Accelerating Industry 4.0 Technology Adoption in Manufacturing Sectors through STI Partnerships among Smart Manufacturing Research and Innovation Centers

APEC Policy Partnership for Science, Technology and Innovation

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APEC Project: PPSTI 01 2022

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Content

Introduction

As everyone has seen, the COVID-19 pandemic has had massive and negative impacts on all businesses and has significantly disrupted manufacturing supply chains worldwide. Additionally, it pointed out unnoticeable gaps and vulnerabilities in the manufacturing sector, particularly in developing economies.

In developing economies such as Thailand, local enterprises and/or local manufacturers mostly struggle with adaptation and recovery from the pandemic. This crisis has unavoidably forced these local enterprises and/or manufacturers to improve their capabilities and strengthen their resilience for maintaining and carrying their businesses forward. As a consequence, to immunize the local enterprises and/or local manufacturers in developing economies, in particular, to be more well-prepared for handling and overcoming unforeseeable and inevitable incidents, including health and economic crises, in the future, Digital Transformation becomes one of the vital solutions to assist these local enterprises and/or local manufacturers in dealing with unexpected forthcoming problems.

With this regard, this project, PPSTI 01 2022 - Accelerating Industry 4.0 Technology Adoption in Manufacturing Sectors through STI Partnerships among Smart Manufacturing Research and Innovation Centers, attempts to enhance the local enterprises and/or local manufacturers' knowledge as well as understanding of the importance of Manufacturing Digital Transformation by firstly focusing on an industry 4.0 readiness assessment since, before closing gaps and improving capabilities, the local enterprises and/or local manufacturers are recommended to go through this readiness assessment to indicate their weak points and pinpoint the most needed solutions with the purposes of time-saving and aligning with some limitations incurred in their businesses, such as budget shortfalls. The readiness assessment can suggest the most suitable intelligent services and/or solutions required for each local enterprise and/or local manufacturer, along with affordable implementation costs.

Further, this project also concentrates on capacity building since one of the common weak points in the local enterprises and/or manufacturers in developing economies is the need for high-skilled human resources. Therefore, the Manufacturing Digital Transformation Course conducted by experts from a developed economy is included along with this project in order to build and develop skills of people, especially ones who are factory managers, factory system integrators, engineers, business owners, as well as who are working in the manufacturing sector regularly.

Apart from the Manufacturing Digital Transformation Course, this project seeks to gather ideas, opinions, and suggestions from APEC member economies and formulate policy recommendations to guide governments to encourage Manufacturing Digital Transformation adoptions in their economies. Importantly, the implementation of this project is parallel with building and strengthening partnerships toward science, technology, and innovation (STI) cooperation among APEC economies.

Background (industry 4.0 meaning, Thailand I4 Index, DTI) Framework for Adopting Industry 4.0 (I4.0)

Transforming and upgrading the technology of a manufacturing company is a complex process. However, problems and failures can be minimized by using a systematic transformation framework. In this project, we use a framework called "LEAD" (EDB, 2020, p. 7), which defines a circular, continuous four-step process for adopting Industry 4.0, as depicted in Figure 1.

Figure 1. The LEAD Framework (EDB, 2020, p. 7)

The LEAD framework is adopted in this project as described below.

1. Learn: Learn the key concepts and technologies of Industry 4.0. Then, we will build a common communication language between teams, business units, and company partners.
2. Evaluate: Evaluate the company's current Industry 4.0 maturity level. The information gathered from this step can be a foundation for architecting an Industry 4.0 transformation roadmap in the next step. Recently, the Thai government developed the "Thailand I4.0 Index," an intended standard industry 4.0 maturity index used in manufacturing companies in Thailand. Nowadays, more than 100 companies in Thailand have been evaluated using the index.
3. Architect: Define a detailed transformation strategy and roadmap for adopting Industry 4.0. The transformation strategy should focus on improving technology and consider business impacts, rules and regulations and other company needs.
4. Deliver: Implement the roadmap, and the Thailand I4.0 Index can be used to evaluate the company's progress in technology improvement.

Although the Thailand I4.0 Index is beneficial in step 2-Evaluate, it could be more helpful when performing step 3-Architect. Since the index mainly focuses on the company's technology maturity. Therefore, in this project, we focus on testing the suitability of the Digital Transformation Innovation (DTI^{TM}) Methodology, which has successfully been used to develop a transformation roadmap in many Singapore companies. However, due to the differences between the companies in Singapore and Thailand, it must be confirmed that DTI can be used to create a practical transformation roadmap for companies in Thailand.

Overall Framework For adopting Industry 4.0 Tech -> LEAD Framework (EDB, 2020, p. 8)

1. Learn
2. Evaluate - Thailand I4.0 Index
3. Architect - DTI (We focus on this step in this project)
4. Deliver

Industry 4.0 integrates advanced digital technologies into manufacturing and industrial processes to create intelligent factories. The revolutionizes industries' operations, enabling greater efficiency, automation, and data-driven decision-making. Key components include:

1. Internet of Things (IoT), Connecting physical devices to the Internet for real-time data exchange.

2. Cyber-Physical Systems (CPS), Blending physical processes with computation and networking.

3. Big Data and Data Analytics, Analyzing vast amounts of data for insights and optimization.

4. Artificial Intelligence (AI) and Machine Learning (ML), Automating and enhancing decision-making processes.

5. Cloud computing Provides scalable and on-demand computing resources.

6. Additive Manufacturing (3D Printing), Enabling custom and rapid production.

7. Augmented Reality (AR) and Virtual Reality (VR), Enhancing training, maintenance, and design through immersive technologies.

The Thailand I4.0 Index is a metric designed to assess the readiness and progress of Thailand's industries in adopting Industry 4.0 technologies. This index aims to guide the transformation of Thailand's industrial sector by measuring 6 dimensions and 17 sub-dimensions. Thailand's government has been actively promoting Industry 4.0 through policies and initiatives to ensure the economy remains competitive in the global market. The I4.0 Index helps track progress and identify areas needing improvement.

In collaboration with the Singapore Institute of Manufacturing Technology (SIMTech), the Digital Transformation Innovation Course was introduced and conducted under this project. The Digital Transformation & Innovation™ Programme is a joint initiative by the Singapore Institute of Manufacturing Technology (SIMTech), a research institute of the Agency for Science, Technology and Research (A*STAR) and the SkillsFuture Singapore (SSG) Agency.

The goal is to equip and guide key organizational personnel to become Digital Transformers who can leverage digital technologies to expedite business model changes and achieve meaningful digital transformation. People can analyze and (re-design their strategies, business models, value streams, and system architecture to achieve sustainable competitive advantage, unleash new business growth, and ensure greater alignment by employing the Digital Transformation & Innovation™ (DTI™) methodology.

In conclusion, Industry 4.0 (I4.0), the Thailand I4.0 Index, and digital transformation innovations are interconnected facets of the modern industrial and business landscape, driving efficiency, innovation, and global competitiveness forward.

Key Activities

The implementation of the project, PPSTI 01 2022 - Accelerating Industry 4.0 Technology Adoption in Manufacturing Sectors through STI Partnerships among Smart Manufacturing Research and Innovation Centers, mainly consists of two essential activities and/or outputs, which are the Manufacturing Digital Transformation Course and the APEC Workshop on Accelerating Industry 4.0 Technology Adoption in Manufacturing Sectors through STI Partnerships among Smart Manufacturing Research and Innovation Centers. The details pertinent to these activities and/or outputs are described below.

1. Manufacturing Digital Transformation Course

The Manufacturing Digital Transformation Course, or Digital Transform and Innovation (DTI^{TM}) Program, was conducted with the assistance of the Contractor from the Singapore Institute of Manufacturing Technology (SIMTech) with the main focus on building the capacity of the local enterprises and/or local manufacturers in developing economies, particularly the local enterprises and/or local manufacturers who cannot afford expensive aboard solutions. This Course is expected to equip the local enterprises and/or manufacturers who participated to prepare for future challenges.

Moreover, implementing the DTI^{TM} Program will help prove the feasibility of applying a Manufacturing Transformation Framework in developing (Thailand) economies' contexts through a Kick-off Meeting and physical and virtual tailored Modules.

The kick-off meeting was conducted via the Webex Platform to increase public attention and awareness regarding adopting Manufacturing Digital Transformation and Industry 4.0. Additionally, this meeting was a stage to promote the DTI^{TM} Program, enroll more stakeholders to participate and handpick a local enterprise in Thailand that is suitable and ready for the transformation roadmap development at its own expense and within a short time.

The final selection of the most suitable local enterprise is Thanakorn Vegetable Oil Products Co., Ltd. or TVOP since this company has already been assessed by the Thailand I4 Index, which will help to reduce time for the transformation roadmap development, there is no language barrier regarding communicating and conducting reports in English. Lately and importantly, executives of the company have made commitments to engage in all modules conducted under this DTI^{TM} Program.

Regarding the online modules of the DTI^{TM} Program, there were four hours each, the relevant details of which are demonstrated below.

Online Module 1:

There were presentations about an overview of the Digital Transform and Innovation (DTI™) Program and the five stages of the DTI™ Methodology. According to the DTI™ Methodology, it consists of five stages as follows.

Stage 1 is to determine the company's Business Model to build a consensus amongst key stakeholders on the company's direction, i.e., value proposition, the business model, the potential Disruptions, and the Competitive Performance Gaps, to derive the business objectives.

Stage 2 maps the current activities and digital system through the team's engagement. The Industry 4.0 Digital Maturity Index concept may be introduced as a benchmarking tool.

Stage 3 is where Hotspots identified on the Activity landscape are clustered to form a thematic area of improvement, i.e., Transformation Areas, using “Digital Maturity Index Descriptions” as a guide.

Stage 4, Initiatives are generated to address the hotspots identified and corresponding Future Activity Landscape System Architecture are generated.

Stage 5 is the development of the action plans, consisting of the Roadmap for digital transformation and the Initiative Visual Board for tracking progress.

Figure 2 Digital Transformation and Innovation™ (DTI™) (SIMTech. “Digital Transformation and Innovation.” 2023)

Online Module 2:

There was a recap of the Online Module 1, Hands-on Competitive Gaps, and Business Objectives.

Module 2 was separated into two sessions: lectures on the DTI™ concepts and hands-on tools for Service BluePrint (SBP) and Digital Value Stream Map (DVSM) with hotspots, As-Is System Architecture, and Transformation Areas.

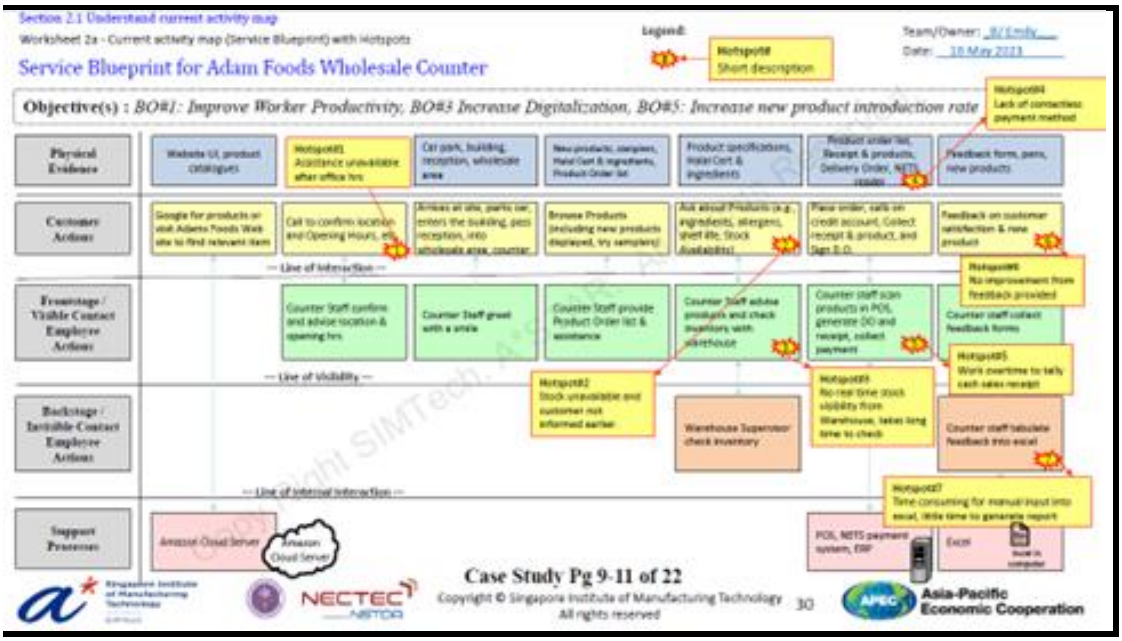

Figure 3 Service Blueprint with Hotspots (SIMTech. “Digital Transformation and Innovation.” 2023)

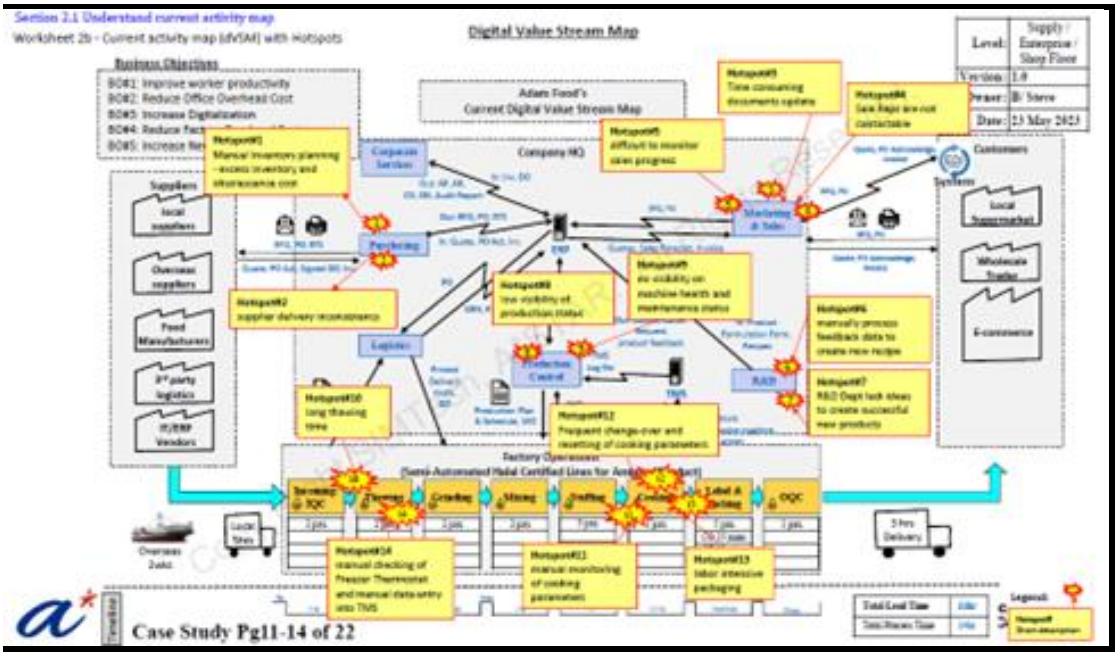

Figure 4 As-Is DVSM, a Company Case Study (SIMTech. “Digital Transformation and Innovation.” 2023)

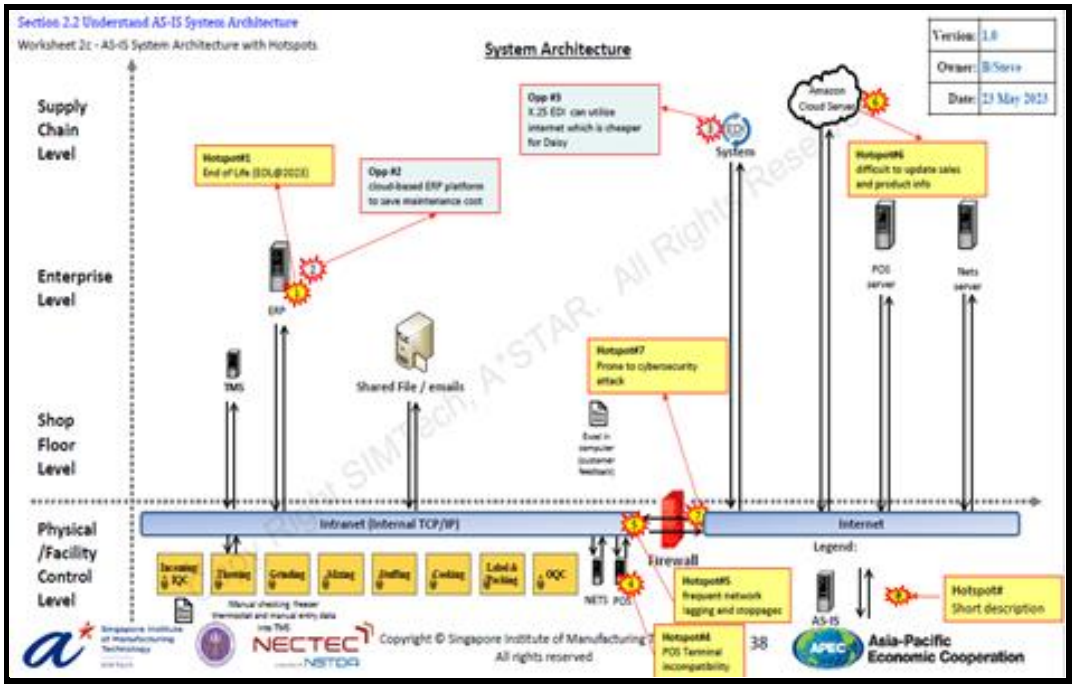

Figure 5 As-Is System Architecture - Adam's Food Case Study (SIMTech. "Digital Transformation and Innovation." 2023)

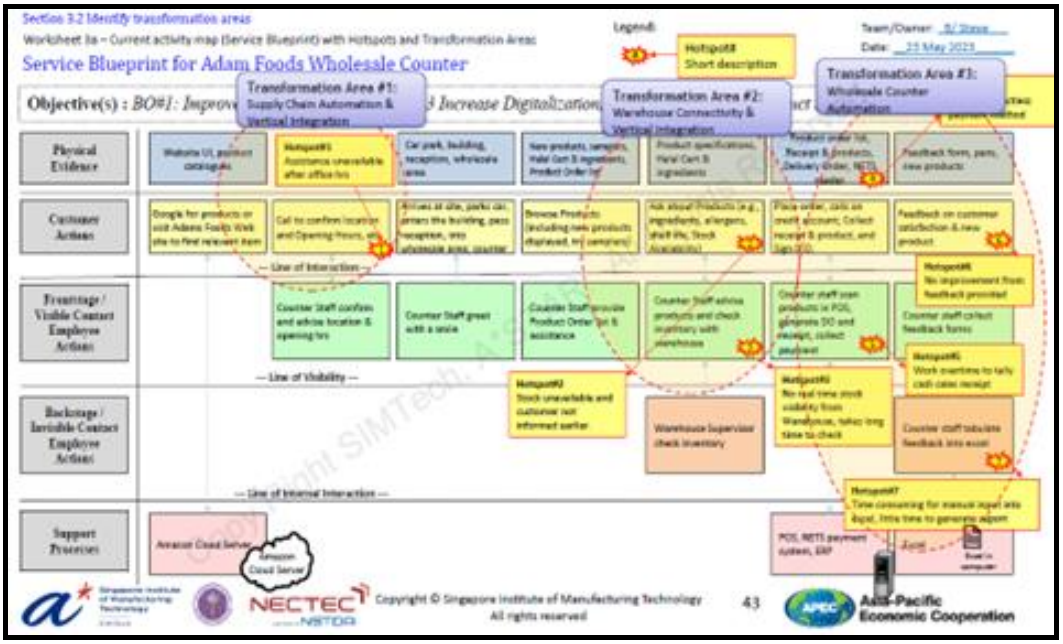

Figure 6 As-Is SB with Transformation Area (SIMTech. "Digital Transformation and Innovation." 2023)

Online Module 3:

There was a recap of Module 2 Worksheets: As-Is Service BluePrint (SBP) with hotspots and Transformation Areas (TA), Digital Value Stream Map (DVSM) with hotspots and Transformation Areas (TA), and As-Is System Architecture with hotspots and Transformation Areas (TA).

The Online Module 3 consisted of two sessions, each consisting of a "DTI™ Immersive Learning" worksheet in preparation for the Virtual Factory Tour, a Presentation

on SIMTech Technologies and Virtual Factory Tour, a Lecture on “Digital Value Drivers” and hands-on tools to Generate Initiatives, To-Be Service BluePrint, and To-Be Digital Value Stream Map.

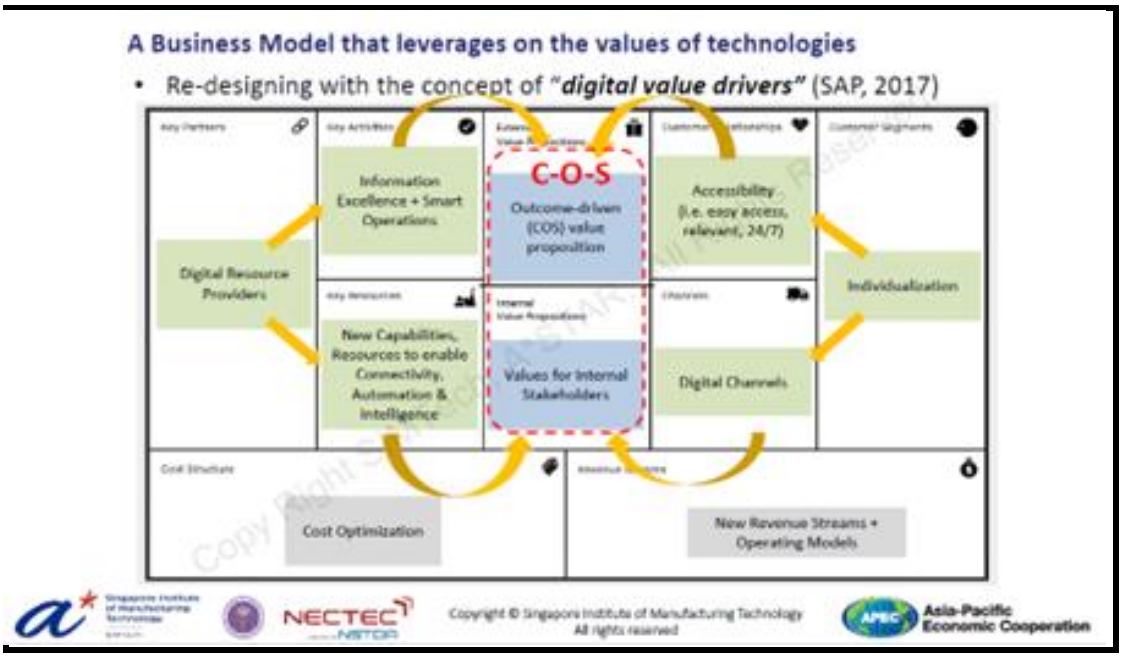

Figure 7 Re-designing with the Concept of “Digital Value Drivers”(SIMTech. “Digital Transformation and Innovation.” 2023)

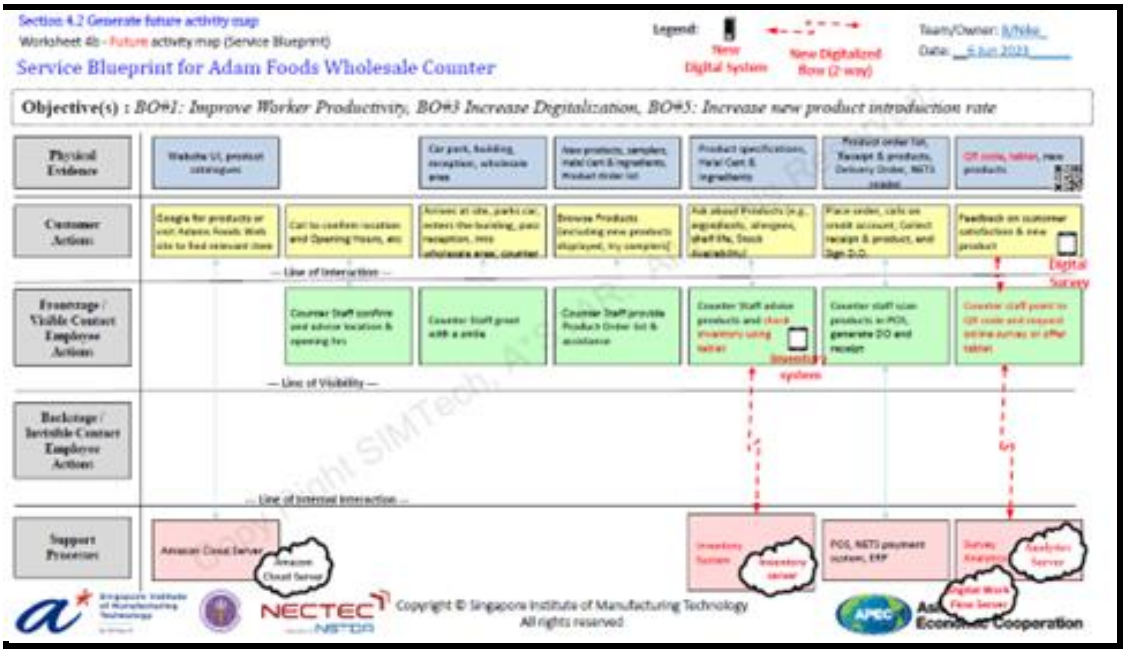

Figure 8 TO-BE Activity Map (Service Blueprint) (SIMTech. “Digital Transformation and Innovation.” 2023)

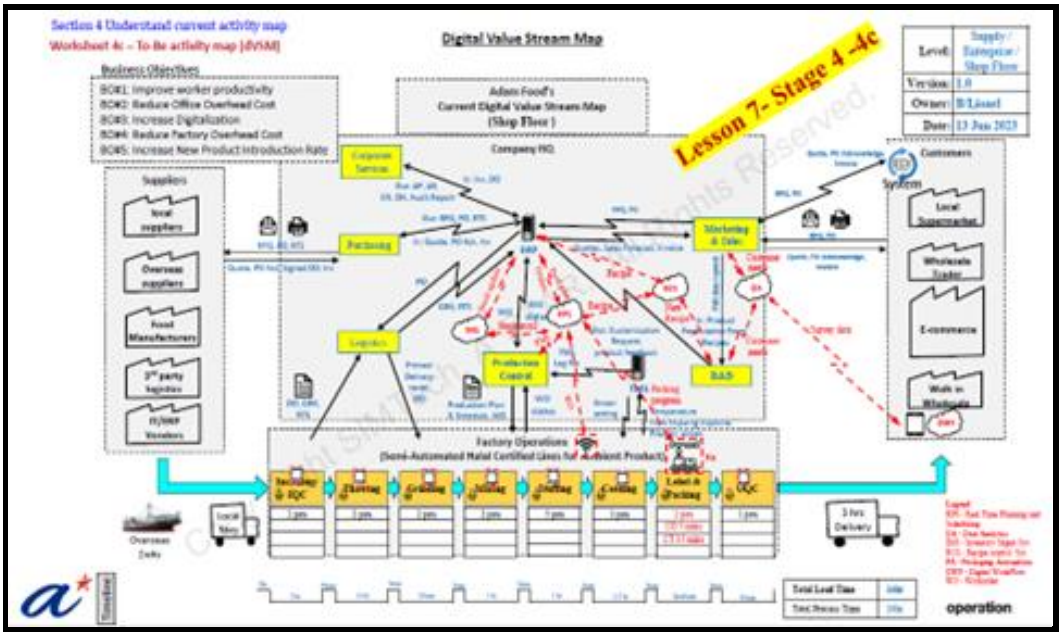

Figure 9 TO-BE Activity Map (Digital Value Stream Map) (SIMTech. “Digital Transformation and Innovation.” 2023)

Online Module 4:

There was a Recap of Module 3 Worksheets: To-Be Service BluePrint (SBP) and To-Be Digital Value Stream Map (DVSM); System Architecture with hotspots and Transformation Areas (TA).

The Online Module 4 consists of two hands-on sessions for To-Be System Architecture, Initiative Descriptions, Roadmap, and Initiative Management.

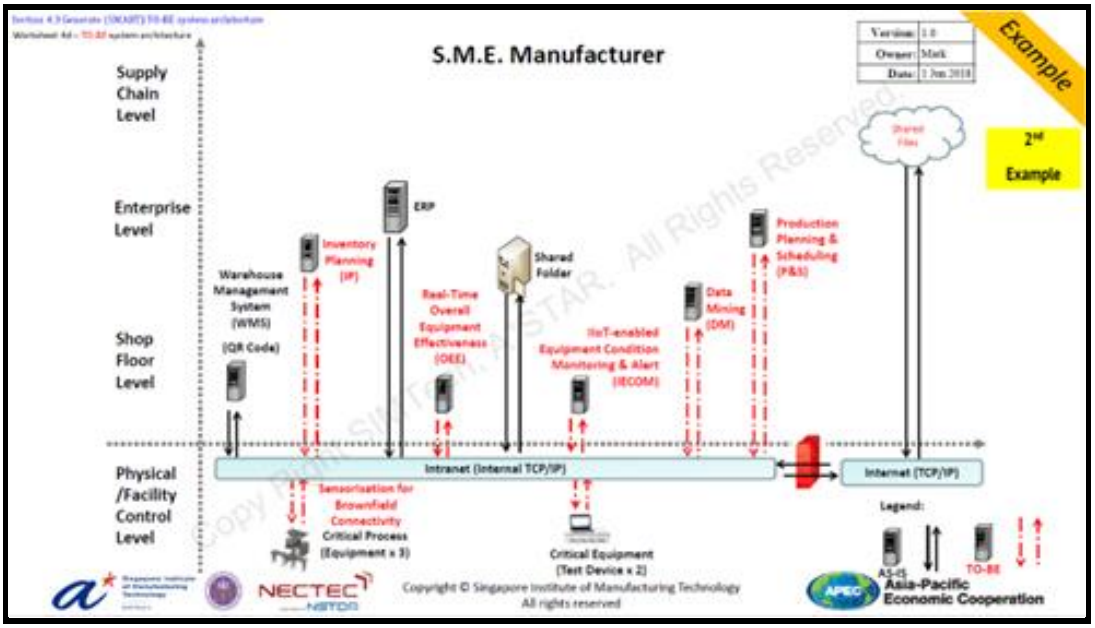

Figure 10 To-Be System Architecture (SIMTech. “Digital Transformation and Innovation.” 2023)

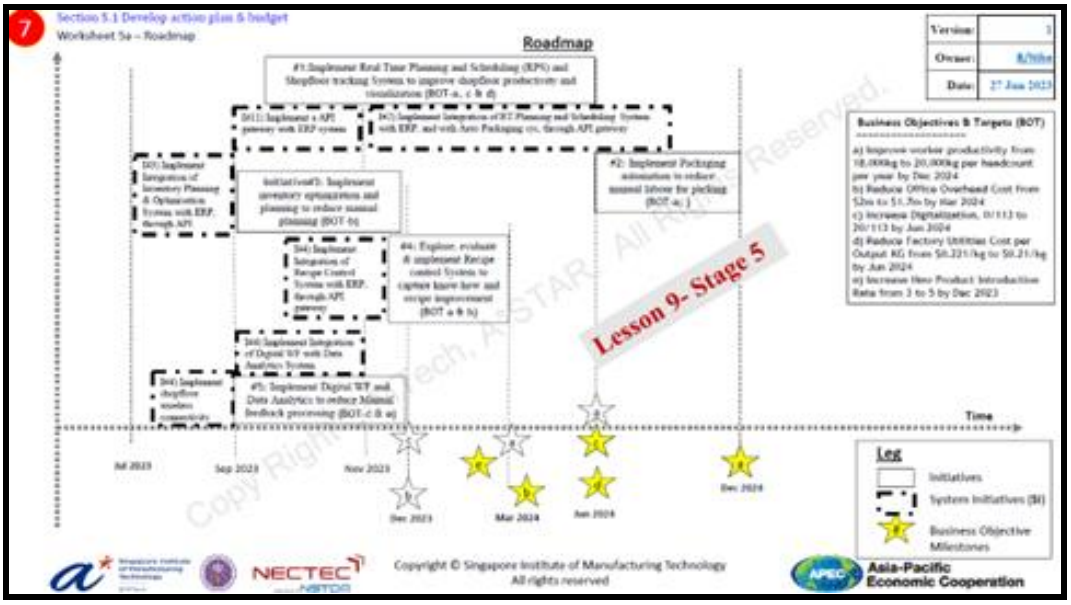

Figure 11 Roadmap (SIMTech. “Digital Transformation and Innovation.” 2023)

Ten modules were conducted to test the DTI^{TM} Methodology's suitability in developing economies' contexts for onsite modules of the DTI^{TM} Program.
The relevant details are demonstrated below.

Onsite Module 1:

The Onsite Module 1 conducted included

- an overview of the DTI^{TM} Methodology where participants learn,
- Business Model Canvas (BMC) as a strategic management tool and
- Business Model 4-Dimensional (4D) Challenges where participants learn challenges companies face in the 4D framework.

Figure 12 Engagement of TVOP Participants on 9 Building Blocks of TVOP Business Model

Onsite Module 2:

In the Onsite Module 2, lectures include Digital Business Strategy, Digital Business Strategy, Business Model Innovation (BMI), and new value propositions such as Low-Cost High Quality.

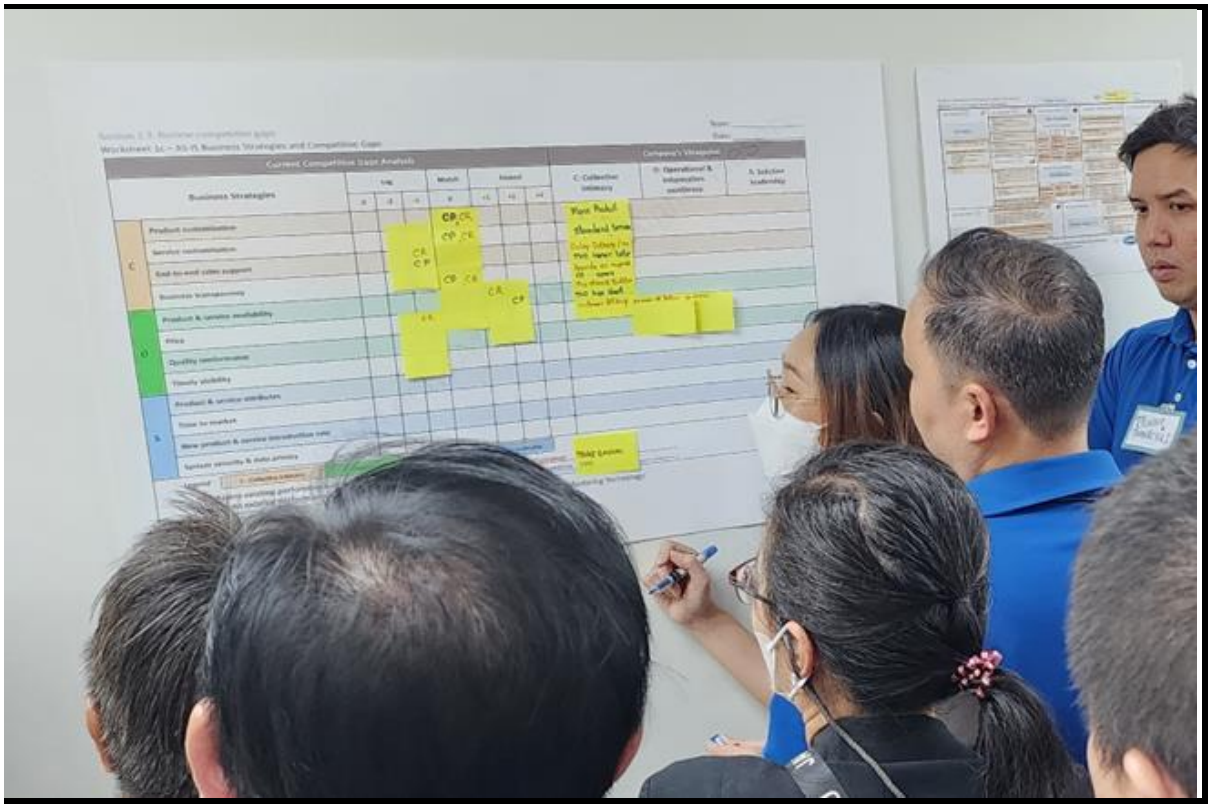

Figure 13 Contribution of TVOP Participants on the Competitive Gap

Analysis (CRCP) Worksheet and AS-IS Business Model (Hotspots) Worksheet)

Onsite Module 3:

In the Onsite Module 3, lectures conducted include Determining Business Objectives, and participants learned further to granularize the above ideas into something more specific using the following guidelines.

Figure 14 Contribution of TVOP Participants on the Business Objectives Worksheet

Onsite Module 4:

In the Onsite Module 4, lectures were conducted to help students understand the current activity landscape.

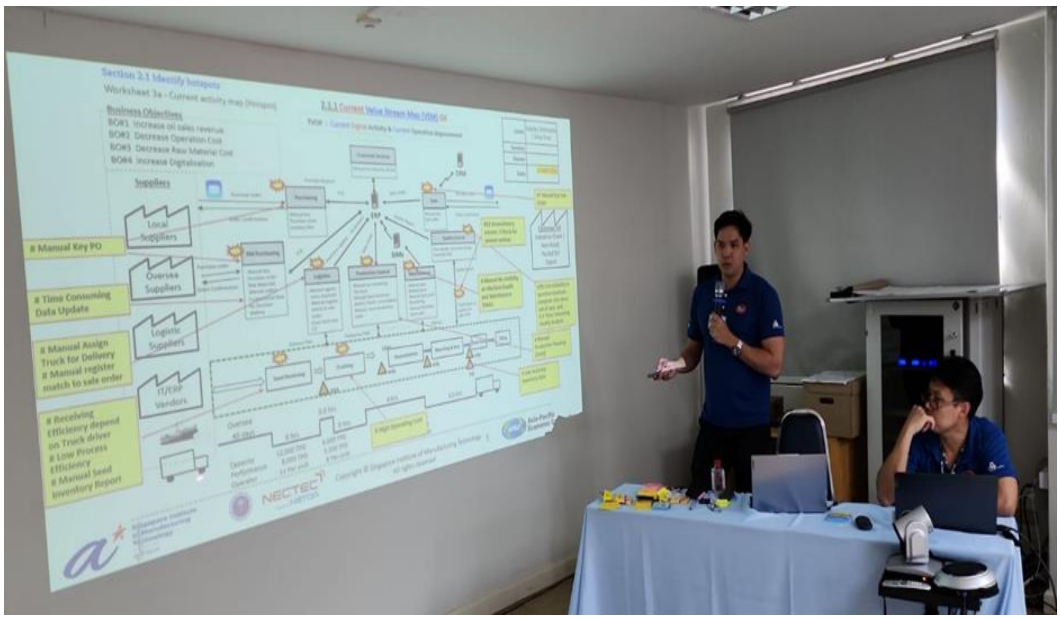

Figure 15 Contribution of TVOP Participants on the DVSM Worksheet

Onsite Module 5:

In the Onsite Module 5, lectures conducted by sharing a Digital Transformation Case Learning examples, including 5 Pillars of Industry 4.0 Digital Transformation, Deloitte's Digital Supply Networks (DSNs), SAP S/4 HANA Integrated Business Planning for better planning and faster response to business exception situations, SAP Connected Manufacturing architecture to connect ERP, MES, PLC from plant to supply chain, SAP Manufacturing Integration & Intelligence to enable companies to integrate plant and enterprise systems and display integrated data, and SAP Leonardo LoT – End-to-End Solutions to leverage the power of the IoT and connect devices, sensors, and machines to gather real-time data.

Onsite Module 6:

In the Onsite Module 6, the lesson plan carried out includes sharing a Digital Transformation Case Learning examples about an Overview of Digital Manufacturing Capabilities in Singapore Institute of Manufacturing Technology (SIMTech), Digital Manufacturing Division Technologies and Capabilities of Cyber-Physical Production System and Smart Virtual Systems, and AI for Manufacturing – Future of Manufacturing with Autonomous Manufacturing.

Onsite Module 7:

In the Onsite Module 7, lectures conducted include

- sharing how to fill in the DTI^{TM} Immersive Learning worksheet,

- identifying and documenting possible solutions in the Technology column and
- Clarify and document the alignment between the hotspots and technology solutions in the Comments column, e.g., a possible solution for Digital Workflow Automation to digitize.

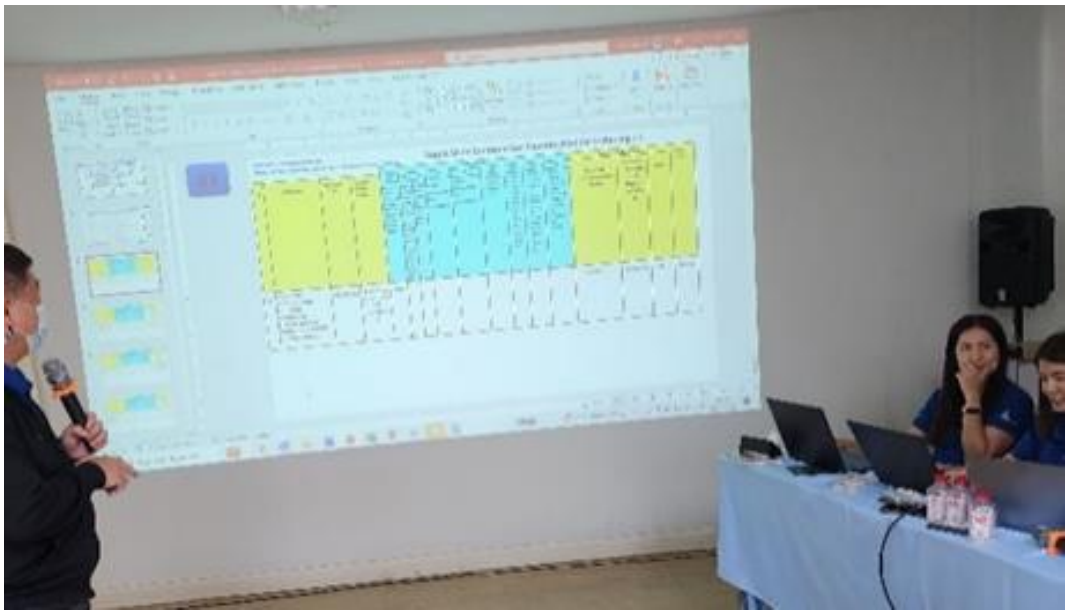

Figure 16 Contribution of TVOP Participants to Generate Initiatives by aligning Business Objectives

Onsite Module 8:

In the On-site Module 8, a lecture was conducted on how to generate a Future Activity Map - TO-BE Digital Value Stream Map, including how digital initiatives could be applied to counteract the various hotspots at the company's enterprise and shop floor areas to meet Business Objectives and Targets, how digital initiatives could come in the form of installation, and how to indicate the new changes into TO-BE Digital Value Stream Map.

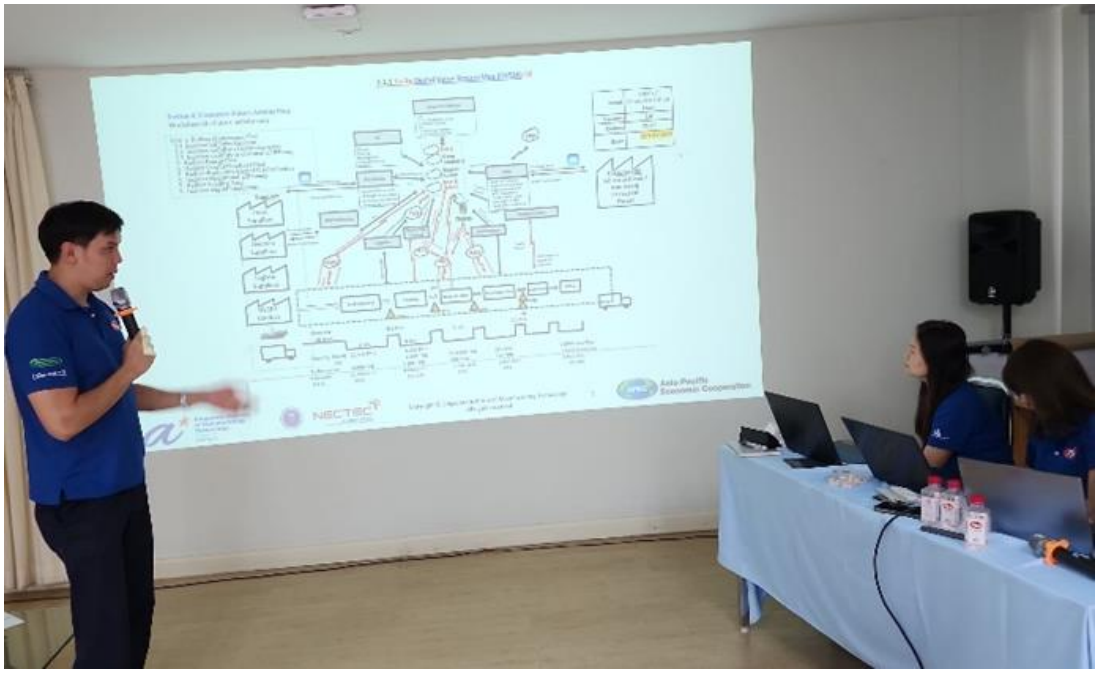

Figure 17 Contribution of TVOP Participants on Future Activity Map - TO-BE Digital Value Stream Map

Onsite Module 9:

In the On-site Module 9, a lecture was conducted on how to tabulate an Initiative Visual Management (IVM) where participants learned to appreciate that IVM,

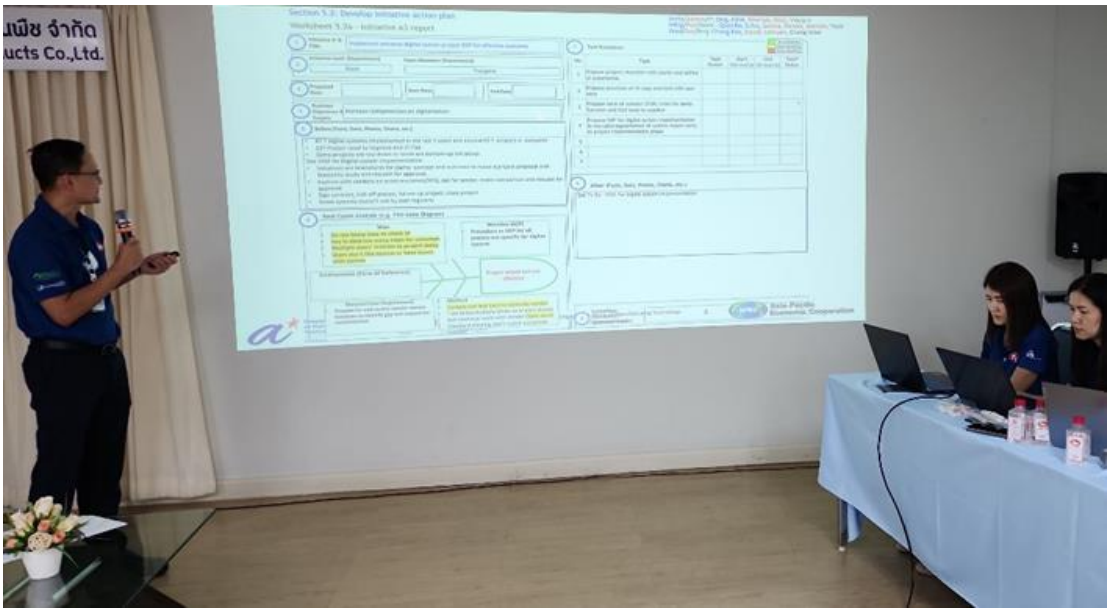

Figure 18 Contribution of TVOP Participants to Formulate an A3 for Enhancement the Digital System Project SOP to Increase Digitalization Competencies including filling in to describe initiatives, adopting the use of RPS, setting their Business Objectives, increasing productivity, and rearranging the rows in an ascending order fashion with the initiative with the shortest Return On Investment (ROI).

Onsite Module 10:

In the Onsite Module 10, the lecture was conducted to show participants how to present in the following sequence, including guiding each participant to reflect:

1. What have been their key learning points from the DTI^{TM} Program?
2. How would they apply what they have learnt?

2. APEC Workshop on Accelerating Industry 4.0 Technology Adoption in Manufacturing Sectors Through STI Partnerships Among Smart Manufacturing Research and Innovation Centers

The Workshop was a two-day event, including a Site Visit at the Sustainable Manufacturing Center (SMC) at the Eastern Economic Corridor of Innovation (EECi), Wangchan Valley, Rayong. Experts and participants from 8 APEC member economies were involved, including China; Indonesia; Japan; the Republic of Korea; Malaysia; The Republic of the Philippines; The Russian Federation; Chinese Taipei; and Thailand. The Project Overseer (PO) and the PO's team provided a tailored program to gather, discuss, and deliver Digital Transformation Policy Recommendations, especially for application to developing economies, and encourage Manufacturing Digital Transformation adoptions within the APEC region. Furthermore, this Workshop was conducted in alignment with the project Outcomes, which are

1. increasing knowledge and awareness of industry best practices and understandings of Industry 4.0,
2. increasing knowledge of the successful implementation of Industry 4.0 transformation for participating enterprises and course participants from many perspectives,
3. increasing in available data to support the digital transformation of manufacturing enterprises in APEC economies and
4. Gaining insights and understanding of the difficulties and limitations of implementing Industry 4.0 in developing economies.

Within the Workshop, there were several critical sessions as follows.

Site Visit at Sustainable Manufacturing Center (SMC)

The Project Overseer (PO) and the PO's team took all experts and participants to visit the Sustainable Manufacturing Center (SMC) to experience actual facilities related to industrial transformation.

Course Experiences Sharing by TVOP

The representative from TVOP shared their experience with their engagement in the DTI^{TM} Programme, as described below.

They have acknowledged that the critical elements for Sustainable Development (SX) should consist of

1. People Transformation (PX) by Changing Mildest, Embracing Technological Change with Gentleness
2. Digital Transformation (DX) with Rapid Digital Transformation, Embracing the Pace, Prioritizing Value and Maximizing Impact. It can be summarized as an equation as SX = PX +DX.

In the DTI™ Program, TVOP underwent various transformation processes, including defining (1) a Business Model with Hotspots and (2) Business Objectives and Targets, (3) Initiatives, (4) TO-BE Digital Value Stream Map (VSM), (5) TO-BE System Architecture, (6) Initiative Description, (7) Digital Transformation Roadmap, (8) Initiative Visual Management, and (9) Digital Project Implementation: VSM, Hotspots, and VSM TO-BE.

Further, according to the transformation, TVOP has continuously improvement their business by using an Intelligence Data-Driven Analysis and Analytic Platform for Smart Soybean Price Forecasting, Smart Accounting and Finance, Smart Predictive and Preventive Maintenance, Smart Procurement, Smart Energy and Utility Management, and Smart HR.

Success Journey and Best Practices of Digital Transformation Sharing by APEC Developed Economies

This session contained 4 presentations conducted by four experts from developed economies, which were

1. Digital Transformation and Wireless Communication Technology for Factory

Delivered Speaker Expert from National Institute of Information and Communications Technology (NICT), Japan. Digital transformation and wireless communication technology are essential in advancing factory operations, but integrating them effectively poses challenges. Wireless communication is critical for enabling factory connectivity, but ensuring stability amidst industrial environments is more complex. Success in Digital transformation for manufacturing hinges on several factors:

1.1 **Technology Maturation:** Continuous improvement and adaptation of technologies like IoT and AI to enhance operational efficiency and decision-making.

1.2 Alignment with Society 5.0: Transitioning towards a human-centred society where technology supports sustainable manufacturing practices and societal well-being.

1.3 Challenges of Wireless Communication: Addressing reliability, security, and interoperability issues to ensure seamless operation within production lines.

1.4 Strategic Deployment: Implementing wireless technologies strategically to match specific operational needs and environments, ensuring they enhance rather than disrupt workflows.

In conclusion, while Digital transformation and wireless communication offer significant potential for the manufacturing sector, carefully considering technological integration and operational demands is crucial for achieving sustained success in modernizing factory operations.

2.Success Journey and Best Practices of Digital Transformation in the Republic of Korea. Delivered by an Expert Speaker from KPMG Samjong Accounting Corporation, Republic of Korea

The Policy Support for Manufacturing Digital Transformation.

2.1 Roadmap: To create a manufacturing DT ecosystem, the Korean government creates an environment to promote cutting-edge investments such as taxes, funds, and regulations, and it provides policy support by establishing new industrial policies for the AI era.

2.2 Human Resource Development: A legal basis and policy support system will be established to expand support for manufacturing robots and automation equipment and secure professional talent for high-tech industries.

2.3 Corporate Support: The government promotes public/private cooperation to accelerate industrial digital transformation and supports connectivity and collaboration between companies to expand data connection synergy.

In conclusion, the government's success in manufacturing digital transformation is underpinned by comprehensive policy frameworks, strategic investments, and collaborative efforts between government, industry, and academia. These initiatives collectively aim to position Korea as a leader in leveraging digital technologies to enhance industrial competitiveness and economic growth.

3. Success Journey and Best Practices of Digital Transportation in Singapore.

Delivered by Expert Speaker Singapore Institute of Manufacturing Technology (SIMTech), Singapore

VALUE Proposition Mission and Vision		
PROCESS Improvement Continuous improvement to the way the work is done	LEADERSHIP Philosophy Management System	PEOPLE Development Sustainable improvement in the capability of the people

DIGITAL Technology Deployment
Horizontal and vertical integration of processes

Figure 19 The five pillars of Digital Transformation:

The five pillars of Digital Transformation, as shown in Figure 19, can be summarized as follows:

1. Value Proposition (Mission and Vision): Establishing clear goals and direction aligned with the organization's mission and vision. This pillar defines how digital transformation will create value for stakeholders and drive the organization forward.

2. Process Improvement (Continuous Improvement): Emphasizing ongoing operational processes and workflow enhancements. This pillar involves adopting agile methodologies, optimizing efficiencies, and leveraging data-driven insights to streamline operations and deliver better outcomes.

3. Leadership Philosophy (Management System): Developing a leadership culture that champions innovation, change management, and digital adoption. This pillar entails fostering a supportive environment where leaders inspire and empower teams to embrace digital initiatives and drive transformational change.

4. People Development (Capability Improvement): Investing in the skills and capabilities of employees to adapt to new technologies and ways of working. This pillar includes training programs, talent development strategies, and fostering a culture of continuous learning to ensure the workforce remains adaptable and capable in a digital environment.

5. Digital Technology Deployment (Integration of Processes): Integrating digital technologies horizontally across departments and vertically across the organization's value chain. This pillar focuses on deploying advanced technologies such as IoT, AI, cloud computing, and analytics to enhance connectivity, data flow, and collaboration within and outside the organization.

In essence, five pillars collectively form the foundation for successful digital transformation, enabling organizations to innovate, optimize processes, empower their workforce, and leverage technology to achieve strategic objectives and sustain competitive advantage in a digital-first world.

Five pillars collectively form the foundation for successful digital transformation, enabling organizations to innovate, optimize processes, empower their workforce, and leverage technology to achieve strategic objectives and sustain competitive advantage in a digital-first world.

4. Success Journey and Best Practices of Digital Transformation for Intelligent Machinery in Chinese Taipei delivered by an Expert Speaker from Industrial Technology Research Institute (ITRI), Chinese Taipei

4.1 Global trends in manufacturing

- Industry 4.0, Reorganizing Supply Chain and Production Sites
- AI, Cloud Computing ➔ Cloud-based Intelligent Manufacturing Services

- From 5G to 6G to enhance IIoT➔ Data Analysis, Digital Twins for machine and process
- Net-Zero brings challenges and opportunities.
- Intelligent manufacturing with low carbon emission
- Automation, remote collaboration, virtual reality, diagnostics, and simulation will accelerate the development of cloud-based manufacturing services.
- Global market to reach USD620 Billion by 2026

4.2 Challenges

- Aging population: increased population of older persons (60+) across the region
- Labour shortage: Automation and intelligent manufacturing are required to increase per capita output value
- Short product life cycles, personalized consumer products
- Difficult to collect data from legacy machines and harsh environment

4.3 Experiences Toward Digital Transformation

- **Promotion Method:** In the face of the leading technology economies with brand advantages to start price-cutting competition, promoting industrial smart manufacturing (Smart et al. 2.0) is an inevitable path. By rooting in basic technology, breaking through critical technology gaps, and enhancing system integration services, we can build an ecosystem for the domestic equipment industry.

- **Promotion Direction:** The government is upgrading from precision machinery to intelligent machinery. The government will assist manufacturers in all aspects of transformation and upgrading through "breadth," "depth," and "height" to achieve the goal of "Smart Machinery as an Industry" and "Industries with Smart Machinery." It will create the machinery industry's next wave of new growth momentum.

Small Group Brainstorming on Digital Transformation Policy Recommendations for Developing Economies and Presentation Preparation

This Session was separated into three small groups: **Group 1: Strategy and Vision, and Organization Management and Governance, Group 2: People and Culture, and Group 3: Technology and Capabilities,** to discuss and share perspectives based on own experiences and own economy's context on topics such as

1. What are policies and/or guidelines for helping escalate the industry sector in an expert's economy to Industry 4.0?
2. What is an issue and/or a barrier concerning implementing policies and/or guidelines found toward escalating the industry sector in an expert's economy to Industry 4.0?
3. What are success and/or failure cases concerning implementing policies and/or guidelines for escalating the industry sector in an expert's economy to Industry 4.0?

4. Based on an expert's economic context, Please provide recommendations concerning policies and/or guidelines toward escalating the industry sector to Industry 4.0.

The Policy Recommendations generated from each group are demonstrated below.

Group 1: Strategy and Vision, and Organization Management and Governance

The following are some solutions proposed by developed economies to address the lack of technology:
The government should first approach trade associations, agencies, research facilities, and businesses like Skills et al. for their local business. They will acquire professionals with in-depth knowledge of particular industries, workforce development, and developing trends. Governments working with them can use this knowledge to practice better-educated policies, training initiatives, and business-friendly economic plans.

Secondly, public entities such as Skills Future Spore should be tasked by
the government with providing financial support to local businesses. Governments should devise appropriate plans to set aside money for loans so that small firms can advance their technological capabilities as they better understand the regulatory obstacles that local enterprises must overcome.
The company can then influence the development of more business-friendly laws and regulations and a regulatory framework that promotes expansion, cuts bureaucracy, and boosts funding for regional businesses.

Lastly, there should be more areas of public-private collaboration in
the economies. The private sector can provide efficiency, investment, and innovation to public projects, just as collaborations with businesses and trade associations can result in mutually beneficial public-private partnerships, such as those that allow the government to concentrate on more comprehensive social and economic outcomes.

Nevertheless, developing economies address issues through many methods, including:

- Digital landscapes and governmental support for developing and implementing essential information infrastructures. The benefits of using digital environments and governmental assistance for the advancement and execution of critical information infrastructures are significant. By augmenting security, stimulating economic growth, increasing public services, and advancing global competitiveness, economies can leverage digital technology to propel innovation and resilience. Furthermore, inclusive digital infrastructures facilitate sustainable development and equitable growth, guaranteeing that the advantages of digital transformation are disseminated across society. With ongoing digitalization, government-supported investment in essential information infrastructures will remain fundamental to domestic advancement and global development.

- Optimal practices, business cases, and implementation, emerging economies encounter considerable difficulties in establishing and executing essential information infrastructures, but by embracing best practices and creative business models, they can surmount these barriers and attain significant advantages. Strategic public-private partnerships, international collaboration, digital inclusion initiatives, promotion of local innovation, and establishment of robust regulatory frameworks are essential elements for effective CII implementation. Business cases illustrate that, with an appropriate strategy, developing economies may establish digital infrastructures that stimulate economic growth, enhance public services, and bolster security. As these economies persist in investing in their digital futures, they will be more strategically positioned to compete in the global economy and equip their populations with the necessary tools to prosper in the digital era.

- Ecosystem to support startups and Innovation in financial and policy, Governments must play a pivotal role in establishing ecosystems that nurture businesses and promote innovation. Governments can diminish entrance barriers for businesses and encourage entrepreneurship by offering financial assistance via grants, venture capital funds, and tax incentives, alongside enacting business-friendly regulations. Moreover, investments in innovation hubs, digital infrastructure, and educational initiatives enhance startup ecosystems, allowing economies to compete in the global digital economy. Exemplary cases from economies such as Israel, Singapore, Chile, and South Korea illustrate that governmental engagement may significantly influence entrepreneurship and innovation, propelling economic growth and technical progress. As the global economy grows digital, governments that adeptly bolster their startup ecosystems will be strategically positioned to spearhead future innovation.

- The shift from labor-intensive to technology-intensive development is altering the economic landscape of numerous developing economies. The transition offers considerable productivity, economic diversity, and global competitiveness advantages but also poses issues with skills development, infrastructure, and job displacement. Through investments in education, digital infrastructure, and policies conducive to innovation, developing economies can effectively manage this transition and establish themselves as significant participants in the global digital economy. A successful case study from China illustrates that, with appropriate strategies and investments, developing economies can leverage technology to foster sustainable growth and enhance the quality of life for their population.

Group 2: People and Culture

Topics related to People and Culture in developed economies are outlined as follows:

- The swift digital transformation of the global education sector has catalyzed the emergence of e-learning platforms and digital resources, propelled by technical progress and changing educational requirements. In this environment, local universities are essential in formulating and executing

research and development (R&D) educational programs that address the requirements of the digital era.

- Knowledge Transfer Among Seasoned Engineers, Retired Professionals, and the Younger Generation Within the Curriculum. Knowledge dissemination is paramount in the rapidly advancing technical environment, especially in engineering. The accumulated knowledge and proficiency of seasoned engineers and retired experts constitute a significant asset that can substantially aid the younger generation. Integrating intergenerational knowledge transfer into educational curricula enables students to access contemporary ideas and technologies and practical insights derived from extensive experience. Furthermore, the emergence of digital technologies facilitates the effective integration of this knowledge into e-learning platforms, rendering it broadly available to learners globally.

- Develop a strategic roadmap outlining the responsibilities of each government sector, academic institution, and non-governmental organization. This strategic roadmap emphasizes each organization's distinct and interrelated functions in cultivating a resilient innovation ecosystem. Governments must establish regulations and infrastructure conducive to innovation, and industries should spearhead digital transformation and allocate resources to research and development. Universities are tasked with cultivating talent and performing research, while NGOs promote inclusivity and assist social entrepreneurs. Collaboration among the organizations above might enhance individuals' understanding of technologies.

Developing Economies towards people and culture issues:

- Cross-Agency Human Resources Policy to Optimise the Workforce for Industry 4.0 Sustainably in Developing Economies Industry 4.0 is transforming global industries through the integration of modern technologies, including artificial intelligence (AI), robotics, the Internet of Things (IoT), and big data. Integrating Industry 4.0 presents both an opportunity and a challenge for developing economies. A workforce possessing the requisite abilities to adjust to these technological advancements is an essential factor in achieving this transformation. Realising this objective necessitates a comprehensive interagency HR policy that promotes cooperation among government entities, educational institutions, industries, and other stakeholders to develop a sustainable, future-orientated workforce.

- Enhancing digital training and offering tax incentives to industries are crucial measures for closing the digital capacity gap in developing economies. Governments must spearhead the establishment of the policy framework and infrastructure essential for these projects, while companies and educational institutions must cooperate in devising and implementing successful training programs. Governments can promote company investment in workforce upskilling through tax incentives, leading to a more competent, technologically adept workforce that fosters innovation, economic growth, and resilience against technological advancements.Understand the demand of each sector and provide for sufficient training.

- Accurately predicting the requisite talents and skills in contemporary technologies is essential for colleges in growing economies. By comprehending industrial requirements, updating curricula, using data-driven methodologies, and encouraging lifelong education, colleges contribute to cultivating a workforce adept for the challenges of the digital economy. Efficient collaboration among universities, industry, and governments is crucial to align talent development with technological trends and promote sustainable economic growth in developing economies.

Group 3: Technology and Capabilities

Developed economy's idea towards technology and capabilities, as mentioned below:

- Government Evaluation of Business Requirements Prior to Initiating Funding and Projects in Technology and Capabilities to maximise the impact of government funding and technological initiatives, they must be grounded in a comprehensive understanding of the actual needs of enterprises. Through industry discussions, sectoral research, and the promotion of public-private partnerships, governments can formulate funding projects that correspond with industry needs. This facilitates more efficient resource allocation, promotes technological adoption, boosts corporate competitiveness, and fosters sustainable economic growth. Governments prioritising enterprises' genuine requirements will be more adept at fostering technical innovation and promoting sustained economic growth. Realign the regulation to ease the process of using technology.

- To enhance legal Frameworks to Facilitate the Licensing and Adoption of New Technologies, governments must amend legislative frameworks to facilitate the licensing and adoption of new technology to stimulate innovation and economic expansion in the digital era. By streamlining licensing processes, updating rules, promoting public-private partnerships, and adopting a proactive stance on technology governance, governments can cultivate a conducive atmosphere for corporate success. Legal enhancements will expedite innovation and economic expansion, augment global competitiveness, foster public confidence in technology, and equip societies for future problems and opportunities.

Developing economy's idea towards technology and capabilities, as mentioned below:

- Government Directives and Performance Metrics for Technology Selection Governments are pivotal in influencing the adoption of new technologies, and explicit standards and performance metrics are needed to guarantee the efficacy of technological investments. These recommendations facilitate the navigation of technological complexities, link investments with domestic objectives, and promote transparency and accountability. By establishing established rules and quantifiable performance metrics, governments can make informed judgements, enhance resource allocation, and expedite technological adoption. This results in innovation and growth that correspond with overarching social objectives.

- The Government Must Solicit Feedback Prior to Policy or Funding Implementation. Governments must solicit input from all stakeholders, including businesses, communities, and industry experts, to ensure effective policy-making and financial distribution before implementation. This guarantees that policies confront genuine needs and issues, aligning resources with the actual demands of the individuals impacted. A balanced methodology, integrating top-down and bottom-up contributions, is essential. The top-down approach guarantees strategic coherence with domestic objectives and long-term planning, but the bottom-up feedback encompasses grassroots requirements, pragmatic insights, and real-world conditions. This dual strategy enhances policies' pertinence, acceptance, and efficacy, cultivating a cooperative atmosphere for sustainable development and innovation. Integrating input into the policy process enables governments to make informed decisions, mitigate inefficiencies, and amplify the effectiveness of their programs.

References

All sources are used throughout the publication, with a proper citation on the reference page.

"Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries" by Boston Consulting Group (2015).

"Industry 4.0: Building the Digital Enterprise" by PwC (2016)

"Smart Manufacturing: The Lean Six Sigma Way" by Anthony Tarantino and Deborah Cernaianu (2020).

"THE PRIORITISATION MATRIX: Catalysing the Transformation of Manufacturing" by EDB (2020).