

An analysis of government policies to maximize the economic and social benefits



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POWERING NATIONAL OUTCOMES FROM NEW DIGITAL TECHNOLOGIES

AN ANALYSIS OF GOVERNMENT POLICIES TO MAXIMIZE THE
ECONOMIC AND SOCIAL BENEFITS

Powering National Outcomes from New Digital Technologies
An analysis of government policies to maximise the economic and social benefits

Professor Steve Burdon AM served as the volume editor.

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CONTENTS

FOREWORD	V
EXECUTIVE SUMMARY	VII
INTRODUCTION	1
Project Goals	1
Importance of Digital Technology	2
Summary of Key Findings	5
Technology	5
Market Sectors	5
Policy and Regulation	6
METHODOLOGY	7
The Approach	7
Review of Literature	7
Survey	8
Expert Interviews	9
THE RELATIVE IMPACT OF NEW TECHNOLOGIES	11
Technologies Ranked	12
Disruptive Technologies	15
Relationships with Customers and External Parties	15
Human Resources	16
Operations, Strategy, and R&D	16
MOST IMPORTANT MARKET SECTORS	17
Sectors Likely to Produce the Best Outcomes	17
MOST IMPORTANT DIGITAL ECONOMY POLICIES AND REGULATIONS	20
Policy and Regulation	20
Initiatives in Case-study Countries	24
Other Survey Findings	24
IMPACT OF COVID-19 ON NATIONAL OUTCOMES	26
COVID's Impact	26
CASE STUDIES	30
Nascent: Indonesia	30
Technology	30
Sectors	33
Policy and Regulation	34
Constraints and Challenges	35

Emergent: Malaysia	37
Technology	37
Market Sectors	39
Policy and Regulation	41
Constraints and Challenges	43
Leaders: Republic of Korea	45
Technology	46
Market Sectors	48
Policy and Regulation	50
Constraints and Challenges	53
Case Studies: Summary of Findings	54
 CONCLUSION	 57
Guidelines for Each Group	58
Group 1: Leaders	58
Group 2: Emergent	59
Group 3: Nascent	60
Group 4: Embryonic	61
Key Questions for Consideration	62
Concluding Comments	63
 REFERENCES	 64
 APPENDIX 1: SUMMARY OF APO DIGITAL ECONOMY DATA	 71
 APPENDIX 2: SURVEY DEMOGRAPHICS	 72
 APPENDIX 3: INTERVIEW THEMES FOR EXEMPLAR COUNTRY INTERVIEWS	 73
 LIST OF TABLES	 74
 LIST OF FIGURES	 74
 LIST OF CONTRIBUTORS	 75

FOREWORD

It is well known that new technologies have a beneficial impact on the digital economy, resulting in higher economic growth, increased productivity, and improved social outcomes. Previous studies indicated the variability of productivity impacts and few details on which government policies are the most important. This study examined how 18 APO members have addressed the challenge of identifying which government policies have the greatest impact.

A research team of APO-appointed experts undertook a quantitative and qualitative research project to provide a methodology for all members to review their digital economy status. While each country needs to design its own specific digitalization strategy, learning from the initiatives of exemplary leaders can be beneficial. In particular, the quantitative study found some commonalities based on the Digital Economy Index and these were grouped into four different segments. By interviewing senior government officials, businesspeople, and academics in Indonesia, the Republic of Korea, and Malaysia, useful and relevant approaches were identified.

In the important area of government policy and regulation, significant variations were found in telecommunications (3G versus 5G mobile), education (schools versus universities), R&D (universities versus business), etc. The fact that exemplar countries in each segment were able to achieve much greater productivity improvement based on technology emphasizes the importance of developing more advanced digital economies.

To help each government navigate the information in the research report, a five-step process was suggested to be followed by each individual country. This will enable government policy officers to make use of the best-practice approaches of comparable economies among APO members and help them optimize their productivity, economic growth, and social outcomes. The APO appreciates the commitment of the multinational expert team led by Professor Steve Burdon of the University of Technology Sydney and the other researchers involved for their dedication to compiling a complex report in the difficult environment of the COVID-19 pandemic.

The APO hopes that *Powering National Outcomes from New Digital Technologies: An analysis of government policies to maximize the economic and social benefits* will be a useful resource for policymakers in the Asia-Pacific region and elsewhere as they promote digitalization in their economies.

Dr. Indra Pradana Singawinata
Secretary-General
Asian Productivity Organization
Tokyo, January 2023

EXECUTIVE SUMMARY

The accelerating advancement of digital technologies is providing a myriad of opportunities for nations, both economically and socially. This study was a collaboration between the Asian Productivity Organization (APO) and the University of Technology Sydney (UTS). It considered how APO member governments might approach the advancement of digital technologies to maximize benefits for their nations.

Specifically, the study considered which digital technologies, industry sectors, and regulatory and policy initiatives had the greatest potential to deliver national outcomes in areas of economic growth, productivity, and social impact.

Overall, the research found that virtually all countries believed that the latest wave of digital technologies would deliver significant economic and productivity growth and that having policies and regulations in place to support a digital economy was important. It also highlighted the different opportunities, constraints, and challenges that individual APO nations faced, which meant that a one-size approach would be inappropriate. So, this report outlines a range of approaches that can be employed by nations, depending on where a country is currently positioned on the spectrum of digital economic development. It provides an initial framework that can be applied to any country, and offers some useful generic approaches, while also proposing specific recommendations for countries at different stages of digital readiness.

The study led us to segment APO member economies into four ‘digital economy’ groups: the embryonic, the nascent, the emergent, and the leaders. In addition, we paid particular attention to three exemplars or ‘case study countries,’ each representing a different level of economic development and digital maturity. These were: Indonesia (nascent), Malaysia (emergent), and the Republic of Korea (leaders). Individual countries can get feedback from this report, in the first instance, by considering their relative standing, i.e., by comparing their individual ratings against the rating of the exemplar country in their respective digital economy group (See Appendix 1 for a list).

At a digital economy group level, our research finds that countries classified as embryonic or nascent would struggle to secure the maximum benefits from digital technologies without further development of technological infrastructure, particularly in telecommunications. Governments in the embryonic group need to support the modernization of technology as well as the accessibility and affordability of broadband. In addition, they need to improve government accountability.

Members of the nascent group also need to support modernization and R&D, while also engaging with the industry, especially in the area of payment systems. In education, they could develop a strategy for integrating ICT capability in the school curriculum, in collaboration with the industry. An efficient and trusted bureaucracy should contribute to a productive business climate, while e-government initiatives could lead the way in digital development. Indonesia, as an exemplar in this group, is also making efforts to support startups and innovations.

One of the biggest challenges for emergent countries is regarding access to digital skills and talent. These countries need to consider how they can develop digital technology skills in their education

systems, and how they can attract talent to fill skill gaps. They need to continue the work they are doing to foster technology adoption and to enhance business and competition policy, ideally through a national government digital economy plan. They should establish national innovation strategies and promote special agencies to maximize innovation by linking industries, universities, and other research institutions. Technology ecosystems will enable new levels of collaboration. Efforts should not be limited to financial incentives but also ensure that businesses have ready access to services, such as consulting, for facilitating technology adoption. Malaysia, an exemplar in this group, has an advanced e-government and is working to make its bureaucracy more efficient and transparent, which means that positive effects should flow through the economy.

While the leaders we have identified are role models for countries in other groups, their challenge is to sustain progress. Our study highlights the importance of continuously improving and reviewing incentives and plans to stimulate a strong ecosystem of technology organizations. The leaders should ensure effective technology transfer of new discoveries from universities and research institutions to the private sector and their commercialization. They should nurture digital entrepreneurs, not only through ease of establishing businesses but also by embedding entrepreneurship in the school curriculum. Countries in this group need to develop policies and regulations supporting lifelong learning and multiple skills formation for future digital capability. It will be vital to ensure data privacy and security, given the increasing dependence of critical infrastructure on digital technologies and the growing threats from ‘bad actors.’ The Republic of Korea (ROK), our exemplar for this group, possesses world-leading broadband infrastructure, e-government services, and ICT manufacturing. The leaders should support and participate in developing a shared vision with other countries in the region and construct a plan with inputs from the industry, the civil society, and other related parties.

Overall, this study shows the value of having strategic plans for national digital economy for the short term as well as the long term through specific and measurable targets that are regularly reviewed. It makes clear that positive outcomes require strong coordination between all levels of government, i.e., federal, state, and local, when implementing such plans. Successful design and implementation of digital economy plans also happen when governments, businesses, and universities work together. Increased government transparency and efficient and effective bureaucracy are required. Dealing with vested interests requires special attention to avoid suboptimal outcomes.

Attending to digital literacy includes encouraging and supporting digital technology leadership in the industry and empowering emerging leaders among millennials.

Asia Pacific is fast becoming a very successful region for development of technology startups and new digital business models. Governments should encourage innovation in digital applications, and support startups and investments in digital services, including initiatives for social good such as digital healthcare. Enhancing cross-border relations can help these businesses grow so that successes can be emulated throughout the region.

Countries have much to learn from each other. There are many initiatives outlined in this report that are worthy of other countries’ attention.

Throughout the course of this study, the world was coming to grips with the COVID-19 pandemic. While it is first and foremost a health crisis, it also illustrates the importance of digital readiness in

an economy. Those countries that were at an advanced stage of digital readiness were able to employ digital technology to ‘track and trace’ infections, manufacture vaccines, adapt work practices, and make faster decisions. This only highlights the need for implementation and constant review and adaptation of national plans for digital economy.

INTRODUCTION

Past studies have produced mixed results when seeking to measure investments in digital technologies against economic growth, productivity, and social outcomes. An approach that considers where countries currently lie on the digital and economic spectrum provides a clearer understanding of the technologies, market sectors, policies, and regulations that can help achieve the greatest benefits for the countries.

Project Goals

The accelerating advancement of digital technologies spawns a myriad of opportunities for nations, both socially and economically. This research project, a collaboration between the APO and the UTS, undertook to inform member economies on the optimal advancement of digital technologies with the goal of achieving national outcomes. Using a macroanalysis lens, the study explored policies and regulations that have the potential to significantly increase economic and social benefits for member economies.

The research, undertaken from mid-2020 to 2021, involved three stages:

- an exploration of the literature on the benefits accruing to countries from advancing investment in digital technologies;
- interviews with experts to gain insights into
 - digital policies and regulations;
 - the important skills and education necessary to support the digital economy;
 - the digital infrastructure and enabling technologies that lead to significant improvements in economic growth and productivity;
 - the role of government and digitization of its services; and
 - the social benefits that accrue from digitization of the economy; and
- a survey collecting data on the technologies and government initiatives perceived to be most beneficial to the economy and the society in future.

A more detailed explication of the research was undertaken for three selected member economies, namely, Indonesia, Malaysia, and the ROK. These countries were chosen to represent different levels of economic development, i.e., developing, emerging, and developed economies, respectively, and the corresponding different levels of digital readiness.

Importance of Digital Technology

The past decade has witnessed significant transformation through digital economy, creating changes in the way nations live, conduct business, and engage with other countries. Specifically, these technologies have changed the way people interact indoors or outdoors; consumers access goods and services across a variety of markets; and businesses produce and distribute goods within domestic and international markets. Digital technologies have contributed to economic growth and productivity and also helped raise living standards.

The empirical economic literature on information and communication technology (ICT) focuses primarily on the impact it has on economic growth and productivity, seeing the latter as the most important driver of the former. What is often lacking in this literature is a discussion of the transmission channels between ICT's impact on productivity and its subsequent impact on economic growth. A direct linkage between ICT and economic growth and productivity is not easy to establish and is not consistent across countries. For example, Pohjola [2] found a positive relationship between ICT investment and economic growth for 23 of the 39 OECD countries studied. It was economist Robert Solow who first raised the question of the 'productivity paradox' 34 years ago when he stated, "You can see the computer age everywhere but in the productivity statistics" [3]. Brynjolfsson's similar findings were that sluggish economic growth could coincide with significant growth in computing capabilities [4].

Several studies have found differing effects of ICT investment on economic activity. A study sponsored by the OECD found that in the USA there appeared to be a positive relationship between ICT and economic growth, while the evidence was weaker in other countries [5]. Using data from 42 countries, Pohjola [6] found that ICT investments made the greatest contribution to economic activity in the USA as did Dedrick, et al [7]. They referred to 50 studies identifying that the ICT component of the capital stock contributed positively to the USA's economic growth but had mixed results for other developing countries (see also Draca, et al's study for similar findings [8]). Van Ark, et al [9] drew similar conclusions when comparing the European Union with the USA.

Dewan and Kramer [10] reported a clear demarcation between developed and developing countries in terms of the effects of ICT on economic growth. Similar findings were reported by Gordon [11] and Watanabe, et al [12], who explained the difference between developing and developed economies with diminishing marginal returns of ICT. It means that ICT is likely to have a greater impact on economic growth when a country is in its earlier stages of economic development as compared with a more developed economy where the level of ICT stock is significantly higher. A country's level of complementary capabilities (e.g., human capital stock) that work with ICT investments may also explain this phenomenon. A less developed country is more likely to have a lower level of complementary skills, which, when improved, will increase marginal returns on ICT and thus have a significant impact on a country's level of economic growth. Mack and Faggian [13] illustrated this in the context of broadband. They found that broadband had a greater impact on productivity when more skilled individuals were using it. Dholakia and Harlam [14] and Mehmood and Siddiqui [14], in their analysis of Asian countries, reported similar findings of a direct relationship between telecommunications investment and economic development.

On the other hand, Brynjolfsson and Yang [15] did not find any evidence of impact of ICT on economic growth. They attributed this to several factors, including the mismanagement of ICT, mismeasurement of data as well as time lags between the introduction of ICT and its impact on economic growth. Brynjolfsson and Hitt [4] found that the lag between ICT investments adding to

growth in productivity could vary by three to seven years. Part of the explanation for this is the necessary organizational transformation that firms need to undergo to utilize ICT investment most efficiently. Hong [16] also reported a lag in the effects of ICT investment on economic activity.

There is also mixed evidence on the diffusion of ICT on economic growth. According to economics literature, while diffusion of technology is expected to have a positive impact on economic growth, some studies showed positive results (for example Jorgenson, et al for the USA [17] and Nasab and Aghaei [18] for OPEC countries) while others reported mixed results (for example, Hassan and Islam [19]) when a heterogeneous set of countries including developed and developing countries was used.

Subsequently, the academic literature in this area has been reviewed to understand the varying impacts of ICT on economic activity, productivity, and economic performance. Cardona, et al [20] undertook an extensive analysis of 150 research papers on this topic and found evidence of a positive relationship between ICT and productivity. Stanley, et al [21] undertook another survey of the literature, using meta-regression analysis of approximately 60 econometric studies. They found that the level of ICT investment did not have an impact on productivity and that wireless ICT technology had twice the impact on economic growth as compared with the impact of landline-based ICT. In a more recent study, Vu, et al [22] examined the relation between ICT's effects on economic growth and total factor productivity. They too found evidence of a direct link, based on these past studies. Particularly, almost all papers examined showed a direct link between ICT investment and gross domestic product (GDP) growth. Also, 78% of the papers examined showed a direct link between ICT investment and total factor productivity.

What is critical here is how firms undertake complementary activities to gain maximum benefit from ICT, specifically by improving organizational capital through business process redesign (see Dedrick, et al [7]) and investments in human capital (see Brynjolfsson and Hitt [23]).

Vu, et al [22] found a direct positive relationship between broadband investment and firm performance in a collection of studies. There were exceptions though. Czernich [24] found no evidence of such a relationship for Germany, while Bertschek and Niebel [25] found no evidence between broadband usage and labor productivity growth. Meijers [26] found an indirect effect of internet usage on economic growth, through international trade. Vu, et al [22] also pointed at the importance of critical mass in ICT investment and infrastructure before there was a noticeable and sizeable impact on economic activity (see also Koutroumpis [27] and Gruber [28]). Jorgenson and Vu [67] found that the larger the ICT investment, the more likely the positive impact on economic growth, particularly in developing countries in Asia. Vu, et al [22] identified the following channels through which these positive effects flow as critical: (1) learning, technology diffusion, and innovation; (2) the quality of decision-making; and (3) the reduction in costs and enlargement in choices that shift both the supply and demand curves to the right.

To gauge how in a digital economy, ICT asset infrastructure has an impact on economic activity, we can decompose GDP growth into its various contributions from labor as well as capital, comprising both ICT and non-ICT assets. Table 1 represents this decomposition of economic growth for APO member economies for the period 2010 to 2019 (the latest data published at the time of writing this report was available till 2019). The average economic growth rate (row 1) can be decomposed into contributions from labor (rows 2 and 3); the digital economy resulting from the use of ICT assets (row 4); and from non-ICT assets (row 5). During the period 2010–19, ICT

assets accounted for 0.4% of the 4.8% average annual growth rate of APO member economies. On an average, this amounted to a 9.3% contribution to the overall level of economic growth in that period. By comparison, ICT assets in the USA (not shown here) contributed approximately 42% to the average annual growth rate of GDP.

TABLE 1**CONTRIBUTIONS TO ECONOMIC GROWTH IN APO MEMBER ECONOMIES.**

APO member economies*	Average for 2010–19
GDP growth, average annual	4.8
Contribution of labor quantity	0.4
Contribution of labor quality	0.4
Contribution of capital services provided by ICT assets	0.4
Contribution of capital services provided by non-ICT assets	2.9
Growth of total factor productivity	0.7

* Excluding Lao PDR, Mongolia, Fiji, and Nepal as data for these countries was not available.

Source: The Conference Board Total Economy Database, July 2020.

For the three countries chosen for in-depth study, their respective contributions to economic growth for the period 2010–19 are given in Table 2. With relatively less sophisticated digital technologies, Indonesia's digital economy (i.e., its ICT assets) contributed a very small component to its overall GDP growth. ICT assets contributed only 0.1% to its average 5.3% GDP growth (2.4% to its overall economic growth during that period). This contribution is relatively small compared with the contribution that ICT assets make to GDP growth in Malaysia and the ROK, where investments in ICT are much greater and so is their widespread usage across various sectors of the economy. For Malaysia, on an average, ICT assets contributed 0.7% to the average 5.2% GDP growth rate (or 13.6% to the overall economic growth in the period 2010–19). For the ROK, ICT assets contributed 0.4% to the average 3.2% GDP growth rate (or 13.2% to the overall economic growth in the given period).

TABLE 2**CONTRIBUTIONS TO ECONOMIC GROWTH DURING 2009–19 FOR INDONESIA, MALAYSIA, AND THE ROK.**

APO member economies	Indonesia (Nascent)	Malaysia (Emergent)	ROK (Leader)
GDP Growth, average annual	5.3	5.2	3.2
Contribution of labor quantity	0.7	1.2	0.3
Contribution of labor quality	0.9	0.3	0.3
Contribution of capital services provided by ICT assets	0.1	0.7	0.4
Contribution of capital services provided by non-ICT assets	3.5	3.0	1.4
Growth of total factor productivity	0.1	0.0	0.8

Source: The Conference Board Total Economy Database, July 2020.

This study also explored various policies and regulations implemented to reap the greatest benefits of digital technologies. From previously published reports, we compiled a list of policies and regulations designed to bolster investments in digital economy with the intent of improving levels of economic efficiency, productivity, and growth. From these findings, a questionnaire was developed and distributed to 436 respondents across all APO member economies. The respondents were people whose core skills related to productivity issues (e.g., economists, policymakers, and strategists) with experience ranging from less than four years to more than 20 years. We also asked

them about the importance of digital technologies and the industries on which these technologies would have an impact. The findings helped us to develop a comprehensive picture of variance in ways that specific policies and regulations are perceived as useful in different APO member economies in identifying strategies for strengthening the digital economy.

Given the digital divide between developed and developing economies, it is difficult to consistently compare the impact of recent digital technologies across various countries. To understand the issues better, we selected three APO member economies for detailed case study, with each country chosen as representing a developing, emerging, or developed nation. Although there are generally consistent recommendations that can be made across all countries, we suggest that policies should be tailored depending on the stage of a country's digital maturity, which in this study was based on the digital evolution score [1]. Adopting this tailored policy approach is motivated by the fact that countries at different stages of their digital economy investments will have different priorities for development. For example, a study in Africa [50] showed there was still a lack of suitable infrastructure and mobile networks to progress to more sophisticated levels of digital economy investment. On the other hand, countries leading in technological development, such as Singapore [29], required different policies to push the frontier of their digital economy. We interviewed stakeholders from the three case study countries and compared the findings. From these findings, we provide suggestions for each country.

Summary of Key Findings

Technology

The fact that telecommunications technologies continue advancing (e.g., from 4G to 5G and 6G), means that countries need to be vigilant to ensure that regulations and policies are sufficiently adaptive to accommodate the rapid pace of development of digital technologies, especially after COVID-19. Countries that had anticipated the possibility of surges in demand and changes to the nature of demand in network connectivity before the pandemic were far better able to manage their 'work from home' implications.

Although stakeholders from Indonesia, Malaysia, and the ROK referred to artificial intelligence (AI), big data, and cloud computing as being important, the obvious difference between these countries was in the level of their adoption of telecommunications technology. Indonesia is still a long way from moving to 5G, while Malaysia has partially implemented 5G. In contrast, the ROK is the most advanced in 5G implementation and has national strategies for 5G. In addition, it has paid more attention to biotechnology, which was not mentioned by stakeholders from Indonesia or Malaysia.

Market Sectors

The survey results revealed that retail, education, and agriculture sectors were consistently seen as having benefited the most from technology compared with other sectors. The finding was consistent with interview data collected from respondents across developing, emerging, and developed countries. A European Union study notes that agriculture, banking, data analysis, and health sectors have also had great successes [30].

However, when looking at individual case studies, it seems that different nations have different 'key' market sectors, depending on the resources they have. For example, stakeholders from Indonesia contended that key market sectors should be related to optimizing the added value of

natural resources, including agriculture, plantations, animal farming, fisheries, and mining, as well as the power of a creative and digital economy.

Stakeholders from Malaysia expected to gain benefits from e-commerce, particularly for SMEs. Three market sectors specifically highlighted were energy, including oil and gas, due to its size in the Malaysian economy; healthcare, especially with the needs of an ageing population and the impact of COVID-19; and digital content creation (arts, media, movies, etc.).

In the ROK, the COVID-19 pandemic has given rise to the so-called ‘untact’ (no contact) services such as online-shopping-and-delivery applications as a result of innovations in the services industry. Agriculture was also mentioned by respondents, although the sector is currently undervalued because economic growth is largely focused on manufacturing. When we explored the impact of technologies on agriculture, we found the situation to be complex. More specific research would be required to examine the technology’s potential for agriculture. For example, inquiry into joint efforts by businesses, governments, non-governmental organizations (NGOs), and the high-tech community is necessary because in agriculture various controversies such as genetically modified food, environmental concerns, and customers’ behaviors cannot be tackled by just one party.

Policy and Regulation

We found that certain policies are considered to be more important than others. Top policy priorities included the ease of establishing a new company, telecommunications regulation, research and development, and skills development in universities. However, each case study country presents different challenges that they must face.

We found that Indonesia was making progress in applying e-government. Most stakeholders generally thought that a good job was being done in areas of intellectual property (IP) protection and privacy. However, in terms of processes, Indonesia has to struggle with the challenges of education, employability, and limited funding. It faces a dilemma between adoption of high technology and its potential impact on employability. In education, there is a debate whether classroom priority should be given to technology skills or to moral guidance. Indonesia also experiences problems of bureaucracy, governance, and corruption.

In Malaysia, the existence of digital awareness, education, and stimulus programs was recognized by the key stakeholders interviewed. The Malaysian government is focused on financing. As in Indonesia, in Malaysia too, bureaucracy, transparency, and availability of hands-on advisory services are seen as key issues. Lack of talent and education that supports digital adoption are the challenges that Malaysia must tackle.

In contrast, the ROK’s economic success has been based on several key factors, including an operating environment where government policy and regulation have enabled growth. Policies were designed, developed, and implemented to foster competition and deployment, including legal changes such as the passage of the Monopoly Regulation and Fair-Trade Act, which established rules for access to fiber lines that barred unfair practices and prohibited unreasonable rates. The ROK has also outlined key digital projects, including the Data Dam initiative, smart government, green and smart schools, and green and smart industrial complexes. The ROK stresses the importance of lifelong learning, multiple skills, and data privacy.

METHODOLOGY

A systematic review of previous studies, a comprehensive survey of APO member economies, and in-depth expert interviews in three case study countries drew out insights on growth of digital technologies, the sectors they are most likely to benefit, and government policies and regulations that support their impact.

The Approach

Our approach was premised on undertaking a ‘grounded’ exploration of the current knowledge on how the digital economy has an impact on economic growth, productivity and social outcomes. (A grounded inquiry is one that seeks to establish a firm footing in prior research by undertaking a systematic review of the recent literature.) First, a literature review was conducted to summarize industry, government, and institutional reports on digital economy. From this review, it was evident that the digital economy’s impact on economic growth related to the level of IT investment, whereas its impact on productivity was derived from improvements in physical and human capital. The social impact arising from the expansion of digital economy could also facilitate inclusion and empowerment.

Second, a series of interviews was held with key stakeholders across APO member economies to seek input on which technologies and government initiatives were likely to be most beneficial. Based on these interviews and on the literature review, a questionnaire was designed, piloted, and finalized.

Third, the resulting survey of APO member economies sought views on the importance of the digital economy, the sectors of the economy most affected and likely to be affected in the future, as well as the policies and regulations important for encouraging and supporting growth in a digital economy.

In addition, more detailed research was undertaken for three member economies, Indonesia, Malaysia, and the ROK, as representative case studies. These three dimensions of the methodology are briefly described below.

Review of Literature

First, we conducted a scoping literature review, the objective of which was to capture key literature in policy-related outlets and understand the main findings related to digital technologies. Altogether, 51 articles sourced from the United Nations (UN) and the top 10 consulting firms were examined. The second literature review included 53 recently published articles, catalogued by major academic and professional databases, focused on digital-related policies and their impact on economic growth. Third, we reviewed APO member economies’ economic data, as outlined in Appendix 1.

Using this data, we categorized APO member economies into four groups, based on their relative degrees of maturity of digital development. Group 1 includes the leader economies having high digital economy scores and rankings. The economies in this group are Singapore, Hong Kong, the ROK, the Republic of China (ROC), and Japan. Group 2 comprises the emergent economies of Malaysia, Thailand, and Türkiye. Group 3 included the nascent economies of Indonesia, Vietnam,

India, the Philippines, Islamic Republic of Iran (IR Iran), and Sri Lanka. Group 4 is categorized as embryonic and includes Pakistan, Bangladesh, Cambodia, and Lao PDR. Mongolia, Fiji, and Nepal are not included because we did not have adequate digital technology data for those countries.

Survey

Survey questions were developed from the review of past work. The questionnaire consisted of four sections.

Section 1 asked respondents to rank the importance of technology for each national outcome (economic growth, productivity, and social services) over the next five years. The technologies included enabling technologies (internet of things, blockchain, quantum computing, biotechnologies, and big data and analytics) and foundation technologies (mobile networks, electronic payment, broadband, and cloud computing).

Section 2 asked respondents to rank those sectors that could achieve the best national outcomes over the next five years. The sectors ranked included government services, healthcare, agriculture, finance, manufacturing, education, finance and banking, technology, and retail.

Section 3 asked respondents to rank the best regulatory and policy initiatives for their respective countries over the next five years, looking at a predetermined list derived from earlier research. The listed areas of regulatory and policy initiatives included education and skills (schools, technical and further education, and universities); R&D; telecommunications regulation; establishing trust (IP, privacy, and security); business and competition policy; and the ease of establishing a new company (online or offline).

The final section of the questionnaire contained the following five additional questions:

- (1) what priority would you attach to the necessity of having additional resources and finances to create a stronger digital economy for your country?
- (2) to what extent would accelerating the adoption of digital technologies significantly improve innovation and national economic and social achievements?
- (3) to what extent has your country taken measures on critical infrastructure systems to avoid cyberattacks?
- (4) to what extent does the government of your country have a long-term digital plan (at least five years)?
- (5) if 'no' to question 4, how advantageous would it be if your country developed a five-year digital plan for the whole of the government and the national economy?

The survey was sent to 436 potential respondents representing all APO member economies. From this distribution, 361 completed the survey (see Table 3). With the exceptions of Türkiye, Fiji, Mongolia, IR Iran, Japan, Pakistan, Vietnam, and Nepal, there were at least 13 responses from each country. Vietnam and Nepal generated six and seven responses, respectively. The three case studies focused on Indonesia, Malaysia, and the ROK were drawn from data that included at least 20 responses per

country. We asked the respondents to nominate their core skills and the survey results show a good balance across all core skills among survey participants. Most participants were experts, with 95% of them having at least five years of experience and 26% having more than 20 years of experience.

We were obliged to remove Japan, Mongolia, and Turkiye from the survey analysis for various technical reasons. We removed Turkiye because we received no key responses. We removed Mongolia because the responses were incomplete. For Japan, the ratings we received in the five responses were uniformly low (mostly 1 and 2), which had a disproportionate impact on the average ratings for Group 1, and most of these ratings were incomplete as well.

TABLE 3**NUMBER OF RESPONSES BY COUNTRY GROUPS AND CASE-STUDY COUNTRIES.**

Country	Number of responses		
	Completed responses	Completion rate	Total attempts
Unidentified	43	75%	57
Group 4 (embryonic) *	29	91%	32
Group 3 (nascent) *	138	85%	162
Group 2 (emergent) *	85	81%	105
Group 1 (leaders) *	66	85%	78
Indonesia	47	84%	56
Malaysia	28	97%	29
ROK	19	86%	22
Total (all countries)	361	83%	436

* See Digital economy group column in Appendix 1.

Expert Interviews

Based on the key findings from the questionnaire, we undertook a series of interviews with influential and knowledgeable stakeholders, such as businesspeople, academics, and government officials, to develop case studies of best practices. For each case study country, we sought out for the senior-most people knowledgeable about the digital economy and digital policies of their countries. The selection of stakeholders included at least two economists, two technologists, and two technology-oriented government policy experts.

Indonesia, Malaysia, and the ROK were chosen as the countries for these interviews as representative of the nascent, emergent, and leader groups pertaining to economic development and digital technology adoption. A total of seven to eight interviews were conducted with the key stakeholders identified. The aim of these interviews was to have both depth and context and to draw out examples of best practices in the areas of policy and regulation.

A total of 22 interviews were conducted with senior key stakeholders across these three countries. The respondents spanned

- government and industry representative bodies, with interviewees including ministers, department heads, and heads of industry bodies;

- technology specialists, including CEOs and Chairs of telecommunications companies and IT vendors; and
- economists, business leaders, academics, partners in major consultancy firms, and industry insights specialists.

The interviews were semi-structured and explored the following topics (see Appendix 4 for more details):

- importance of policy and regulation for new technologies in terms of productivity, economic growth, and social impact;
- published long-term technology strategy;
- foundation issues in telecommunications networks;
- education and skills;
- establishing trust;
- innovation and competition policy;
- digitization of government services;
- enabling technologies;
- economic sectors that can gain the most from new technologies; and
- social benefits arising from the digital economy.

Across the three countries, the respondents provided considered, deep, and meaningful insights into digital technologies, the industries on which they were having an impact, as well as policies and regulations. There was a consensus among the respondents that cloud computing, big data, and AI were the most important emerging technologies. In addition, there was a consensus that the retail industry benefited the most from investments in digital technologies, although each of the respondents also identified other key market sectors benefitting from the digital economy. From these interviews, we identified the policies that were considered to be more important than others.

THE RELATIVE IMPACT OF NEW TECHNOLOGIES

In general, reports published by consulting firms and research published by the UN agree that seven groups of technologies will dominate the future [35–40]. These technologies include digital reality, cognitive technologies, big data, internet of things (IoT), distributed ledger, cloud computing, and quantum computing. The first six technologies are already in use across industries and their greater use is predicted in future. They are discussed briefly here:

Digital reality technologies: Digital reality technologies, including augmented reality/virtual reality (AR/VR), mixed reality, voice interfaces, speech recognition, ambient computing, 360° video, and immersive technologies, promote more natural user engagement by seamlessly extending a human-centric experience beyond the confines of keyboards and screens. The goal is to enable natural, intuitive, and potentially imperceptible interactions using underlying technologies.

Cognitive technologies: Cognitive technologies, such as machine learning, neural networks, robotic process automation, bots, natural language processing, neural networks, and the broader domain of AI have the potential to transform nearly every industry. These technologies personalize and contextualize the human–technology interaction, allowing businesses to provide tailored language- and image-based information and services, with minimal or no human involvement. Accenture reports that these technologies are expected to have the most impact in future.

Big data and analytics: Big data comprises extremely large datasets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behavior and interactions. This is a well-known technology and has been predicted to become a significant technology in future, particularly in the social media realm where data can be retrieved in real time through mobile devices. Most of the reports mentioning the importance of big data are from the UN. The combination of big data and AI is predicted to be a powerful tool for forecasting trends.

IoT and autonomous vehicles: IoT is the interconnection of computing devices embedded in everyday objects with the internet, thus enabling those devices to send and receive data captured through sensors. Companies are starting to use such technologies to run, not just monitor, complex operations, so that systems can make autonomous decisions based on the data reported by sensors. For example, smart networks now use sensors to monitor vehicle flows and reprogram traffic signals accordingly or to confirm whether repairs have been effective in electric power grids.

Distributed ledger technology/blockchain and cryptocurrency: Blockchain was a critical technology priority for more than half of those who participated in Deloitte’s 2019 Global Blockchain Survey, which marked a 10-point increase over 2018 [41]. Blockchain, which is a type of distributed ledger, is also mentioned by Accenture and BCG as one of the more disruptive technologies for the future. It uses independent computers (referred to as nodes) to record, share, and synchronize transactions in their respective electronic ledgers (instead of keeping data centralized in a traditional ledger). Blockchain organizes data into blocks, which are chained together in an append-only mode.

Cloud: Cloud is a term used to denote on-demand availability of computing resources, especially of data storage and computing power, without direct active management. The main enabling technology for cloud computing is virtualization. Virtualization software defines a physical computing device into one or more ‘virtual’ devices, each of which can easily be used and managed to perform computing tasks. Cloud computing has become an essential element across industries.

Quantum computing: The concept of quantum computing is still very new. The basic idea of quantum computing is to use certain phenomena from quantum mechanics, such as superpositioning and entanglement, to perform operations on data. Quantum computing is yet to be applied in industries. However, it is forecast to be a game-changing technology. Although this technology is still very new, some countries have already started to invest in it, suggesting its potential for growth.

Technologies Ranked

Tables 5A through 5C show the average scores given by respondents to various technologies in the context of their importance for economic growth, productivity growth, and social services growth. Overall, electronic payment, mobile network, broadband, big data analytics and AI, and cloud computing are the most important technologies for all the three areas.

Our study shows that telecommunications infrastructure as a means for internet and mobile phone access is the focus of technological development in developing countries because of the wide gaps in access to digital information [43–45]. Telecommunications is known to play a key role in fueling the economy [43, 46]. In addition, from an economic perspective, it seems mobile and internet usage is the indicator most often used to measure ICT adoption [47, 48]. However, our survey shows that telecommunications technology remains important for advanced countries as well.

We found that mobile network technologies had the biggest impact on economic growth, followed by electronic payment, broadband, and cloud computing. A similar pattern was observed for social services and productivity. The survey also found that most of the participants placed more priority on foundation technologies, no matter which country grouping they belonged to. However, Group 4 (embryonic) showed the lowest priority compared with other groups. For example, when ranking the importance of mobile networks for economic growth, this group’s average score was 6.5 while the other groups’ scores were above 7 (see Table 5A). This is the case across all responses about the importance of ICT for economic growth, productivity, and social services. What is notable is that biotechnology, quantum computing, and blockchain were given the least priority. Furthermore, the embryonic countries in Group 4 placed relatively low emphasis on biotechnology compared with other groups, with average scores of 5.3, 5.0, and 5.0 respectively, while other groups gave scores above 6.5 (see Tables 5A–5C).

The importance of ICT for economic growth and productivity is also confirmed by the data on contribution of ICT assets to GDP growth across all four groups of countries. In Table 4, we present the contribution of ICT assets to GDP growth (among other factors of production) for the four groups of countries. For the more technologically developed countries in the leaders and the emergent groups (groups 1 and 2), ICT assets have contributed, on an average, between 12% and 15%, respectively, of GDP growth since 2010. This is more than double the contribution that ICT assets have made to GDP growth for the digitally nascent and embryonic countries in groups 3 and 4, respectively.

It is not surprising to see the responses to survey questions from countries in groups 3 and 4, where interviews (see below) focus more attention on foundation technologies as compared with enabling technologies. With a greater diffusion of foundation technologies in group 1 and 2 countries (as suggested by the ICT contributions in Table 4), it is not surprising that more emphasis is placed on enabling technologies to facilitate greater levels of productivity and economic growth.

TABLE 4**ICT's CONTRIBUTIONS TO ECONOMIC GROWTH (2010–19).**

APO member economies	Group 1	Group 2	Group 3	Group 4
GDP growth (average)	4.0	4.8	5.1	5.8
Contribution of labor quantity	0.3	0.6	0.5	0.6
Contribution of labor quality	0.4	0.5	0.4	0.2
Contribution of capital services provided by ICT assets (growth 2010–19)	0.6 (15%)	0.6 (12.5%)	0.3 (5.9%)	0.4 (6.8%)
Contribution of capital services provided by non-ICT assets	1.7	2.2	3.6	4.0
Total factor productivity growth	1.0	0.9	0.3	0.6

Source: The Conference Board Total Economy Database, July 2020.

Survey participants from the three case study countries, Indonesia (nascent), Malaysia (emergent), and the ROK (leaders), also emphasized the importance of the telecommunications technology.

Indonesia is developing its digital infrastructure through projects such as the *Palapa Ring*, a priority infrastructure project that aims to provide 4G internet service access to more than 500 regencies across the country. However, the 5G technology is yet to arrive. By 2025, around 80% of all subscribers in Indonesia will continue using a 4G connection, while another 14% will still be having the 3G technology. The survey participants from Indonesia also referred to AI, cloud computing, and big data as important technologies. However, their implementation in Indonesia is still at a very early stage. In addition to that, the government faces a dilemma on storing data in the cloud. On one hand, people recognize that cloud will help them with data management. On the other hand, there are laws in place that prohibit data being on the cloud as it may be managed by ‘outsiders.’

Malaysia has progressed further in developing its digital economy and has a relatively well-developed telecommunications and IT infrastructure sector to support digital service delivery. However, there are certain limitations. Although fixed broadband is reasonably well deployed in urban locations, there are significant challenges in delivering broadband to rural communities. Improving the foundation technology, primarily using mobile wireless technology along with a broadband backbone, was highlighted by all interviewees as a priority. Significant initiatives are under way towards that end. The government has announced the introduction of *Jalanan Digital Negara (JENDELA)* or the National Digital Network, a digital infrastructure plan to meet the needs of digital connectivity and to prepare the nation for a gradual transition to 5G. When stakeholders were asked about high-level enabling technologies, the most frequently reported were big data, AI, robotic process automation (RPA), and cloud computing. However, it appears that a full appreciation of the importance of data is still a way off. More private sector organizations need to see data as an asset rather than a byproduct of activities.

The ROK is known for having one of the fastest internet networks in the world, as a result of successive governments developing and expanding the use of landlines and the internet. Long

before 5G was introduced, the government formed a pan-government committee that included private companies and academic institutes to focus on the 5G network. This committee was charged with working to introduce the 5G network as rapidly as possible. The ROK introduced commercial 5G in April 2019 and by April 2020 it had more than 6 million subscribers. Expert interviews revealed that big data, AI, cloud computing and IoT are also considered key future technologies for growth. More enterprises in the ROK have also started to invest in biotechnology.

TABLE 5A
THE IMPORTANCE OF TECHNOLOGIES FOR ECONOMIC GROWTH.

Digital evolution score	Economic								
	IoT average	Blockchain average	Quantum computing average	Biotechnology average	Big data analytics and AI average	Mobile network average	Electronic payment average	Broadband average	Cloud computing average
Group 1 (leaders)	4	6	7	2	1	1	4	5	3
Group 2 (emergent)	5	6	7	4	3	1	1	2	2
Group 3 (nascent)	4	7	6	5	4	1	2	3	4
Group 4 (embryonic)	3	5	5	5	4	1	3	2	2
Indonesia	2	7	6	5	3	1	2	2	4
Malaysia	6	7	7	5	5	2	1	3	4
ROK	4	7	9	2	1	3	6	8	5

Note: 1= most important; 9 = least important.

TABLE 5B
THE IMPORTANCE OF TECHNOLOGIES FOR PRODUCTIVITY GROWTH.

Digital evolution score	Productivity								
	IoT	Blockchain	Quantum computing	Biotechnology	Big data analytics and AI	Mobile network	Electronic payment	Broadband	Cloud computing
Group 1 (leaders)	2	5	7	3	1	2	4	6	4
Group 2 (emergent)	5	7	8	6	4	1	1	3	2
Group 3 (nascent)	3	5	5	4	3	1	2	2	3
Group 4 (embryonic)	4	7	6	7	5	2	1	3	1
Indonesia	3	5	6	4	3	1	3	2	2
Malaysia	7	9	8	6	4	2	1	3	5
ROK	3	6	7	5	1	2	4	5	4

Note: 1= most important; 9 = least important.

TABLE 5C

THE IMPORTANCE OF TECHNOLOGIES FOR SOCIAL SERVICES GROWTH.

Digital evolution score	Social services								
	IoT	Blockchain	Quantum computing	Biotechnology	Big data analytics and AI	Mobile network	Electronic payment	Broadband	Cloud computing
Group 1 (leaders)	5	7	8	3	1	2	7	4	6
Group 2 (emergent)	5	7	8	6	4	3	1	2	3
Group 3 (nascent)	4	4	8	7	6	3	2	1	5
Group 4 (embryonic)	4	6	7	5	5	3	1	2	3
Indonesia	3	7	6	5	2	1	4	2	4
Malaysia	2	6	5	4	4	3	1	3	3
ROK	4	7	8	5	3	1	5.8	2	6

Note: 1= most important; 9 = least important.

Disruptive Technologies

Technologies are predicted to have an impact on all industries. Reports from the top 10 consulting firms show that no industry is immune to disruptive technologies. Industries are reported as having taken advantage of, and invested in, a variety of technologies in areas such as healthcare, transportation, music, travel, finance, fashion, consumer products, and governance.

Technologies change industries in a number of ways, including how companies connect with partners and customers; how they manage their workforce; and how they strategize, run their operations, and conduct their R&D.

Relationships with Customers and External Parties

Ecosystem approach [49–54]: The ability to partner will be a source of competitive advantage in the digital ecosystem era. The most successful ecosystems have about 40 partners, and 83% of digital ecosystems involve partners from more than three industries [55].

A technology ecosystem enables new levels of collaboration. Companies are developing partnerships with value-chain stakeholders to reshape customer experience, mass producing customized products on demand, and sharing data to react rapidly to demand fluctuations. Supply chains will be visible from end to end. They will also be intelligent so that companies will be able to prototype products, services, and processes before launching them. They can also develop relationships with customers through crowdsourcing, online communities, etc. to better understand their needs.

Digitizing customer relationships [35], [52–54], [56–59]: Companies increasingly develop interactions that take place between customers and brands on digital platforms such as mobiles, desktops, or tablets. Digitizing customer relationships enables companies to develop more personalized in

customer experiences. From hotel pillow menus to Netflix recommendation lists, services are becoming increasingly customized. Customers expect companies to know what they want and to tailor service offerings to their specific needs and preferences. Companies can also provide integrated service offerings. Companies like WeChat in PR China and Amazon in the USA win customers by offering a broad range of services in a single place. In retail, consumers have moved from the shopping mall to a central app or website to purchase just about everything they need.

Human Resources

A shift from use of human labor to automation is taking place [49, 53, 56, 57], [60–63].

Automation and high-skill labor: McKinsey estimates that between 400 million and 800 million people could be displaced by automation of lower skilled jobs. At the same time, new, high-skill, and more knowledge-intensive jobs will be created. [64]. By 2030, it estimates, 20 million to 50 million jobs will be generated globally in IT services.

Contingent worker employment: The shape of the global workforce is changing dramatically. The rise of technology and customers who expect faster and more personalized services drives businesses and governments to access highly skilled professionals for short-term projects. Technology is the key enabler to facilitate supply and demand: available talent and organizational need. For businesses, technology is creating new and more flexible ways to manage their workforces. Based on an Ernst & Young survey, one in three employers of 100,000-plus employees expect 30% of their workforce to be contingent workers [40].

Operations, Strategy, and R&D

Significant changes are taking place in these areas as well [37, 38, 49, 54, 57, 65].

Digitized manufacturing: Companies that are digital leaders in their sectors have faster revenue growth and higher productivity than their less-digitized peers. They improve profit margins three times more rapidly than similar companies in the same industries and are often the fastest innovators and disruptors in their sectors. Examples of digitized manufacturing include virtual reality for manufacturing maintenance and training, energy management for buildings, ‘smart’ water management, pollution monitoring, remote manufacturing, manufacturing quality control, asset tracking, and predictive maintenance [37].

Blurred lines between strategy and operations: Operations are no longer the last mile of fulfilment. Digital transformations are experienced and processed by front-line staff. The era of continuous improvement for lowest cost is being replaced by the era of flexibility, resilience, and customization. It means that in the digital transformation strategy, the focus is no longer wholly on costs.

Regional value chains: Goods-producing value chains, particularly in areas of automotive, computers, and electronics, are becoming more regionally concentrated [57] as companies increasingly establish production facilities in proximity to demand.

MOST IMPORTANT MARKET SECTORS

Sectors Likely to Produce the Best Outcomes

In our survey, respondents expected that over the next five years digital technologies would produce the best outcomes for the retail and agriculture sectors in countries with better established digital technologies, i.e., countries in the leaders and emergent groups.

In agriculture, while digital technologies hold the prospect of delivering a positive impact, the situation is complex, and it is not easy to unlock all of the technology's potential. Digital technologies and analytics are making a farm's field processes more efficient and helping to improve financial performance and boost yield. But, today, less than 20% of acreage is managed using digital agriculture technologies [42]. A collaborative effort from businesses, governments, non-governmental organizations (NGOs), and the high-tech community will be required.

In groups 3 and 4 (nascent and embryonic), respondents suggested that a mix of retail, education, government services, and banking and finance would benefit from further investment in digital technologies, in turn contributing to economic, productivity, and social services growth.

Tables 6A through 6C illustrate these findings.

TABLE 6A

MARKET SECTORS THAT CAN ACHIEVE THE BEST NATIONAL OUTCOMES TOWARDS ECONOMIC GROWTH IN THE NEXT FIVE YEARS.

Digital evolution score	Economic								
	Government services	Health	Agriculture	Finance	Manufacturing	Education	Finance and banking	Technology	Retail
Group 1 (leaders)	6	5	1	7	4	3	3	5	2
Group 2 (emergent)	6	5	2	6	4	4	3	4	1
Group 3 (nascent)	3	7	3	6	5	2	4	4	1
Group 4 (embryonic)	4	5	7	6	8	5	3	2	1
Indonesia	2	5	4	4	2	3	4	4	1
Malaysia	4	5	1	5	3	2	3	5	1
ROK	7	6	2	8	3	2	4	5	1

Note: 1= most important; 9 = least important.

TABLE 6B

MARKET SECTORS THAT CAN ACHIEVE THE BEST NATIONAL OUTCOMES FOR PRODUCTIVITY GROWTH IN THE NEXT FIVE YEARS.

Digital evolution score	Productivity								
	Government services	Health	Agriculture	Finance	Manufacturing	Education	Finance and banking	Technology	Retail
Group 1 (leaders)	4	6	2	7	4	3	4	5	1
Group 2 (emergent)	6	7	2	6	5	4	4	3	1
Group 3 (nascent)	3	7	3	6	4	2	5	5	1
Group 4 (embryonic)	3	7	6	4	5	5	2	2	1
Indonesia	2	5	3	4	3	3	5	4	1
Malaysia	5	7	2	6	3	3	5	4	1
ROK	6	7	2	8	5	3	4	5	1

Note: 1= most important; 9 = least important.

TABLE 6C

MARKET SECTORS THAT CAN ACHIEVE THE BEST NATIONAL OUTCOMES FOR SOCIAL SERVICES IN THE NEXT FIVE YEARS.

Digital evolution score	Social services								
	Government services	Health	Agriculture	Finance	Manufacturing	Education	Finance and banking	Technology	Retail
Group 1 (leaders)	3	4	1	8	7	5	4	6	2
Group 2 (emergent)	3	2	2	4	3	3	2	2	1
Group 3 (nascent)	2	3	1	6	4	5	3	5	1
Group 4 (embryonic)	3	4	5	4	5	6	2	2	1
Indonesia	2	4	2	6	3	4	3	5	1
Malaysia	7	8	2	7	3	4	5	6	1
ROK	5	2	1	7	8	6	4	6	3

Note: 1= most important; 9 = least important.

The survey findings were confirmed through the interviews, with respondents particularly noting that they expected the retail industry to benefit the most from further adoption of digital technologies over the coming five years.

In Indonesia, the seven key stakeholders provided insights on key market sectors necessary for optimizing added value in natural resources and digital products. Natural resources included agriculture, plantation, animal farming, fisheries, and mining. During two periods of economic crises, namely the monetary crisis of 1997 and the COVID-19 outbreak, the agricultural sector provided a stable contribution to domestic economic growth. Other stakeholders also expected financial investment, logistics and transportation, and education sectors to be among those poised to benefit the most in the next five years. The health sector did not feature in this list, according to the respondents.

Stakeholders from Malaysia expected the benefits to come from e-commerce, particularly for SMEs. Financial support from the SME Digitalisation Matching Grant and the SME Technology Transformation Fund has enabled the digitalization of SMEs, thus making e-commerce much more vibrant. E-commerce activities were anticipated to contribute about MYR170 billion to the economy in 2020. The stakeholders believed that all industries would benefit to some degree. They identified early adopters in services and specific functions such as supply chains, as well as industries such as IT, communications, and media. Three sectors that were specifically highlighted as likely to benefit the most in the coming years were energy (including oil and gas), due to its size in the Malaysian economy; healthcare, especially given the ageing population and the impacts of COVID-19; and digital content creation including arts, media, and movies.

In the ROK, the coronavirus pandemic has seen an acceleration in the so-called ‘untact’ (no contact) services, such as online shopping and delivery applications. Under the country’s Digital New Deal, a key focus is on fostering this untact industry by laying the groundwork to promote it by setting up infrastructure closely related to people’s daily lives. Examples include medical, work-related, and business-related infrastructure. The ROK has also digitalized education infrastructure by expanding digital infrastructure and educational materials. In addition, it has built smart medical and care infrastructure and added smart components to urban spaces, industrial complexes, and logistics systems. Agriculture was also mentioned by the respondents, although it is still undervalued in terms of what digitalization can offer. The economic growth is still focused on manufacturing.

MOST IMPORTANT DIGITAL ECONOMY POLICIES AND REGULATIONS

Policy and Regulation

Figure 1 illustrates the initial framework connecting possible policies to economic growth, based on insights from our review of existing literature.

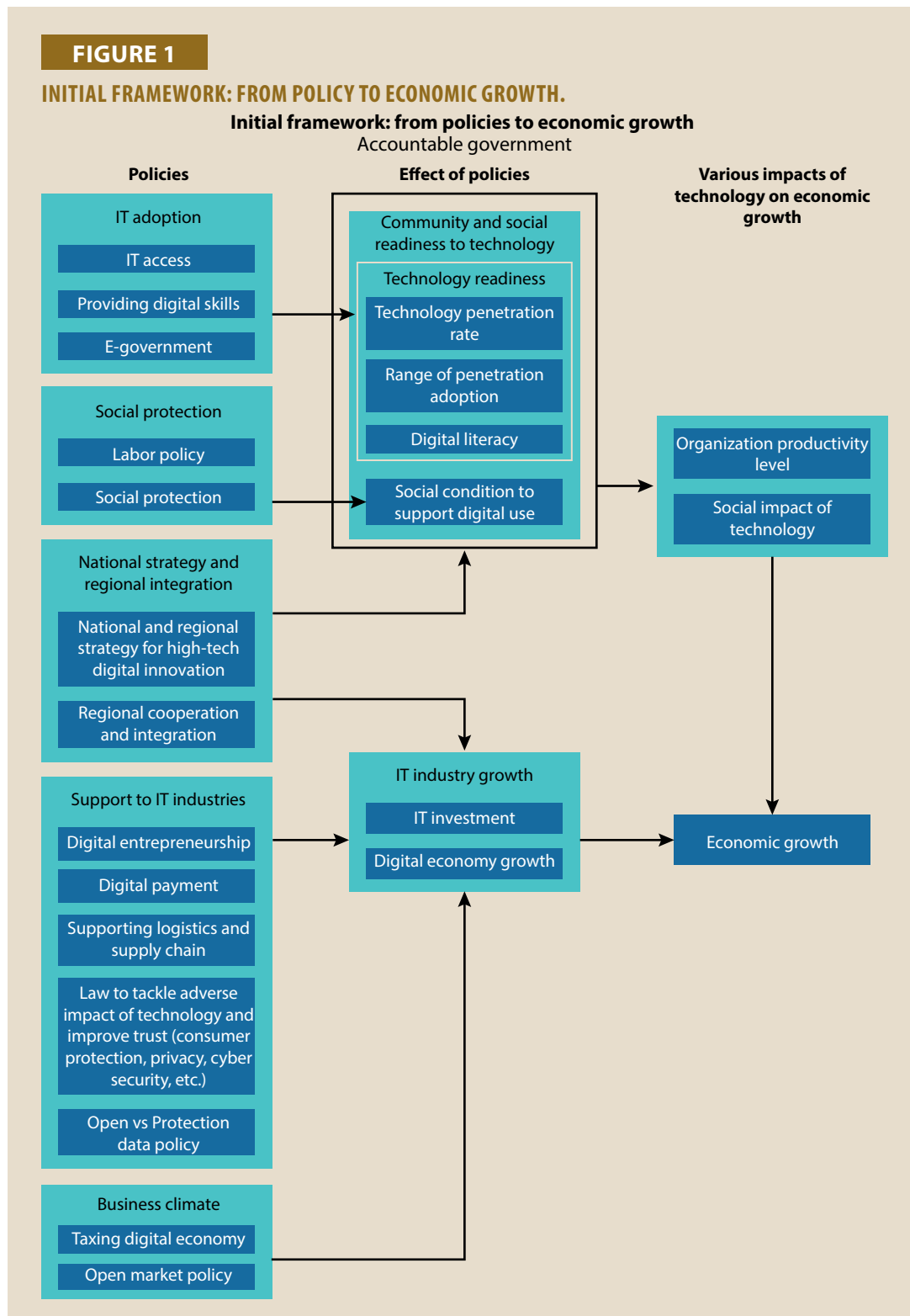
It is an imperfect picture, not the least because of the evolving subject matter it covers. Inevitably, the limits arise from a rapid pace of technological changes and the challenges governments face in keeping up and adapting their policy and regulatory frameworks. In addition, industrial policies that worked well in the past may no longer work well in a new global market landscape [66]. For those reasons, this report does not claim to be an exhaustive treatment of all aspects of policies for economic growth.

With that understanding, this research has collated policies found in reviewed papers and classified them into five categories (see Figure 1). The first category is IT adoption, which relates to the use of technology for personal or organizational purposes. The second category relates to social protection, while the third category pertains to the availability of national and regional strategies for high-tech development and regional cooperation and integration. The fourth category is about support to IT and IT-enabled service industries. It relates to policies that support the development of IT industries, which include ICT production, digital-economy industries, and IT service industries. The fifth category relates to the development of a conducive business climate.

Frameworks addressing ICT policies often require the breadth to address a variety of complex challenges that emerge from the development, management, and integration of technology into all facets of society. A comprehensive ICT policy framework can be developed along seven dimensions: (1) connectivity and access; (2) usage; (3) legal and regulatory framework; (4) production and trade; (5) skills and human resources; (6) cyber security; and (7) new applications [67].

Digital technologies create benefits such as increased empowerment and inclusion among citizens, as well as speedier service delivery. However, with the benefits also come risks. Although digital technologies make almost everything cheaper, faster, and more convenient, most tasks other than the most routine ones require human judgment, instinct, and decision. In other words, they require skilled human capital. Without matching improvements in human capital, digital technologies may fail to deliver social and economic benefits to a country.

To maximize the benefits of digital technology, a country should put emphasis not only on the development of the technology but also on its complements such as rules, institutions, and skills, which are often termed analog complements [45, 68, 69]. These complements include regulations that create a vibrant business climate, allowing firms to leverage digital technologies to compete and innovate, along with skills that allow workers, entrepreneurs, and public servants to seize opportunities in the digital world. They can make institutions more accountable by using the internet to empower citizens.



The digital revolution may open a new door to businesses but not in situations where incumbents control market entry. Open economies and market competition are more likely to hasten innovation. Technology can improve efficiency and innovation but not when employees, businesses, and institutions lack the knowhow and familiarity with devices and software. When government systems lack accountability, digital technologies may help monitor public servants' productivity,

but they will not make public sector processes more transparent. That depends on framing the use of the technologies in question. Technologies do not determine their use and applications. That depends on how they are framed, socially constructed, and politically limited.

Policies related to the development of digital technologies should evolve as countries progress toward digital transformation [69]. For example, in countries where internet accessibility is low, the focus should be on growing access to digital technologies and encouraging digital literacy. As countries transition to advanced income levels, the focus should shift toward developing an effective business climate and augmenting workers' skills. Given the constraints on resources, a developing country should assign a much higher priority to fostering ICT adoption than investing in ICT production [66].

Developed countries should find ways to encourage competition, ensure lifelong learning, and use the internet to improve the efficiency and accountability of government functions. Countries that have solid analog foundations will gain ample digital benefits, such as increased innovation leading to economic growth, more jobs, and better services [45, 68, 69].

From the survey (Tables 7A–7C), we found that the ease of establishing a new company has the biggest impact on economic growth, followed by telecommunications regulation, R&D, IP, and skills development at universities. A similar pattern has been observed for the impact on productivity: the ease of establishing a company has the biggest impact, followed by telecommunications regulation and R&D. For the impact on social services, the highest priority goes to R&D and technical and further education, as well as to the ease of establishing a new company and business and competition policy.

TABLE 7A
POLICY AND REGULATORY INITIATIVES TO ACHIEVE THE BEST NATIONAL OUTCOMES FOR ECONOMIC GROWTH IN THE NEXT FIVE YEARS.

Digital evolution score	Economic									
	Schools	Technical and further education	University	R&D	Telecom regulation	IP	Privacy	Security	Business and competition policy	Ease of establishing a new company
Group 1 (leaders)	9	7	6	3	2	8	5	7	4	1
Group 2 (emergent)	7	6	3	2	2	4	5	5	4	1
Group 3 (nascent)	3	4	2	1	3	5	7	6	4	2
Group 4 (embryonic)	1	1	2	2	4	3	5	6	3	2
Indonesia	2	4	1	3	5	5	7	6	7	4
Malaysia	7	3	5	1	4	2	5	6	5	3
ROK	5	7	6	3	1	8	4	8	5	2

Note: 1= most important; 9 = least important.

TABLE 7B

POLICY AND REGULATORY INITIATIVES TO ACHIEVE THE BEST NATIONAL OUTCOMES FOR PRODUCTIVITY IN THE NEXT FIVE YEARS.

Digital evolution score	Productivity									
	Schools	Technical and further education	University	R&D	Telecom regulation	IP	Privacy	Security	Business and competition policy	Ease of establishing a new company
Group 1 (leaders)	3	6	4	2	1	8	5	7	5	2
Group 2 (emergent)	3	5	2	1	1	3	3	5	4	1
Group 3 (nascent)	5	5	3	1	4	4	6	5	6	2
Group 4 (embryonic)	3	3	2	1	5	4	6	7	4	1
Indonesia	4	4	1	2	3	2	4	4	4	1
Malaysia	8	5	4	1	3	3	3	7	6	2
ROK	4	8	7	3	1	9	5	10	6	2

Note: 1= most important; 9 = least important.

TABLE 7C

POLICY AND REGULATORY INITIATIVES TO ACHIEVE THE BEST NATIONAL OUTCOMES FOR SOCIAL SERVICES IN THE NEXT FIVE YEARS.

Digital evolution score	Social services									
	Schools	Technical and further education	University	R&D	Telecom regulation	IP	Privacy	Security	Business and competition policy	Ease of establishing a new company
Group 1 (leaders)	4	4	5	2	5	5	5	3	1	4
Group 2 (emergent)	3	5	2	1	2	4	5	6	5	2
Group 3 (nascent)	4	1	3	1	4	2	4	2	3	2
Group 4 (embryonic)	1	3	3	2	5	6	6	6	4	2
Indonesia	5	6	3	2	4	1	5	4	4	4
Malaysia	6	3	4	3	1	3	5	7	2	3
ROK	6	4	7	1	3	10	9	5	2	8

Note: 1= most important; 9 = least important.

Initiatives in Case-study Countries

This study's three case study countries illustrate the range of policy and regulatory initiatives being taken by nations having digital economies at different stages.

Indonesia (nascent) is in the process of implementing e-government. As a guiding policy, Presidential Regulation No. 95/2018 states that one strategy to implement e-government is to develop a national e-service portal, to include all services provided by central and local government. It is targeted to be completed by 2025. IP protection and privacy are not sensitive issues in Indonesia. Most stakeholders considered that a good job is being done in this regard, generally. Indonesia has innovation programs, and had published a new 'omnibus law' on jobs creation, called *Cipta Kerja*, in 2020. This law is expected to further support technology adoption and innovation and make establishing a company easier. However, this study's interviews highlighted that Indonesia has had to struggle with challenges in education and employability. The government faces a dilemma between the adoption of high technology and the employability of its citizens. Also, in education, there is a debate on what should be taught first: technology skills or moral skills. Indonesia also faces issues of bureaucracy, governance, and corruption.

In Malaysia (emergent), awareness, education, and stimulus programs promoting technology were recognized by the stakeholders interviewed. The Malaysian government is focused on financing for digital innovation, especially in support of the startup ecosystem, with the aim of establishing more digital companies and leveraging the achievements of the digital economy. As with Indonesia, too much bureaucracy and a lack of transparency and advisory services are considered issues that need to be resolved. The lack of talent and education promoting digital adoption are also challenges for Malaysia to tackle.

The economic success of the ROK (leader) has been the result of several factors, one of which is an operating environment in which government policies and regulations have enabled economic growth. As the country entered the 2000s, the government repeatedly set new national goals with metrics, analyzed market barriers, and developed policies to foster competition and deployment in business. These included law changes, such as the Monopoly Regulation and Fair Trade Act, which established rules that barred unfair practices and prohibited unreasonable rates for access to fiber lines. The law also restrained corporate concentration in the telecom sector by restraining mergers and acquisitions and the overall market share any one company was allowed to hold. Such changes shifted the telecom market from a duopoly in 1999 to an apparently more competitive market consisting of four companies in the 2000s.

Further elaboration on case studies can be found in the subsequent chapter.

Other Survey Findings

In the survey, all the countries' respondents placed a high priority (above 5) on additional resources and finance, importance of adoption of digital technologies, and measures to avoid cyberattacks on critical infrastructure systems.

An interesting comment from a group 1 (ROK) respondent was that it was time for the ROK to put more efforts into developing more society friendly technologies. "The digital divide becomes a bigger issue to make one skeptical about its sustainability. We must strive to make the technology more society friendly, rather than market friendly."

Positive comments were received from Singapore on government efforts in digital technologies, e.g., “I’m sure the country has many big plans in the future” and “Singapore’s government has planned for the future with all necessary procedure.”

Respondents from group 2 (emergent), 3 (nascent), and 4 (embryonic) nations also articulated various themes in relation to governments and political situations in their respective countries. For example, a Philippine respondent stressed on “corruptions” and a respondent from Indonesia noted the need for “renewal of regulations and rules.”

Another theme frequently mentioned by respondents from groups 3 (nascent) and 4 (embryonic) was the need to improve technology infrastructure. For example, a comment from Bangladesh was that “developing infrastructure, telecommunications, and strengthening the IT sector is necessary for the country.” From Indonesia, a respondent said, “Indonesia still needs to improve on building the infrastructure.” The comment was echoed by a respondent from the Philippines, “In the Philippines, the internet is very poor in terms of speed and performance. It is time to upgrade this in terms of internet services and communication services.”

IMPACT OF COVID-19 ON NATIONAL OUTCOMES

The COVID-19 pandemic has only increased the speed at which digital technology is being adopted, illustrating the challenges and opportunities for nations. Years of development have been squeezed into months in some cases, bringing into sharper focus the technologies that are likely to dominate the future and the ways technologies can change industries.

COVID's Impact

The Asia Pacific region has been adopting digital technology to improve productivity for many decades. Some countries, such as the Republic of Korea (ROK), already have high connectivity. Others, such as Indonesia, have experienced the benefits of digital technology despite their challenges with foundational infrastructure. But uppermost for all respondents to this study's survey was the impact of COVID-19 as a disruptive force challenging the ways we work, connect with each other, and constitute the society at large.

Studies by McKinsey and Bain suggest that, because of COVID-19, changes that could have taken years to take effect have been achieved in months, with the speed of adoption continuing to accelerate. A report on a global survey of executives by McKinsey says, "Companies have accelerated the digitization of their customer and supply-chain interactions and of their internal operations by three to four years. And the share of digital or digitally enabled products in their portfolios has accelerated by a shocking seven years" [31].

The COVID-19 pandemic has varied in its intensity across the Asia Pacific (see Table 8). With approximately 185 million people contracting COVID-19 and 4 million deaths globally [92], including nearly 650,000 deaths in the countries studied [93], it could be easy to think that COVID-19 has had the same impact across each country. This, however, is not the case. PR China, Vietnam, and the ROK have managed to control outbreaks through a combination of significant lockdown measures, public education programs, and vaccination rollouts. Significant disruption in movement of people did occur, but lockdown restrictions were eased as infection rates dropped. Other countries, such as India and Indonesia, did not fare as well, with significant cases of COVID-19 infection and resulting deaths.

TABLE 8

COVID-19 DATA.

Country	Deaths	Total cases	Vaccinations	% vaccinated
Bangladesh	15,392	966,406	4,282,891	2.5%
PR China	4,636	91,949	223,299,000	15.9%
Hong Kong	212	11,944	1,645,286	21.9%
India	404,211	30,663,665	65,525,089	4.8%

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Country	Deaths	Total cases	Vaccinations	% vaccinated
Indonesia	61,868	2,345,018	14,267,980	5.3%
IR Iran	85,095	3,286,923	1,641,010	2%
Lao PDR	3	2,356	595,647	8.4%
Japan	14,834	809,909	19,136,719	15.2%
ROK	2,033	162,753	5,463,292	10.6%
Malaysia	5,677	792,693	2,868,760	8.8%
Pakistan	22,469	966,007	3,363,490	1.5%
Philippines	25,296	1,445,832	2,920,448	2.7%
Singapore	36	62,640	2,187,709	38.4%
Sri Lanka	3,313	267,433	1,250,443	5.7%
Thailand	2,333	294,653	3,082,746	4.6%
Vietnam	97	22,341	235,570	0.24%

Source: [94].

Digital technology has been used extensively to adapt work and life practices amid COVID-19. According to GSMA, the shift to online channels for many social and economic activities resulted in sharp increases in mobile and fixed data traffic for operators in the Asia Pacific [32]. In the ROK, operators reported traffic increases of 13%, reaching 45–60% of their deployed capacity, while NTT Communications in Japan reported an increase of 30–40% in data usage. In Indonesia, operators recorded a considerable rise in data traffic during the 2020 Eid al-Fitr celebrations compared with previous years because of large-scale social restrictions. The increase in data usage has relied on existing infrastructure, which has generally performed relatively well.

MIT says the greatest adoption and use of digital technology as a result of COVID-19 has been in relation to the following [32]:

- **Remote working:** The transition to working remotely full-time has been a shock to the system, figuratively and in some cases literally when user demand exceeded system bandwidth. But the silver lining is that with such a high percentage of the working population now operating remotely, digital collaboration is improving by leaps and bounds, both in terms of the sophistication of the tools to facilitate it and workers' level of comfort with it.
- **Omnichannel commerce:** As many physical business locations shut down, consumers have turned to online shopping to meet their needs, even those who historically had been reluctant to do so. Businesses are blending the physical and the digital to offer delivery methods such as kerbside pickup and contactless delivery to their customers. Physical–digital integration is more important now than ever before.
- **Digital content consumption:** Home-bound consumers are turning to digital content providers to meet their entertainment needs, with 51% of internet users worldwide

watching more shows on streaming services due to the coronavirus pandemic, according to data from Statista. Netflix alone secured 16 million new signups to its service in the first three months of 2020. Many film studios have been pushing new releases to captive audiences who have subscribed to streaming services.

- **Platformification:** Institutions and organizations of all types started trying out digital platforms to operate successfully during the pandemic. The fitness industry shifted to holding virtual classes on streaming services, using both live and prerecorded sessions. Educational institutions, from elementary schools through universities, largely shifted to blended learning, with variable components of online courses. Large-scale conferences and events have been held virtually. While some businesses are reverting to their traditional models as the crisis abates, others have been opting for a hybrid approach as they recognize the benefits of recurring revenue.
- **Digital health solutions:** Telemedicine and remote diagnostics are helping patients to obtain medical advice and diagnoses at home so that they do not need to go to a doctor's clinic or hospital, with 3D printing being used to expedite the production of critical medical supplies, such as personal protective equipment (PPE). Digital contact tracing has been used effectively to slow the spread of COVID-19 in east Asia.

The pandemic delivered a major shock to work involving high physical proximity and will continue to influence the shape and direction of this workforce in the future. Jobs that once helped offset labor displacement are among those that are most affected by the long-term repercussions of COVID-19, with workers facing unprecedented transitions requiring wholly new skills to advance into the more highly paid jobs being created. An active labor market policy that delivers the required skills formation required will obviously be a good policy.

Accounting network BDO highlights that use of digital technology accelerated during the pandemic and anticipates continuing increased usage in the wake of the health crisis. Those organizations that successfully implemented digital technology accrued a number of advantages [33]:

- **Efficiency advantage:** They harnessed digital technologies to streamline operations and automate manual processes, resulting in greater speed, less waste, and more focus on revenue-generating activities.
- **Productivity advantage:** Employees were already prepared for remote working, so the focus was on leveraging collaboration technology and tools to maximize workforce productivity and sustain company cultures.
- **Security advantage:** These employees were better prepared for and more resilient in the face of proliferation of cyber threats in the current environment.
- **Customer advantage:** They were able to mine customer data to monitor for shifts in demand and uncover emerging customer needs.
- **Agility advantage:** They leveraged data-driven insights to make decisions faster and act on them rapidly. They had built-in cultural flexibility to adapt or change course at any point of time.

Many respondents to a McKinsey survey across all sectors and geographies reported a significant increase in remote working, changing customer needs (reflecting new health and hygiene sensitivities), as well as customers' preferences for remote interactions [34]. Respondents reporting significant changes in these areas and increasing migration to the cloud were more than twice as likely to believe these shifts would remain after the crisis, rather than expecting a return to precrisis norms.

Respondents reported that the crisis spurred shifts in their supply chains as well. The nature of these shifts varied significantly by sector, and they have taken place less quickly than other changes because of the contracts that were in place before the pandemic. Respondents in consumer-facing industries, such as retailing, often cited disruptions to the last-mile delivery (to the end user). Other shifts, such as building redundancy into supply chains, were reported more often in sectors that create physical products.

The results also suggested that companies are making these crisis-related changes with the long term in mind. For most, the need to work and interact with customers remotely required investments in data security and an accelerated migration to the cloud. Now that the investments have been made, these companies have permanently removed some of the precrisis bottlenecks to virtual interactions. Most respondents expect such technology-related changes, along with remote working and customer interactions, to continue. Nearly a quarter of the respondents also reported a decrease in their physical footprints.

The respondents said that funding of digital initiatives had increased more than anything else, i.e., more than costs, the number of people in digital or other technology roles, or the number of customers.

COVID-19 may propel faster adoption of automation and AI, especially in work environments having high physical proximity. Experience has shown that in periods of recession, the share of jobs with mainly routine tasks declines. Businesses seek to control their cost base while dealing with margin pressure and mitigating uncertainty by improving efficiency. Two ways by which they have done this are through adopting automation technologies and redesigning work processes.

CASE STUDIES

Nascent: Indonesia

A number of factors are restraining the tremendous growth potential of Indonesia, which is object of our case study representing nascent digital economies. The Indonesian government recognizes the key role of technology in overcoming these constraints and notes that projects like *Palapa Ring* will vastly improve connectivity. With improvements in infrastructure in place, digital technology adoption can then be enhanced through e-governance and policies that support an optimal business environment.

Indonesia is the world's fourth-most populous nation and the tenth-largest economy. It is by far the largest country, by both measures, in the Association of Southeast Asian Nations (ASEAN) region. It has sustained average economic growth rates of above 5% since 2000 and made significant strides in reducing poverty. Yet, economic analyses point to several factors constraining Indonesia's growth potential, notably tepid productivity growth and slowing expansion in the labor force and manufacturing industries. Technology has a key role to play in overcoming these constraints and boosting future growth.

Internationally, advanced and developing economies alike see emerging technologies offering sustainable growth. Adopting new technologies allows industries to become more productive by enabling more efficient resource usage, new product development, and entry into new markets. Indonesia is no exception in this regard, and the Government of Indonesia recognizes the role of technology and innovation in achieving economic growth targets and higher incomes. Technology adoption has been proposed as possibly contributing up to USD2.8 trillion to the Indonesian economy by 2040, while spurring GDP growth by an additional 0.55 percentage points annually over the next two decades.

In a population of around 270.2 million, about 26.4 million Indonesians still live below the poverty line. Without a significant expansion of social assistance, as many as 8 million more could have been pushed into poverty because of the COVID-19 shock. In its immediate response to the pandemic, the government produced a fiscal package amounting to 4.3% of the GDP, including funds to improve the preparedness of the health sector and a substantial increase in social assistance. The World Bank is supporting Indonesia's emergency response, which involves enhancing social assistance and healthcare systems while also strengthening the resilience of the financial sector [70].

For this study, seven interviews were undertaken with key stakeholders from government, technology, and economic backgrounds during an eight-week period from November 2020 to January 2021. Insights from the interviews are discussed in relation to our four focus areas: technology, market sectors, policy and regulation, and constraints and challenges. The interviews were supplemented by secondary research.

Technology

The sheer size of Indonesia means that it has among the highest number of active internet users in the world, which stood at around 171.3 million as of June 2019, according to Statista. However, with a total population of over 260 million, the internet penetration rate was just 53.7%, lower than

many countries in the Asia Pacific region. In addition, blocked content and various media restrictions meant that Indonesia was rated as only ‘partly free’ in the 2019 Freedom House Index, which ranks countries according to their degree of internet freedom [71].

Indonesia’s internet penetration rate is half that of its ASEAN neighbor Malaysia and far behind that of leaders such as the UK, Japan, and Canada. Its large population also means that Indonesia is home to the world’s third-largest population of individuals without access to the internet. Geographically, digitization is uneven across Indonesia. With internet penetration strongly correlated with income per capita, poorer regions have lower penetrations. Only the large population centers, such as Jakarta and Yogyakarta, have penetration rates above 45%.

Mobile and internet access are cheap, but service quality can be poor: The number of smartphone users in Indonesia was estimated to have reached 81.87 million in 2020. Currently, Indonesia is the fourth-largest smartphone market in the world after PR China, India, and the USA. In 2018, the subscriber count for telecommunications provider Telkomsel amounted to 163 million, more than its rivals, Indosat and Hutchison. As of the fourth quarter of 2018, approximately 90% of Indonesian cities had access to a 4G LTE mobile network. The share of Indonesians accessing the internet from their smartphones was expected to have grown to 67% in 2020.

With a large portion of Indonesia’s digital traffic going to international sites such as Facebook and Google, international bandwidth is an important consideration in planning Indonesia’s digital future. According to TeleGeography, Indonesia’s international capacity is limited, at only 0.01 Mbps per user, compared with Singapore’s 2.74 Mbps per user. Connectivity is also concentrated, with most of the lines going through Singapore, a situation that leads to less than competitive pricing. In addition, 40% of landing points are in just three cities, namely, Batam, Dumai, and Jakarta.

Data traffic in Indonesia was expected to rise sixfold by 2020, placing pressure on the capacity of the domestic network, i.e., the linkages through submarine and overland fiber-optic cables. To raise fixed broadband penetration, which stood at 2.5%, it is vital to expand availability beyond the greater Jakarta area by strengthening connectivity in western and central Indonesia and expanding it into eastern Indonesia [72].

As for 5G, it is a long way off. While 5G attracts many headlines, 4G connections will still be used by about 80% of all subscribers in Indonesia by 2025. A further 14% of users in Indonesia will even rely on 3G technology. Affordability is also an important consideration, both from data subscription as well as devices point of view.

The Palapa Ring project will significantly improve connectivity: In late 2019, the government announced the completion of Palapa Ring, a priority infrastructure project that aimed to provide access to 4G internet services to more than 500 regencies across the country. The project is estimated to have cost USD1.5 billion and comprises 35,000 km of undersea fiber-optic cable and 21,000 km of land cable, stretching from the westernmost city of Sabang to the easternmost town of Merauke. The cables transverse every district from the northernmost island, Miangas, to the southernmost island, Rote. A stakeholder said in an interview:

“I think Indonesia is highly progressive. We planned to build the Palapa Ring project because we wanted to provide for the future needs. And now, we can see that the needs are higher than we thought they were. The project aims to build a digital system reaching all areas in Indonesia... the

problem occurring afterwards might be whether the infrastructure is available or not, the signal range is good or not, no matter how good your smartphone is. And the government regulation, such as cyber security and many more, I do not exactly know, but I trust that the existence of Indonesian Ministry of Communication and Informatics (*KOMINFO*) as well as Board of Telecommunications and Information Accessibility (*BLU BAKTI*) are more than enough.”

Through the Palapa Ring, the government can facilitate a network capacity of up to 100 Gbps for even the most outlying regions. The government hopes that the project will improve connectivity and increase economic development, particularly in outlying regions.

Connected Indonesians are very digitally savvy: Indonesians with digital access are connected citizens in every sense of the word, with a need for constant connectivity, instant information, and a growing appetite for digital content. They spend a higher-than-average amount of time on the internet, primarily engaging in heavy social media usage and e-commerce. Their social media usage is among the highest in the world, with Jakarta being widely considered a global Twitter capital. In 2016, e-commerce revenues in Indonesia amounted to USD6 billion, while 78% of existing internet users had made online purchases. A respondent noted:

“Talking about infrastructure development, the data shows that actually the internet is already available in the villages. This is a great accomplishment. *Badan Usaha Milik Negara (BUMN)*, i.e., Ministry of State Owned Enterprises and private companies also have put substantial efforts in it. That is what the government has done. It also proves that the internet penetration towards people in any degree, from junior high to university, or from village to city, is relatively high. I mean, with the recent economic condition, this is actually the chance to drive numerous sectors in various regions. Utilizing technology, with the internet as the base, should be adequate. This is not perfect yet, compared to other countries, but with that penetration, it is enough.”

The industry is expected to grow by about 18% annually in the next five years, reaching a market volume of USD16.4 billion by the end of 2020. Indonesia is a mobile-first nation, where about 75% of online purchases are made via mobile devices. The usage statistics far exceed those of digitally mature countries such as the USA, where these media have been around much longer and are firmly established. Furthermore, Indonesia’s internet population is set to boom due to the growing accessibility of the mobile internet as well as the increasing availability of inexpensive smartphones. Indonesia was expected to add 50 million new internet users between 2015 and 2020, reaching a penetration rate of 53% [72]. During COVID-19, internet users in Indonesia increased dramatically to 73.7% of the population in the second quarter of 2020, clocking 196.7 million [73].

Indonesia is one of the most sought-after markets globally for e-commerce, with large local players and global heavyweights fighting for a pie of the market that is growing fast off an already considerable base. By 2017, about 20 million people were shopping online, and the number was forecasted to increase to 65 million by 2022 [71]. More than half of all smartphone users in Indonesia primarily access the internet through their mobile devices, buying goods and services online. Besides their websites, most of the top e-commerce companies also have mobile applications allowing users to shop online through mobile devices [71].

Telkom dominates but private competition is being encouraged: Indonesia’s size and geographic complexity compound the challenges of digital distribution and access. While the country’s performance dramatically improved in the 12 months after the introduction of 4G, opportunities

for further improvement require investment from both the national state-owned carrier Telkom and private organizations such as Axiata and Indosat. According to a respondent:

“Telkom really dominates the telecommunications industry, compared to the other private companies like Indosat, Axiata, etc. The weakness is the unequal playing field. The government provides bigger incentive facility for *BUMN*. But please note that *BUMN* also plays more role. They can serve in the areas that the private companies can't; the ones with low profitability, for example, building infrastructures in remote and out-of-reach areas. Telkom reaches outer islands. Are Indosat or Axiata willing to do this? I don't know. I don't think so. So, there are reasons why the government provides incentives to Telkom.”

Government needs to be engaged: With improvements in basic infrastructure, government policy, and regulation to stimulate more digital usage, respondents identified big data, AI and cloud computing as key enabling technologies that would have the largest impact. In an interview, one stakeholder suggested:

“If it's digital, in my opinion, the cloud is important, right? The cloud, then big data. But those two points are alike if we talk about producers like the raw material: the cloud is for storage, the big data is for data itself. But I prefer to use cloud or big data. So, I see artificial intelligence (AI)... yes, it seems that is what we need. If you look at technological developments from the simplest ones like in our cell phones to even the handling of this COVID, I see that everything ultimately leads to AI. We can see, for example, how AI has been used. Big data can be processed with AI so that it can become informative or something more meaningful.”

Sectors

The 2019 World Economic Forum Global Competitiveness Index (GCI) ranked Indonesia 50th. That was down five places from the previous year, though the decline in its GCI score was small (down by 0.3 to 64.6) and its performance essentially unchanged. Indonesia ranks fourth within ASEAN, behind Singapore (1st), Malaysia (27th) and Thailand (40th). Indonesia's main strengths are its scores and rankings in market size (82.4, 7th) and macroeconomic stability (90.0, 54th).

Looking at other measures in the index, there is considerable room for improvement in its distance-to-frontier score, which captures the gap between an economy's performance and a measure of best practice (based on the entire sample of 41 indicators for 10 Doing Business topics, excluding labor market regulation). Indonesia's distance-to-frontier is a gap of 30 to 40 points. However, the GCI rates it as having a vibrant business culture (with score of 69.6 and ranking of 29) and a stable financial system (64.0, 58th), both of which were improvements over 2018. It also had a high rate of technology adoption (55.4, 72nd), considering the country's stage of development and that the quality of access remains relatively low. Innovation capacity remained limited (37.7, 74th) but has been increasing.

Indonesia needs to boost its labor productivity, on which it ranks second lowest among our 20 selected markets, ahead of India only. While it could be argued that this is partially because of the large population of Indonesia, the counter example is PR China, which has a labor force almost seven times larger than Indonesia's, but which has achieved labor productivity almost twice that of Indonesia, largely due to much higher capital-to-labor ratios through state investment strategies.

The use of technology has increased productivity in a wide array of business settings. Productivity improvements from digital can generate cost savings and increase efficiencies across the value

chain, from product development and operations to sales and services. Industry 4.0 can revolutionize operations with the combination of IoT sensors, advanced analytics, and autonomous machines. For example, equipment with sensors can conduct self-diagnostics to enable predictive maintenance, translating into lower overall equipment downtime. With unprecedented access to operational data, advanced analytics can play a key role in offering new insights into optimizing yield, energy, and resources while delivering on non-negotiable work necessities like health and safety.

Each digital lever delivers varying levels of impact for Indonesia's economic sectors. McKinsey's bottom-up analysis indicates that the 'operations optimization' lever has the highest impact, given the large size of the industrial sector in Indonesia, with low productivity and low IT spend. Operations optimization alone can add USD98 billion to Indonesia's economy in 2025, with manufacturing standing to gain the most. Other sectors such as retail, transport, mining, agriculture, telecom and media, healthcare, public sector and utilities, as well as the financial sector, could also generate value through digitally enabled productivity improvements. In all, improved productivity from digitization could provide a boost worth USD120 billion annually by 2025 [72].

Interviews with seven key stakeholders in Indonesia provided insights with regard to key market sectors on which to focus, including the optimization of added value in natural resources as well as the power of the creative and digital economy. There is a tradeoff between technology adoption and unemployment in Indonesia, as one stakeholder stated:

“The problem we have in Indonesia is that we own an excessive workforce surplus. Although our unemployment is not that high, it is still the highest if we compare with our peers. If we compete with the Philippines and Malaysia, whose unemployment is much lower than us, they are still able to recruit foreign labor while we are not able to. The same goes with the ROK. In Indonesia, the unemployment rate is high and even those who are already employed are merely working as average, beginner, and unskilled workers in their workplaces. If the government intends to apply technology to the fullest, say Industry 4.0 in the manufacturing field, the question would be: What is its implication to minimize unemployment rate and to quantitatively create employment? That is the challenge for Indonesia. So, in my humble opinion, the priority should be set. There should be a sorting out, perhaps, in terms of the sector and the subsector that needs to adopt technology faster and the ones that need to be prioritized in order to create more employment, since that is also one of our needs. If we don't make a priority list, then we need to accept the consequence that there will be a gap in society, both economically and socially.”

Policy and Regulation

Digital technology adoption can be enhanced by the government sector taking a prominent role in implementing policies and regulation that encourage more government services to be delivered via digital e-government platforms and also by helping to create an optimal environment in which to undertake business. These two issues are discussed below in the Indonesian context and illustrated with respondent insights.

E-government implementation: Based on the UN e-government survey, Indonesia moved from middle index group of the E-Government Development Index (EGDI) in 2014 [74] to high index group in 2020 [75]. Bappenas Deputy Director of Public Services, Husni Rohman, had published an article highlighting the progress in relation to Indonesian e-government, which was also confirmed by this study's respondents. However, the implementation of e-government is still in the early stages. Presidential Regulation No. 95/2018 on e-government states that one strategy to

implement e-government is to develop, by 2025, a national portal for e-service that will include all services provided by central and local governments.

Business operating environment: Indonesia has published a new Omnibus Law on job creation, *Cipta Kerja*, which is expected to help technology adoption, innovation, and ease of establishing a new company. However, community acceptance of the legitimacy of the law is not guaranteed [76]. Rejection of the Omnibus Law continues to come from various elements of the society, such as academic workers and students. The government also introduced incentives and laws that are expected to boost innovation, such as the national innovation law *Sinas Iptek*.

Indonesia has policies to support digital uptake by firms, particularly startups, and the creation of new businesses. One well-known program is ‘1000 Start-ups,’ which, with its successor ‘1001 Digital Startup Movement,’ aims to support inexperienced entrepreneurs in developing their businesses.

With regard to security and data protection, respondents’ views revealed that privacy and security were not a major concern in Indonesia. In fact, on 24 January 2020, President Joko Widodo signed the Personal Data Protection (PDP) Bill, which is currently being finalized by the Indonesian House of Representatives (DPR). Upon finalization of the PDP Bill, Indonesia will become the fifth country in ASEAN to implement regulations for personal data protection [77].

“I trust that the existence of Indonesian Ministry of Communication and Informatics (*KOMINFO*) as well as the Board of Telecommunications and Information Accessibility (*BLU BAKTI*) are more than enough.”

Constraints and Challenges

With respect of other constraints and challenges that Indonesia faces when employing digital technologies to enhance productivity, respondents provided a number of insights concerning education, employability, bureaucracy, governance, and corruption.

Education and employability: Indonesia released a policy for higher education called *Kurikulum Merdeka* in 2020. To socialize this policy, it launched the Merdeka Campus website (<https://kampusmerdeka.kemdikbud.go.id/>). *Kurikulum Merdeka* is dedicated to connecting higher education and industry, by giving students more opportunities to get involved in industries and contribute to the society. In *Kurikulum Merdeka*, students can pick up eight different activities that make a direct contribution to industries or society. Examples of activities are: being involved in humanity projects, developing business, and teaching in primary schools. This policy is expected to develop various skills that are relevant for the future. Some views of the respondents in this regard are listed below:

- “Unfortunately, at this time, we lack experts in the digital field. One group includes the technician, which is what vocational education usually generates. A second group has the engineer, the designer, or the programmer, at the undergraduate level or above. The last and the most important talent group has the entrepreneur. When we look at these three groups, you can say that we are still lacking in all of them.”
- “When it comes to education, again, education in Java and outside Java, even in the eastern parts of Indonesia, is different, in terms of quality, facility, and infrastructure. So, this can

be an exciting story even though we must be able to make a breakthrough in this digital era. Maybe that's the thing."

- "According to our current Minister of Education and Culture, coding and computer skills will be implemented in schools. Do all people agree? Well, I am not sure. A professor from Bandung Institute of Technology (ITB) and a national education expert does not agree with this. He said that the computer skill indeed needs to be taught in schools, but it should be in line with manners and morals. Something like that. The coding skills are taught in schools now, but we have omitted moral education and its variations. Hence, it results in a philosophical debate. However, if the question is: is it needed? then the answer is: yes, it is."

Bureaucracy: Some of the respondents' views are listed here;

- "Impossible to make all those innovations in National Innovation System (SINAS) to become one law or regulation that we call policy. But the aim is actually to achieve streamlining of bureaucracy so it will be more adaptive and responsive, as well as to improve the quality of its service. Hence, they will be able to support the implementation of innovation at different levels. What I mean by different levels is that each area and its sector have different levels of innovation. But, more importantly, the narration should be continuously socialized."
- "The concern is, sometimes, we want this country's development to speed up. Yet, those things happen. This is real. We need to improve the central as well as the regional government's bureaucracy. Also, sometimes that bureaucracy inhibits us, the government officers. We will automatically be frustrated because we want to take worthwhile actions, but the other regulations prevent it, and so on. Right?"

Governance and corruption: Respondents provided their views on this topic as well. Some of those views are listed below:

"Indonesia already has competition laws, right? There are also supervising commissions for business competition as well as related regulations and institutions. From the governance side, the problem lies at the level of the person in charge (PIC) of business competition enforcement. Often, the assignment of the PIC is affected by political matters. The PIC is assigned by the government. This means, often, the supervising institution for business competition and the relevant regulation are not necessarily leading to fair competition in the industry. The climate is not conducive yet, as when a company violates the regulation of business competition, often it is not subjected to any appropriate and relevant punishment or sanction. Political backups exist. This reduces the conduciveness of a competitive climate."

"The playing field is unequal. For example, there are complaints like, 'The government does require import companies to use distributors, but it applies to local businesses so that they can control the process.' Also, the cost is highly different, because of diverse distribution requirements. Well, this involves a great deal of businesses, and the size is varied. So, I think, one of the problems in Indonesia is the competition, the level playing field."

"It is not exactly that the formal bureaucracy does it. But the corrupt people inside do it instead. Every time we open up a plant here, there are a bunch of people who will visit us and ask for fees."

The threats from those corrupt individuals are real. Government policies are constructively good. The government corrupt individuals aren't."

Emergent: Malaysia

Malaysia has evolved from an agricultural and commodity-based economy to be a middle-income nation with a strong foundation in telecommunications and IT infrastructure. It now hopes to fast-forward its digitalization journey, especially in the significant SME sector, through major initiatives like the *Jendela* plan to improve connectivity. Challenges include fostering digitally skilled local talent.

Malaysia is a Southeast Asian country occupying parts of the Malay Peninsula and the island of Borneo. It is known for its beaches, rainforests, and mix of Malay, Chinese, Indian, and European cultural influences. The capital, Kuala Lumpur, is home to colonial buildings, busy shopping districts such as Bukit Bintang, and skyscrapers such as the iconic, 451-meter-tall Petronas Towers.

Malaysia has successfully expanded its economy from being agriculture- and commodity-based to becoming a leading exporter of electronic parts, electrical appliances, and components. After the Asian financial crisis of 1997–98, Malaysia's economy has been on an ascent, averaging growth of 5.4% since 2010. It is expected to move from an upper-middle-income economy to a high-income economy by 2024 [78]. However, income disparity in Malaysia remains high relative to other east Asian countries, though it is gradually decreasing.

Malaysia's near-term economic outlook will depend more than usual on government measures to sustain private sector activity as the shock of COVID-19 reduces exports-led growth, and as a depleted fiscal space limits public investment-led expansion. The COVID-19 outbreak has put pressures on Malaysia, particularly on its vulnerable households. Over the longer term, as Malaysia converges with high-income economies, incremental growth will depend less on factor accumulation and more on raising productivity to sustain higher potential growth. According to the World Bank's Human Capital Index, Malaysia ranks 55th out of 157 countries [78].

Interviews for this study were undertaken over a six-week period in December 2020 and January 2021 with key stakeholders comprising members of IT associations, technologists, and academics.

Technology

Malaysia has evolved into a middle-income economy and has a well-developed telecommunications and IT infrastructure to support digital service delivery, though with limits. Although fixed broadband is reasonably well deployed in urban locations there are significant challenges in delivering broadband to rural communities as also mentioned in the survey by one of the respondents, "I wish Malaysia ... develop(ed) stronger wide internet connection."

This need for improved foundation technology, primarily using mobile wireless technology with a broadband backbone, was highlighted by all of the respondents. For example:

"If we were to talk about Malaysia, or if you talk about Indonesia or the Philippines, you're talking about mobile. Because of the difficulty of laying fiber in some of the regions and terrains, it is not even possible. But you can have technologies like 3G, 4G, and now 5G, and another one called Wi-Fi."

“So, the technology that would have the greatest advancement would be 5G, because it is the one that they’re putting in. Now, there’s no magic about 5G, except that it has a couple of things that 4G doesn’t have. It has a lower latency, so you can probably put up the use case of remote operations. It does have the ability to send more data, so that’s good. But there are many things that 4G can still do.”

“I think when we talk about digital technology in the country, there is a lot of progress in the sense that a lot of things are happening. We are already deploying 5G here in the country.”

Significant initiatives are under way. The government recently announced the introduction of the National Digital Network (*JENDELA*), a digital infrastructure plan to meet the needs of digital connectivity and to prepare the nation for a gradual transition to 5G technology.

In August 2020, Prime Minister Tan Sri Muhyiddin Yassin outlined in the *New Straits Times* that the action plan, under the 12th Malaysia Plan 2021–25 (12MP), was formulated through laboratory sessions and would pave the way for the provision of a comprehensive and high-quality broadband service coverage. *Jendela*’s first phase, he said, would begin by expanding 4G mobile broadband coverage from 91.8% to 96.9% of populated areas. Mobile broadband speeds would also be improved from 25 Mbps to 35 Mbps, giving 7.5 million premises access to gigabit-speed fixed line broadband.

Big data, AI/RPA, and cloud computing are key technologies: When stakeholders were asked about high-order enabling technologies, the most highlighted ones centered on big data, AI/robotic process automation (RPA), and cloud computing.

“If you ask me, from everything that I have experienced, the biggest impact really is big data, in terms of all numbers and data of the company, be it regarding finance, customer, or product... with that, you have the access tools around it, which can enable the company. And by company, I mean that everyone in the company can individually access this data, and process it with the queries he has and get the right answers. Technology, people, processes, everything relies on it. I think this is the biggest impact I have seen because you get to faster decisions, and you get much faster analysis done of everything. So, it changes basically the pace of the company and the way the company works.”

“I think of course RPA. Everyone is starting to play around with machine learning. I think that’s clear. And of course, everyone looks at the cloud as a way to do so. So, I would say basically say, AI, mainly machine learning, and cloud. I think it’s probably sort of there and I would put analytics as well as part of AI. And RPA, I think it’s probably where most of the focus has been. It’s less about the technology, because I think at the end of the day, we’re solving a business problem. It’s about a business pain point either for consumers or internally.”

Internet of Things (IoT) was referred to by a number of respondents but involving none of the technology aspects:

“If you treat IoT as a technology, I think it is obviously one of the major factors. But I don’t see IoT as a technology. I would say it’s a technology, plus a methodology, plus a strategy. Because previously, without IoT, you’d have no idea whether your machine is running, whether it is running at full capacity or 50% capacity, or the capacity is reducing. You only know the efficiency of the machine if either it produces less products or stops working at all. And by the time you try to fix the machine, you lose income, lose productivity.”

The National 4IR and Digital Economy Council and the National Digital Infrastructure Plan (*JENDELA*) will accelerate the growth of Malaysia's digital economy. This includes the formation of the National Technology and Innovation Sandbox, which aims to produce digitally skilled local talent by providing opportunities for R&D, innovation, and high-tech entrepreneurship capabilities. The implementation of 5G infrastructure and Industry 4.0 practices will push the adoption of technology and digital transformation, which is necessary for the country's economic trajectory [79].

Market Sectors

The seven interviews for this study provided insights into specific market sectors where digital technology would have the highest impact. These insights were complemented by secondary interview data [79] with Datuk Wira Dr HJ Rais Hussin Mohamed Ariff, chairman of the Malaysia Digital Economy Corporation (MDEC), and Sang Hoe Chow, consulting leader for EY ASEAN and consulting managing partner for EY Advisory Services Sdn Bhd.

Most of the interview respondents agreed that all industries will benefit to some degree, but services and specific functions were early adopters. So, for example, supply chains and industries such as IT/communications/media would benefit the most.

"The biggest impact can be achieved in companies that are already well prepared to some extent and are having some sort of underlying digital infrastructure and digital knowledge. They can build on that to take that step. So, they can be faster and have results, not just in terms of speed but in terms of the overall impact. I don't think there is a major difference between different sectors in terms of benefits of digitalization. I believe that the impact is higher in industries that are closer to the customer. Once you have the customer element in it, it just increases your volume of data and the use you can make of it. So, I think maybe industries that are closer to the customer will have more immediate benefits and maybe even long-term benefits. But then, of course, you have Industry 4.0 with all the different stuff that's happening there, which has a huge impact as well."

"I would say basically services. Of course, it's typically because it's easier to apply. So financial services, telecoms, and manufacturing are the areas. I would say, second is Industry 4.0. I don't know what the updated numbers are, but a couple of years ago, if you looked at global production assets, I think 70% to 80% were not connected. And for those that were connected, only 20% or 30% of data was used. So, if you want to apply, you start with basic connectivity and basic use of data. So, there's clearly a massive impact potentially. Of course, it's easier to get going in service-related industries."

"I think it is across the board. With IoT, a lot of industries can be improved. But if you want me to pick up some of them, I think those would be logistics and supply chain. I think IoT enables you to combine a lot of processes that were previously working in silos. Let's say you're talking about an end-to-end enterprise solution. If something happens in your manufacturing, that will affect the supply chain. Something happening in the supply chain will affect deliveries. Using IoT, you can track a particular product asset across a supply chain a lot more efficiently. Unfortunately, there is a side effect that some of the manual labor jobs will be obsolete."

"In every industry, there is a certain way in which firms or rivals make money."

The SME sector will have a large impact, especially on ‘normal folk.’ In Malaysia, as also stated by Dr HJ Rais, there is now a tremendous focus on e-commerce [79]. E-commerce is expected to grow to about 20% of the digital economy. Financial support from the SME Digitalisation Matching Grant and the SME Technology Transformation Fund has enabled the digitalization of bricks-and-mortar SMEs. E-commerce activities were expected to contribute about MYR170 billion to the economy in 2020. The views of respondents corroborate these expectations:

“About 90% of the businesses in Malaysia are SMEs. They generally make up 40% of GDP, which is a lot. And when we look at them, we are looking at e-commerce, we’re looking at logistics change, and we’re looking at platforms that are for goods and services. So, for increasing productivity for normal folks, for the populace of Malaysia, and for making up 40% of the GDP, we look towards SMEs. Let’s say there are three parts to SMEs. There’s the retail part, there’s the agribusiness part, and then there’s the manufacturing part. To break them into three small groups doesn’t gather everybody in. But it’s good enough.”

“SMEs are most likely going to adopt a strategy of what I call belonging. So, they’re just going to join a digital platform or get on to a solution that everybody is using and that’s it. They don’t have the resources.”

Three market sectors that were specifically highlighted by the respondents were energy (including oil and gas), due to its size in the Malaysia economy; healthcare, especially with the needs of an ageing population plus the impacts of COVID-19; and digital content creation (arts, media, and movies):

“Technology has touched almost every aspect of life here in the country but not all sectors are growing as rapidly as we want them to. I think in terms of energy, we are still not there yet. When we talk about energy, we’re talking about the electricity providers, utility providers, and the oil and gas sectors. I think their usage of technology, be it automation, AI, or IoT, is still not that high.”

“Without a doubt, I would say healthcare. Healthcare is the single-largest sector that will benefit from digital transformation. Malaysia has a two-tier healthcare system. We have government-funded healthcare, which covers actually the majority of our population. And then we have the private healthcare system for people who can afford it. The private healthcare system is a little bit more ahead in terms of digital transformation and adoption of digital technologies. But it’s necessarily fragmented because it’s owned by different private entities. If we imagine, say, patients’ medical records being accessed by doctors across the entire healthcare system, a unified medical record system is needed. Something like this has to be driven by the government. And I can assure you that we are very, very far away from this. And I think as the Malaysian population ages and chronic health conditions overtake other health conditions as the primary burden of the healthcare system, this need to digitize becomes very important.”

“Arts, communications, broadcasting, and journalism, are among the areas that are really finding themselves pushing their own boundaries and thinking differently about how they engage and communicate, which is why digital tech has been so important.”

“Given the diversity of Malaysia’s industries, we can start with key sectors with competitive strengths as well as high-value and high-impact segments. These include finance, digital halal products and services, digital healthcare, digital education and digital government facilitation

services. Now is the right time for business enterprises and entrepreneurs to unleash their creativity and innovation to mitigate the severe effects of the COVID-19 pandemic and fast-forward the country on its digitalization journey.” [79].

Policy and Regulation

Awareness, education, and stimulus programs recognized by key stakeholders: Some of the respondents’ views are stated below:

“I see a lot of efforts in Malaysia to actually foster this digital ecosystem from the government. Also, some of the companies, like Axiata have some very, very helpful programs about digitalization.”

“What I think helps in many countries, but you can’t really force it, is to intervene from a government perspective on mainstream digital topics. One of it is payments, right? So, once the government gently pushes to make better use of mobile payments, first of all you create habits, you even create skills, and you transfer a part of the value-adding system to digital straightaway. It cuts across the society. It’s not only the tech savvy who are using it. Everybody is using it at some point in time. So that could be one push.”

“Industry 4.0 implementation is done by the Malaysian government. Industry 4.0 is more of a smart manufacturing. This is especially targeted at bringing SMEs, who are not adopting digitalization, to move into Industry 4.0.”

“I think in terms of digital adoption, the government is pretty aggressive in pushing the agenda.”

“There’s a great deal of interest from the government in moving Malaysia forward, using digital technologies. They’ve got the fiberization plan, which is about pushing fiberization into areas that would be otherwise unattended. They are also taking fiber to rural areas.”

Government has introduced a range of policies, regulation and incentives: This was reflected in the views expressed by the respondents:

“The Finance Minister has announced that they have actually created a sort of venture, or they have attracted venture companies from all over the world, with the promise to double up their investments from the government.”

“I would say, basically IP protection has always been an issue in Malaysia, but it’s not holding people back. I don’t think that’s an issue and privacy too is a less sensitive issue here. I think people are generally doing a good job. So, these are not barriers.”

“This involves, again, funding from the government. So, the government is providing incentives and subsidies to assess about 500 SMEs in Malaysia to see where they are in terms of digitalization. Let’s say an SME goes through the assessment process and are only rated at Industry 2.5 level. But the target is to go to Industry 4.0. So, the government will actually give funding up to 1 million per company to adopt that technology.”

“We do have policies. I mean, there are not many policies yet, but we are growing. There are already, say, AI frameworks that are currently from a couple of agencies, and then there’s the IoT

framework. Then, there's also the new economic policy whereby to encourage digital adoption in the country, say, by way of tax deduction."

"If you go to the MDEC website, 10 Bills of Guarantee (BoGs) are offered there. There are a lot of things that MDEC has done, e.g., encouraging the growth of startups in Malaysia, especially those that are dabbling in tech."

"It is about equipping people with skills, and putting real money behind that as well, to make that happen. So, whether, of course, there is the political instability of Malaysia, where we are at the moment in terms of our particular government and how that has been formed, that may lead to some of that being stalled. And also, of course, that policy was predicated on us coming out of COVID. So, recovery movement controls orders. And some of that still as we enter a second or third wave. So, what do we need to do? How do we need to equip people with the skills to recover our economy as quickly and as purposefully as we can?"

"I think the Malaysian government is focused on financing. So, they have set up funds as well as funding mechanisms, especially the startup ecosystem for the creation of digital companies and for powering the digital economy. So, definitely, I think the Malaysian government is taking action from that angle. They've also offered loans, soft loans, and grants to firms in traditional industries, notably SMEs in manufacturing, logistics, and distribution. All these industries need to digitize and transform their processes."

"I think our antitrust and competition laws are not equipped to deal with the emergence of, say, platform businesses that dominate sectors and abuse their powers. I think it's difficult for the courts to decide what constitutes abuse, what constitutes abuse of market power, and what constitutes a fair use of market power. I think the law is not clear on this. The other thing is regulatory frameworks around data governance. It's not clear. And I think the root cause of this is lack of expertise within our governments to be able to write these laws and produce these regulatory frameworks."

"In the Asian context, at least the countries I know, i.e., Indonesia, Malaysia, India, and Bangladesh, there is quite a substantial impact of government policies. One of the best examples is the ROK, where they really leapfrogged, and that's why they have the bandwidth today, because the government made an effort to put in a substantial amount of investment and money to build that infrastructure and then pay it off through usage."

Bureaucracy, transparency, and advisory services: Malaysia announced government initiatives starting from the 1990s, e.g., the establishment of the Multimedia Super Corridor in 1996, which was a key strategic thrust for developing Malaysian ICT SMEs, so as to proliferate ICT expertise and development within Malaysia's public and private sectors [80]. The 2014 UN E-Government Survey classified Malaysia as having a high EGDI [74]. Malaysia continued its efforts in e-government and as a result became one of the leading Asian countries, with a very high EGDI in 2020 [75].

Malaysia initiated a long-term collaboration with the World Bank Group to execute the Open Data Readiness Assessment (ODRA) program, from July 2016 to January 2017, with the ODRA report published in May 2017. The report was launched by the Prime Minister's Department during Open Data Day on 25 May 2017 [81]. Listed below are some related views of respondents:

“I think, first you really need to build awareness. And there I think Malaysia is doing quite ok. There are lots of awareness programs. A lot of agencies are involved in trying to educate, particularly the SMEs, across sectors. So, at least the government has done a good job on this front. The second element, which I think most governments do not do and have not understood, is that it’s not about just telling SMEs what to do. You really have to help them with the ‘how.’ If I look at Malaysia, I just don’t see any agency that provides advisory services.”

“Most companies, particularly SMEs, need hands-on support in some form or shape.”

“I think in Malaysia, the government has a lot of these policies. But policies being policies, they’re executed by bureaucrats.”

“All right. So, the execution leaves a lot to be improved. Because the people who work on these projects are not from the industry. They don’t know the industry’s pain points.”

“The only thing that probably would be very helpful is the transparency of the governance. Sometimes, for example, it is important to ascertain if the grants that are given out to help these companies grow, or the tax incentives that are given the green light by the government are followed through properly or not.”

“The government has these great ideas. In fact, the Mayor of Kuala Lumpur had a great idea. He wanted to do smart poles, smart digging, and all that stuff. But he got bound up in bureaucracy.”

“Malaysia is such a critical country with so much innovation potential... when you look at the world map where it fits and what it could be, what its potential really is, there is this bureaucratization base. It is really, really repressive for lots of types of innovation.”

“Often, I find that when the government wants to address these regulatory issues, they will form some kind of partnership with the private sector and ask the private sector to essentially submit proposals like that. Now, the problem with this is that these proposals obviously include vested interests, stuff that benefits the vested interests of these industry players. The other thing is that when industry players have conflicting proposals, the government is then put in a position where it is in a kind of decision paralysis.”

Constraints and Challenges

The key additional constraints and challenges highlighted by the interview respondents are in relation to talent, education, and planning.

Talent

Respondents’ views on the topic are listed below:

“I think the biggest challenge in Malaysia is really the talent pool, and this is not a short-term fix. I think the biggest thing they could do in the mid-term is to radically overhaul the education system and make sure that it provides the types of talents that you need... not only the knowledge but also the behavioral skills are important and so is the way of thinking. That is possibly the biggest block for the whole development. And that’s clearly a government’s job to fix it. It’s not much of a private initiative.”

“I think the thing that is currently hindering a little bit of growth, while we are progressing, is the number of job-ready tech talents. They go to school, they learn computer science, but are they ready to come out into the job, into the workforce, to be introduced into the field of AI, for example? Are they ready? Are they actually equipped to do that? Whether the universities and the industries are talking to each other to equip the students or not, that’s where a lot of the conversation is lacking. And that’s where the company I’m currently attached with is trying very hard.”

“As far as I am concerned, talent is something that is hindering us from progressing fast. Right now, based on my experience with my present company, there are a lot of companies that are already showing interest in having AI in their businesses. But the fact is that we don’t have enough talent to help them come up with the models that they want. So that’s why I say it’s talent.”

Education

Respondents’ views on the role of education are provided below:

“It goes back to schools again, to equip schools with the necessary tools so that people get used to digital tools early on.”

“Where I think the government is not doing enough is actually in preparing the workforce for the future. And I think the education system is very, very outdated. Any attempts to introduce subjects like coding and computer literacy are very half-hearted and, quite frankly, taught by people who are not qualified. And so, this is going to be a major hurdle to the transformation of the Malaysian workforce. In future, rote learning and memorization of facts will give them very little value.”

“Because at the end of the day, if you want to future proof, you need to steer long-term changes in the education system.”

“I’ve been in Malaysia since 1996. I think the education topic has been around for 25 years, since I was watching the launch of the Multimedia Super Corridor and the setup of MDEC, and nothing has happened. I mean, now of course there are good efforts at some universities, but it’s not at scale ... As I look at the future jobs we need, such as Industry 4.0 experts, cloud engineer, and UI/UX engineers, these are not sexy jobs. Yes, data science sounds a bit sexy, but who wants to do coding?”

“So, it is not set up at scale and it creates a real problem in the country. And I think it’s unfortunate because everyone in Malaysia understands what the education challenges are, but they don’t tackle it for political reasons.”

“We have about 75,000 graduates in Malaysia every year. Of these, 25% are unemployed, particularly those with a STEM background. So, you’re creating a problem now.”

“I believe if you want to teach digital, you can’t. It’s not classroom, it has to be applied, you have to combine it with an apprenticeship program.”

Planning

Respondents’ views on the topic are stated below:

“I think one of the moves in Malaysia that will bear some interesting results is called *PENJANA*. It is primarily focused on skills development, the recognition of people moving out of certain careers

into other ones at a time of quite seismic change in the country. So, it's about lot of work around graduates, lot of work around people in very low-income groups, and how you might support them in skills development."

"When Celcom TM brought out new services it was amazing to see how quickly they were picked up by the general population. So, people in Malaysia are quite savvy on how to use it. So how are they using it? How is it changing productivity? We'll talk about one thing, i.e., e-commerce ... but it's the planning by the government and working backwards up to the depth of the infrastructure is how people eventually will use it. So, if you provide these things, you can provide these platforms, they will use them."

"So, if it's about planning, then it's about knocking on the head all the barriers that people put up to prevent you from getting to that. So, it's about planning so that you get to use technology, you get to use digitization. You've to get to use those things. It's not like you might want to use them; you've to get to use them. That's it. It's not a question. So how to get to where we're using it? So, it really, really starts back at the planning stage."

"I think the more effective we can get at business reporting and understanding data, the better our lives will become. That's quite a general comment, but I think it applies. So, for example, we're talking at the moment about these sorts of themes, heads of department dashboards, where everything can be pulled up. So how do you understand how many students on a month-by-month basis are applying for your course, how much money do you have in your budget left, what research income is coming in? So that's kind of quite internal data, but then let's go even broader. What's the Malaysian economy looking like? What are the trends happening in southeast Asia? How many people are entering the hospitality industry right now? Because actually that data is out there. If we can get to a point where we are equipping people who make decisions to use their internal and external data in a much more interactive and on-demand manner, that's it. if you'd said this to me 10 years ago, I would have looked at you and said, "You're off your tee. It's never going to happen."

Leaders: Republic of Korea

Having achieved remarkable economic growth, the Republic of Korea (ROK) is now looking at spurring innovation and further growth over the long term in a way that reduces social polarization. The Digital New Deal is a key pillar and is already fostering innovation in no-contact services that will be critical in the post-COVID era as well as in digitization of social infrastructure. The government is encouraging a 'lifelong learning' approach to skills development.

The ROK has achieved remarkable economic growth over several decades. In 2017, it became the seventh country to join the 30/50 club of countries with a per capita gross national income (GNI) surpassing USD30,000 and a population of over 50 million. As the ROK's economy matured, however, its growth rate began to decline, which is a normal phenomenon as a country moves out of being relatively underdeveloped, while its insufficient social security system widened polarization. The average annual growth rate reached 6.9% in the 1990s, then declined to 4.4% and 2.9% in the 2000s and the 2010s, respectively. At the same time, the income quintile share ratio, i.e., the ratio of total income received by the top 20%, increased from 3.86 in the 1990s to 4.52 and 4.57 in the 2000s and the 2010s. Against the challenges of slower growth and polarization, the ROK has been shifting its paradigm towards a people-centered economy to realize former President Moon Jae-in's vision for an innovative and inclusive country for all. In the face of the COVID-19

pandemic, the ROK's economy has encountered two major challenges: recovery from a severe economic recession and addressing structural transformation [82].

The Korean New Deal: National Strategy for a Great Transformation by the Government in July 2020 is an excellent example of visionary thinking combined with specific objectives and actions by date. The Korean New Deal centers on two pillars, namely, the Green New Deal and the Digital New Deal. While the Green New Deal focuses on transitioning the ROK to a net-zero emissions economy, the Digital New Deal would lay the foundations for a digital economy that spurs economic growth and innovation. While most of the stimulus plans around the world have focused on helping firms survive the COVID-19 recession, the Korean New Deal is designed to invest in the capacity of the economy over the long term. By the end of 2022, the government expects to invest KRW13.4 trillion (USD11 billion) in the Digital New Deal.

For this study, seven interviews were conducted with key stakeholders from government, technology, and economic backgrounds during an eight-week period from November 2020 to January 2021. Insights from these interviews are discussed in our four focus areas: technology, sectors, policy and regulation, and constraints and challenges. These insights are provided in context with other secondary research, primarily the digital components, i.e., the Digital New Deal.

Technology

The ROK has one of the fastest internet networks in the world. Paired with the high availability of high-speed internet, it is no surprise that about 92% of the population use the internet. Internet infrastructure has had a high priority in numerous governmental regulations, leading to its rapid and thorough expansion. There are three major broadband internet providers: KT Corporation, SK Broadband, and LG Uplus. As of 2019, KT Corporation was the market leader with around 41% of all subscriptions to high-speed internet. KT Corporation started as a state-owned telephone company in 1981 but was privatized in a bid to fuel competition in 2002.

The government played an important role in the development of landlines and the expansion of the internet, and the influence of the government in internet development is not declining. Long before the ROK introduced 5G, the government formed a pan-government committee that included private companies and academic institutes. All these forces were expected to work together to introduce 5G as rapidly as possible. In April 2019, the ROK introduced commercial 5G. By April 2020, the 5G network had more than 6 million subscribers.

Since 5G contracts still use 'upswitching' (meaning users are connected to 4G but use a 5G service), the base of the fast expansion is a strong 4G network and the ROK has one of the best. According to data collected mid-2019, one provider even offered 99.5% availability of 4G [83]. In February 2020, the ROK had around 55.5 million 4G subscriptions.

As of April 2020, the leading mobile internet carrier was SK Telecom, which belongs to the same conglomerate as SK Broadband. It had around 29 million subscribers, out of 69.3 million total subscribers. KT was next with about 18.4 million subscribers, followed by LG Uplus with 14.4 million subscribers. In 5G, SK Telecom secured its market leading position once again, with about 2.9 million subscribers out of a total of 6.3 million subscriptions. Even though SK Telecom had the lowest number of base stations in September 2019, the network had the highest experienced 5G availability in early 2020 [83], with

- 46.35 million ROK internet users in 2019;
- 95.9% internet penetration among the population in 2018; and
- the ROK's internet penetration rank being first in Asia as of June 2020.

After more than 20 years of investment in fiber infrastructure, the ROK boasts one of the highest fiber-to-the-home (FTTH) penetrations in the world, as well as one of the most advanced consumer broadband products, offering speeds up to 10 Gbps. Most people use packages above 100 Mbps, which are mostly bundled with mobile services by the three dominant players, KT, SK Telecom, and LG Uplus.

Key aspects of the Digital New Deal from a technology perspective are outlined below, combined with qualitative insights from respondents:

Building one of the most advanced fiber and mobile networks in the world that everyone connects to: Infrastructure sharing was considered crucial for faster rollout of base stations across the ROK's vast interior, much of which was difficult to access because of poor roads and lack of electricity. The industry subsequently saw significant restructuring of infrastructure businesses, with operators creating and hiving off these units in some cases. There was also an increased willingness to use other companies to build infrastructure. Communications towers were central to this business.

Universal fiber network access, where nearly every citizen has access to high-speed broadband, has existed in the ROK for years now.

Big data, AI, cloud computing, and IoT are key future technologies for growth: Each of these technologies feature heavily within the Digital New Deal and were also articulated by our respondents:

"I think the IoT field is very important and will continue to be so. Next, I think 'big data analytics and AI' and 'biotechnology' are the areas that are needed for technology activation. Electronic payment is a commercialized technology used by all Koreans and is ahead of other countries. Broadband is also a technology that has already been commercialized since infrastructure has been established. Overall, the cloud is not very popular in many state-owned enterprises and commercial areas. However, as I know, a big conglomerate like Samsung have adopted it and are using it."

"Biotechnologies and big data have started but these days the government is investing a lot of money in Green New Deal policy and data. The priority is likely to be high in future also. Because it is an enabling technology, the public sector needs to build a lot of infrastructure. While biotechnologies are strong in many enterprises, it seems that the government is trying to invest in infrastructure in areas such as big data and IoT. In the case of big data, the term 'data dam' is used. The government will take the initiative in creating a data dam like the National Statistical Office, which uses data from public institutions such as the Bank of Korea."

To support the government's Korean New Deal objectives, the three operators agreed to invest a combined USD2.1 billion through 2022, initially rolling out 5G in the capital, Seoul, and six other metropolitan areas, before extending the coverage nationwide. Growing mobile phone penetration and high fixed-broadband uptake among households will fuel growth over the next five years. The

strategic and economic competition between the ROK and PR China is at the center of advanced technology competition and the future of global data and communications. For most developed countries in the region, gaining strategic and economic power depends heavily on having technological ascendancy, especially in data and communications [84].

Market Sectors

The Korean New Deal highlights the impact of COVID-19 within specific sectors and highlights potential areas of action. The pandemic is expected to change people's behavior and perceptions, ultimately bringing structural changes to economies and societies the world over. These structural changes include a rising demand for no-contact or 'untact' services, a growing call for an environmentally friendly economy, together with rapid labor market changes. As a result, government action is essential to accelerate the transition towards a digital economy and drive the shift towards a green economy, while also alleviating polarization.

First, the rising demand for untact services can accelerate the transition towards a digital economy. The need for online services that allow consumers to enjoy normal everyday activities while conforming with quarantine rules has been growing rapidly. The ROK's online consumption, which made up 22.9% of overall consumption in January 2020, rose to a monthly average of 26.9% from February to May, indicating that e-commerce and delivery services were replacing offline purchases. In addition, the increase in Microsoft Teams users around the world, from 20 million in November 2019 to 75 million in April 2020, showed that areas such as remote working and virtual learning were rapidly being digitalized.

In line with such changes, the traditional service industry, as well as small and medium-sized manufacturing businesses with less digital capacity, have been hit the hardest by the pandemic. On the contrary, sales of online and platform businesses have been growing, as is evident in the 169% hike in the sales of Zoom, a video telephony platform, in the first quarter of 2020 compared with a year earlier. This highlights how the speed of the transition towards a digital economy can affect the competitiveness of a country's industries and businesses and emphasizes the need to invest in digital infrastructure.

The overall transformation of economic and social structures, including the greater use of web-based services, has once again emphasized the importance of digital capabilities. Businesses providing untact services, such as e-commerce and remote working tools, are forming an increasingly promising industry, while SMEs and microbusinesses that lack a digital capacity are lagging behind.

The Digital New Deal heightens the competitiveness of the ROK and its industries by establishing digital infrastructure in areas such as data, networks, and artificial intelligence (DNA). At the same time, major infrastructures, including those for transportation, water resources, urban planning, and logistics, will be digitized. In addition, the Digital New Deal fosters untact industries, which are critical for the post COVID-19 era, while also strengthening support for SMEs and microbusinesses in the changing business environment. Through these efforts, the ROK seeks to generate greater added value and create more jobs while bridging digital gaps.

Key aspects of the Digital New Deal from a sector perspective are outlined below, combined with qualitative insights from respondents.

Education

Digitalization of educational infrastructure will be achieved by expanding digital infrastructure and educational materials to incorporate a blend of online and offline methods into the learning environments of all schools, universities, and job training institutions across the country. This will involve creating technology-based education infrastructure for grades 1–12 with full coverage of high-speed classroom Wi-Fi being provided to all elementary, middle, and high schools; and by strengthening the online education system of universities and job training institutions.

“Education seems to be the most important part of the government’s role. The rest of agriculture and retail seems to be doing well in the private sector. If education is left to the private sector, it will create a gap. Because it is a country with a wide income gap, so families that can pay more for private education are more advantageous. It is important for the government to fill that gap.”

“I work in business school and most people hate regulations. In the ROK, education and skills are heavily regulated. The government is giving each university a quota system for applicants, and it is impossible to run a university without subsidies. The population is shrinking but universities rely only on subsidies from the Ministry of Education. And the Ministry of Education wants globalization. So, universities attract students from abroad and the Ministry of Education gives more subsidies for these schools. It is a problem because there are many international students who only register their names with scholarships and do not participate in classes. There are many so-called zombie universities.”

Untact Services

The coronavirus pandemic is giving life to untact services, such as online shopping and delivery applications. The Korea Institute for Industrial Economics and Trade said in a report released in May 2020 that while the coronavirus outbreak had hurt the overall service industry, it also served as an opportunity for the industry to innovate. Experts argue that policy support is required to allow new business models to settle in the market, with untact services expected to thrive in the post-coronavirus era [85].

Within the Digital New Deal, a key focus is on fostering the untact industry by setting up relevant infrastructure closely related to people’s daily lives, e.g., medical, work-related, and business-related infrastructure. About KRW2.5 trillion, including KRW2.1 trillion from the Treasury, will be invested by 2025 to create 134,000 jobs.

“Even if we don’t mention it, I think it’s right for technology to become stronger because almost everything is based on technology. Retail is changing very quickly in the ROK. While department store companies or those based offline are struggling, online giants are growing tremendously. Manufacturing and finance seem to be at the very beginning of change. In the ROK, the government did not give internet banking or mobile banking licenses to companies. However, the existing industry has been changing recently. Education, finance, agriculture, and government services will not disappear, but other sectors can disappear. Education seems to be the biggest problem. Although it has changed a lot, but this is what the government has set as a ‘duty,’ so there is very little momentum for educational institutions to change themselves.”

Health

Smart medical and care infrastructure will utilize digital technologies such as 5G and IoT, with 18 smart hospitals to be built that allow real-time monitoring of inpatients along with interdisciplinary

diagnosis and treatment. To provide safer medical treatment, 1,000 specialized clinics for patients with respiratory symptoms and fever will be established.

“The ROK is also facing an ageing society. Health is right for people’s happiness or wellbeing. It may sound very cruel, but the economically active population is under the age of 65. Taxes are heavily spent on people after the age of 65. The country is not self-sufficient in food and imports a lot from other countries. And the ageing society is serious, while the population is decreasing in rural areas.”

Digitization of major social overhead capital infrastructure: ICT technologies are being applied to key social overhead capital (SOC) infrastructure to provide centralized units comprising skilled people, processes, and technologies that work together to deliver end-to-end security capabilities. This will deliver safer and more convenient lifestyles and add smart components to urban spaces, industrial complexes, and logistics systems to strengthen the competitiveness of relevant industries. These include smart management systems for transport, utilities and water; digital innovation in urban space; and smart logistics and supply chain management.

Manufacturing continues to resonate: Manufacturing does not get specific attention in the Digital New Deal but was consistently mentioned in interviews.

Several interviewees stressed the importance of digital technology adoption within the manufacturing and agricultural sectors, yet these received only a passing reference in the Digital New Deal as “Stronger Integration of DNA throughout the Economy – promoting the use and integration of data, the 5G network and AI (DNA) throughout all sectors to create new digital products and services, while also enhancing the productivity of the Korean economy”.

“Manufacturing or productive capability is the ROK’s strength. Since the outbreak of the coronavirus, it has been difficult to move toward industrialization in the biotech industry unless manufacturing or production goes together. Recently, a company called Samsung Biologics has risen to fourth place in market capitalization in the ROK. In an aged society, the government has no choice but to spend a lot of money on welfare. However, data and diagnostic technologies can reduce this spending. In this sense, biotechnologies and big data have impact at the social-benefit level.”

“The ROK’s government thinks economic growth is the most important thing. Economic growth is still focused on manufacturing.”

Policy and Regulation

The ROK’s economic success has been based on several key factors, one of which is government policy and regulation that enable an operating environment for growth. A number of these factors are discussed below in conjunction with qualitative insights from key stakeholders interviewed in the ROK.

Competition and shared access: As the country entered the 2000s, it repeatedly set new national goals, with metrics and analyses of market barriers, then developed and implemented policies designed to foster competition and deployment. These included law changes such as the passage of the Monopoly Regulation and Fair Trade Act, which established rules banning unfair practices and prohibiting unreasonable rates for access to fiber lines. The law also restrained corporate concentration in the telecom sector by restraining mergers and acquisitions and addressing the overall market share that any one company was allowed to hold. Such changes shifted the telecom

market from a duopoly in 1999 to a somewhat more competitive market of four companies. In just a handful of years, the ROK effectively reached universal fiber access.

The ROK government took decisive action in the private sector, adopting a consistent policy of deregulation that it maintains today. It ensured that barriers to entry were low for new internet service providers (ISPs), fostering an atmosphere of competition. With these liberal standards in place, private-sector operators were able to expand the internet from a skeleton framework to a country-wide system. This process has accelerated through relentless competition.

New infrastructure sharing policies were explicitly designed to reduce the cost of deployment and ensure that wireless competitors operated on an equal footing. By ensuring that every wireless company was allowed to access fiber infrastructure at fair and reasonable rates, it was guaranteed that fiber capacity would be available to connect their 5G towers anywhere in the country. Such access was achieved despite opposition from the largest incumbent telecom carrier, which undoubtedly held an advantage over its competitors in 5G by already having the largest infrastructure. Rather than listening to the self-serving arguments of the largest corporation in the telecom sector, policymakers moved forward with a policy estimated to reduce deployment costs by USD1 billion. The success that has followed in the form of 5G deployment is undeniable.

“Telecommunications regulation is well established, and I think there is nothing to modify.”

“In the ROK and other countries, regulation follows reality. If there’s a problem, we have to make regulations. Regulators and bureaucrats don’t know better than companies and practitioners like us. Europe has some EU-wide action against monopolies and the ROK seems to be doing good just in terms of privacy and digital problems.”

The ROK is a leader in delivering online e-government services: During a joint press briefing in Seoul, the Ministry of Interior and Safety and other related agencies announced extensive plans for digital transformation. The government pledged to use advanced technology to improve its public services and social welfare programs. Capitalizing on AI, cloud computing, and other advanced technologies, the government said it would offer tailored services for the public by giving them more access to their personal data stored in its current system. “We are accelerating our efforts to provide integrated services for the public by moving beyond the barriers of individual government agencies,” Interior Minister Chin Young said during the briefing, also attended by ICT Minister Choi Ki-young [86].

One of the key items within the Digital New Deal was an emphasis on smart government, i.e., using digital technology to deliver improved, integrated services across multiple agencies and in doing so further enhancing the usage of digital technology across segments. There are two key references in the Digital New Deal:

- Smart government: A smart government will utilize the 5G network, blockchain technology, and other new digital technologies to quickly process and provide customized public services.
- Making a smart government that utilizes 5G and AI: The government will adopt a smart working environment by utilizing 5G and cloud networks, while also being innovative to quickly provide customized public services.

This government stimulation is supported by respondents:

“I think government service is the most important. There are many things that are generally complex and difficult for the general public to understand, and they are provided online with various difficulties and explanations. Personally, I used it a lot in the areas of taxation and documentation.”

“The ROK is the most important country in the world, and it is ahead of the world. The UN e-government survey is held once every two years and the ROK has always been ranked first, though recently it ranked second or third. I can say it’s the best in the world.”

Research, development, and innovation: The simultaneously proactive yet hands-off stance taken by the government towards the country’s industry encourages innovation and competition. Because of the uniquely Korean culture of cooperation between private and public sectors, the country’s technology-driven economy provides a host of benefits to its citizens.

“Technology development strategies were announced at the national level in the second half of this year and priorities are considerably higher than in other areas.”

“Research and development is the most important area because it directly impacts the business area. Almost all universities are participating in R&D projects due to active government support. Government is supportive in changing policies and regulations whenever researchers and scholars state the need for it. There seems to be more active support for government as well as corporate research over the next five years.”

“Most companies are actively implementing the ROK government-led policies. Accordingly, the government is actively supporting deregulation and companies’ big R&D projects. In particular, big data and IoT are being highly focused and developed by the government or the companies.”

“Personally, I think innovation and competition policy form the weak point of the ROK. I’m also helping with venture businesses, and our policies are very well established to foster startups. There is a lot of government support in R&D, initial funding, linking with angel investors, and so on. But then, when the company is likely to grow into a unicorn, they tighten the regulations. It seems that it is because the existing economic entity is centered on conglomerates (*chaebols*).”

“The more regulations there are, the less flexibility there is, so it seems that there is an opportunity cost to increasing productivity. There seems to be a need for some regulation but there are too many regulations in the ROK. In the case of Singapore, regulations on technology are relatively low.”

“I think the government plays a big role in research and development. It takes time for technology to be developed and applied to real life through R&D. The government has the biggest role to play. If an ecosystem is established in the private sector, the role of the government may be reduced a little, but it is not the case in the ROK today. Also, there is a role for the government to play in financing, and I doubt how well it will be done. There was a venture boom in the 1990s and the allocation of resources was absurd. Recently, the government’s role in funding new technologies has been an issue and how resources will be allocated is important. Education also may require government intervention, but it should only remain as a role to support them. In that sense, the role of the government is important, but I don’t think the government should intervene much.”

“Regarding telecommunications regulations, there are three big mobile companies in the ROK and there are actually many regulations, such as an antitrust law. One that must be applied well is the price regulation. There is a concern that there may be less investment due to the price regulation in situations where more investment is required.”

“There are continuously politically controversial regulations on telecommunications fees and handset subsidies in the ROK, but it is difficult to say that this affects the investment or development of telecommunications companies.”

“I think it’s research and development. As I said earlier, there are quite a few areas where new innovations and technologies are blocked by efforts to protect the vested interests of people in existing industries. We believe that regulations have the greatest impact.”

“The private and public sectors are very strict about IP security. If you go to a private company, you can even trace who printed the documents. One is unable to access private clouds in public institutions. Security regulations have been established and well followed. I think it has strengthened a lot since there were security incidents around 2000.”

Constraints and Challenges

Culturally, Koreans trust their government and each other a little more than most Western citizens do, though they do turn out in droves to protest if they feel betrayed. So, government-led initiatives are an important part of getting things done in the ROK. In 1995, the ROK had only one internet user for every 100 citizens. In that year, though, the government initiated the Korean Information Infrastructure project, a 10-year program that started by laying internet infrastructure between government buildings and rolled out country-wide broadband by 1998. By the year 2000, the ROK had connected nearly 20 million of its 45 million citizens, this is a higher percentage of its population than Japan, France and PR China. Today, thanks in large part to the government’s infrastructure and education initiatives, the overwhelming majority of the ROK’s population have internet access. The government’s timely and well-executed internet policies gave it a huge headstart that continues to pay off [87].

In addition, in early 2000, data breaches were considered to be high in the ROK [88]. The government released the Personal Information Protection Act in 2011 [89] and it was followed by other laws, such as the Digital Signature Law [90] and Protection of Location Information [91].

The significant success has largely been achieved through a combination of the public and private sectors working in a balanced approach, in conjunction with a Korean cultural trait of working together as a team as opposed to an individualistic approach.

Lifelong learning, importance of multiple skills, and data privacy: Respondents’ views on the topic are listed below:

“I think the ROK is more interested in education after graduation, such as lifetime education. Not only the ROK’s policies but also individual thoughts have changed a lot. ICT workers take it for granted but when I ask people in other fields also, they know that they have to continue to study something as well as work at the company. In that sense, I think that being at work and obtaining additional education in addition to basic education has a significant impact on economic growth.”

“Recently, there have been quite a few people who want to enter the fields of application by doing a double major in computer science while doing economics in university. It seems that the talent needed in the future is not limited to one area. People with the ability to utilize the new technologies is what the market wants. Five years ago, there were few such people. Of course, the schools created a beginner coding course as a required course, but that’s not enough. Now, more and more students want to major in those fields. It’s based on the demand and prospects of the market.”

“When the COVID-19 first spread, there was a hesitation in tracking people’s contact numbers due to personal information protection. The government can access the base station and get everyone’s number and in the case of the city center, the base station is more closely set up, so they can track it more accurately. As you know, services that combine online/offline played a very important role. Big companies were less affected because of the videoconferencing system, which allowed employees to continue with their work well without having to go to work. I think the well-established IT infrastructure was very important in overcoming the problems of COVID-19 quickly and being less affected.”

Challenges in delivering key digital projects: The ROK government has certainly delivered a comprehensive plan to map a way out of COVID-19, building increased capability for future while managing the present health issue. A key challenge will be with respect to delivering across all key projects. However, with a past track record for excellence, the nation is in a strong position to implement the plan. The key digital projects outlined in the Digital New Deal are:

- **Data dam:** The transition towards a digital economy will be accelerated, and 5G and AI will be integrated across all sectors by strengthening the foundation for data collection, processing, trading, and utilization.
- **Smart government:** A smart government will utilize the 5G network, blockchain technology, and other new digital technologies to quickly process and provide customized public services.
- **Green and smart schools:** The installation of energy-saving facilities supports environmentally friendly classrooms, while the use of technology-based educational materials provides a learning environment that incorporates a blend of both online and offline methods.
- **Digital twin:** A digital replica of an object that can be used for the analysis and prediction of the future through simulation. Digital twins will be made for roads, underground spaces, harbors, and dams to lay the foundation for new industries such as drones and self-driving vehicles and to allow for the safe management of land and facilities.
- **Digitalization of SOC:** Key infrastructure that ensures safe and convenient lifestyles will be digitalized, and systems will be prepared to efficiently prevent and respond to disasters.
- **Smart and green industrial complexes:** Industrial complexes will be made smart and ecofriendly (high productivity, high energy efficiency, and low pollution), based on digital technology.

Case Studies: Summary of Findings

This study has generated insights allowing the development of specific guidelines for key technologies, target sectors, and policy and regulatory initiatives for each country depending on its digital economy grouping (see Table 9).

TABLE 9

SPECIFIC GUIDELINES FOR TECHNOLOGIES, INDUSTRIES, AND POLICY AND REGULATORY INITIATIVES FOR EACH COUNTRY, BY GROUPS.

	Embryonic/nascent	Emergent	Leaders
Education and skills	<p>Indonesia is preparing talents for the future by implementing an open curriculum in its universities called '<i>Kurikulum Merdeka</i>'. This curriculum supports collaboration and cooperation between universities and industries.</p> <p>Indonesia needs to boost its labor productivity. Labor productivity in Indonesia is ranked second lowest among our 20 selected nations, ahead only of India.</p>	<p>One of the biggest challenges that countries in this group face is in relation to talent and education. They should develop policies to attract talent and build education that supports the demand for relevant skills in the short and long terms.</p> <p>Malaysia has released a program called <i>PENJANA</i>, which is primarily focused on skills development and the recognition of peoples' qualifications as they move from one career to another.</p>	<p>Developing skills and recruiting talent are challenges for all countries, including countries in this group. One way they are dealing with this challenge is by facilitating and providing support for lifelong and multiple-skills learning.</p> <p>In the ROK, people are encouraged to be interested in lifelong education after graduation.</p> <p>In relation to digital development, there is an encouraging number of students undertaking double majors in computer science conjointly with another major at the university.</p>
Business and competition policy, e-government	<p>The quality of business climate is highly related to the establishment of a public sector bureaucracy that is efficient and trustworthy.</p> <p>Countries in this group should focus on building efficient bureaucracy and fight against corruption to build a transparent and productive business climate.</p> <p>One of the ways to make bureaucracy more efficient is to develop e-government with protocols of openness and transparency.</p> <p>In Indonesia, the implementation of e-government is still at an early stage. It plans to develop a national portal for e-services that covers all services provided by central and local governments, targeted to be completed by 2025.</p> <p>Big data, cloud, and AI have the potential to provide significant productivity gains, but the government needs to be engaged.</p>	<p>The countries in this group are transitioning to become advanced countries while avoiding the middle-income trap. They face similar problems to the countries in the embryonic and nascent categories. These problems include lack of transparency, inefficient bureaucracy, and shortage of skills and talents. Therefore, they need to improve the quality of their public sector bureaucracy.</p> <p>Malaysia announced government initiatives to tackle some of these issues starting in the 1990s. One example was the establishment of the Multi-Media Super Corridor in 1996, which had as a key strategic thrust on developing Malaysian SMEs to populate ICT expertise and development within Malaysia's public and private sectors.</p> <p>The country subsequently became one of the leading Asian countries in the E-Government Development Index (EGDI) in 2020.</p>	<p>As the ROK entered the 2000s it repeatedly set new national goals, with specific targets against which to measure achievement.</p> <p>It analyzed the market barriers, then developed and implemented policies designed to foster competition and deployment. These included the Monopoly Regulation and Fair-Trade Act, which barred unfair practices and prohibited unreasonable rates for access to fiber lines.</p> <p>Although regulations on telecommunications fees and handset subsidies in the ROK remain politically controversial, it is difficult to say that this affects the investment or development of telecommunications companies.</p> <p>The ROK is also a leader in delivering online e-government services. The government pledged to use advanced technology in improving its public services and social welfare programs. Capitalizing on AI, cloud computing, and other advanced technologies, it announced that it would offer tailored services for the public.</p>

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	Embryonic/nascent	Emergent	Leaders
Establishing trust, privacy, and security	<p>The interview results show that privacy and security are not issues in Indonesia.</p> <p>In January 2020, President Joko Widodo signed the Personal Data Protection (PDP) Bill, which is currently being finalized by the Indonesian House of Representatives (DPR). Upon finalization of this PDP Bill, Indonesia will become the fifth country in ASEAN to implement regulations regarding Personal Data Protection.</p>	<p>The interview results show that privacy and security are not issues in Malaysia.</p> <p>Malaysia initiated a long-term collaboration with the World Bank Group to execute the Open Data Readiness Assessment (ODRA) program, from July 2016 to January 2017, with the ODRA report launched by the Prime Minister's Department in May 2017.</p>	<p>In the ROK, security and privacy regulations are established and well observed socially.</p> <p>The government released the Personal Information Protection Act in 2011 and followed it with other laws, such as the digital signature law and the law for the protection of location information.</p>

CONCLUSION

The aim of this research report is to provide guidance for APO member economies on policies and regulations to optimize economic growth, productivity, and social outcomes with their digital economies. Ideally, each country should undertake a detailed analysis of its specific environment, as each strategy will be unique, varying with the national context. However, our research indicates some possible generic approaches and priorities, drawn out from our quantitative and qualitative research of APO member economies, together with a detailed literature review of global academic, government, and commercial research.

- Step 1:** Most countries already have a digital economy strategic plan in place, and a good starting point is to review this plan. In particular, is this plan still relevant in a fast-changing environment after COVID-19 and cyber security concerns? In addition, have the future aspirations for your digital economy changed?
- Step 2:** Comparing our results with other research databases produced by sources such as the OECD, we found several relationships that helped differentiate each country's situation, as well as generic different approaches. For example, the digital economy's status in each country had some commonality with its GDP in purchasing power parity (PPP) terms, and therefore successful approaches and momentum aspirations can be reviewed within that focus.
- Step 3:** By using the Digital Economy Momentum Performance Index, we were able to compare current digital economy scores with momentum performance. This is important, as a high momentum score is indicative of a country's performance over the last five years along with its rate of improvement. Details can be seen in Appendix 1.
- Step 4:** Our study analyzed APO member economies in four groups. For each group, countries' priority actions for the technology market sector and government policies and regulations have been calculated. Recycling your own plans against these could provide fresh information for better plans.
- Step 5:** We undertook a more detailed look at three exemplar countries and their priorities and approaches. These can be used to review current priorities against best-in-class countries at similar stages of development.
- Step 6:** Having worked through this process, the final step is to review your current plan and see if our research findings suggest changes that could improve your future digital economy plans.

We saw that the higher the digital economy score, the higher the GDP of the country, which reflects the strong impact of digital technologies on economic growth. Although measuring the precise impact of digital technologies remains challenging, there is no question that digital technologies are critical to economic development.

However, the economic disruption and uncertainty caused by digital technologies can create social and political concerns. This disruption can be managed using policies and regulations that maximize the

benefits of digital technologies, by accelerating digital transformation while at the same time minimizing short-term disruptions. Each country must address its own short-term disruptions. Indonesia, for example, struggles with unemployment. It needs to address the dilemma between the adoption of high technology and the impact on employability. On the other hand, the ROK has started to develop its capacity to support lifelong learning, as rapid adoption of digital technologies requires upskilling.

The survey showed that, overall, the most important technologies, for all groupings, are electronic payment, mobile networks, broadband, and cloud computing. Biotechnology, quantum computing, and blockchain were found at the bottom. Retail and agriculture have the biggest impact of all sectors for economic growth, productivity, and social services, followed by finance and banking as well as the technology sector. Although most of the interviewees believe that agriculture is important, that sector remains undervalued.

Looking at the interview results, each country nominated the retail industry as the sector that will experience the greatest impact from digital technology. Throughout the survey, and supported by the case studies, we found that the policies supporting the ease of establishing a new company have the biggest impact on economic growth, followed by telecommunications regulation, R&D, IP, skills development, and the business and competition policy.

Guidelines for Each Group

Because every country has its own challenges and starting points for technological policies, we developed specific guidelines for technologies, sectors, and policy and regulatory initiatives for each country, depending on their digital economy grouping.

Group 1: Leaders

The top issues for the digital economy leaders to consider are:

Foundation technology (telecommunications):

This was seen as the most important foundation and highest technical priority for the digital economy, to ensure that a country remained at the forefront of best practices. Common focus areas were penetration of smartphones, 5G mobile networks, and broadband.

Emerging technologies

All of the emerging technologies were regarded as important, but the highest priority was given to big data and AI, biotechnology and cloud computing.

Sectoral focus

The retail sector was seen to be the most important market for economic growth, productivity, and social services.

Social services impact

Finance and banking, and government services were regarded as most important for social outcomes.

Policy and regulation

R&D and ease of establishing new companies (online and offline) stood out as having the greatest impact on economic growth, productivity, and social services.

Other important policy issues

Governments placing a high priority on business and competition policy were regarded as having a high impact on economic growth, productivity, and social services. In addition, a focus on school education, further education, and universities was important.

National plans

A common theme for group 1 countries was the creation of a national government digital economy plan with specific objectives and programs. Most of these plans had specific targets, metrics, and time limits.

Trust

This is a generic term covering several important metrics in our research, including IP, privacy, and security. Group 1 considered these metrics important, but interestingly not as important as they were judged by countries in other three groups (except perhaps the question of security). This is probably because a certain level of assurance can be assumed to have been reached in group 1 countries on these parameters.

Ecosystems

Generating ecosystems of technology companies was seen as a critical factor in achieving national outcomes. Most group 1 countries are deploying significant plans and incentives to stimulate strong ecosystems. Many have started this process by imitating Silicon Valley, with its complex interaction of universities, technology companies, service organizations (such as law firms), and social networks and facilities. However, there is a need to think beyond the spatial model of Silicon Valley and explore digital entrepreneurial ecologies.

Government approach

A fairly strong relationship was observed between the importance of growing the digital economy and the office in the government having this role (to grow the digital economy). The highest priority was for the President's or Prime Minister's level; the second-highest priority was for a specific ministry; while the last priority was to assign it to a minister having other responsibilities. Successful countries put significant effort into coordinating digital economy plans through the three levels of government, i.e., national, state, and local.

Group 2: Emergent

Emergent countries had high interest in creating a strong digital economy but were not achieving at quite the same level as the leaders Group. The priorities of emergent countries are slightly different.

Foundation technology (telecommunications)

As with Group 1, the strongest priority technology is telecommunications, but with a slightly different and greater emphasis being given to broadband, and to speed and network coverage.

Emerging technologies

The high priorities were big data, cloud computing and electronic payment. IoT also achieved a high level of importance.

Sector focus

There were some differences due to some countries in this group having different industry structures. However, on average agriculture and retail were regarded as making the greatest contribution to economic growth.

Social services impact

Compared with Group 1, there is a stronger interest in, and focus on, technology that improves productivity and social services.

Policy and regulation

For Group 2 countries, R&D was given the highest priority for economic growth, productivity and social services. This emphasis was regarded as necessary for a country to achieve economic growth and the development of technology-related local industries.

Other important policy issues

A shortage of skills was seen as an impediment to delivering new technology industries and to making existing industries more efficient. University was seen as the most important focus.

National plans

The development of strategic plans with specific national initiatives was given a high priority.

Trust

The issues of IP, privacy and security were given lower priority than Group 1 countries.

Ecosystems

As with Group 1, creating such systems was seen as important in some countries in this group, such as Malaysia, which set up ecosystems some 20 years ago.

Government approach

Some of the fastest improving digital economy countries exist in this group. Their initiatives are worth reviewing even for Group 1 countries. They tend to give higher prominence to having a Ministry responsible for these initiatives.

Group 3: Nascent

At the beginning of this research project, grounded research indicated that APO member economies could be segmented into three groups. Subsequent analysis of the quantitative and qualitative research suggested a better approach would be to split the initial group 3 countries into two groups, the nascent and the embryonic, with the latter becoming group 4.

Foundation technology (telecommunications)

As with groups 1 and 2, telecommunications was seen as the most important technology. A stronger focus was given to 4G technology coverage, affordability, and broadband.

Emerging technologies

The highest importance was placed on electronic payments and big data.

Sectoral focus

This was regarded a complex issue, with the focus being on avoiding job losses. For some countries with high unemployment, this was an important social issue. Productivity improvements were given a higher rating, with a particular focus on finance.

Policy and regulation

For both economic growth and productivity, a high focus on R&D, together with the ease of setting up new companies, was seen as the most important government policy.

Other important policy issues

There were some differences between countries in this group, with countries such as Indonesia having a strong focus on schools and technology education while others having a strong focus on universities.

National plans

Digital economy plans were regarded as very important, especially for our exemplar case study of Indonesia.

Trust

IP protection was rated a high requirement to encourage R&D and innovation, with privacy and security given a lesser priority.

Government approach

Balancing employment implications against the advantages of a stronger digital economy was a complex issue for many in this group. In addition, a number of interviewees commented on the need for stronger IP protection for startups and the need to address special interest groups' ability to affect the goal of increased competition.

Digital momentum

A number of group 3 countries were among the highest rating globally for digital momentum and therefore the plans and initiatives of these countries were worthy of attention by other countries. It is this aspect that underscores their nascent status.

Group 4: Embryonic

The countries with a digital economy score below 40 were found to have a significantly different set of priorities when the survey results were analyzed. At a macro level, the relative importance of developing new technologies, creating digital industries, and advancing specific government policies for the digital economy were all seen as less important. The focus areas were:

Foundation technology (telecommunications)

The strongest emphasis was on technologies, with the focus areas being mobile coverage and affordability.

Emerging technologies

The highest scores for importance were given to cloud computing, broadband, and electronic payments. The emerging technologies of IoT, blockchain, quantum computing, and big data were not given high priority.

Sectoral focus

For economic growth and productivity, respondents from this group gave less importance to focusing on specific industries than those in other groups. However, the industries with higher scores were retail, finance and banking, and technology.

Social services impact

Again, there was less emphasis on a specific sector. However, those with a higher score were government services, finance, and retail.

Policy and regulation

There was a strong emphasis on education and the ease of establishing new companies.

Other important policy issues

In this group, a strong emphasis was on education, IP, and R&D.

Education

With regard to education, countries in this group had different priorities for economic growth, productivity, and social services.

Economic growth

There was a high priority for technical and further education, followed by university education.

Productivity

The strongest focus was on university, followed by technology and further education.

Social services

The strongest focus was on schools, followed by technology and further education.

Key Questions for Consideration

It is a complex issue for each country to decide the importance of developing a more advanced digital economy and the kind of development that is needed. It is not an isolated decision. As with many other government decisions, such as those regarding employment, government funding needs to be balanced for the best outcomes. Some of the current dichotomies include:

Telecommunications priorities: For each of the four groups analyzed, telecommunications was always the most important technology for development. Balancing government policies such as those on competition and on coverage versus the implementation of new technologies like 5G, need to be thought through.

Best sectoral focus: Digitizing retail was regarded as an important priority by all groups. However, it is a complex undertaking to help retailers digitize supply chains; to put in place policies to encourage online purchases; and to improve the technical skills of SMEs in this sector.

Emphasis on biotechnology: During the fieldwork for this study, the first and second waves of COVID-19 were seen as major change agents for government policy. In-country vaccine production became paramount for several countries and the need to develop biotechnologies appears to have been given a higher priority.

The future for jobs: While the debate in developed countries about job losses from AI, robotics, and related technologies still does not have a firm conclusion, the possibility that job losses could occur quicker than the creation of new opportunities is still regarded as a threat. In the poorer countries, where high unemployment is already a social issue, the digitization of services in retail and agriculture poses a conundrum.

National security: The growing incidence of hacking of computer systems by criminal organizations and national governments is putting pressure on countries to have digital capabilities to minimize

the negative impacts. In addition, real or potential conflict means that countries need the technological capability to deal with new weapons such as drones and missiles.

Concluding Comments

The overarching finding from this study is that all APO national governments participating in the research believed that having government policies and regulations to support a digital economy was important. For each country, the generic framework we have produced can be supplemented with context-specific ideas and assistance for the development of a national digital technology plan.

Since the fieldwork for this study began, key events such as the COVID-19 pandemic and the emergence of a new technology, the National Digital Currency, have occurred. This only highlights the need for constant review and adaptation of plans for a digital economy.

It is believed that further research could be beneficial for APO members. Our research highlighted that there were three key policy and regulation areas where governments were required to make complex and important proactive decisions. These were R&D, skills development, and telecommunications. Detailed research on how APO digital economy leaders and exemplars deal with each of these areas could provide examples of strategies and approaches that were successful and how they were implemented.

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APPENDIX 1: SUMMARY OF APO DIGITAL ECONOMY DATA

APO member economies	Digital economy score	Digital economy momentum	Digital economy ranking	Digital economy group
Singapore	98.8	25	1	1
Hong Kong	88.1	15	3	1
ROK	83.1	11	11	1
ROC	80.8	40	14	1
Japan	77.8	54	19	1
Malaysia	69	14	26	2
Thailand	53	44	48	2
Turkiye	52.4	40	50	2
Indonesia	47.7	3	58	3
Vietnam	46.8	5	60	3
India	46.6	4	61	3
Philippines	44.3	52	64	3
IR Iran	43.1	6	67	3
Sri Lanka	42.8	85	68	3
Pakistan	34	86	80	4
Bangladesh	32.7	23	83	4
Cambodia	32.3	33	84	4
Lao PDR	32.1	72	86	4
Mongolia	-	-	-	-
Fiji	-	-	-	-
Nepal	-	-	-	-

Source: Adapted from Fletcher Business School Report 2020

Notes: Digital economy score is out of 100;

Digital economy momentum: 1=best; 90=worst.

Digital economy ranking: 1=best; 90=worst.

Digital economy groups: 4 groups established from data.

APPENDIX 2: SURVEY DEMOGRAPHICS

Tables 10 and 11 provide the demographics of the respondents along with the completion rate. As can be seen in Table 10, we have respondents distributed equally across various core skills. The majority of respondents (95%) had more than five years of experience. There were 436 total attempts at the survey, with 361 completed responses. We have at least 13 responses for each country except for Fiji, IR Iran, Japan, and Pakistan, where there were fewer than five responses each; and for Vietnam and Nepal, where we had six and seven responses respectively; and Turkiye, where we had no responses.

TABLE 10

DISTRIBUTION OF CORE SKILLS BY COUNTRY GROUPS AND EXEMPLAR COUNTRIES.

Group/country	Core skills							
	Economist		Policy maker/ strategist		Technologist		Other	
Unidentified	6	10%	18	29%	29	47%	9	15%
Embryonic	11	38%	4	14%	6	21%	8	28%
Nascent	44	23%	53	28%	66	35%	25	13%
Emergent	20	15%	48	36%	48	36%	18	13%
Leaders	18	25%	20	28%	28	39%	5	7%
Indonesia	19	40%	18	38%	18	38%	12	25%
Malaysia	9	32%	9	32%	13	46%	3	11%
ROK	8	42%	6	32%	8	42%	4	21%
Total (all countries)	98	29%	124	36%	161	47%	68	20%

TABLE 11

DISTRIBUTION OF AVERAGE YEARS OF EXPERIENCE BY COUNTRY GROUPS AND EXEMPLAR COUNTRIES.

Group/country	Average years of experience							
	0-4		5 - 9		10 - 19		20+	
Unidentified	2	5%	18	42%	14	33%	9	21%
Embryonic	1	3%	9	31%	13	45%	6	21%
Nascent	5	4%	48	34%	58	41%	29	21%
Emergent	7	8%	21	25%	29	34%	28	33%
Leaders	3	5%	23	35%	18	27%	22	33%
Indonesia	4	8%	18	38%	20	42%	6	13%
Malaysia	2	7%	7	25%	13	46%	6	21%
ROK	0	0%	2	11%	6	32%	11	58%
Total	18	5%	119	33%	132	36%	94	26%

APPENDIX 3: INTERVIEW THEMES FOR EXEMPLAR COUNTRY INTERVIEWS

Importance of policies and regulations for new technologies in terms of productivity, economic growth, and social impact: Compared with your economic equals (GDP per head of population), does your country aim to be a leader? Should it do more?

Do you have a long-term technology strategy that is published?: Where should the priority be versus other issues?

Foundation issues, telecommunications networks: Does your country get the trade-off between technical sophistication, i.e., 5G versus 4G and broadband versus cost of services and coverage.

Education and skills: Does school education do enough to teach computer skills, coding, etc.? Are technical and university educations producing enough IT and engineering graduates, and undertaking enough research and development?

Establishing trust: What are the rules and regulations for IP security to ensure that the population is prepared to take up new technical services?

Innovation and competition policy: The right policy settings can establish an environment for startups, to press the larger companies to innovate and take up more advanced technical solutions. Are the settings of policy and funding adequate or could they be improved?

Digitization of government services: Typically, governments make up a significant part of economies. Is your country a leader? The advantages of reaching leadership include better and more cost-effective services and encouraging citizens to gain technical skills.

Enabling technologies: Which of the new digital technologies do you think are more important, e.g., internet of things, cloud computing, big data analytics, quantum computing, etc.?

Sectoral focus: Which economic sectors have the most to gain from the new technologies? Governments often play a significant part in supporting technologies and industries that have the biggest impact on economic growth, productivity, and social outcomes. Which sectors do you think could benefit the nation the most, e.g., agriculture, education, retail, etc.?

Social benefits: Social benefits from the new technology could include better transport systems, more effective health and education services, including tracing and tracking for COVID-19, for example. How important are these and what emphasis should be put on these rather than the economic ones?

LIST OF TABLES

Table 1	Contributions to economic growth in APO member economies.....	4
Table 2	Contributions to economic growth during 2009–19 for Indonesia, Malaysia, and the ROK	4
Table 3	Number of responses by country groups and case-study countries	9
Table 4	ICT's contributions to economic growth (2010–19)	13
Table 5A	The importance of technologies for economic growth.....	14
Table 5B	The importance of technologies for productivity growth.....	14
Table 5C	The importance of technologies for social services growth	15
Table 6A	Market sectors that can achieve the best national outcomes towards economic growth in the next five years.....	17
Table 6B	Market sectors that can achieve the best national outcomes for productivity growth in the next five years.....	18
Table 6C	Market sectors that can achieve the best national outcomes for social services in the next five years.....	18
Table 7A	Policy and regulatory initiatives to achieve the best national outcomes for economic growth in the next five years	22
Table 7B	Policy and regulatory initiatives to achieve the best national outcomes for productivity in the next five years	23
Table 7C	Policy and regulatory initiatives to achieve the best national outcomes for social services in the next five years	23
Table 8	COVID-19 data	26
Table 9	Specific guidelines for technologies, industries, and policy and regulatory initiatives for each country, by groups.....	55
Table 10	Distribution of core skills by country groups and exemplar countries	72
Table 11	Distribution of average years of experience by country groups and exemplar countries	72

LIST OF FIGURES

Figure 1	Initial framework: from policy to economic growth.....	21
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LIST OF CONTRIBUTORS

Lead Researcher

Prof. Steve Burdon AM

*Professor of Strategic Management and Technology
University of Technology, Sydney.*

Researchers

Prof. Stewart Clegg

*Emeritus Professor, University of Technology, Sydney
and Professor, Sydney University.*

Babak Abedin

*Associate Professor
Macquarie University.*

Christopher Bajada

*Associate Professor
University of Technology, Sydney.*

Dr. Kyeong Kang

*Senior Lecturer
University of Technology, Sydney.*

Dr. Diah Priharsari

*Lecturer
Universitas Brawijaya.*

John Clay

*Adjunct Lecturer
University of Technology, Sydney.*

APO Secretariat

Dr. Asaithambi Manickam

*Program Officer
Asian Productivity Organization, Tokyo.*

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