company is confident it can upgrade the testing and grading method to an advanced level and is introducing a construction scheme to upgrade all other operation centers in the following years.

15.4.2 Networked Business with PJT Service Offering Platform

(1) **Operation process of networked transaction**

A typical transaction on PJT starts as all business actors with their own inventory are welcomed to list products on the PJT online marketplace for bidding after the products are shipped to and tested in operation centers. A small fee is collected for the information matchmaking and supply chain services, including reverse logistics, testing, grading, pricing and distribution. Let us take a closer look through an example. A telecom shop in rural China is often ignored by headquarters in Shenzhen and lacks a new product supply. In response, the shopkeeper determines to sell secondary premiums at the same time as new products. In fact, the number of such small businesses is in the millions in China. The shopkeeper registers on PJT Platform as a buyer and quickly finds an abundant stock of iPhone X ranging from a very low price to $900 according to respective conditions and testing results. Based on customer preferences, the shopkeeper chooses a device certified Class A-3 and bids $500 for it, eventually winning the bidding. The specific product had been sent from a third-party reseller to the AHS operation center, and the device was tested one to three days before the online auction. Once the bidding closes, the product is collected from the storage rack by a rail-guided vehicle and then handled by a robot arm before packaging and shipping to the shopkeeper.

When a deal is completed, AHS normally charges the supplier a commission of 3% and the buyer a commission of 2% for the described data matching and supply chain services. The company does not include the total funds paid by consumers for marketplace purchases in its reported revenue. Rather, it reports the revenue from the value-added services it provides to both sides. In the example, the total commission for the $500 iPhone was $25. The total value of products sold—both from AHS's self-run recycling business and from third-party vendors—is termed the platformed gross marketplace value. This marketplace model enables AHS to handle transactions multiple times as indicated by the share of the market it reports as revenue.

Such online auctions are held in many sessions daily, generating annual processing and shipment of more than 10 million units to shopkeepers and customers in need of electronics products. It is not necessary for participants to sign supplier agreements or procurement contracts in ink. All processes are performed digitally online and monitored under an AI risk-control system. Thanks to full digitization, one can quickly add a new model for sale on the platform without adding new internal structure or convening meetings and initiating processes on the e-commerce and logistics platform.

(2) **Fundamental differences between the new business network and previous offline transactions**

Three factors underlie the new business network, making it a transformative model compared with the traditional handshake way of doing business, which used to be commonplace in the secondary circulation industry. The traditional linear business model has not disappeared but is slowly losing importance. This new competitor is not another recycling company. Rather, it is a means to satisfy the same needs in a very different way, and it avoids marketing campaigns and the need for bricks-and-mortar shops, making them irrelevant.

The first difference is that for the networked business, strategy is focused on reinforcing coordination instead of winning competitions. AHS increased its backend supply chain capabilities to serve the needs of all industry participants, not only as a supplement to AHS's business scope or for cost-effectiveness purposes but also to emphasize a change in competitive strategy. For the foreseeable future, direct competition between recyclers and resellers could be fierce, forcing each of them to cope with marketing and price variations, which could severely limit AHS's business strategy. To obtain an advantageous position, the company positioned itself as an aggregator in creating the infrastructure of the secondary market. Here, "infrastructure" refers to a portfolio of tools and mechanisms that undergirds an efficient business network, such as a customized sourcing function, real-time bidding, a pricing engine for reference, credibility remarks from vendors and supply chain financing. Infrastructure comprises basic services required by nearly every participant in the platform's work environment and to build such an infrastructure often requires a significant amount of investment.

Networks are interconnected systems of participants and products or services. Although motivated by self-interest, participants who leverage the infrastructure objectively enhance coordination and strengthen the network effect. Once the infrastructure has achieved an initial number of end users, suppliers will participate in the infrastructure on the aggregator's terms—in this case PJT Marketplace's grading standards and trading rules—and effectively commoditize their supply. These additional suppliers then make the infrastructure more attractive by increasing the number of offers users have to choose from, which in turn attracts more suppliers in a virtuous cycle. For the established infrastructure, customer acquisition cost decreases over time.

The second difference is that the networked business focuses on the efficiency improvement of the entire industry rather than seeking the aggregator's own short-term gain in operating profits. As a centralized exchange platform, PJT Marketplace unbundles business activities from the traditional linear supply chain and brings business actors into a multisided collaboration network. It omits unnecessary middlemen, shortens the trading chain and reduces the number of times a product changes hands among resellers, therefore facilitating delivery efficiency. Traditionally, from the seller's perspective, the fast growing market share of new phones hastens the obsolescence of older ones, which encourages a larger group of small recyclers with no access to large groups of buyers. Those who lack sufficient market access were exploited by layers of middlemen. Making matters worse, there were very few reliable price indicators for sellers. In the past, an "advanced" price benchmark was nothing more sophisticated than a spreadsheet with iPhone reselling prices from the previous month in the Shenzhen distribution market. As a result, recyclers would only dare diagnose and recycle a small number of popular models based on their experience and their estimate regarding the selling price. Simultaneously, the buyers typically operated a bricks-and-mortar retail business and relied on location and known resellers or distributors for procurement. These buyers and exporters also wanted access to a large selection of products rather than a small number of choices with unfair prices from the local device market.

15.5 Analysis of Business Innovation and Its Impact on the Industry and Society

In the context of the industrial internet, an ICT-based business network and intelligent system can rebuild the connectivity and increase the efficiency of any industry—even in the little noted smartphone recycling sector. We analyze the direction of networked business innovation with new ICT in the industrial internet through answering the following five questions.

(1) **What human desires and issues in human society or business are the objectives of ICT utilization?**

To omit unnecessary middlemen and gain full access to a broad market are common desires for all types of business actor. Since middlemen, such as redundant resellers, hinder the information flow and make their profit through this opacity, pricing and transactions are far from being efficient. Leveraging the industrial internet based on the ICT revolution, small businesses can break the linear value chain and share business opportunities in the network. This market-oriented exchange behavior gradually nurtures precedents and provides guidance valued by sellers seeking faster turnover and buyers who want to procure products in a cost-effective and timely manner.

(2) **What technologies and functions are utilized to solve issues or realize human desires?**

【Digital transformation of business actors and products】 When AHS expanded its business, digital transformation that included computerized visual recognition capacity enabled offline customer behavior to be recognizable. Such data could be analyzed to help optimize the company's storefront services, facilitating nationwide store coverage and effective store management. PJT Marketplace also draws offline transaction behavior online and makes the entire process trackable. With automated facilities in backend operation centers, the testing and digitization process transforms irregular products into a standardized commodity. Digitization and online operation enable business actors and their interactions to be observed, and their behavior can be anticipated with the help of machine intelligence.

【AI enhances transaction efficiency】 Based on data accumulated offline and on the platform, the company uses artificial intelligence to find an exact real-time price benchmark and make product suggestions based on learning regarding client preferences, which significantly reduces mismatch and transaction friction. AI also plays a crucial role in detecting fraud behavior and helps reduce financial losses. The complexity of the platform increasingly exceeds the limits of human management capabilities, and it is hard to make correct corresponding decisions based on prior knowledge. On PJT Platform, data scientists are developing to find unnoted relevance among dispersed orders so that they can transform temporary requirements into constant service suites.

(3) **What are the value creation methodologies?**

The path choice of the company—whether to stick to the self-run shops approach or exclusively opt for the service offering network—should center on client needs, the development of client needs, and what value the company can create to better realize client values. Competition with peers is one way to win the customer in the short term. However, a company like AHS must go further to form a marketplace and related facilities if it is to solve the fundamental trust problem. This method has substantially enhanced the network of industry coordination. The core company leverages the power of the market and orchestrates the service for end clients while choosing to sacrifice short-term profits to create future markets.

Similar to other industries, the AHS case exemplifies that a leading manufacturing or retail company can at least bring the servitization strategy into discussion. That is, can the company meet all client needs through vertical integration (i.e., do it all independently)? If not, it is wise to discuss whether opening access to best practices and existing facilities as a service offering can make other business nodes more capable. Through enabling other nodes, smaller business actors are no longer required to provide the duplicated backend structure, such as server procurement, storage and logistics management, testing and maintenance, and the leading company can leverage the scale of other business actors for its own economic benefit, creating a win-win situation.

(4) **What is the relationship between human/business activities and the ICT system, and what are the relationships among users, ICT providers, and other stakeholders?**

Internet-enabled marketplaces and their respective core operation companies share an unconventional value compared with the hierarchical management method: they emphasize a flat organizational structure and occasional flexible adjustment. This perspective embraces change and the iteration method, which is a continuous improvement context and dynamic with respect to the workforce, rather than believing that top management can control and guide everything properly.

The service offering platform externalizes such internet company organization, encouraging a free-flowing network of interconnected business actors to perform business transactions based on their own economic motivations. The goal of the platform is to establish initial principles and contentedly accept the decentralization trend, and AHS headquarters does not claim to possess all the answers with respect to guiding the course of the platform. In a decentralized business network, small businesses and even individuals can do business to earn extra income via the service AHS and other leading companies offer instead of being hindered by the size of large institutions and being forced to perform procurement via inefficient channels. We are observing a rapid increase in new and supplementary needs as well as new job creation via service platforms.

(5) **How has human life, business, or society changed in terms of innovation, revolution of business models, creation of new eco-systems, and changes in human life?**

【Trust enhancement】 In the AHS case, on the one hand, for all business actors in the value chain, the networked platform aggregates dispersed supply and demand and facilitates transactions according to certain standards so that the company can be viewed as trustworthy by unfamiliar participants. On the other hand, the mass of consumers can confidently buy pre-owned products after understanding the data-cleaning standard and transparent circulation process.

【Connectivity matters】 Thanks to the networked industrial internet platform, unfamiliar business actors can collaborate on a massive scale. The platform business model reconstructs the interrelation of nodes and makes connectivity essential. Connectivity includes the point of contact not just between a company and its client but also the company's relation with its suppliers and selling channels and even the relation between a company and the client of its client. In addition, the rapid expansion of networked business encourages the value cocreation mechanism, which requires a socialized division of labor and cooperation. Pure-play companies are likely to be marginalized if they refuse to initiate connection with the network.

15.6 Conclusion

To sum up, the transition of Aihuishou company from a linear recycling business to an exchange platform indicates that it is feasible to leverage the digitization of participants in an existing value chain, to provide networked coordination, to introduce standardization in previously self-run operations, and to adopt a data-driven methodology to collectively make a platform business scalable. A successful platform also creates positive externalities for businesses and the service providers who participate in it. Aihuishou has found a means to secure an advantageous position in the value chain and makes a profit largely by enabling others to provide certified products and coordinated solutions.

References

Currier J (2018) Network effects Bible. https://www.nfx.com/post/network-effects-bible/

Foster RN (1988) Innovation: the attacker's advantage, Summit books

Guo Q, Li Z, Nie J (2019) Strategic analysis of the online recycler's reselling channel selection: agency or self-run. Sustainability 12(1):78. https://doi.org/10.3390/su12010078

Handy C (2016) The second curve: thoughts on reinventing society. Random House

Rui O, Yu F (2018) Aihuishou: balancing social responsibility & corporate success. CEIBS case. https://www.ceibs.edu/alumni-magazine/aihuishou-balancing-social-responsibility-corporate-success

Thompson B (2015) Aggregation theory. https://stratechery.com/2015/aggregation-theory/

Wang F (2020) Smart E-commerce shakes the mult-billion new market of phone recycling. http://www.xinhuanet.com/fortune/2020-01/23/c_1125495660.htm

Zeng M (2018) Smart business: what Alibaba's success reveals about the future of strategy. Harvard Business Press

Zhu X, Li W (2020) Research on the pricing strategy of "Internet +" recycling platforms in a two-sided network environment. Sustainability 12(3):1001. https://doi.org/10.3390/su12031001

Chapter 16
Local Social Innovation by Blockchain Technology: A Trial in a Provincial City in Japan

Kunio Shirahada, Hiroki Oyama, and Tatsuya Ohsaki

Abstract This chapter describes the social application of blockchain technology with the aim of discussing how the concept and technology of blockchain can contribute to changing society. The safe recording system enabled by blockchain is valuable as a basis of supporting improvements in society. This recording system is expected to be combined with the visualisation of people's activities by Internet of Things (IoT) devices and appropriate service design, thereby achieving social innovation to solve many social issues. After explaining the technical mechanism of blockchain, this chapter describes examples of applying blockchain in industry and local communities as well as a trial using a blockchain developed for solving local social issues in an aging society. As a discussion, we propose the way of alleviating social issues by using blockchain as a "social blockchain design", which consist of (i) system analysis including analysis of the stakeholders and their relationships, (ii) IoT design to accurately digitalise human activities that are relevant to solve social issues, and (iii) service design to appropriately utilise cryptocurrencies as valuable resources generated from the data of digitalised activities.

16.1 Introduction

This chapter describes the social application of blockchain technology. Nowadays, many people are familiar with the word "blockchain" as the basic technology of cryptocurrencies such as bitcoin. Whenever people hear news about cryptocurrencies fluctuating, they may think that blockchain is only for investors with a high tolerance for risk. However, the safe recording system enabled by blockchain is potentially valuable as a basis of supporting improvements in society. This recording system is expected to be combined with the visualisation of people's activities by Internet of Things (IoT) devices and appropriate service design, thereby achieving social innovation to solve many social issues.

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The purpose of this chapter is to discuss how the concept and technology of blockchain can contribute to changing society. To begin with, we explain the technical mechanism of blockchain. The subsequent sections describe examples of applying blockchain in industry and local communities. Afterwards, we will describe a trial using a blockchain developed for solving local social issues in an aging society. Based on the examples, this chapter examines how blockchain can contribute to social innovation in local communities through the five questions that are shared throughout this book.

16.2 What Is Blockchain?

According to the Japan Blockchain Association (Japan Blockchain Association 2020), blockchain means "*a technology with a data structure which can easily detect manipulation using digital signatures and hash pointers, and where the data has high availability and integrity due to distribution across multiple nodes on a network*." The digital signature proves that the transaction was made by the person who wants to transact, and the hash pointer indicates that the current state of the blockchain is "true". The mechanism of public key encryption and cryptographic technology called a hash function are included in the digital signature and hash pointer, respectively, while the consensus algorithm including Proof of Work is included in the operation.

Figure 16.1 shows a bitcoin transfer mechanism using blockchain technology (Orcutt 2018). Suppose, Person A wants to send bitcoin to Person B. The transaction information with the electronic signature of Person A is encrypted. This verifies that

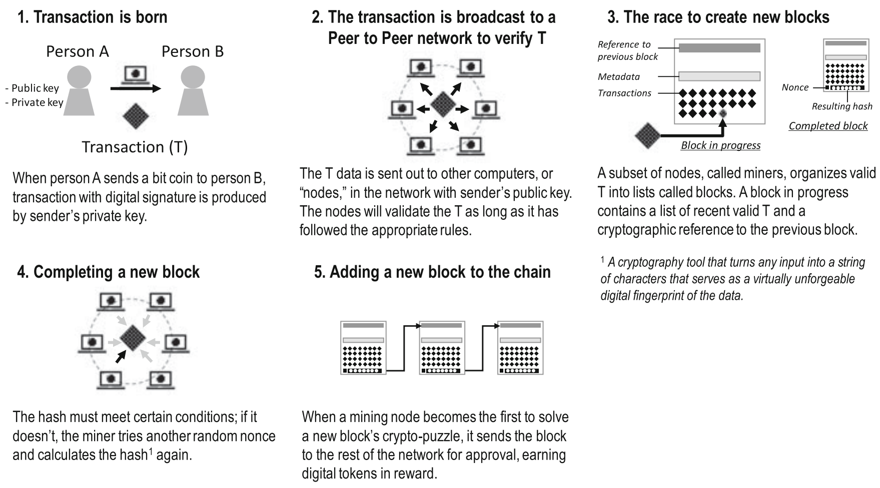

Fig. 16.1 Bitcoin transfer mechanism (based on (Orcutt 2018))

the sender (Person A) is indeed authorised to make the transaction. Encrypted transaction information is shared by specified/unspecified computers (called "nodes") on the Internet. Then, legitimate transactions are entered into a clumped data structure called "blocks".

A block contains the information of the previous block, metadata, and transaction information encrypted by a hash function in 16 numbers. This is called a hash value. When the value has a fixed number of leading zeros, a block is closed. The value used for substitution is called a "nonce" (number only used once). This prevents transaction fraud such as double transfers. This is because, even if Person A inputs transaction information in which he/she transfers more than his/her balance to multiple people, there is no consistency with the data of past blocks (Peryaudo 2020).

Here, in the hash function, the output value is the same for a certain input value, but the output value is completely different when the input value is slightly different, so the output and input values are difficult to predict. For example, with the SHA -224 hash function, entering "kunios" results in "3207AC050E3E2C585DA89634B589C9C619B 522656BF0837400D9C570", whereas entering "Kunios" results in "91C31604F0219655CD68 DEAF42ABCD1DAB84FC7A2683A3F43B0FCDBC", indicating that the value changes completely just by capitalising one letter.

The task of finding the nonce is called mining, and there is a consensus algorithm in which the miners have to calculate the hash to meet a narrow criterion (e.g. Proof of Work) mentioned earlier and find the nonce in order to add a new block. Those who do the mining participate in this work because they are rewarded for finding a nonce.

This technical mechanism is also recognised as a distributed ledger system. Orcutt (2018) describes blockchain as "a public, permanent, append-only distributed ledger." The management of the records is not centralised, but specific or innumerable individuals manage the records jointly. The authenticity of the transaction can be proven, because falsification is made infinitely difficult by the disclosure of the record and the existence of the consensus algorithm, even if there is no clear record manager. In addition, this has the advantages that the operation cost is low and the system does not go down easily (Noguchi 2017).

The blockchain systems are classified into public blockchains, in which unlimited participants can participate, and permissioned blockchains, in which limited participants can participate. At present, many financial institutions are considering the use of permissioned blockchain (Gartner 2019) (Fig. 16.2). Permissioned blockchains are further subdivided into consortium blockchains, in which multiple particular participants can participate, and private blockchains, in which only one participant can participate.

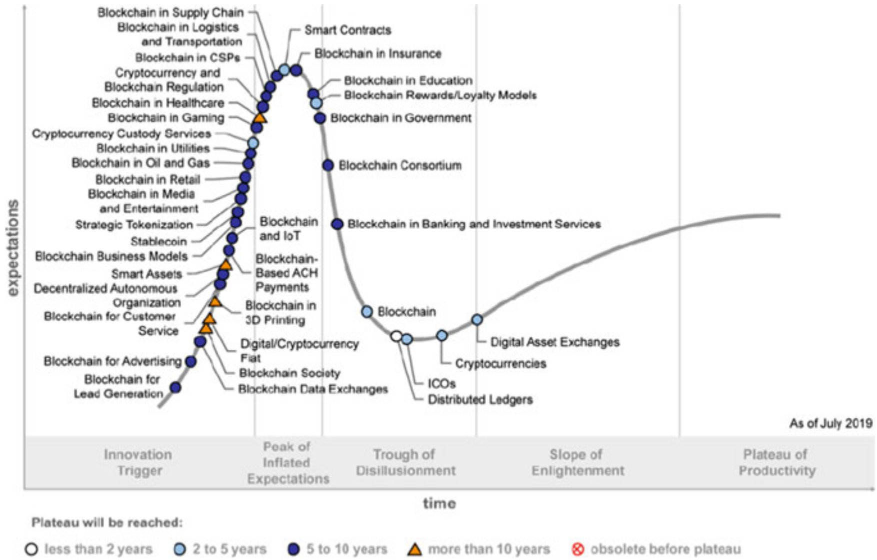

Fig. 16.2 Gartner's Hype Cycle for blockchain business, 2019 (Gartner 2019)

16.3 Blockchain Application in Industrial Digitalisation

The distributed recording system based on the blockchain concept is expected to bring innovation to the money transfer system and become an innovative basic technology. It can be used for certification of identity, registration by public institutions, election systems, tracking of product history, and management of personal data such as medical data, learning data, and qualification data.

In addition, there is a system called a smart contract in which a contract is defined in advance on the blockchain and is automatically executed when a specific condition is satisfied. By combining blockchain and smart contract, various intermediate business processes (such as inventory control and ordering of equipment) done manually up to now can be automated, leading to improved efficiency.

According to Liao (2017), blockchain has also been applied to trade finance (financing and providing credit for smooth import and export), and the first international trade involving blockchain took place in October 2016. Briggan Cotton has partnered with Wells Fargo and Commonwealth Bank of Australia to use blockchains to send cotton from Texas to China, and they have used smart contracts to settle and track Texas-to-China exports. IBM formed an international trade platform called TradeLens in cooperation with Maersk, a major Danish transport and logistics company, to digitally and safely manage various documents generated in the process of international physical distribution as well as to improve Maersk's efficiency on the basis of IBM's permissioned blockchain (TradeLens 2019).

Here is an overview of the industry's expectations for blockchain in 2019. In Gartner's Hype Cycle (Gartner 2019), blockchain technology is already in the "Trough of Disillusionment", and people know to some extent what blockchain is and is not effective for in business and society. Expectations for the use of blockchain in insurance, education, and government have also peaked and will take about 5–10 years to plateau.

On the other hand, blockchains have just started to be used in oil, gas, and utilities, and decentralised automatic structures have started to be formed by combining smart contracts. This means that blockchain applications are beginning to be expected in a wide range of areas, from retail, entertainment, and customer service to sales engineering, such as creating solutions to show potential customers.

According to a report from McKinsey in 2019 (Higginson et al. 2019), many blockchain projects are still in the idea stage, with no noticeable output under development. The report pointed out three areas where blockchain is worthwhile in practice:

(1) Niche applications: There are specific use cases for which blockchain is particularly well-suited. They include elements of data integration for tracking asset ownership and asset status. Examples are found in insurance, supply chains, and capital markets, in which distributed ledgers can tackle pain points including inefficiency, process opacity, and fraud.
(2) The value of modernisation: Blockchain appeals to industries that are strategically oriented toward modernisation. In particular, global shipping contracts, trade finance, and payments applications have received renewed attention under the blockchain banner. In many cases blockchain technology is a small part of the solution and may not involve a true distributed ledger.
(3) Reputation Value: A growing number of companies are pursuing blockchain pilots for reputational value; demonstrating to shareholders and competitors their ability to innovate, but with little or no intention of creating a commercial-scale application. Arguably blockchains focused on customer loyalty, IoT networking, and voting fall into this category. In this context, claims of being "blockchain enabled" sound hollow (Higginson et al. 2019, p. 44).

Thus, although there are various expectations for blockchain applications, their actual use is limited in industry.

16.4 Blockchain Applications in Society

The previous section described how blockchain is being applied to supply chains and other specific business areas. What about using blockchain in wider society? Local currencies are now encrypted and traded digitally in various regions. In this section, we introduce related cases in Japan and the UK.

16.4.1 HullCoin in UK

HullCoin is the world's first local cryptocurrency, created by Kaini Industries in April 2016 in the English city of Kingston upon Hull, commonly called Hull (Kaini Industries 2016). In 2014, Hull was struggling with economic stagnation and high poverty. In an attempt to alleviate these problems, a local currency was considered as a way to promote behaviour benefiting the local community. Dave Shepherdson, a financial inclusion officer, and Lisa Boville, head of welfare rights, left the city government and formed Kaini Industries to digitalise the local currency.

HullCoin is a digital cryptocurrency that can be acquired by doing good deeds, such as reading books to children, running club activities for young people, and organising events for pensioners (ex. The Fintech Times 2017). Sheperdson told the Financial Times that HullCoins are like a corporate loyalty card but for community loyalty (Bird 2017). A history of good works is recorded along with a time stamp, so that job-seekers can use it as a social curriculum vitae (Bird 2017).

As of 2017, HullCoin had been tested with 800 volunteer users and 140 retailers were offering discounts. Figure 16.3 shows the system of HullCoin (Sylvester-Bradley 2018). Coin owners receive discounts from local merchants on their smartphone apps. If you scan a store's QR code on your smartphone, you can get a discount of about 10–50% in exchange for coins. Though the member store bears the source of the discount and the transaction cost, it can access the user base through the application and utilise the application to attract customers with advertisements and sales promotions (Shimizu and Mochiji 2018). Unlike, normal discounts, which may risk damaging a company's brand, discounts with HullCoin enable companies

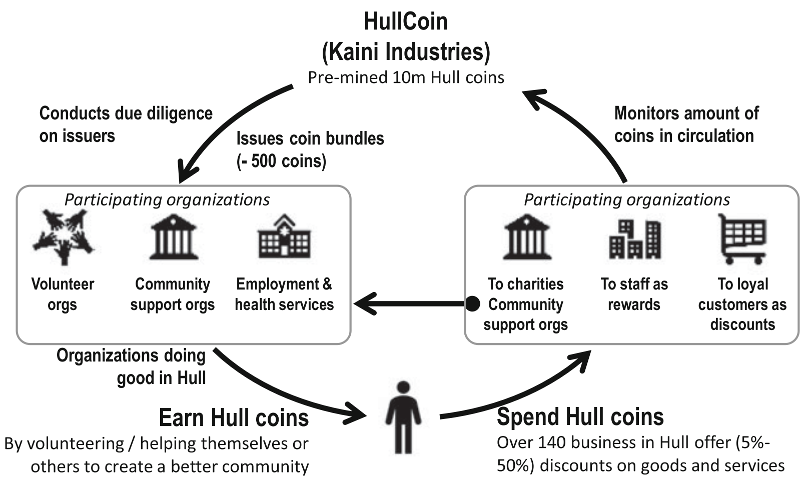

Fig. 16.3 The system of HullCoin (based on Sylvester-Bradley (2018))

to engage in corporate social responsibility by supporting community-based volunteering. Even if the companies cannot afford to pay volunteers, HullCoin allows them to easily reward volunteers..

16.4.2 Sarubobo Coin in Japan

Hida City in Gifu Prefecture, Japan, started a related experiment in blockchain based local currency called Sarubobo Coin in 2017, and the practical use of Sarubobo Coin officially started at the end of the same year. The issuer is Hida Credit Union, making it the first financial institution to issue an electronic regional currency in Japan. Figure 16.4 shows the structure of the basic stakeholders involved in Sarubobo Coin (Hida Credit Union 2019). One Surubobo Coin is equivalent to ¥1, and 1% points are given as a reward when charging. If you scan the QR code on your smartphone, you can use Sarubobo Coin for payment. There is no need for a dedicated terminal, and the commission for cash exchange by member stores is set at 1.5%, which is cheaper than for credit cards. Sarubobo Coin can also be used in inter-company transactions of local stores, which means the coin has a distributive property. The service charges only 0.5% for transfer between franchisees using Sarubobo Coin, making it possible to use the service for less than the usual fee.

The 1% reward given to the user is all borne by Hida Credit Union, which earns money only on the commission for cashing and money transfers. According to the company, Sarubobo Coins are expected to improve the circulation of money in the local economy as much as possible. In the long run, Sarubobo Coins can be expected to help increase deposits and lending (Yoneyama 2018). The number of affiliated stores has been increasing year by year. Since the autumn of 2018, Hida Credit Union has enabled Alibaba's smartphone payment service Alipay to also be used on the Sarubobo Coin payment system in order to increase Chinese tourism to Gifu

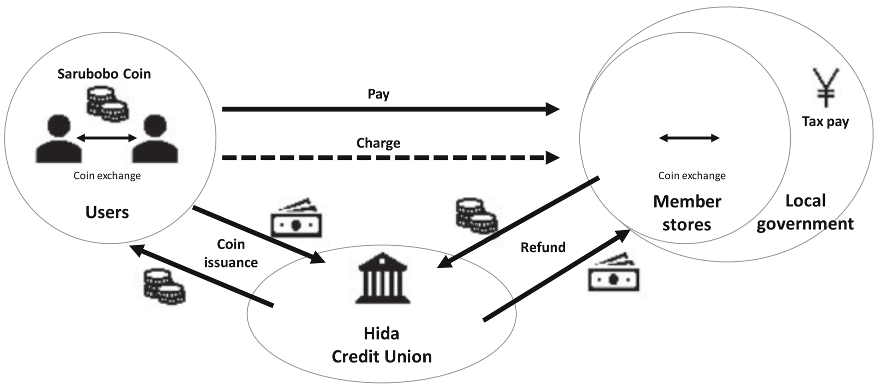

Fig. 16.4 Sarubobo Coin structure (based on Hida Credit Union (2019))

Prefecture and revitalise the local economy (Nikkei 2018). Furthermore, Sarubobo Coin can now be used to pay city taxes (Hida Credit Union 2019).

Since Hida Credit Union is a financial institution, it has insufficient knowledge on digital information technology (IT). Therefore, they needed to work with IT companies. Hida Credit Union has been carrying out this project in cooperation with iRidge. According to iRidge, they started verifying the blockchain technology for use in the O2O (Online-to-Offline) area 9th September 2016. On 30th November 2016, Sarubobo Coin became the first electronic local currency to be commercialised using blockchain technology (iRidge 2017). This surprisingly short development period shown that in the digital society, if the basic concept is clear and the understanding of related stakeholders is obtained, rapid implementation is possible.

16.5 Application Trial of Blockchain in Aging Society of a Provincial City in Japan

We have considered the future of social applications of blockchain in well-being oriented service research (Transformative Service Research: TSR) (Anderson et al. 2013) for aging societies. Japan has one of the world's fastest aging societies, so local governments urgently need to enhance social services to support the well-being of the elderly.

16.5.1 Blockchain for Lifelong Learning Services

(1) **Lifelong learning support service**

One of the social services is lifelong learning support, which has the potential to stimulate the intellectual curiosity of the seniors and enhance their quality of life (Li and Perkins 2007; Luppi 2009). Lifelong learning support services are operated at the discretion of the local governments. In addition to establishing and operating social education facilities such as community centres and libraries, the local governments support organisations providing lifelong learning. We interviewed people in a city in Ishikawa Prefecture, Japan. As a result, it was found that the lifelong learning system of the city mainly involves the local government (i.e. the city), facility managers, lifelong learning service providers, and residents, as shown in Fig. 16.5. The local government plans the lifelong learning program, selects the appropriate provider, and offers courses to the residents for a fee or for free. Here, the facility manager does not necessarily participate in the planning actively but mainly provides and manages the facility. Lifelong learning service providers that are commissioned by the city provide services to residents. Residents participate in the programs by paying for them as needed. This structure can be called a government-initiated lifelong learning

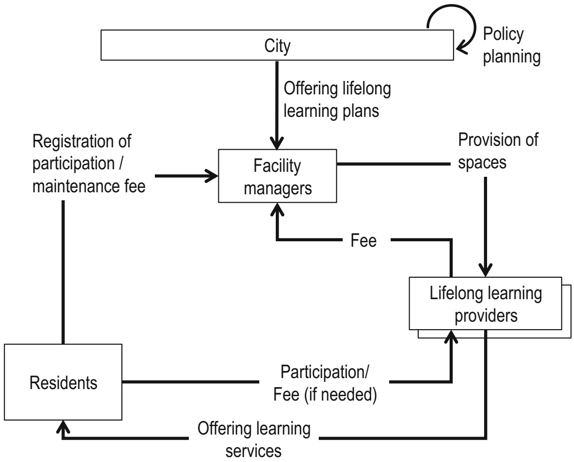

Fig. 16.5 Traditional style of systems of lifelong learning services

service from the viewpoint that the local government plans the program and offers the service using the region's facilities.

(2) **Challenges**

In the case of the government-initiated lifelong learning services, the manager of the facility that hosts the lifelong learning service has little or no financial incentive to positively utilise the facility. In Japan, the city is subdivided into neighbourhood associations, and a city administrator is appointed to manage public facilities for each neighbourhood association. The facilities are effectively utilised if the neighbourhood association is an active one, but facilities may be utilised only about 1 or 2 times a week if the neighbourhood association is not so active. In addition, in some small neighbourhood associations, lifelong learning services are offered for a fee because their cost/benefit is poor, which leads to unfairness between regions.

Mr. Hiroki Oyama, who is one of authors and was a master's student at the Shirahada Laboratory in JAIST (Japan Advanced Institute of Science and Technology) at the time concluded there are three main challenges obtained from the abovementioned interviews and observational surveys.

(1) Establishment of an incentive structure for each stakeholder
(2) Nurturing well-being by increasing health and autonomy of senior participants
(3) Effective use of the facilities.

A blockchain application has been examined in order to meet these challenges by replacing them with a research problem of constructing a social service which satisfies them. In short, we found that blockchain technology could be developed into a new social and technological base in local governments for promoting well-being.

16.5.2 Well-Being Oriented Blockchain for Lifelong Learning Services

We considered that by combining IoT and blockchain, we can promote collaboration among the four parties involved in lifelong learning mentioned in Fig. 16.5, which has not been effectively achieved so far, and enable the four parties to gain value. In addition, the technical problem and the possibility of social innovation have been examined by prototyping and testing a well-being oriented blockchain for lifelong learning services.

(1) **Overall structure**

Figure 16.6 shows a lifelong learning system based on our blockchain. This is a form of human well-being oriented blockchain application. It describes the integration of a social value co-creation system (right) and information system (left) to enable participants in lifelong learning services to enhance their well-being. As an example, this subsection explains how a lifelong learning service system based on a blockchain works when a city sets a goal to improve the health of residents through lifelong learning from the viewpoint of preventive medicine.

(2) **Social value co-creation system**

To realise the three goals described above, the city requests the facility manager to come up ideas to improve residents' health. Blockchain has the advantage of securely recording quantitative data, so that quantitatively evaluable contracts can be concluded to increase the involvement of facility managers. For example, a contract might state that, "Rewards are based on the amount of activity performed by participants at the facility."

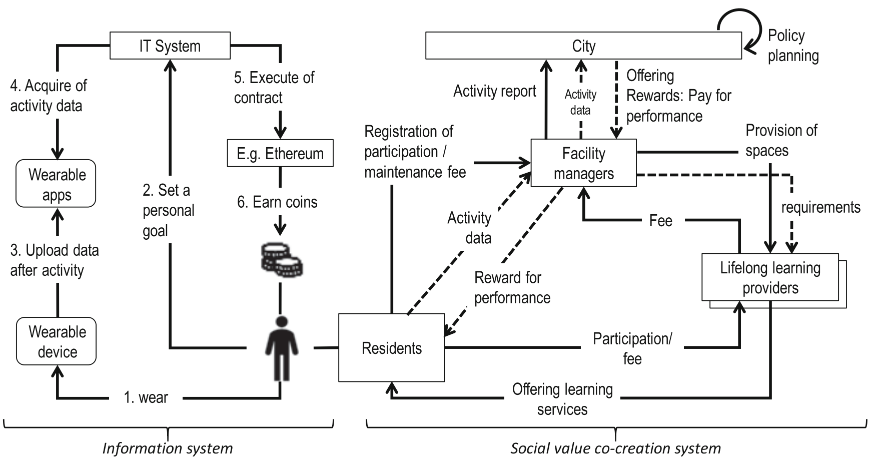

Fig. 16.6 Blockchain based lifelong education service

On the basis of the contract concluded with the city, the facility manager prepares the lifelong learning program which has the maximum expected profit and selects the lifelong learning enterprise. This is economically rational behaviour. Facility managers who can more concretely understand the actual situation of the area of the neighbourhood association are encouraged to plan the program. The program may be realised as an exercise class or as a nature walking and learning tour in the local region.

The facility manager can now make some kinds of contract in order to give incentives to lifelong learning providers. For example, a specific contract that states, "The city will pay a performance-based fee based on the number of elderly participants in the course." To achieve the target value effectively, the contract incentivises lifelong learning providers to provide residents with attractive opportunities.

The new relationship thus formed is depicted in the dashed lines in the right half of Fig. 16.6. The amount of activities done by residents can be read by facility managers and city administration as digital information, which enables them to verify the effect of local government policy.

(3) **Information system**

As part of an information system which supports this social co-creation system, participating residents need to measure their own activities by first wearing wearable equipment. Fitbit Charge 2 by Fitbit Co. was used as an activity meter this time.

The participants set their goal activity quantity, and if they achieve the goal in the lifelong learning service, they are given a coin which can be distributed and exchanged. By repeating their activities, participants may become more socially active. As already described, the activity result is shared as data to facility managers and the city, and the facility manager can evaluate whether the lifelong learning provider is appropriately providing the service. The city can use the data for planning welfare policy in the next fiscal year.

The kind of wearable device used is a key for this information system to function effectively. From the trial experiment, the detailed time series reference data such as minutes was valid only for the device tied to the developer's account, so the reference data was only for the total value of the specified date except for the data of the device tied to the developer's account. It is important to consider how many degrees of application programming interface (API) freedom IoT devices should be adopted to estimate the learners' detailed activity.

In addition, since blockchain is used, mining is required in order to decide the transaction of digital assets such as cryptocurrencies and tokens. The smart contract enables the contract to be automatically executed, but its approval depends on the setting of the miner. In a private blockchain, the manager and the miner are the same, so the time for approval depends on when the manager mines. The system does not immediately approve a trade when the miner does not mine periodically or continuously. Therefore, to operate such a system effectively, a consortium or public blockchain system will be effective.

16.5.3 Social Innovation by Blockchain Based System

Along with digitalisation of society, blockchain technology, which securely records transactions, has the potential to make value transfer more efficient. Therefore, blockchain offers the possibility of social innovation to change human interaction and regional life. Takemiya (2016) considered the use of electronic currency (called "Moe") by blockchain introduced at an event held in Fukushima Prefecture, Japan. He pointed out that there is significance in not only exchanging coins but also building human relations through the exchange. He introduced a rule that two parties needed to wave their smartphones next to each other to issue a coin which could be used at the event. The rule caused people to engage with strangers and construct new relationships.

We believe that the proposed well-being oriented blockchain application has seeds of social innovation in terms of envisioning a new way to build social relationships. For example, would the rewards earned by residents be used for exchange among lifelong learners rather than as money? Participants in exercise clubs have so far been rewarded only with better health, but if they are able to exchange cryptocurrency acquired by exercising for the handicrafts of the participants in the handicraft club, their activities may have a value in exchange for the new reward, which may be expected to motivate them to exercise further. The blockchain mechanism will also motivate interactions between those different activities.

On the basis of this assumption, we conducted a questionnaire survey to examine whether residents would actually participate in such an activity-based exchange and what kind of value distribution design would encourage residents' to sustainably participate in lifelong education programs. The questionnaire was answered by 23 senior citizens in Ishikawa Prefecture in January 2018. The survey items asked how they felt about being evaluated on an individual and group basis for generating points, what kind of goods and services they would want to exchange the obtained points for, and their demographic information. Respondents were 20 women and 2 men; 7 were in their 50s and 60s and 15 were in their 70s and 80s.

In their answers, respondents said that points should be earned through not only individual activities but also group activities. On the other hand, they said that points should be able to be used to purchase tangible goods in shops and services that are beneficial to the town rather than goods such as souvenirs and mechanisms for self-esteem such as ranking systems. From these results, it is considered that a desirable reward mechanism may promote activities under the following conditions: (1) the activity can be evaluated on both an individual level (e.g. calories burned during exercise) and group level (e.g. the sum of calories burned by all participants during exercise), and (2) a point-exchange mechanism can be made which rewards both individuals (e.g. the points can be used to buy goods/services participants want) and groups (e.g. the points can be used to buy goods/services that will provide benefits to the group).

If the activities of each participant are summarised, returned as points to all members, and made available for the group or regional use, participants may have motivations to participate in the activity other than just their own personal reasons and make new relationships with others, which has the potential to increase well-being and social innovation. Our trial can also be an opportunity to consider the seeds of such social innovation. At the same time, social systems and rules need to be developed and modified on the basis of these results in order to use the well-being oriented blockchain more effectively.

16.6 Analysis from Social Innovation Perspectives

On the basis of the common business innovation perspectives in this book, this section considers (1) what kind of needs can exist for the purpose of using information and communications technology (ICT), (2) what kind of technologies and functions are used to meet the needs, (3) what kind of methods can be introduced to create value, (4) what kind of relationship is desirable for actors involved in ICT, and (5) what kind of changes can occur in life and society by introducing ICT.

(1) **What are desires and/or issues in society or business are the objectives of ICT utilisation?**

From the cases using the blockchain technology, it is proven that the starting point should be setting needs to be met to solve social issues. There is a need to stimulate economic activity in the local community as seen in the Sarubobo Coin case as well as the need to incentivise good works and volunteer activity as seen in the HullCoin case. In addition, our efforts identified the need to effectively use local facilities, improve the health of residents, and establish collaborative relationships among relevant actors.

(2) **What technologies and functions are utilised to solve issues or realise desires?**

To meet social needs, technologies are required to (1) securely record the contents of activities, (2) make activity resources on the basis of the recorded contents, and (3) design the distribution of resources by applying specific rules. Blockchain can satisfy these technical needs, but (3) depends on not only technology but also human service design capability. One of the ideal ways of service design shown in the HullCoin case is that the resources generated by good deeds can be used mainly as a discount coupon for goods but cannot be used to purchase goods which can generate health problems such as alcohol and tobacco.

(3) **What value creation methodologies exist?**

Figure 16.7 shows the process of creating value through introducing blockchain. First, there are always social problems. Someone needs to define the problems and clarify the needs to be met. After clear needs are formed, the structure of a particular

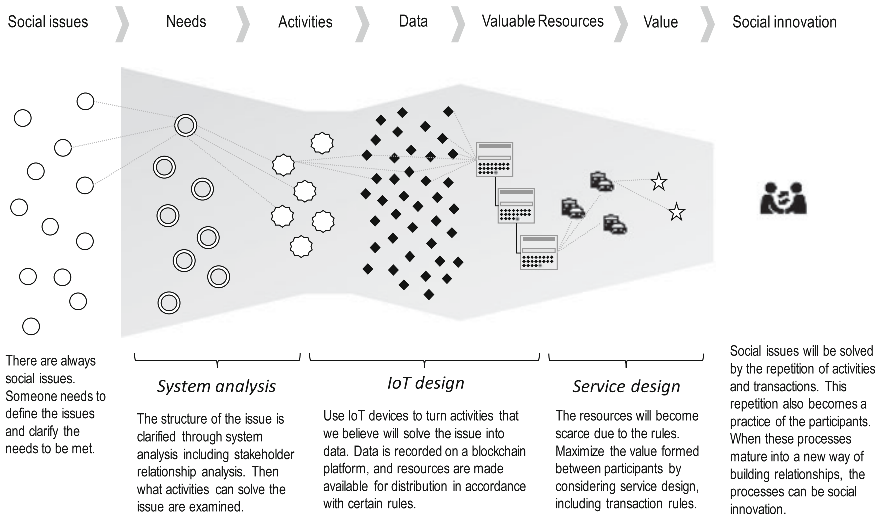

Fig. 16.7 Blockchain system design for social innovation

issue is clarified through system analysis, including stakeholder relationships. The actors then examine what activities of stakeholders can improve the issue by using IoT devices and turn activities that they think will solve the issue into data. The data is recorded in the blockchain platform and becomes a distributable resource on the basis of certain rules. Resources that can be distributed will become scarce due to some rules of the blockchain application. By considering the service design including the transaction rule of the resources, the value generated by integrating the resources between participants is maximised. Social problems will be alleviated by repeating activities and transactions. This repetition also becomes a habit of the participants. When these processes mature into a new way of building relationships, the processes can be called social innovation.

Blockchain safely records the activity content and enables it to be converted into distributable and valuable resources. At this time, what resources to make must be decided. In the case explained in this chapter, human activities are transformed into resources. Especially, in the case of health improvement through lifelong education programs, we collected the activity data of individuals using a wearable terminal and designed the service so that the activity may become a valuable resource as individuals are rewarded for achieving their goals. By doing so, individuals become more motivated to continue the activity. In addition, we explained that stakeholders are expected to come up with ideas for improving the quality of education programs to achieve the goals in their contracts. To enable multiple entities to create such value, the technique is needed to design services that meet all the clarified needs.

(4) **What are the relationships between people/businesses (including employees, organisational culture, leadership, etc.) and ICT systems and**

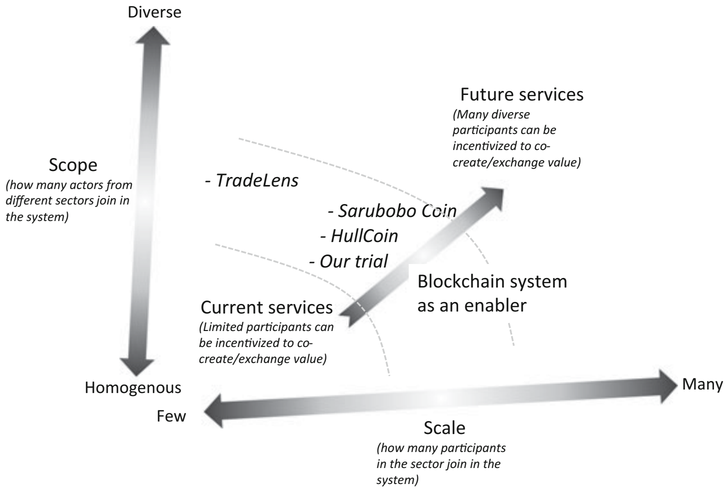

Fig. 16.8 The future development of blockchain based services

the relationships among users, ICT providers, and other stakeholders (Collaboration)?

The involvement of the stakeholders is indispensable for effectively implementing social services based on blockchain. As shown in Fig. 16.8, there are two directions in terms of future development of blockchain based services: (i) the direction of the scale to increase actors in the same industry and (ii) the direction of the scope (diversity) to increase the variety of actors with different functions.

To further popularise Sarubobo Coin and HullCoin, it is desirable to increase the partner enterprises offering goods and services in exchange for the coins, which is included in the "scale" axis. In fact, one attraction of Sarubobo Coin is that the number of the partner stores increases year by year. On the other hand, in the case of TradeLens by IBM, the attractiveness of ICT utilisation is constructed by connecting the activities of actors with various functions in the supply chain by blockchain. This is similar to the case of lifelong learning. It will be important to unitarily connect actors involved in lifelong learning and managing various actors under a recording system to achieve social innovation. Blockchain is innovative in that it can embrace diversity. This will increase the number of participants and improve the quality of services. In the future, more diverse participants will be motivated to create service value and co-create mutual value. Blockchain could be an enabler of that direction.

(5) **How has daily life, business, or society changed? Consider cases of innovation, revolution of business models, creation of new eco-systems, and changes in people's lives** .

Blockchain is a secure record management technology on a network. Secure record management can be a fundamental infrastructure for social development. In combination with IoT, human activity data, which has not been noticed so far, is attracting attention and offers an opportunity to bring about social innovation. In fact, this chapter has introduced and analysed cases directly connected to people's lives such as promoting volunteer activities and incentivising lifelong learning. By combining the appropriate service design with blockchain platforms, participants will contribute to social developments which encourage people to utilise their own abilities and to benefit others. In this sense, it is considered that blockchain applications will support social innovation through people's cooperation. In the future, innovative IoT design will enable us to visualise natural environment data and manage and operate it in combination with human activity data. This will enable the power of people's cooperation to contribute to global environmental sustainability.

16.7 Concluding Remarks

This chapter has examined the impact of blockchain technology on social innovation through case studies. As a result of the consideration, we found the possibility of alleviating social issues by effectively practicing (i) system analysis including analysis of the stakeholders and their relationships, (ii) IoT design to accurately digitalise human activities that are relevant to solve social issues, and (iii) service design to appropriately utilise cryptocurrencies as valuable resources generated from the data of digitalised activities. It was proposed that these three practices could promote social innovation which can in turn increase cooperation among people.

The process of systematically analysing social issues from the viewpoints of system analysis, IoT design, and service design and utilising the blockchain platform to solve social issues can be called "social blockchain design". We believe that the social blockchain design should be appropriately utilised for regional revitalisation. In the future, that new social innovation can be expected to be generated by the progress of research on mechanism designed from the viewpoint of social blockchain design.

References

Anderson L, Ostrom A, Corus C, Fisk RP, Gallan AS, Giraldo M, Mende M, Mulder M, Rayburn SW, Rosenbaum MS, Shirahada K, Williams JD (2013) Transformative service research: an agenda for the future. J Bus Res 66(8):1203–1210. https://doi.org/10.1016/j.jbusres.2012.08.013

Bird J (2017) Hull launches its own 'social' cryptocurrency

Gartner (2019) Gartner 2019 Hype Cycle for blockchain business shows blockchain will have a transformational impact across industries in five to 10 years. Retrieved April 4, 2020, from https://www.gartner.com/en/newsroom/press-releases/2019-09-12-gartner-2019-hype-cycle-for-blockchain-business-shows

Higginson M, Nadeau M-C, Rajgopal K (2019) Blockchain's Occam problem. Retrieved April 4, 2020, from https://www.mckinsey.com/industries/financial-services/our-insights/blockchains-occam-problem#
IRidge (2017) Results briefing material. Retrieved February 5, 2020, from https://ssl4.eir-parts.net/doc/3917/ir_material/79542/00.pdf%0D
Japan Blockchain Association (2020) The definition of blockchain. Retrieved January 29, 2020, from https://jba-web.jp/
Kaini Industries (2016) Hullcoin: unlocking the hidden value in Hull's economy. Retrieved February 7, 2020, from https://www.hull-coin.org/
Li Y, Perkins A (2007) The impact of technological developments on the daily life of the elderly. Technol Soc 29(3):361–368. https://doi.org/10.1016/j.techsoc.2007.04.004
Liao R (2017) How blockchain could shape international trade. Foreign Affairs Report
Luppi E (2009) Education in old age: an exploratory study. Int J Lifelong Educ 28(2):241–276. https://doi.org/10.1080/02601370902757125
Orcutt M (2018) Blockchain. MIT. Technol Rev 121(3):18–27
Peryaudo (2020) The system of bitcoin. Retrieved February 25, 2020, from https://bitcoin.peryaudo.org/index.html (in japanese)
Sylvester-Bradley O (2018) Hullcoin: can blockchain unlock the hidden value in Hull's economy?
The Fintech Times (2017) Foreign aid blockchain. The £14Billion game changer for UK tech. Retrieved February 7, 2020, from https://thefintechtimes.com/foreign-aid-blockchain/
Tradelens (2019) Tradelens. Retrieved February 6, 2020, from https://www.tradelens.com/
Nikkei (2018) Hida Credit Union introduces Alipay system. Retrieved from https://www.nikkei.com/article/DGXMZO34012690Z00C18A8L91000/ (in Japanese)
Takemiya M (2016) Value creation by human relationships. Gendai Shisou 45(3):100–104 (in Japanese)
Shimizu M, Mochiji R (2018) A case of local revitalization in the UK using Fintech and virtual local currency. Retrieved February 18, 2020, from https://www.jeri.or.jp/membership/pdf/research/research_1807_01.pdf (in japanese)
Yoneyama H (2018) Revitalizing local economies through cashless operations: the case of "Sarubobo Coin". Retrieved February 18, 2020, from https://www.fujitsu.com/jp/group/fri/knowledge/opinion/2018/2018-10-8.html (in Japanese)
Noguchi Y (2017) Blockchain revolution. Nikkei Business Publications. (in Japanese)
Hida Credit Union (2019) Hidashin disclosure 2019. Retrieved February 18, 2020, from https://www.hidashin.co.jp/images/about/disclosure/disclosure_2019.pdf (in Japanese)

Chapter 17
An Information-Sharing System for Multiprofessional Collaboration in the Community-Based Integrated Healthcare System: A Case Study of Nomi City in Japan

Hideaki Kanai

Abstract Currently, Japan is rapidly aging. The Japanese government would like to introduce the community-based integrated healthcare system for this end. The system aims to provide elderly people living at home with appropriate health, medical, and welfare services. It is essential to collaborate among health, medical, and welfare staff to work the system successfully. We have been developing a supporting system for sharing information on the situation of the elderly at home and conducted a field test around one year. The users and supporters with ICT skills got together to develop and operate the system. In this chapter, we introduce a case study of the information-sharing system in Nomi city, Ishikawa Prefecture, Japan. We explain about the effectiveness of our system and findings through the field test.

17.1 Introduction

In recent years, the population of Japan has been aging. On October 1, 2018, the number of the population aged 65 and over was 35.58 million, accounting for 28.1% of the total population (aging rate) (Cabinet Office Japan 2019), as shown in Fig. 17.1. The number of elderly people living alone is remarkable. The rate of males in the elderly population was 13.3% and that of females was 21.1% in 2015. In addition, 42.2% of men and 30.2% of women over the age of 60 want to be cared for at home. Against this background, the Ministry of Health, Labour and Welfare (MHLW) is promoting an integrated community-based healthcare system that allows older people to continue living in their own homes and in their own residential areas. Figure 17.2 shows the structure of this healthcare system. The public service provided depends on the situation of the elderly individual. The government aims to care for the elderly population at home as much as possible. The government seeks to reduce welfare costs. When an older person gets sick, he or she goes to the doctor or is admitted

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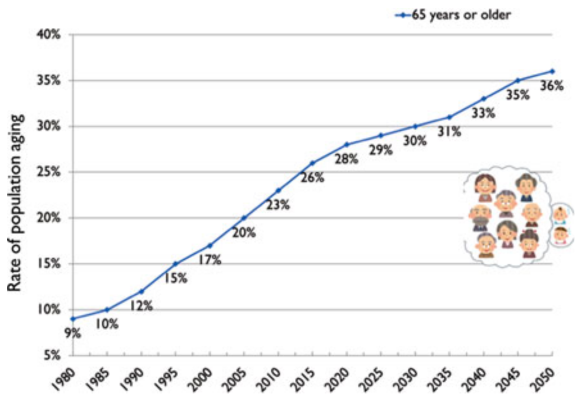

Fig. 17.1 Rate of population aging in Japan. Annual report by Japanese Ministry of Health, Labour and Welfare (MHLW) FY2019

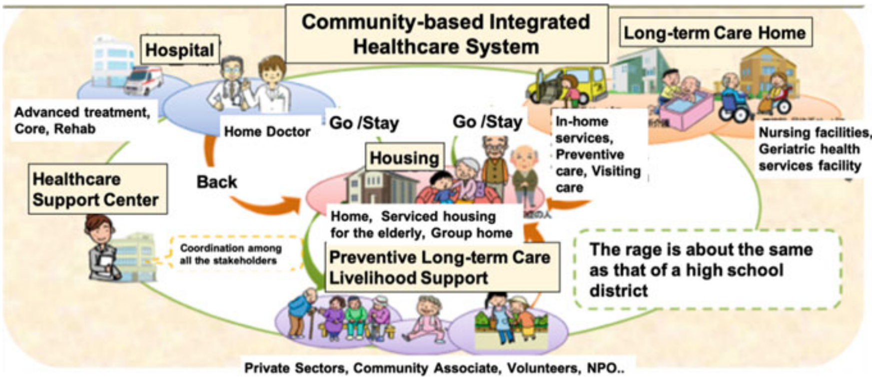

Fig. 17.2 Community-based integrated healthcare system in Japan. Annual report by Japanese Ministry of Health, Labour and Welfare (MHLW) FY2019

to the hospital. When the older person feels better, he or she returns home. When an older person needs a daytime care service, he or she goes to a care center or is admitted to a care home. When the older person feels better, he or she then returns home.

To connect these services organically, specialists engaged in healthcare, nursing, and welfare activities in the community should work in cooperation with each other (Abe and Morita 2014). The Ministry of Health, Labour, and Welfare also mentions the importance of multiprofessional cooperation for in-home healthcare in the community-based integrated healthcare system. To promote multiprofessional collaboration, community care meetings have been introduced in the healthcare system. These meetings aim at improving the support of the elderly population and improving the social infrastructure, i.e., community improvements (Ministry of Health, Labour and Welfare (MHLW) 2014). Namely, care meetings play a role in sharing information about elderly in-home care. All stakeholders should be involved in these care meeting to share the information in more detail. However, that is not realistic because these stakeholders are usually operating under a high workload. In this research, we aim to support multiprofessional collaboration for the in-home care of an integrated community-based healthcare system using an information-sharing system based on ICT (Information Communication Technologies). We consider that the information-sharing system has the following advantages:

- Properly grasping the situation of the elderly population, and
- Providing the elderly population with adequate care services with the proper timing.

We have developed an information-sharing system for multiprofessional collaboration in the community-based integrated healthcare system. In this chapter, we introduce an information-sharing system for multiprofessional collaboration in the community-based integrated healthcare system. To evaluate these issues, we conduct a field test in Nomi city, Ishikawa Prefecture, Japan.

17.2 Related Works

Currently, ICT is used to support multiprofessional cooperation and support for caregivers. The following section introduces research on support for multiprofessional collaboration in medical care and nursing care and support for caregivers.

17.2.1 Multiprofessional Collaboration for In-Home Care

Amir et al. (2015) clarified the characteristics of a multidisciplinary care team, including a family doctor, a home nurse, and a neurologist, for the care of children with chronic diseases such as developmental disorders. This study suggests related problems such as inadequate communication, difficulty in coordinating care between members of the care team and setting goals for treatment with family members. One of the reasons for these problem is that the activities of healthcare workers and caregivers are loosely coupled and weakly interdependent (Pinelle and Gutwin 2006). Therefore, it is crucial that healthcare workers and caregivers recognize each other's activities.

Yamamoto et al. developed a patient information-sharing system among multiprofessional healthcare professionals for home healthcare collaboration (Yamamoto et al. 2018). This system has a patient information sharing function, healthcare worker information sharing function, and a text chat component. These functions are useful for sharing information among multiprofessional medical staff belonging to different medical institutions. The study shows medical staff belonging to core hospitals. However, elderly people have shown interest in information other than records registered by healthcare professionals belonging to different organizations and the possibility of smooth medical cooperation through the notification function. This system is not intended for family or patient use. Therefore, it is considered difficult to obtain requests and consultations from family members and to obtain home information from the family's point of view.

In this case study, the information-sharing system using ICT is used not only by medical and nursing care workers but also by the family members of the elderly individuals. Our system aims to activate communication between medical professionals and family members.

17.2.2 Support for Family Caregivers

Some studies use ICT to support caregivers. Duncan et al. developed a monitoring system for eldercare (Duncan et al. 2009). The system installs sensors and cameras at the entrance to the elderly individual's residence. The system takes a photograph of the person at the entrance when the doorbell rings or the door opens and sends the image as a message to the caregiver's mobile phone. The system enables caregivers to reduce the cognitive load necessary for confirming the elderly individual leaving the home and visiting people in remote places. As a result, such a system can improve the care and quality of life for elderly individuals.

As psychological support for family caregivers, Yamashita et al. (2013) clarified the nature of the stress and the needs of family caregivers with depressed patients and their demands for social relationships with others. Based on these findings, the authors developed an Internet application for nursing records to support family caregivers of depressed patients (Yamashita et al. 2017). Family caregivers can use the Internet application to record the daily activities and moods of depressed patients, record the activities of family caregivers, and facilitate family caregiver reflection analysis. This application clarified that communication between patients and family caregivers could be activated.

In this case study, information that is usually difficult to know, such as the activity and physical condition of elderly individuals at home, is shared not only with healthcare professionals but also with especially distant families.

17.2.3 Development Process for Healthcare Support Systems

Currently, support for a community-based integrated healthcare system using information systems is being promoted to realize multiprofessional collaboration. Most of the current community-based integrated healthcare support systems have been built for professionals and their purposes, such as systems for hospitals, care homes, and healthcare support centers. In these systems, various information on the elderly individuals at home (medical data, visiting nursing records, and notes on progress such as medicine notebooks and memorandums of the individual) has been distributed and managed for each professional. In monitoring support for the elderly population at home, it is necessary to exchange information and status of the target elderly population with professionals by hand, such as by telephone or fax. That process places a terrible burden on these individuals. We consider that introducing these systems in such a way as to deviate from the actual operations confuses those at the work sites.

In medical institutions, some system development companies have developed information infrastructures by expanding the electronic medical record system. For example, Kanamic Network Co., Ltd. (2020) has developed a multifunctional system that integrates information systems for each professional (e.g., an electronic medical record system for medical professionals and a care record system for caregivers). Electronic medical records are intended for medical professionals. Due to the bloated nature and complexity of the input items in the system, it is difficult for nonprofessionals such as residents, family members, and individuals who are involved in community-based integrated healthcare to use it. We consider that one of these issues is caused by the system development from the viewpoint of the conventional system provider, without considering various stakeholders at the sites where the system is used.

In the field of information technology, system development companies have built and operated various systems. Disruptive innovation is also occurring in ICT. Due to the commoditization of the system technology and the cloud migration of information infrastructure, the technical hurdle of system development and operation has been reduced. There has been one software development method created: prototyping. In this process, a prototype is created at the initial stage of software development. The functions and operability of the software are confirmed, and user requirements and evaluations are reflected in the prototype system until an acceptable prototype is achieved. This process also creates a base by which to produce the final system. The method is an iterative trial and error method that takes place between the developer and the users. The advantage to this process is that the processing content and usability can be confirmed and corrected during development, and deviations and problems with a system can be found at an early stage.

The community-based integrated healthcare system covers the whole community care, and its issues affect the entire community. We consider that it is essential that various stakeholders, such as medical professionals, related administrative sectors in the area of healthcare and welfare, families, and residents collaborate and provide prompt feedback for the development of the healthcare system. We consider that it is more important to develop a system together with information developers as one of the stakeholders rather than developing systems from the viewpoint of conventional system development companies.

17.3 Background and Objectives of the Target Society

In this chapter, we introduce an information-sharing system for multiprofessional collaboration in the community-based integrated healthcare system. We conduct a field test of the system in Nomi city, Ishikawa Prefecture, Japan. The following is an introduction of Nomi city and its home medical cooperation.

17.3.1 Overview of Nomi City, Ishikawa Prefecture

As of 2015, Nomi city, Ishikawa Prefecture, had a population of 48,881, and those individuals aged 65 or over in the population numbered 11,983 (Statistics Bureau of Japan 2020). According to the Japan Medical Association, in 2015, the aging rate in Nomi city, Ishikawa Prefecture was 24.5% (national average 26.3%). The number of doctors per 100,000 population is 147.30 (national average 230.56), and the number of nurses and nursing staff per 100,000 population is 29.56 (national average 18.17) and 109.33 (national average 93.02), respectively. The total number of nursing homes is approximately 15% higher than the national average. In Nomi, Ishikawa, there are more caregivers than medical staff.

17.3.2 Multiprofessional Cooperation Among Home-Based Medical Care in Nomi City

In this research, we collaborate with a community care conference on "medical care and nursing care cooperation," organized by a promotion organization of multiprofessional cooperation in Nomi named "Memory Care Network Nomi." We investigate problems with in-home medical care cooperation and develop and introduce an information-sharing system.

The activities of this "medical and nursing care cooperation" are classified into two categories, "multioccupation coordination meetings" and "home care utilizing ICT." The "multiprofessional coordination meetings" are divided into "regional meetings" and "on-site meetings." At regional meetings, various stakeholders, such as doctors, caregivers, and elderly support center staff, participate. At the local meetings, activity reports from the three districts of Nomi city and reports on the contents of on-site meetings are shared, and discussions on the operation and functions of an information-sharing system using ICT are held. In the on-site meetings, family caregivers participate, in addition to the stakeholders in each of the field districts. They confirm their opinions and reports on what they want to share.

The on-site meetings are held once a month. In "home care utilizing ICT," elderly people in target field districts are monitored using the information-sharing system introduced. The contents followed by each professional are input to the system and shared among professionals.

17.3.3 Issues for Solving with the ICT System

Japan is rapidly aging. As one of the measures to help this situation, a community-based integrated healthcare system will be introduced in Japan. This healthcare system aims to provide elderly people living at home with appropriate health, medical, and welfare services. For the system to succeed, all stakeholders should share information about the situations of the elderly population living at home with each other. Currently, information about the elderly population is stored separately in each department's system. Information on older people is not shared among divisions and is not available throughout divisions (Fig. 17.3). For example, hospitals manage the elderly population with electronic medical records, while nursing center records use other systems and community centers are managed by using paper. In home scenarios, most cases do not record information. As a result, it becomes difficult to grasp the status of the elderly population properly, and it becomes impossible to intervene/provide care services for the elderly population at the appropriate time. There are some issues caused by this lack of information sharing as follows:

- Difficulty in properly grasping the situation of housebound elderly individuals, and
- Difficulty in providing elderly individuals with adequate care services at the right moment.

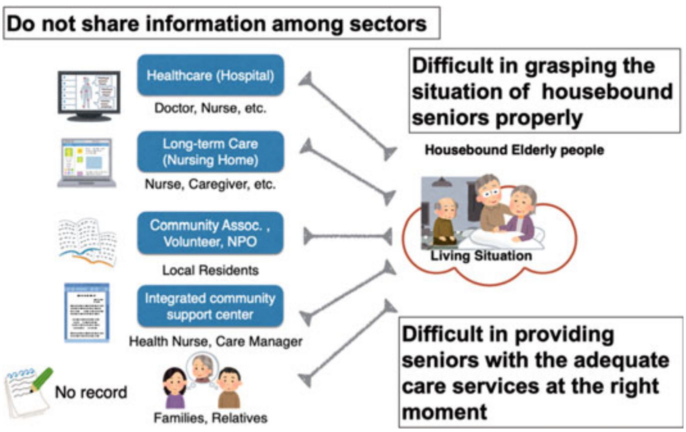

Fig. 17.3 Issues for solving problems with the ICT system

Therefore, we try to solve these issues by using an information-sharing system as an ICT system. We consider that such a system enables stakeholders to share information about the situations of the elderly population with each other.

17.4 MCNBook: Information-Sharing System with Smartphones

17.4.1 System Overview

We have developed an information-sharing system called the MCNBook System to support multiprofessional collaboration in the community-based integrated healthcare system. We conduct a field test in Nomi city, Ishikawa Prefecture, Japan. Figure 17.4 shows the configuration of this system. The MCNBook system aims to facilitate the sharing of information among medical professionals of different affiliated organizations and family members. Medical and nursing care workers, including family caregivers, input the information that they have noticed from the observed state of and conversations with the elderly individuals into the system and share the information with other professionals using devices such as smartphones, tablets, and personal computers via the Internet.

However, stakeholders in the current cooperation systems of local healthcare organizations are assumed to be mainly medical professionals. Thus, participants in the current cooperation systems must understand the medical information that is shared among them. In the MCNBook System, we considered the types of information shared and the representations of that information from a perspective that family caregivers could easily understand. We discussed with system users the issue of how to define the shared items for approximately ten months. As a result, the items to be

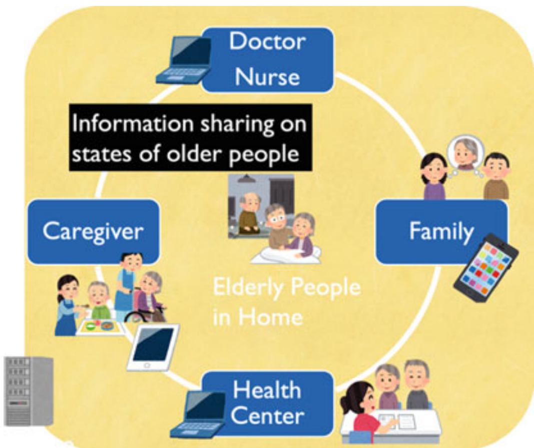

Fig. 17.4 System structure

shared are as follows. Each item is entered as an arbitrary level. For example, the status of temperature is represented as “Extreme fever and need to contact with a medical professional,” “High fever,” “A little fever rather than normal,” “Normal.”

- Physical condition: temperature (4 levels), blood pressure (4 levels), dullness (4 levels) and excretion status (4 levels)
- Intake status: drug (3 levels), meal (4 levels) and water (3 levels)
- Activity: going out (4 levels), exercise, independence with cooking (4 levels), independence with excretion (4 levels) and exercise (3 levels)
- Living situation: sleep (4 levels), communication (4 levels), and garbage disposal (4 levels)
- Features of individuals: items according to the characteristics of the target. Ex., levels of back-pain
- Involved member: family members, contact list and stakeholders.

The MCNBook System is implemented on a virtual machine of our affiliation (Japan Advanced Institute of Science and Technology) as an Internet service. The cost is free because the system is a research project in our laboratory. Our laboratory members are responsible for developing the system and the system management. The system is mainly operated by our collaborators (a local government and a volunteer promotion association of the community-based integrated healthcare), as described in Sect. 17.4.3.

17.4.2 Functions for the Information-Sharing System

The system supports multiprofessional collaboration for in-home care by the following functions:

- Function of sharing information about the elderly individuals’ situations;
- Function of sharing messages; and
- Function of alerting about changes in the elderly individuals’ statuses.

In the function of sharing information about the elderly individuals’ situations, users can input and access the shared items mentioned above. To make it easier for users to enter and confirm the status of the elderly individuals, the information is displayed and shared in four stages: “emergency,” “caution,” “attention,” and “normal.” Users can also trace the history of these statuses. In the function of sharing messages, users can communicate by using sending messages, such as SNSs (Fig. 17.5). Users get to know the state of the elderly individuals through shared items and advice and instructions from others. Users can also attach image files to each message to enable the sharing of handwritten care record documents, images of diseased areas, and activity (Fig. 17.6). In the function of alerting about changes in elderly individuals’ status, the system can alert preregistered persons when there are changes in the situation of an elderly individual. The criteria of the alert are based

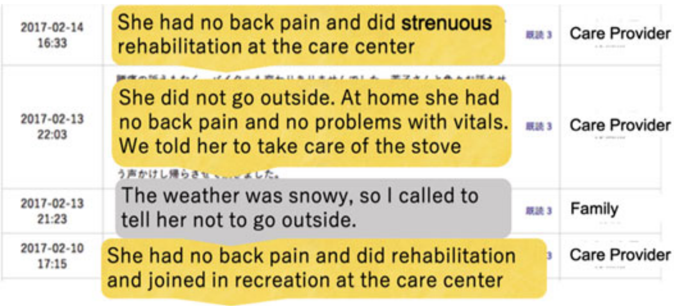

Fig. 17.5 Screen image: sharing messages such as SNS. Message about an elderly person living alone between the family and the care provider

Fig. 17.6 Attached image files on messages: handwritten care record documents, images of diseased areas, and activity

on certain rules created for an individual. For example, some statuses only became an "emergency" if the situation continues after the fifth successive observation.

17.4.3 Service and Spiral System Development Process

As mentioned in Sect. 17.2.3, we consider that it is more important to develop a healthcare support system together with the stakeholders of community-based integrated healthcare and information developers rather than developing systems from the viewpoint of conventional system development companies.

Thus, we have developed and operated an information-sharing system, the MCNBook System, to support multiprofessional collaboration in community-based integrated healthcare from FY2015. Our laboratory members are in charge of prototyping the system. We have conducted the development and operation with the help of the local government (Nomi city, Ishikawa Prefecture), a volunteer promotion association of community-based integrated healthcare (its name is "MCN: Memory Care Network Nom") with members including medical professionals, community comprehensive care centers, NPOs, and universities) and an industry-academia-government collaboration group from the Hokuriku district called the "Hokuriku Life Care System Study Group." Thus, the stakeholders in the MCNBook System are family members as well as medical professionals from different affiliated organizations. We collaborated with the MCN members to decide on the types of information shared and the representations of that information from a perspective that family members could easily understand. We discussed with the system users the issue of how to define the shared items described in Sect. 17.4.1 for approximately ten months.

We conducted a trial operation (total of 6 subjects) in Nomi city starting in the latter half of 2016. There was an on-site meeting for each subject where the system users, including the family members of a subject and our laboratory members as system developers, gathered approximately once a month. At that meeting, we shared information about the situation and observations of the target elderly person to monitor and make requests for improvements to the prototype system. There was a multiprofessional coordination meeting where our laboratory members and multiprofessionals (doctors, care managers, caregivers, helpers, staff of healthcare support centers, local welfare committee members, etc.) met approximately once a month (Fig. 17.7). At

Fig. 17.7 Multioccupation coordination meeting

the meeting, we shared information on the usage status of the stakeholders of all subjects and decided on the improvements to and operations of the system, such as the setting of information access authority for each stakeholder, the decisions on operation policy and the selection of a new target person. In this way, the system users and the developers exchanged opinions carefully to improve the system and the operation policy.

Through these meetings, we conducted the improvement process in the form of a spiral development process, as shown in Fig. 17.8. In this figure, a “spiral system development” is a technical change of the prototype system, and an “expansion of knowledge” is a change in the information technology and operations of the stakeholders. The prototype system was improved through the spiral development process. For example, the multiprofessional coordination meeting initially decided to implement “an inquiry style for health status” as a “function to share information on health status.” We conducted a field test of the prototype system and evaluated the results. As a result of the verification, we found that the “function to share information in messenger style,” such as LINE, which was provided as an auxiliary in the system, was mainly used rather than “an inquiry style.” In the on-site meetings and multiprofessional coordination meetings, we continually collaborated with the stakeholders to examine the problems and improvement points. As a result, we improved the functions of the messenger style, such as the inclusion of a keyword search for messages, icons for notifying whether messages were read or not, and functions for using messages as care records (Fig. 17.8: Step 3). Additionally, the users proposed a function to attach files in messages to share a photograph of the elderly person’s daily state. After incorporating this function in the system, the users frequently utilized the function to share handwritten care record documents, images of diseased areas and activity related to the care home (Fig. 17.6). The users themselves changed the usage of the services and functions provided in advance.

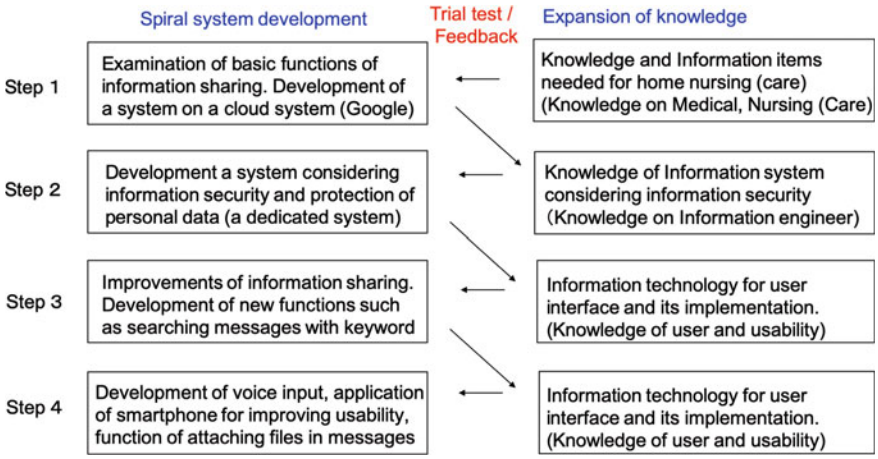

Fig. 17.8 Spiral system development process

We consider that the changes mentioned above to the system functions and stakeholders are examples of the "copromotion of people/communities and information systems." We think that this copromotion is not only based on the coexistence of stakeholders in a specific place but also on an environment where stakeholders discuss issues with each other and share and cocreate values.

17.5 A Field Test of the System

We conducted a field test of the system in three districts of Nomi city. The field test consisted of six elderly individuals.

17.5.1 Subjects

The subjects of the test were elderly people who ranged in age from their 70s to 80s. The start of the operation of the system differed for each subject due to each subject's circumstances. Table 17.1 shows the subjects' information for the period of operation, their household situation, the level of care needed, the degree of independence of the elderly persons with dementia, and the stakeholders of the in-home care. Subjects A and B live in the first district, Subjects C and D live in the second district, and Subjects E and F live in the third district.

17.5.2 System Usage Logs in the field Test

We analyzed the system usage logs for the three districts where this system has been installed. There are two subjects in each area. The responsible persons are "Doctor A," who is in charge of the first district; "Doctor B," who is in charge of the second district; and "Doctor D" and "Care manager XX," who are in charge of the third district. Tables 17.2, 17.3, and 17.4 show the usage logs of the stakeholders for the subjects in each area. These tables show the totaled results of the usage logs from the start of using the system until September 30, 2017. For example, Table 17.2 shows that there is one doctor, "Doctor A," three family members "Family-1, Family-2 and Family-3," one care center, one care manager, one care house, and one home helper for Subject A, as well as their usage logs. According to Tables 17.2 and 17.4, some users never used the system, since their number of logins is 0. On the other hand, most users tend to confirm the status of the subjects and their messages frequently. We found that household members living together tended to share information due to "emergency" or "caution" alerts and that household members living alone tended to share messages.

Table 17.1 List of subjects

Subject (age)	Period (months)	Household situation	Level of care needed (5 levels)	Degree of independence of the elderly persons with dementia (8 levels)	Stakeholders of in-home care
A:80s	4	Alone	3	None	Family, doctor, care manager, center, care house
B:80s	10	Child, wife of child	1	6	Family, doctor, care manager, center, care house (2 places)
C:80s	4	Wife, child	3	7	Family, doctor, care manager, center, care house (2 places), neighbor
D:70s	9	Wife	1	3	Family, care manager, center, care house, neighbor
E:80s	9	Alone	1	None	Family, doctor, care manager, center, care house
F:80s	9.5	Alone	1	None	Family, doctor, care manager, center, care house

17.6 Interview Survey

We interviewed the system users of the field test. Through these interviews, we investigated the following items:

- The state of the multiprofessional cooperation before the introduction of the system;
- Changes in care and work after the opening of the system; and
- Changes in the elderly individual after the opening of the system.

The following results are based on the stakeholders of “Subject A.” “Doctor A” is the family doctor of the subject.

Table 17.2 Usage logs of the stakeholders in the first district: Neagari

	System user	Number of logins	Number of checking status data	Number of inputting status data	Number of checking messages	Number of inputting messages	Number of sent images
	Doctor A	55	150	2	98	24	1
Subject A	Family-1	78	128	1	95	48	5
	Family-2	0	0	0	0	0	0
	Family-3	92	96	0	83	0	0
	Care center	60	88	0	34	7	0
	Cater manager	49	63	3	51	4	0
	Care house	167	241	31	191	36	4
	Home helper	24	25	6	31	10	0
Subject B	Family	201	484	149	233	24	0
	Care manager	12	12	0	18	6	0
	Care house	213	348	107	294	132	0

Table 17.3 Usage logs of the stakeholders in the second district: Terai

	System user	Number of logins	Number of checking status data	Number of inputting status data	Number of checking messages	Number of inputting messages	Number of sent images
	Doctor B	68	123	2448	55	14	2
Subject C	Family-1	1	1	0	0	0	0
	Care manager	7	25	0	9	0	0
	Caregivers	33	104	18	63	22	0
Subject D	Doctor C	201	484	149	233	24	0
	Family	12	12	0	18	6	0
	Care center	16	31	0	10	0	0
	Care manager	67	98	4	80	24	0
	Caregivers	6	7	0	6	2	0
	District welfare officer	66	83	0	65	6	0

Table 17.4 Usage logs of stakeholders in the third district: Tatsunokuchi

	System user	Number of logins	Number of checking status data	Number of inputting status data	Number of checking messages	Number of inputting messages	Number of sent images
	Doctor D	93	105	0	105	5	0
	Care manager	54	124	6	56	2	0
Subject C	Family-1	15	19	1	20	4	0
	Caregivers	60	133	37	67	29	0
	Care house	20	50	14	26	12	0
	District welfare officer	0	0	0	0	0	0
Subject D	Family	2	4	0	0	0	0
	Caregivers	88	265	66	138	46	0
	District welfare officer	0	0	0	0	0	0

17.6.1 State of the Multiprofessional Cooperation Before the Introduction of the System

"Doctor A" commented that "The only way to contact other professionals was to contact them by phone or in person instead of by e-mail, and the information about the elderly person living alone was available only during consultation hours." The doctor also commented that "As a result, I did not know the medical information from other medical institutions, and caregivers or care managers could make decisions about the care policy and service without consulting with me." "Care Manager A" commented that "Care managers have a central role and must be in contact with other stakeholders frequently. However, the only time I can meet with the family doctor is during the elderly person's consultation hours, and the only way to know the situation of the elderly person is by a monthly report from the nursing care establishment. Hence, I cannot knowledgeably discuss the situation with other professionals."

Moreover, the care manager commented that "I have many elderly persons whom I am in charge of and have to visit twice a week, especially those living alone. I have to spend much time and effort to understand what the elderly people with dementia say. I usually contact the care center once a month with some issues related to the elderly persons. I end up dealing with these issues even if I report them." "Family-1" commented, "Before using the system, we visited the elderly person, and we stayed for a week or ten days, since we live a distance away from the elderly individual. The actual situation with the elderly person and their house was usually different from what I had heard about from the elderly individual themself. We frequently had difficulty contacting the family doctor and the care manager due to time issues, and we were vaguely anxious about this situation." According to these comments, we find that it was difficult for stakeholders to contact each other before the opening of the system. We consider that information on the elderly population could only be obtained incompletely among all the stakeholders and that stakeholders had difficulty in performing appropriate interventions in the elderly population. The families consulted with the professionals but did not know the proper responses. Hence, we consider that inappropriate care policies and services were possible prior to the opening of the system.

17.6.2 Changes in Care and Work After the Introduction of the System

The care house commented that "We have only information about how the elderly individuals behave in the care house twice a week. Using the system, we can get to know their meals and medicines at home and understand what we need to pay attention to." The home helper commented that "I know the situation at home and the thoughts of the elderly person's family more clearly. In cases in which I would like to know information about the situation of the elderly person outside of the home, which other professionals have, I previously had no choice but to ask the care manager about it. The situation information is now available to me. At my staff meeting, I can inform other staff members of the information that other professionals have, which could not previously be shared." The care manager stated that "It is effortless to realize what we should care about and tell the family since we can access the current situation and information about the elderly people in the system. As a care manager, the number of visits to the subject decreased. I used to visit a family doctor, the care house, and the elderly person's household; however, now, I only need to go to the care house or the elderly person's household once a week". A family member commented that "My younger brother's wife is also checking on the system, and she can come to the house at a certain time if she is worried. She can know the proper time to visit." In the logs of "Subject A" in Table 17.2, all the stakeholders frequently use the system. According to the number of information checks, they emphasize sharing information among them.

"Family-1" commented that "If there is a note of care for the elderly individual stored in a warehouse, then I had to visit the care house to access the note. Using the system, I can check the notes in the system. I realize that the staff cares for the elderly individual carefully. I can input the current situation of the elderly individual more firmly. I like to input the state of the elderly individuals in the house and the details of my conversations with the elderly individuals as much as possible. I am not worried about the elderly individuals because a family doctor and other professionals can care for them and give some advice depending on the current situation of these individuals". From these comments, we consider that active monitoring by multiprofessionals was a kind of "trigger" that encouraged family members to share information.

17.6.3 *Changes in the Elderly Population After the Introduction of the System*

We find that "Subject A" changed after the introduction of the system." For example, "Family A" repeatedly remarked to "Subject A" that many people were observing and caring for them and making various observations. As a result, it seems that Subject A gradually began to be aware of this situation. "Family A" commented that "There are some sensors to recognize whether "Subject A" lives a regular life based on his motion or not. In a case in which the sensors do not recognize motion, the sensors alert the home helper. Before the introduction of the system, the alert often occurred. Since "Subject A" has made changes to live a regular life" after the opening of the system, the number of alerts has decreased. "Subject A" commented that "I feel that family and other people watch over me. So, I began to live a regular life." This change in the subject is one of the good changes regarding the elderly person. We consider that the system fosters multiprofessional collaboration and that the quality of care improves.

17.7 Discussion

In the following, we discuss the effects of using the MCNBook System on multi-professional collaboration for in-home care and future directions based on these considerations.

17.7.1 *Effects on Multiprofessional Collaboration for in-Home Care*

The analysis using the logs and interview surveys reveals the effects of cooperation among all stakeholders, including family members, using the system as follows:

- It is possible to grasp the state of the elderly person at home, which had previously been difficult to confirm, to help find out and share problems unique to the elderly person.
- It is possible to obtain detailed information about elderly individuals through the information-sharing function of this system and to reduce the effort of care, i.e., the number of visits made to professionals and the elderly persons' homes. The results show that professionals could thus care for more elderly people.

- The system is useful for reducing the burden on care managers who play a central role in cooperation among other professionals, including family members, and for improving efficiency by utilizing information obtained from them.
- The family members are encouraged to input and share the state of the elderly individuals at home because they understand that they can better grasp the exact situation of the elderly individuals and obtain appropriate advice from the professionals by using the system.
- The input of the information by all stakeholders leads to the reduction of their burdens and the improvement of care.

Thus, we consider that information sharing by all professionals not only improves care for the elderly population but also has the effect of reducing workloads, increasing efficiency and promoting the sharing of information among the elderly individuals' families.

17.7.2 Difference in the Usage Status of This System for Each Household

Compared with the first district in Table 17.2 and the third district in Table 17.4, the use of this system seems to be less frequent in the second district shown in Table 17.3. The "Care manager of Subject A" commented that "multiprofessional collaboration using such an information-sharing system would not be successful if only medical professionals used it." We consider that one of the reasons for this is that there is little information provided from family members of the elderly individuals.

Comparing Tables 17.2 and 17.3, the use of the system by the family members of "Subject C" is less than that by the family members of "Subject A" even though family members of Subject C started their operation of this system at the same time as the family members of Subject A. We consider that there is a relationship between the usage by the family members and that by the professionals. Namely, as the use by the family increases, the information sharing by all the stakeholders will also increase. Therefore, we consider that it is essential to regard family members as multiprofessionals and to actively share information with each other in multiprofessional collaborations.

"Doctor B" inputs their information more frequently than do the other doctors but has less total input and fewer message confirmations. "Doctor A" stated that "The number of inputs depends on the purpose of the usage. If a doctor who has a strong relationship with medical information inputs a message, a care manager who wants the information will inevitably input and confirm the messages." We consider that the sharing of medical information by doctors is one of the factors related to active information sharing.

17.7.3 Effects on the Elderly Population

We consider that the system fosters multiprofessional collaboration using information sharing among all the stakeholders. We find that the system also has a positive effect on the elderly individuals who are observed. For example, Subject A said, “I feel that family and other people watch over me. So, I began to live a regular life.” We consider that the system provides the elderly individuals with a kind of awareness of their health.

17.7.4 Issues of the System

We consider that specifying the degree of importance enables users to understand essential messages at a glance and contributes to more precise information sharing. However, it is not easy for stakeholders, especially family members, to set appropriate importance levels for each message. Therefore, it is necessary to carefully consider whether they will avoid the input operation itself due to the complexity of the work and the related increase in the amount of work. In a case where high importance is set for a message, stakeholders might have a kind of sense of duty toward dealing with that message urgently. This sense of urgency increases the burden on stakeholders such that they might avoid using the message sharing function. We consider the balance between the improvement of the function and the increase in the burden. In the future, we will pay careful attention to the impacts of field use to improve the system.

As mentioned in Sect. 17.4.1, the MCNBook System is implemented on a virtual machine of our affiliation. The cost is free because the system is a research project in our laboratory. Our laboratory members are responsible for developing the system and the system management. The system is mainly operated by our collaborators, as mentioned in Sect. 17.4.3. There is one issue regarding the issue of how to deal with the cost burden from the viewpoint of the sustainability of system development and operation. We recognize that this is one of the problems that must be resolved to disseminate the system throughout the whole region. In the future, we will study how to treat this issue of this system.

17.8 Analysis of Business Innovation

We analyze this case from the viewpoint of business innovation based on the following items.

(1) **What are the needs of people, the issues in society and business and the objective of utilizing ICT? (needs)**

The community-based integrated healthcare system will be introduced in Japan. This healthcare system aims to provide elderly people living at home with appropriate health, medical, and welfare services. For this community-based integrated healthcare system to succeed, all the stakeholders should share information about the situation of the elderly individuals living at home with each other. Currently, information about these elderly individuals is stored separately in each department's system. Information on older people is not shared among divisions and is not available throughout the whole divisions. There are some issues caused by a lack of information sharing as follows:

- Difficulty in properly grasping the situation of housebound elderly individuals, and
- Difficulty in providing elderly individuals with adequate care services at the right moment.

(2) **What technologies and functions are utilized to solve these issues or realize the needs of people? What is the role of ICT in value creation? (technologies)**
We try to solve these issues with an information-sharing system. We consider that the system enables stakeholders to share information about the situation of the elderly individuals with each other.

(3) **What are the value creation methodologies? (value creation)**
In this case study, the system users and our laboratory members serving as system developers got together to develop and operate the system. As a result, the development-improvement spiral process is able to be changed quickly and appropriately. We consider that it is important that system users and supporters with ICT knowledge and skills cocreate and take charge of system development and operation. The stakeholders are not just system users themselves, and they recognize that they are also in charge of the development and operation.

(4) **What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (human/business activities)**
In this case study, we held two types of meetings. One type was an on-site meeting for each subject where system users, including the family members of a subject and our laboratory members serving as system developers, gathered approximately once a month. At that meeting, we shared information about the situation and observations concerning the monitoring of the target elderly person and requests for improvements to the prototype system. The second type was a multiprofessional coordination meeting where our laboratory members and multiprofessionals gathered about once a month. At this meeting, we shared information about the usage status of the stakeholders of all subjects and decided on the improvements and operation mechanisms of the system, such as the setting of information access authority for each stakeholder, the decision about operation policy and the selection of a new target person. The system users and the developers exchanged opinions carefully to improve the system and the

operation policy. As a result, we achieved a prototyped system flexibly according to the exact requirements derived by the experiences of the stakeholders, as mentioned in Sect. 17.4.3.

Currently, system development companies and IT providers have been mainly responsible for system developments and operations needed to solve social issues with ICT. Hence, it is not easy to perform necessary and sufficient functions (services) and their improvements appropriately because the system users are just "clients." On the other hand, in this case study, the system users and our laboratory members serving as system developers got together to develop and operate the system. As a result, the development-improvement spiral is able to be changed quickly and appropriately. Therefore, we find that it is important that system users and supporters with ICT knowledge and skills cocreate and take charge of system development and operation.

Currently, the system development of the MCNBook System is almost complete. We created the user manuals and distributed them to our collaborators. The collaborators recruit users who want to use this system. The collaborators then introduce the system themselves and independently operate the system. We only manage the system technically. We think that this independent approach might be cultivated by the "service and spiral system development process" mentioned in Sect. 17.4.3. We consider that the collaborators recognize the effect on their work and understand the value of the MCNBook System during the process because the functions of the MCNBook System depend on their demands, and we collaborate with them to update the system.

(5) **How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (innovation)**

The system fosters information sharing among stakeholders. In this case study, we found the following effects of using the MCNBook System on multiprofessional collaboration for in-home care:

(a) Effects on multiprofessional collaboration for in-home care:
We consider that information sharing by all professionals not only improves the overall care for the elderly population but also has the effect of reducing workloads, increasing efficiency and promoting the sharing of information with the elderly individuals' families.

(b) Difference in the usage status of this system for each household:
We consider that it is essential to regard family members as multiprofessionals and for the stakeholders to actively share information with each other in multiprofessional collaboration.

(c) Effects on the elderly population:
We consider that the system provides the elderly population with a kind of awareness of their health. In addition, the system not only improves the overall quality of care, such as the provision of appropriate care reducing the burden on stakeholders, but also changes the consciousness and behaviors of the stakeholders, such as the induction of more aggressive care behavior.

17.9 Conclusion

In this chapter, we introduce an information-sharing system to support multiprofessional collaboration in a community-based integrated healthcare system. We conducted a field test of the system in three districts of Nomi city, Ishikawa Prefecture, Japan. According to an analysis of the system usage logs and an interview survey, the information-sharing system was effective in reducing the burden on professionals such as care managers and in improving efficiency. It was also found that active information sharing by professionals promotes activities related to the confirming and inputting of messages for the family members of elderly individuals. Additionally, the elderly persons were aware that the stakeholders were watch over them carefully, and this awareness had the effect of making their daily life more regular. From these results, we consider that the use of this system makes it possible to share information that was previously difficult to share among all the stakeholders and demonstrates the possibility of promoting the health of the elderly individuals themselves.

In this case study, system users and our laboratory members serving as system developers got together to develop and operate the system. The development-improvement spiral is able to be changed quickly and appropriately. Therefore, we consider that it is important that system users and supporters with ICT knowledge and skills cocreate and take charge of the system development and operation.

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References

Abe Y, Morita T (2014) A measure to quantify the quality of communication and cooperation among medical, nursing, and welfare services in a region. Palliative Care Res 9(1):114–120. (in Japanese) (Abstract in English, https://www.jstage.jst.go.jp/article/jspm/9/1/9_114/_pdf. Access 25 March 2020

Amir O, Grosz JB, Gajos ZK, Swenson MS, Sanders ML (2015) From care plans to care coordination: opportunities for computer support of teamwork in complex healthcare. In: Proceedings of ACM conference on human factors in computing system 2015 (ACM CHI2015), pp 1419–1428

Cabinet Office Japan (2019) Annual report on the aging society [Summary] FY2019. https://www8.cao.go.jp/kourei/english/annualreport/2019/pdf/2019.pdf. Access 25 March 2020

Duncan J, Camp J, Hazelwood RW (2009) The portal monitor: a privacy-enhanced event-driven system for elder care, Persuasive'09, Article No. 36. 9 p. https://doi.org/10.1145/1541948.1541995

Japanese Ministry of Health, Labor and Welfare (MHLW) (2014) Care meeting, https://www.mhlw.go.jp/seisakunitsuite/bunya/hukushi_kaigo/kaigo_koureisha/chiiki-houkatsu/dl/link3-0-01.pdf. (in Japanese). Access March 25th, 2020

Kanamic Network Co., Ltd. (2020) https://www.kanamic.net. (in Japanese). Access 25 March 2020

Pinelle D, Gutwin C (2006) Loose coupling and healthcare organizations: deployment strategies for groupware. In: Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work (CSCW'06), pp 537–572

Statistics Bureau of Japan (2020) http://www.stat.go.jp/english/index.htm. Access 25 Match 2020

Yamamoto R, Yoshino T, Nishibata M, Nakai K, Yanagimonoto M, Irie M (2018) Evaluation of a cooperative patient information system for home care providers. J Inf Process (JIP) 59(5):1351–1361 (in Japanese)

Yamashita N, Kuzuoka H, Hirata H, Kudo T (2013) Understanding the conflicting demands of family caregivers caring for depressed family members. In: Proceedings of ACM conference on human factors in computing system 2013 (ACM CHI'13), pp 1637–2646

Yamashita N, Kuzuoka H, Hirata H, Kudo T, Aramaki E, Hattori K (2017) Changing moods: how manual tracking by family caregivers improves caring and family communication. In: Proceedings of ACM conference on human factors in computing system 2017 (ACM CHI2017), pp 158–169

Chapter 18
Summary

Michitaka Kosaka, Jie Wu, Ke Xing, and Shiyong Zhang

Abstract This chapter summarizes the case studies and discusses the trends emerging from the cases for business innovation with new ICTs. Firstly, several key concepts are discussed in connection with business innovation in the twenty-first century. Next, the key characteristics and messages of the case studies are summarized respecting the five questions posed in Chap. 1 and are analyzed in relation to those key concepts. Based on such analysis, a conceptual model for business innovation with new ICTs is then proposed. The chapter concludes with a discussion on the direction for future business and social developments with new ICT solutions beyond COVID-19.

18.1 Introduction

This chapter summarizes the case studies and discusses the trends emerging from the cases for business innovation with new ICTs. Firstly, several key concepts are discussed in connection with business innovation in the twenty-first century. Next, the key characteristics and messages of the case studies are summarized respecting the five questions posed in Chap. 1 and are analyzed in relation to those key concepts. Based on such analysis, a conceptual model for business innovation with new ICTs

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is then proposed. The chapter concludes with a discussion on the direction for future business and social developments with new ICT solutions beyond COVID-19.

18.2 New Concepts Related to Business Innovation in the Twenty-First Century

Despite the diversity of the case studies in contexts, perspectives and methods applied, there are common characteristics of those cases emerging from the analysis. These characteristics are in line with some key new concepts related to business innovation in the twenty-first century, which are Sustainable Development Goals (SDGs) for new business and social developments, Cyber-Physical System (CPS) for digitalization of business operations, Service Dominant Logic (SDL) and Transformative Service Research (TSR) in the areas of new Service Science, Platform Economy for new business models, Society 5.0 as a new paradigm for integration of social, economic and technological developments, and Environmental, Social and Governance (ESG) for modern management and investment models. They represent the key drives for business innovation with new ICTs.

(1) **Sustainable Development Goals (SDGs)**
According to the United Nations, the Sustainable Development Goals, aka SDGs, represent social needs and people desires in the global society. SDGs were enshrined as the Global Goals and embraced by all UN member states in 2015, calling for collective actions to end poverty, protect the planet and promote peace and prosperity by 2030 (https://www.undp.org/content/undp/en/home/sustainable-development-goals.html). There are seventeen goals in total, including (1) eliminate poverty, (2) erase hunger, (3) establish good health and well-being, (4) provide quality education, (5) enforce gender equality, (6) improve clean water and sanitation, (7) grow affordable and clean energy, (8) create decent work and economic growth, (9) increase industry, innovation, and infrastructure, (10) reduce inequality, (11) mobilize sustainable cities and communities, (12) influence responsible consumption and production, (13) organize climate action, (14) develop life below water, (15) advance life on land, (16) guarantee peace, justice, and strong institutions, (17) build partnerships for the goals. These goals are integrated to recognize their mutual connections in delivering balanced outcomes of development for social, economic and environmental sustainability. Achieving the SDGs requires concerted effort from every part of the society with creativity, knowhow, technology and financial resources. Therefore, they should be the ultimate goals of business innovation in the twenty-first century.

(2) **Cyber-Physical System (CPS)**
Cyber-Physical System, or CPS hereafter, is an important concept in relation to digital-inspired innovation with new ICTs, such as IoT and AI, and their

synthesis. CPS integrates computing, networks and data analytics with physical processes. The technology has digital systems embedded in devices and instruments and interact with physical processes of the equipment applications through monitoring and control, with feedback loops to influence the digital model established as the 'virtual twin' of the physical processes. CPS links the dynamics of the physical processes with those of the software and data, providing enhanced modelling, design, and analysis capabilities for the whole integrated system. This area has attracted increasing attention and investment for the technology development and implementation. CPS appears to have strong potential in delivering value for both business and the societal needs, becoming a key focus of innovation with new ICTs toward realizing SDGs. Lee (2008), Lee et al. (2015).

(3) **Service Dominant Logic (SDL) and Transformative Service Research (TSR)**

Service is defined to create values for customers and society. Therefore, Service Science is important for business innovation to create new values with ICTs. Service Dominant Logic (SDL) and Transformative Service Research (TSR) represent two new concepts of Service Science gaining traction in business innovation over the recent decade.

Proposed by Vargo and Lusch (2004) as a new concept of service, SDL is featured as opposite to the traditional Goods Dominant Logic (GDL) in how the value for customers is determined. The concept of "value in use" is essential to maximize human satisfaction with services. SDL provides a new perspective for service systems, where goods are "vehicles" or "medium" in delivering services to customers. Vargo and Lusch also stressed the importance of value co-creation by service providers and customers as an essential characteristic of SDL. The service value in SDL is determined by customers. Therefore, they are collaborators in realizing service value and active participants in service design and delivery.

The concept of TSR focuses on human well-being enhancement. According to Anderson et al. (2013, p. 1203), TSR is an emerging area of Service Science and defined as "*the integration of consumer and service research that centers on creating uplifting changes and improvements in the well-being of consumer entities: individuals (consumers and employees), communities and the ecosystem.*" TSR sets the emphasis of value creation through service innovation on contributing to well-being in human society. This is well aligned with the directions of SDGs. Hence, both TSR and SDL provide theoretical underpinnings for value creation and value capture in service-oriented business innovation.

(4) **Platform Economy**

Platform Economy has been discussed as a new form of economy stemmed from and enabled by the evolution of the Internet and digital technology. The nature of Platform Economy represents a digital transformation by which the evolutions of the Internet and ICTs power tools and frameworks to shape and facilitate economic and social activities. In the digital domain, the "platforms" are underpinned by computable algorithms and data capabilities hosted in the cloud to support a diverse range of activities from production to consumption and from manufacturing to services. In the economic domain, "platforms" are "frameworks that permit collaborators—users, peers, providers—to undertake a range of activities, often creating de facto standards, forming entire ecosystems for value creation and capture" (Kenny and Zyaman 2015, 2016). So far, there are many successful cases of Platform Economy, with Uber and Airbnb as the most prominent examples, in new service-oriented business models coupled with novel Internet-based ICT solutions and digital applications.

(5) **Society 5.0**

Society 5.0 is a concept first coined in Japan and is represented by the federation of Japanese economic organizations. Society 5.0 was proposed in the 5th Science and Technology Basic Plan as a future society that Japan should aspire to. The term follows the notions of "Hunting Society" (Society 1.0), "Agricultural Society" (Society 2.0), "Industrial Society" (Society 3.0), and "Information Society" (Society 4.0). While bearing some resemblance to Industry 4.0 in the technological sense, Society 5.0 is defined as "*a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space*." In order to achieve both economic development and solutions to social problems in concurrency, Society 5.0 requires drawing upon the progress of new technologies, such as IoT, robotics, AI, and Big Data, and incorporating them in innovations for all industrial and social activities. The scope of Society 5.0 encompasses a range of social, economic and environmental targets, which include reducing greenhouse gas (GHG) emissions, increasing production and reducing loss of foodstuffs, mitigating costs associated with the aging society, supporting sustainable industrialization, redistributing wealth, and correcting regional inequality.

Therefore, inherently Society 5.0 aspires the direction of social innovation and business innovation using new technologies and aims to shape new paradigms of society by linking ICT solutions with delivering SDGs. Fukuyama (2018), Mavrodieva and Shaw (2020), Takahashi (2018).

(6) **Environmental, Social, and Governance (ESG)**

Under the above trends, new management concepts such as ESG management and ESG investment have gaining momentum in business fields. The notion of ESG highlights environmental impacts, social responsibility and corporate governance as the three key aspects that determine the Triple Bottom Line performance of a business or organization. It also sets the criteria for companies to measure and strategically manage future risks in relation to business operations and business innovation with implementing new technologies (Holland 2011).

As discussed above, these concepts intrinsically fit in with the characteristics of future business innovation. The nature of SDGs is related to human desires and ultimate goals of business innovation. CPS is a system concept with new ICTs to enable business innovation for value delivery. SDL and TSR contribute to value co-creation among stakeholders such as ICT providers, service providers

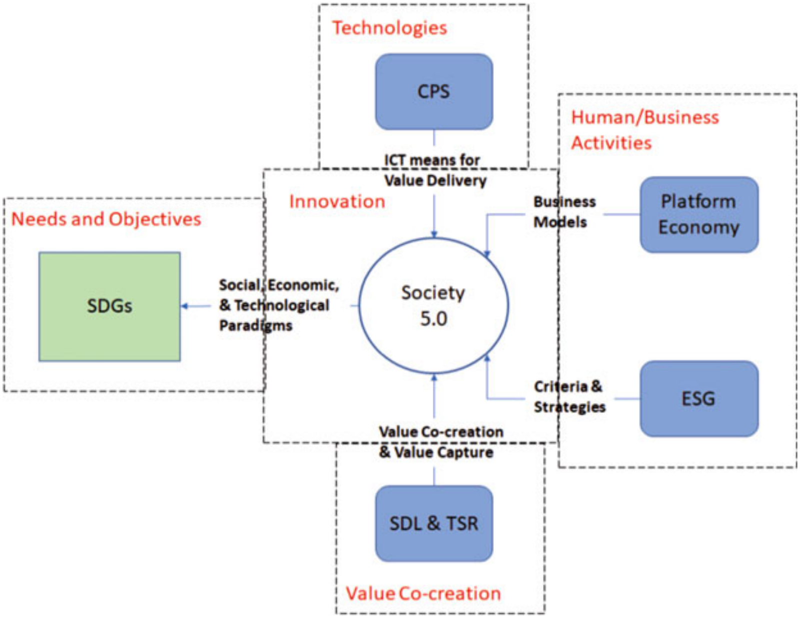

Fig. 18.1 Connections of the new key concepts

and customers through creating collaborative communities share same value propositions and standards. Platform Economy presents Internet-based novel business models in supporting value co-creation on digital business platforms. ESG represents a management concept in the era of SDGs in defining business strategies and performance criteria for performance management. Society 5.0 delivers a paradigm of Smart Society in realizing the objectives of SDGs by integrating technological, business and social innovations. Figure 18.1 illustrates the relationship among the seven concepts and their alignment with the five perspectives applied for examining the case studies in this book, i.e. "Needs and Objectives", "Technology", "Human/Business Activities", "Value Co-creation" and "Innovation".

18.3 Analyses of Case Studies on Business Innovation with New ICT

In Chap. 1, five main questions are introduced for analyzing the trends of business innovation with new ICTs in the Asia-Pacific, which are:

(1) Question 1: What are the needs of people, the issues in society and business and the objective of utilizing ICT? (Needs and Requirements)

(2) Question 2: What technologies and functions are utilized to solve these issues or realize the needs of people? What is the role of ICT in value creation? (Technologies)
(3) Question 3: What are the value creation methodologies? (Value Creation Methodology)
(4) Question 4: What is the relationship between human/business (including employee, organizational culture, leadership, etc.) activities and an ICT system and that among users, ICT providers and other stakeholders (collaboration)? (Human/Business Activities)
(5) Question 5: How has human life, business and society changed in consideration of innovation, revolution of business models, creation of new eco-system and change of human life? (Innovation)

The case studies cover fourteen examples selected from Mainland China, Taiwan, Japan, Australia, Malaysia and Vietnam. These case studies are clustered in four categories, i.e. the perspectives of ICT providers, the perspectives of changes of traditional businesses and services, the perspective of new business models enabled by smartphones and the Internet, and the perspectives of new application fields of ICT solutions. In this section, the characteristics and the findings of the case studies in those four categories are summarized in relation to those five questions and analyzed through the lenses of the key concepts described in the previous section.

18.3.1 Analysis of Case Studies from ICT Providers' Perspectives

To elucidate the potential directions for ICT venders toward business innovation with new ICTs, four cases are examined from the perspectives of ICT providers, which include two giant Japanese ICT venders (i.e. Hitachi and NEC), one Taiwanese information service provider (i.e. Advantech), and one Chinese ICT solution provider for retail business (i.e. NEXTTAO). Table 18.1 summarizes the responses in the four case studies with regard to (a) Needs and Objectives, (b) Technologies, (c) Value Creation Methodology, (d) Human/Business Activities and (e) Innovation.

As reflected in the case studies, the problems presented to and the solutions developed by those ICT providers are not only related to improving business efficiency for their clients, but also intended for enabling social and environmental well-beings as promoted by **SDGs**. Major ICT providers such as Hitachi and NEC express strongly their commitments in making contributions to address social challenges in line with the scope of SDGs.

In order to provide technological means for tackling such issues, ICT providers prepare ICT platforms, including IoT and AI, and create tailored solutions by integrating their knowhow with various ICT resources (both software and hardware). For instance, Hitachi implements the Lumada platform, NEC prepares an ICT platform for digital inclusion including biometrics, Advantech Co. adopts the WISE-PaaS, and

Table 18.1 Summary of the case studies from ICT providers' perspectives

(a) Needs and objective (ICT providers)		
Chaps.	Case context	Needs and objectives
4	Hitachi Ltd., Japan (Information and electronic systems)	Objectives are resolving the social issues outlined in the UN's SDGs, simultaneously improving social, environmental, and economic values
5	NEC Corporation, Japan (Information systems and services)	ICT is introduced to deliver well-being, hospitality, and convenience for a rewarding life where their human qualities can flourish.
6	Advantech Co., Taiwan (Information systems and services)	Objectives are increasing productivity and performance, providing value to customers. The goal of Advantech is to build an intelligent planet
7	NEXTTAO, China (Information systems for retail)	Objectives are great convenience for people's daily life and new business opportunities to better serve customers, generate more returns
(b) ICT technology (ICT providers)		
Chaps.	Case context	Technology
4	Hitachi Ltd., Japan (Information and electronic systems)	Real data are accumulated into cyber space and analyzed, and the results are fed back into physical space through Lumada. (CPS)
5	NEC Corporation, Japan (Information systems and services)	Each of the three cases used services based on technologies developed by NEC such as IoT, biometric authentication, and AI
6	Advantech Co., Taiwan (Information systems and services)	WISE-PaaS is to serve hardware manufacturers, software developers, system integrators, and organizations system seeking to adopt AIoT
7	NEXTTAO, China (Information systems for retail)	The cloud-based platform, DataForce, processes vast data, provides real time computing of business AI and coordinates the systems with real-time
(c) Value creation mechanism		
Chaps.	Case context	Value creation methodology
4	Hitachi Ltd., Japan (Information and electronic systems)	Lumada has customer co-creation methodologies: NEXPERIENCE. It covers a wide range of phases for satisfying customers' goals
5	NEC Corporation, Japan (Information systems and services)	By orchestrating NEC's activities with those of diverse stakeholders, they aim to implement Digital Inclusion

(continued)

Table 18.1 (continued)

(c) Value creation mechanism		
Chaps.	Case context	Value creation methodology
6	Advantech Co., Taiwan (Information systems and services)	The value creation is done through constructing a marketplace in which various stakeholders can be benefited
7	NEXTTAO, China (Information systems for retail)	Every enterprise can use digital technologies to increase its internal operation and collaboration efficiency across the industry value chain
(d) Community and business model		
Chaps.	Case context	Human/business activities
4	Hitachi Ltd., Japan (Information and electronic systems)	Lumada connects not only internal business units (IT, energy, industry, mobility, and smart life) but also external stakeholders and Hitachi group
5	NEC Corporation, Japan (Information systems and services)	NEC creates business innovation with customers, enabling them to work together on the creation of social value (B to B to Society)
6	Advantech Co., Taiwan (Information systems and services)	Relationship among Advantech, customers, hardware/software producers, and system integrators is interdependent on the WISE-PaaS.
7	NEXTTAO, China (Information systems for retail)	Enterprise build a proprietary eco-system to orchestrate all related partners to better serve customers with state-of-art ICT technologies
(e) Created innovation (ICT provider)		
Chaps.	Case context	Innovation
4	Hitachi Ltd., Japan (Information and electronic systems)	Hitachi creates social innovation, which resolves issues faced by society and customers
5	NEC Corporation, Japan (Information systems and services)	NEC pursues the realization of Digital Inclusion by creating social value in terms of safety, security, fairness, and efficiency
6	Advantech Co., Taiwan (Information systems and services)	Advantech speeds up the AIoT-based solution implementation. As a result, productivity is increased and energies are saved

(continued)

Table 18.1 (continued)

(e) Created innovation (ICT provider)		
Chaps.	Case context	Innovation
7	NEXTTAO, China (Information systems for retail)	It changed in-store workforce's customer service model and efficiency. Customers are happy with intimate services and satisfactory products

NEXTTAO employs the cloud-based DataForce platform. These platforms enable interactions between digital models and physical processes, akin to the dynamics of **CPS**, to provide better solutions to customers.

For those ICT providers, **value co-creation** (as defined by **SDL** and **TSR**) is paramount for their business. Hitachi applies the value co-creation methodology, NEXPERIENCE, for co-creation with customers. NEC promotes value co-creation activities across their projects. Advantech and NEXTTAO also prepare marketplaces or business models for co-creation with customers and stakeholders. Their business strategies are to establish **digital-enabled collaborative innovation eco-systems**, including internal business units and external stakeholders, to provide better services to customers with state-of-art ICT solutions. Through these activities, ICT providers solve issues faced by customers as well as by the society, improve both the efficiency of business operations for customers and the quality of life for the broad community, and contribute to social innovation, which are inherently aligned with the concept of **Society 5.0**.

18.3.2 Analysis of Case Studies from Changes of Traditional Business and Services

In order to cast light on how traditional businesses and services can be affected by new ICTs and transform, four case studies on firms from manufacturing, agriculture, transportation and education industries are analyzed with respect to the five questions, which are summarized as follows (Table 18.2).

For traditional businesses, a main objective of utilizing ICTs is to instigate transformation of their business models and processes toward better capability for value creation, value capture and value delivery. In the case of Industry 4.0 transformation of the manufacturing industry in the City of Salisbury, the investigation highlights the need for **digital innovation and transformation of business models** allowing a more interactive partnership between local firms and their stakeholders. The case study identifies the needs for and the gaps in aptitude and readiness for innovation with employing new digital technologies and platforms, such as IoT, AI, and **CPS**, and enhancing supply chain integrations for value creation. This case study also reveals several challenges for digitalization such as cybersecurity risks related to IoT, cloud technology and data analytics.

Table 18.2 Summary of case studies from changes of traditional business and services

(a) Needs and objective (Traditional businesses and services)		
Chaps.	Case context	Needs and objectives
8	The city of Salisbury, Australia (manufacturing)	Transforming traditional manufacturing towards new advanced manufacturing processes is central to the future economic viability for the City of Salisbury. There is an urgent need to explore and adopt new strategies and operatios models for Industry 4.0
9	Fujitsu, Japan (Information system) Spread, Japan (Plant firm) MimosaTEK, Vietnam (ICT solution)	Objectives based on various issues in global agricultural business are to increase yield optimization, to improve crop protection, and to optimize food supply chain. This is one of SDGs for human beings in the twenty-first century
10	JR-EAST, Japan (Railway transportation service)	Customers' needs are safety and relief railway transport service Employees' needs are management of huge volume of infrastructure
11	Wuxi vocational institute, China (Higher vocational education)	Needs of education providers and learners are to provide high-quality, affordable and easily accessible education services in vocational education

(b) ICT technology (Traditional businesses and services)		
Chaps.	Case context	Technology
8	The city of Salisbury, Australia (manufacturing)	High awareness of digital innovation as well as relatively strong business motivation and capability for digitalisation, data security and phyiscal ICT platforms for operations. But, need to strengthen data analytics, data/system integration for interoperability
9	Fujitsu, Japan (Information system) Spread, Japan (Plant firm) MimosaTEK, Vietnam (ICT solution)	A total system optimization approach, collecting data with IoT, analyzing it with AI for optimization, controling equipment, and creating suitable information for decision makers, is a type of CPS
10	JR-EAST, Japan (Railway transportation service)	The autonomous decentralized system for realizing partial replacement To realize high frequent data gathering by IoT, maintenance decision by AI

(continued)

Table 18.2 (continued)

(b) ICT technology (Traditional businesses and services)		
Chaps.	Case context	Technology
11	Wuxi vocational institute, China (Higher vocational education)	4G/5G wireless communication, mobile computing, cloud computing, virtual reality and augment reality, and artificial intelligence more recently
(c) Value creation mechanism (Traditional businesses and services)		
Chaps.	Case context	Value creation methodology
8	The city of Salisbury, Australia (manufacturing)	Industry 4.0 technology advancement for better value creation and business innovation to reshape the existing industry structure for improved value capture. Positive workplace culture and values to motivate innovation
9	Fujitsu, Japan (Information system) Spread, Japan (Plant firm) MimosaTEK, Vietnam (ICT solution)	Value is co-created between agriculture people and providers In agricultural ICT business, agricultural knowledge is indispensable for providers to create values with agricultural people by using ICT
10	JR-EAST, Japan (Railway transportation service)	ICT makes railway service provider and customers get closer and ICT reduces time lag of communication
11	Wuxi vocational institute, China (Higher vocational education)	WVIC utilizes various digital resources such as video, audio, eBooks, and PowerPoints for knowledge transmission
Table (d) Community and business model (Traditional businesses and services)		
Chaps.	Case context	Human/business activities
8	The city of Salisbury, Australia (manufacturing)	To upgrading workforce skills (particularly soft skills) for digital capability and innovation aptitude. Actively engage with collaboration eco-system and regional strategies for supporting the concept of change in firms and in the public mindset
9	Fujitsu, Japan (Information system) Spread, Japan (Plant firm) MimosaTEK, Vietnam (ICT solution)	Co-creation and collaboration are indespensable for the future ICT business Fujitsu proposes a smart agriculture concept with stakeholders, Spread promotes partnership, and MimosaTEK collaborates with farmers
10	JR-EAST, Japan (Railway transportation service)	ICT improved the environment of information sharing between service providers and customers, and made sharing process smooth
11	Wuxi vocational institute, China (Higher vocational education)	ICT redefines relationships among three stakeholders including education providers, learners and ICT service providers

(continued)

Table 18.2 (continued)

Table (e) Created innovation (Traditional businesses and services)		
Chaps.	Case context	Innovation
8	The city of Salisbury, Australia (manufacturing)	Demonstrate medium level of Industry 4.0 Transformation Maturity Index for digital innovation and endorse a concerted effort through captured synergies across existing initiatives, programs and entities
9	Fujitsu, Japan (Information system) Spread, Japan (Plant firm) MimosaTEK, Vietnam (ICT solution)	Agricultural ICT innovates a food supply chain with agricultural products and a productivity of agricultural products This is a new innovation in agriculture
10	JR-EAST, Japan (Railway transportation service)	JR provides social innovation by contribution of social infrastructure service through new values in transportation
11	Wuxi vocational institute, China (Higher vocational education)	ICT has transformed and expanded conventional vocational education by reducing its cost, improving its availability and accessibility

In the case of agriculture business, Fujitsu, Spread and MimosaTEK have deployed various ICT devices, such as sensors, IoT, AI, smartphones. Cloud computing and **CPS** are adopted for enhancing productivity. ICT providers and farmers collaborate to change the agriculture business for more efficient operations with utilization of ICTs. Such a practice is expected to help with better improving food security, which is one of **SDGs**. In the transportation case study on JR-EAST, they employ ICT solutions not only for improving safety and smoothness in their transportation services, but also for diversifying their services to other business domains, including retail and electric payment. JR-EAST aims at improving customer experience by integrating various services in supporting during customer mobility. JR-EAST and customers **co-create value** with each other by using their ICT system platform, SUICA, and smartphones for information services. In education case of Chinese vocational school, various ICTs are utilized for online lectures. This changes the teaching style from traditional face-to-face lectures in classroom to interactions in the virtual class environment. Teachers and students co-create value in achieving desired outcomes through the **Internet-based platform** for learning-and-teaching. The effectiveness of online lectures has been improved during COVID-19. These case studies show real examples of **digital transformation with new ICTs**, which can reshape both how businesses operate and how customers access the services.

18.3.3 Analysis of Case Studies from New Business with Smartphones and the Internet

A major phenomenon of business innovation with new ICTs is the development of new business models and platforms underpinned by the fusion of smartphones and the Internet, driving profound changes to people's lifestyle. This book presents three case studies on mobile payment (UnionPay), automotive aftermarket e-commerce (Sparke Autoparts), as well as e-hailing and e-hypermarket (E-business Market), with their features summarized in Table 18.3.

Despite their differences in context, the aims of those new businesses with smartphones and the Internet studied are to cater for the needs of their customers for better and more convenient lifestyle and to streamline business process by leveraging on the power of mobile devices and business platforms on the Internet. Businesses partner with their stakeholders and customers in collaboration on these business platforms for creating, capturing and delivering value. China UnionPay collaborates with business partners to provide better services to customers on the mobile payment platform. The mobile payment system enables expedient and reliable transaction processes with mobile phones. Sparke Autoparts is the result of win-win relationship between PKT and Baturu on the automotive e-commerce platform. The automotive aftermarket e-commerce provides efficient business processes for trading automotive products and services. The e-hailing and e-hypermarket platform facilitates value co-creation between service providers and customers, offering improved access to better information and more convenient service provisions. These case studies exemplify the concept of **Platform Economy** and its applications for business and social innovations in creating new value through mobile media and Internet-based platforms.

18.3.4 Analysis of Case Studies from New Application Fields with New ICT Solutions

New needs and desires for novel ICT applications arise from changing business and social environments. An eminent example is the demand for innovative ICT solutions in care services for elderly people due to the progress of aging society. Three cases regarding new application fields for ICTs are studied in the book, i.e. the mobile phones recycle services by Aihuisho (AHS), the lifelong learning services by JAIST and a community-based integrated health care system by JAIST and Nomi city. The attributes of these cases are analyzed as follows (Table 18.4).

The objective of utilizing ICT in these cases is to provide better services more efficiently toward emerging needs, especially for well-beings of human life and the environment. This is in line with the direction of **Transformative Service Research (TSR)** as postulated by Anderson et al. (2013). In traditional ICT business, ICT systems are developed by ICT providers, while users adopt them for satisfying their

Table 18.3 Summary of case studies from new business with smartphones and the Internet

(a) Needs and objective (New business with smartphone and internet)

Chaps.	Case context	Needs and objectives
12	China UnionPay, China (Financial services)	It calls for extreme convenience to fulfull the payment process. The major human desire for the mobile payment is excellent user experience
13	Sparke Autoparts, Malaysia (Automotive aftermarket business)	The objective of the new system is to improve the business efficiency and credibility in automotive aftermarket industry
14	E-business market, Malaysia (e-hailing and e-hypermarket)	Objectives are to satisfy customers who today are better informed, aware of their needs and have a clear idea of the product or service they want

(b) ICT technology

Chaps.	Case context	Technology
12	China UnionPay, China (Financial services)	New technologies such as TEEI are utilized in mobile payment product Risk management technologies are used to identify and prevent risk
13	Sparke Autoparts, Malaysia (Automotive aftermarket business)	IT platform consists of six systems as ERP, EPC, WMS, payment gateway, TMS and Sparke platform (website and mobile application)
14	E-business market, Malaysia (e-hailing and e-hypermarket)	Mobile devices such as smartphone or tablet as well as network access conduct transactions of exchanging value, information, and products

(c) Value creation mechanism

Chaps.	Case context	Value creation methodology
12	China UnionPay, China (Financial services)	The main methodology for value creation is through the innovation of technology integration and the innovation of industry coordination
13	Sparke Autoparts, Malaysia (Automotive aftermarket business)	The method of value co-creation is the Sparke e-commerce platform The process of value co-creation is similar to the steps of KIKI model
14	E-business market, Malaysia (e-hailing and e-hypermarket)	E-commerce in Malaysia is based on the concept of co-creation value between companies and customers to increase customer satisfaction

(continued)

Table 18.3 (continued)

(d) Community and business model		
Chaps.	Case context	Human/business activities
12	China UnionPay, China (Financial services)	It has brought convenience to life styles of consumers and business models The consumption and payment habits of consumers have gradually changed
13	Sparke Autoparts, Malaysia (Automotive aftermarket business)	"Sparke" is the result of win-win relationship between PKT and Baturu This is one of such global collaboration examples
14	E-business market, Malaysia (e-hailing and e-hypermarket)	Two-way communication between e-hailing companies and customers, and opinion leasders in e-hypermarket have important roles

(e) Created innovation		
Chaps.	Case context	Innovation
12	China UnionPay, China (Financial services)	There are changes in human life, business model, ecosystem Over half of payment transactions are conducted with mobile phones
13	Sparke Autoparts, Malaysia (Automotive aftermarket business)	The automotive aftermarket e-commerce is emerging business field ICT allows for more transparency and efficiencies business
14	E-business market, Malaysia (e-hailing and e-hypermarket)	Government's policy is making e-hailing as public services in Malaysia E-hypermarket creates better online shopping experience

requirements. In these three cases, however, new ICT systems and solutions are developed by their users (i.e. service providers and their collaborators), rather than by ICT providers. For instance, AHS developed the PJT Marketplace which draws offline transaction behavior online and makes the whole process trackable. JAIST developed service systems with blockchain and mobile phones through collaborations among the stakeholders of community services. **Value co-creation** through ICT platforms is also a very important feature in these cases as a way to enhance the efficacy of ICT systems towards satisfying varying requirements of end- users. In AHS case, value is co-created on the PJT platform. It "*embraces changes and adopts the "iteration method", which is a continuous improvement context and dynamic in workforce rather than believe in the notion that top management can control and guide everything properly*" (Chap. 15, 15.5(4)). In the two cases of JAIST, value co-creation is among stakeholders by using information sharing systems. The ICT systems are developed and enhanced through a spiral process in response to changing

Table 18.4 Summary of case studies from new application fields with new ICT solutions

(a) Needs and objectives

Chaps.	Case context	Needs and objectives
15	Aihuishou, China (Smartphone recycle services)	Market-oriented exchange behavior is required by sellers and buyers who want to make procurement in a cost-effective and timely manner
16	JAIST and a local city, Japan (Community services with blockchain)	There is a need of economic activation in the local community as well as the need of activation of citizen goodness and volunteer activity
17	JAIST and Nomi city, Japan (Services in aging society)	The healthcare system aims to provide elderly people living at home with appropriate health, medical, and welfare services

(b) ICT technology

Chaps.	Case context	Technology
15	Aihuishou, China (Smartphone recycle services)	Digitization and online operating with PJT Marketplace allow business actors their interactions to be seen with the help of machine intelligence
16	JAIST and a local city, Japan (Community services with blockchain)	To meet social needs, blockchain provides the function which satisfies needs It depends on not only technology but also human service design capability
17	JAIST and Nomi city, Japan (Services in aging society)	An information-sharing system, which enables stakeholders to share information on the situation of the elderly among them, can solve issues

(c) Value creation mechanism

Chaps.	Case context	Value creation methodology
15	Aihuishou, China (Smartphone recycle services)	AHS goes deeper to form a marketplace and related facilities to solve the fundamental trust problem, and this enhances industry coordination
16	JAIST and a local city, Japan (Community services with blockchain)	By considering service design including transaction rule of the resources, value generated by resource integration between participants is maximized
17	JAIST and Nomi city, Japan (Services in aging society)	Development-improvement spiral through co-creation with stakeholders can be turned quickly and appropriately

(continued)

Table 18.4 (continued)

(d) Business model and community		
Chaps.	Case context	Human/business activities
15	Aihuishou, China (Smartphone recycle services)	Internet-enabled marketplaces emphasize flat organizational structure and flexible adjustment from time to time
16	JAIST and a local city, Japan (Community services with blockchain)	The involvement of the stakeholders is indispensable for the effective promotion of the social system based on the blockchain
17	JAIST and Nomi city, Japan (Services in aging society)	Users and our members as system developers get together, develop and operate the system through on-site meeting and professional meeting

(e) Created innovation		
Chaps.	Case context	Innovation
15	Aihuishou, China (Smartphone recycle services)	The rapid expansion of networked business urges value co-creation mechanism, which requests socialized division of labor and cooperation
16	JAIST and a local city, Japan (Community services with blockchain)	This can make use of the power of citizen cooperation, thereby may contributing to global environmental sustainability issues
17	JAIST and Nomi city, Japan (Services in aging society)	It improves care for the elderly, reduces workload efficiently and promotes the sharing of information with the elderly's families

requirements through communications among stakeholders. These features represent a direction for ICT-based service business innovation in the future.

18.4 The Proposed Model of Business Innovation with New ICT in the Twenty-First Century

The features of the fourteen case studies are examined through the lens of the key concepts for business innovations as discussed in Sect. 18.2. The analysis underscores the notion that the role of ICTs for business innovation in the twenty-first century is not just to improve the performance of business operations, but also to better create and deliver value for human needs as well as social and environmental well-beings. Based on such considerations, a conceptual framework for business innovation with ICTs is constructed (as shown in Fig. 18.2) by drawing upon those key concepts and

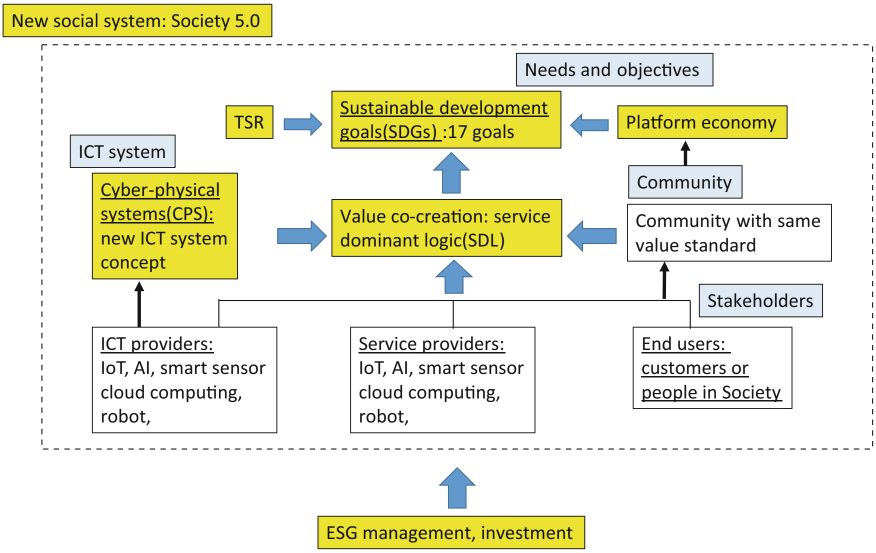

Fig. 18.2 The framework of business innovation with ICTs

their interconnections as depicted in Fig. 18.1.

As proposed by the framework, the utilization of ICTs in business innovation aims to revolutionize traditional business forms, to develop new social infrastructure and to transform industries and the societies. These fit well in the new socio-technical system paradigm in forms of Society 5.0 and contribute fully to the scope of SDGs, as embodiments of the needs and objectives of Society 5.0. According to SDL and TSR, value co-creation involving ICT providers, service providers, customers and other stakeholders is indispensable for forming communities with shared value standards and realizing collective needs and desires. These are inherently in line with the characteristics of Platform Economy, which are to support human well-being enhancement of TSR and underpinned by the Internet and ICT environment. Being core to the role of ICT systems, CPS integrates IoT, AI, smart devices and Internet-based platforms to instigate digital transformation for business and social activities in linking up goals, sharing knowledge and information as well as co-creating and co-delivering value among partners. Through these activities, various business innovations with ICTs, supported with enhanced ESG management and investments, help to shape and enable smart societies toward achieving the objectives of SDGs.

Essentially, the framework in Fig. 18.2 represents a superordinate conceptual model which is echoed by most of case studies with respect to their business environments and the characteristics of respective regions and countries. Powered by innovations with new ICTs, various nimble business approaches are tailored to aspirations of people and needs of communities for achieving desired outcomes. This differs from GAFA (Google, Amazon, Facebook, Apple)'s approach which establishes a common business model implemented across the world.

18.5 Concluding Remarks

During the course of development of this book, the outbreak of the COVID-19 has ravaged economies and societies in the Asia-Pacific region as well as around the globe. While most of activities in the physical world are halted by the spread of virus and the lockdown measures imposed by various jurisdictions, many companies, however, have significantly boosted their footprints online by exploring novel ways in utilizing digital platforms and ICT solutions to operate businesses and engage with stakeholders (both internal and external). The roles played by ICTs in the face of the pandemic underscore the importance and potential of business innovation with new ICTs in supporting businesses and livelihood.

The new ICTs instigate digital transformation not only in the technical sense, but also in terms of market demands. Some unconventional, Internet-based business forms have thrived during the COVID-19 period, such as online retail, online office, online education, telemedicine and online entertainment. They will continuously make strong impacts in the future economy. It is expected that new business types and modes will emerge through ICT-enabled innovation. Shared and personalized manufacturing, service manufacturing and intelligent manufacturing will grow up quickly with the rapid development and deployment of industrial internet of things. Digital transformation of service industry will also accelerate. A batch of new leading enterprises will be born through providing digital platforms for supply chains and, facilitating industry-finance connections for businesses, and helping digital transformation for small and medium-sized companies. Digital medicine and telemedicine service development will speed up. Applications of Fintech will improve service quality and even reshape the service mode of the financial industry.

Such digital transformation efforts with new ICTs, especially those of IoT, 5G, big data, cloud computing and AI, have stepped into a new phase. Also, many companies in the Asia-Pacific region, as well as around the world, have adopted own unique philosophy, vision and methodology for business innovation, which will continue to evolve in accordance with the changing times. It is expected that ICTs will have profound impact on our life in the post-COVID world and play even more influential role in creating new value for both businesses and societies. We hope that the case studies presented in this book can help to inform thinking and discussion on innovation with new ICTs for future businesses.

References

Anderson L et al (2013) Transformative service research: an agenda for the future. J Bus Res 66:1203–1210

Fukuyama M (2018) Society 5.0: aiming for a new human-centered society. Jpn SPOTLIGHT (July/August 2018):47–50

Holland J (2011) A conceptual framework for changes in fund management and accountability relative to ESG issues. J Sustain Fin Invest 1(2):159–177. http://eprints.gla.ac.uk/71971/

Kenny M, Zyaman J (2015) Choosing a future in the platform economy: the implications and consequences of digital platforms. Kauffman Foundation New Entrepreneurial Growth Conference, Amelia Island Florida June 18/19, Discussion Paper, pp 1–23

Kenny M, Zyaman J (2016) The rise of the platform economy. Issues Sci Technol pp 61–69. National Academies of Sciences, Engineering, and Medicine, The University of Texas at Dallas, Arizona State University, Spring 2016

Lee EA (2008) Cyber physical systems: design challenges. Technical Report No. UCB/EECS-2008-8, Electrical Engineering and Computer Sciences University of California at Berkeley. http://www.eecs.berkeley.edu/Pubs/TechRpts/2008/EECS-2008-8.html

Lee J, Bagheri B, Kao H (2015) A Cyber-physical systems architecture for Industry 4.0-based manufacturing systems. Manuf Lett 3:18–23

Mavrodieva AV, Shaw R (2020) Disaster and climate change issues in Japan's Society 5.0—a discussion. Sustainability 2020 12:1–17. http://www.mdpi.com/journal/sustainability

Takahashi T (2018) Behavioral economics of addiction in the age of a super smart society: Society 5.0. Oukan 12(2):119–122