United Nations
Office for South-South Cooperation

UNDP

South-South Ideas

Cooperation, technology and digital transformation:

The case of Arab countries

United Nations Development Programme
304 East 45th Street
New York, NY 10017 USA

Disclaimer

The views expressed in this publication are those of the authors and do not necessarily represent those of the United Nations, UNDP or the United Nations Member States. The designations employed and the presentation of materials on maps do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations or UNDP concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

South-South Ideas

Cooperation, technology and digital transformation: The case of Arab countries

September 2022

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

This paper was authored by Professor Dr. Samia Satti Osman Mohamed Nour, Economic Research Forum (ERF) Research Fellow and Full Professor of Economics and Head of the Department of Economics at the University of Khartoum, Sudan1[1]. It is based on an ERF research project (grant number 2021–055) under the United Nations Development Programme (UNDP) and United Nations Office for South-South Cooperation (UNOSSC) joint project titled "South-South Global Thinkers – A Global Coalition of Think Tank Networks for South-South Cooperation."

The authors of this research study are extremely grateful to the United Nations Office for South-South Cooperation (UNOSSC) and the United Nations Development Programme (UNDP) for their sponsorship of this research project under the 'South-South Global Thinkers – the Global Coalition of Think Tank Networks for South-South Cooperation' initiative.

The author would like to gratefully thank the above mentioned joint project for the research grant. The author would like to also thank the ERF for coordination of the research grant, useful comments and research support that significantly contributed to the completion of this research. Thanks are also due to Dr. Chahir Zaki, Dr. Adel Ben Yousef, Ms. Ramage Nada (ERF), Ms. Shams Banihani (UNOSSC/UNDP) and two anonymous referees from UNDP for their comments on an earlier draft of this research. All the usual disclaimers apply. The views, analysis and policy recommendations in this research are those of the author and do not necessarily reflect the views and policies of ERF, UNDP-UNOSSC.

1 More on the author: Prof. Dr. Samia Satti Osman Mohamed Nour was a Visiting Professor of Economic and Research Fellow, the Centre for the Study of African Economies (CSAE), Department of Economics, University of Oxford, United Kingdom (January–July 2020), Affiliated Researcher, UNU-MERIT, University of Maastricht, Maastricht, The Netherlands and Full Professor of Economics and Head of the Department of Economics, the Department of Economics, Faculty of Economic and Social Studies, University of Khartoum, Khartoum, Sudan. E-mail: samiasatti@yahoo.com.

ACRONYMS AND ABBREVIATIONS

3G	Third-Generation
5G	Fifth-Generation
AI	Artificial Intelligence
AICTO	Arab Information and Communication Technologies Organization
ALECSO	Arab League Educational, Cultural and Scientific Organization
DAI	Digital Adoption Index
DEI	Digital Evolution Index
DiGiX	The Digital Index
EDI	Enabling Digitalization Index
ESCWA	United Nations Economic and Social Commission for Western Asia
GCC	Gulf Cooperation Countries
GDP	Gross Domestic Product
GSMA	Groupe Speciale Mobile Association (aka Global System for Mobile Communications Association)
ICT	Information and Communication Technology
IoT	The Internet of Things
ITU	International Telecommunication Union
OECD	Organisation for Economic Co-operation and Development
SDG	Sustainable Development Goal
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOSSC	United Nations Office for South-South Cooperation

EXECUTIVE SUMMARY

This global South case study discusses the use of information and communication technologies (ICT) and digital transformation in the Arab region[2]. In particular, the paper explains potential opportunities and challenges and the positive and negative impacts of ICT and digital transformation in Arab countries and offers recommendations for South-South cooperation.

The paper uses descriptive and comparative approaches and employs the most recent secondary data obtained from the International Telecommunication Union (ITU) ICT Indicators database and other relevant sources. Trends in global ICT use and digital divides among world regions and the Arab region during the period 2005-2021 are shown. Specifically, the paper's results are drawn from information based on five observations: 1) increasing trends and the rapid diffusion of ICT indicators in the Arab region and world regions during the period 2015-2021; 2) the incidence of the global digital divide in ICT indicators between the Arab region and other world regions during the period 2005-2019; 3) increasing trends and widening digital divides in ICT indicators between the Arab region and other world regions during the period 2015-2021; 4) differences in the growth rate and diffusion of different modes of ICT indicators in the Arab region during the period 2005-2021; and 5) incidence and trend of digital divides within the Arab region (defined by urban/rural area 2015-2019.

ICT provides several opportunities for supporting economic development and sustainable development. In particular, ICT has the potential to support digitalization, digital transformation and digital economies in Arab countries, for instance, by supporting government and social services. This is demonstrated from several indices, including the Digital Index (DiGiX), the Digital Adoption Index (DAI) and the Euler Hermes Enabling Digitalization Index (EDI). On the other hand, ICT creates challenges for economic development and sustainable development when there is a digital divide. Substantial discrepancies were observed in digital indices, digitalization and digital transformation within the Arab region, with high performance reported in Arab Gulf high-income countries compared to Arab middle-income and low-income countries. This discrepancy is not surprising and can be explained in relation to corresponding substantial discrepancies in economic development, income levels and human development among Arab countries. The concentration of ICT diffusion is found in the Arab Gulf countries and there are wide disparities between these and other Arab countries with regard to the use of ICT (percentage of population accessing the internet, internet subscribers and users). The richest Arab Gulf countries, with the highest gross domestic product (GDP) per capita and better average years of schooling, have higher percentages of people accessing the internet and better opportunities for digitalization and digital transformation, while poorer Arab countries with a lower GDP per capita and less schooling have a correspondingly smaller percentage of inhabitants accessing the internet and poor opportunities for digitalization and digital transformation.

South-South cooperation in the use of ICTs has the potential to accelerate sustainable economic development. Examples already exist of Arab-Arab, China-Arab and Indian-Arab South-South cooperation in ICT. Existing regional initiatives in ICT and digitalization are contributing towards closing gaps in digital divides. Recommendations are provided at the end of the paper to further strengthen Arab-Arab and other South-South cooperation in ICT to address digital divides within and among Arab countries.

2 The Arab region is composed of 22 countries/entities, including Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, State of Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen.

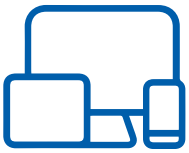
1. INTRODUCTION

There is increasing concern about the intensified use of ICT to accelerate sustainable development in the global South.

This section presents an introduction to South-South cooperation, technology and digital transformation in the Arab region and shows the context, value added, policy relevance, contribution and originality of the research and the research objectives, research questions and structure of the research.

1.1. The context, policy relevance, value added, contribution and originality of the research

In recent years there is increasing concern about the intensified use of information and communication technology (ICT) to accelerate the digital transformation, economic growth, economic development and sustainable development in the global South, including in Arab countries. Since March 2020, the serious economic and social consequences and effects of the Coronavirus (COVID-19) pandemic motivated intensified use of ICT in all countries, including Arab countries. The use of ICT provided opportunities for managing some of the fallout of the Coronavirus pandemic, such as allowing work from home, intensified home delivery services and remote social and government services, like e-education and e-health. This was especially the case in those countries with more advanced ICT infrastructure and strong digital economies. Meanwhile, poor countries in the global South, including some poor Arab countries, lacked appropriate ICT infrastructure to effectively utilize ICT to manage pandemic socio-economic impacts. Thus, the pandemic drew to light and intensified the digital divide both between and within countries in the Arab region and across the world.



South-South cooperation in ICT creates opportunities and challenges for bridging digital divides in Arab countries.

Based on the above background, the policy relevance and potential policy impacts of this research is that it provides some useful insights and sound policy recommendations to strengthen South-South cooperation, including Arab-Arab cooperation in ICT, to address the digital divide and scale-up digital transformation for Arab countries.

The value added of this paper and the relevance and contribution of this research is that it investigates major opportunities and challenges of South-South cooperation, technology and digital transformation, with a particular reference to Arab countries.

Earlier studies in the literature discuss the digital economy in the Arab region (cf. United Nations Economic and Social Commission for Western Asia (ESCWA) Report, 2018) and digital trends and ICT trends and developments in the Arab region during the period (2017-2020) (cf. ITU, 2021). Other studies in the Arab literature examine the mixed positive and negative impacts of ICT, mainly the positive impacts of ICT in facilitating the creation and transfer of knowledge in Sudan and the negative impacts of ICT on intensifying the digital divides in the Arab region and increasing inequality in Sudan (see Nour, 2018, 2017, 2015, 2014, 2006). Different from previous studies in the Arab literature that discuss the role of ICT for creating opportunities and challenges for development in the Arab region (ITU, 2021; ESCWA Report, 2018; Nour, 2006), this paper discusses the role of South-South cooperation, including Arab-Arab cooperation, for facilitating technology and digital transformation in the Arab countries. South-South cooperation in ICT, including Arab-Arab cooperation, creates opportunities and challenges for bridging digital divides in Arab countries. Different from previous studies, this paper intends to: fill gaps in the Arab literature by discussing the impacts of ICT and potential opportunities

and challenges for enhancing economic development and sustainable development through digitalization, digital transformation and the digital economy in Arab countries; discuss the positive impact of ICT to facilitate digital transformation; and add to previous studies in the literature by providing more elaborate and in-depth investigation of the negative impact of ICT in creating digital divides.

The originality of the research is that it provides a comparative analysis and explains the variation, disparity and discrepancy in the use and the adoption of digital technologies to foster digital transformation and digital divides across Arab countries in three groups defined according to income level. A novel element of the analysis is that various positive and negative impacts and opportunities and challenges related to utilization of ICT to manage the Coronavirus (COVID-19) pandemic in the Arab region is investigated. Also, it confirms the importance of technological and digital cooperation among the global South, including Arab countries, to support achievement of the sustainable development goals (SDGs), particularly to address inequality and poverty in Arab countries.

In the author's view, the main challenges in the Arab region, particularly in the less advantaged countries, are to enhance the positive impacts of ICT to support digital economies, digital transformation and digital inclusion. Promoting investments in ICT can foster economic growth and accelerate progress in the SDGs. A pertinent challenge is to implement coherent policies to increase utilization of the digital economy, for instance by increasing investment in telecommunications infrastructures, fostering demand for broadband and developing software industries. Coherent and sound public policies and ICT policies are important for ensuring equality of access and use of ICT, which, if organized properly, can facilitate the provision of social and government services (e.g., health and education, among many others) and enhance equality and social inclusion.

1.2. Structure of the research, research objectives and research questions

The paper is organized as follows: Section 1 provides an introduction; Section 2 presents a literature review on ICT, digitalization, digital economies and digital transformation and economic development and sustainable development; Section 3 gives an overview of ICT and digitalization in the Arab region; Section 4 discusses potential opportunities and challenges of ICT for economic development and sustainable development through digitalization and digital transformation in three groups of Arab countries, touching on the impacts of the COVID-19 pandemic in Arab countries; Section 5 discusses South-South cooperation in ICT, including Arab-Arab, China-Arab and India-Arab cooperation; Section 6 offers conclusions and policy implications and recommendations, in particular for enhancing South-South cooperation in ICT, emphasizing Arab-Arab cooperation, for supporting digital transformation in the Arab region.

To understand the impacts of ICT on economic development and digital transformation in the Arab region, the below questions were researched.

- What are the current statuses and trends of the use of ICT in Arab countries?
- How has the COVID-19 pandemic affected the use of ICT and what are the major opportunities and challenges ICT has created for Arab countries?
- What are the major opportunities ICT creates for digitalization, digital economies and digital transformation in Arab countries?
- What are the major challenges ICT creates for economic development and sustainable development and for digital divides among and within in Arab countries?
- What major South-South cooperation initiatives in ICT are taking place, including Arab-Arab country cooperation?
- What policy recommendations can be made to address the challenges and foster the role of ICT to support digitalization, digital transformation, economic development and sustainable development in Arab countries?

As for method of data collection and to answer the above questions, this research used new secondary data obtained from various relevant international data sources on the use of ICT in the global

South and Arab countries, including data from the International Telecommunication Union (ITU) World Telecommunication/ICT Indicators database. In addition, data was used from the World Development Report (2016), the DAI, EDI 2019 and DiGiX 2020. Regarding methodology, this research used descriptive and comparative approaches and quantitative and qualitative analysis. Mainly, this research used four indicators of ICT (use of the internet, computers, mobile devices and telephones) to fulfil the research objectives, answer the research questions and provide useful policy recommendations.

2. LITERATURE REVIEW

Technical change is a creative process that creates opportunities for development, while also imposing certain restrictions on development.

This section presents a literature review of the importance of ICT for economic development, digitalization, digital transformation, digital economies, sustainable development and global South cooperation in ICT, touching on both the positive and negative impacts of ICT in developed and developing countries.

While the impact of ICT and technological progress in general is difficult to measure, some studies used indicators to approximate its effect on economic growth and discuss the positive and negative impacts (opportunities and challenges) that ICT has had on the global economy[3]. Some studies, for example, have used an index of investment or expenditures on ICT, IT, computers and computer equipment and provided robust results showing the various influences on economic growth and development (cf. Jorgenson and Stiroh 1995; Phojola 2000, 2001). Various studies also discuss the hazards ICT creates for economic development. Most of this literature is based on the idea that technical change is a creative process that creates opportunities for development, while also imposing certain restrictions on development. For example, several studies have highlighted the negative impact and implications of the increasing use of IT or ICT on employment and the labour market (cf. Freeman and Soete 1985, 1994, 1997). The literature indicates a growing but limited effect of ICT diffusion in developing countries due to a lack of investment in complementary infrastructures, such as education, skills and technical skills. (cf. Pohjola 2001; Nour 2002, 2006).

The 2030 Agenda recognizes "the spread of information and communication technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies.

Currently, recognition is increasing of the importance of ICT for all countries, including global South and Arab countries. The 2030 Agenda for Sustainable Development recognizes "the spread of information and communication technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies."[4] While none of the 17 SDGs specifically cover ICTs, several targets make reference to the subject. The importance of ICT is confirmed in SDG Target 9.c, which states the international commitment to "significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020." This target demonstrates the importance of ICT infrastructure to facilitate the integration of all countries in the information society and digital economy. The use of internet and ICT services in various areas, including education, health and government services, provides opportunities for digitalization and digital transformation.

Econometric modelling for the Arab States region provides a set of analyses that estimate the economic contribution of broadband and digitization and the impact of ICT policy on the development of the digital economy in the Arab region. It provides substantial evidence regarding the positive impact of broadband and digital transformation on the economy and the impact of institutional and regulatory variables on the growth of the digital ecosystem[5].

3 The first wave of innovation was the Industrial Revolution, the second, the Age of Steam, the third, the Age of Electricity, the fourth, the Age of Mass Production and the fifth, the rise of Information and Communications Technology and Networks (Moody and Nogrady, 2010).

4 2030 Agenda for Sustainable Development: ICTs and the SDGs: www.itu.int/en/ITU-D/Statistics/Pages/intlcoop/sdgs/default.aspx (accessed 29 August 2021).

5 See ITU (2020) 'The Economic contribution of broadband, digitization and ICT regulation: Econometric modelling for the Arab States

Some studies discuss legal dimensions of digitalization, for instance Ramzy and Zaki (2021) discuss the interaction between trade integration and South-South cooperation and digitalization and discuss the importance of the legal framework of digitalization in African countries and the role of institutional variables that provide a legal basis for digital trade at the regional and global levels. They investigate the importance of digitalization in fostering trade integration among Southern economies with an emphasis on intra-African trade. They argue that as the global economy experiences important changes brought about by digital technologies, South-South cooperation presents new opportunities for—and areas of—cooperation among Southern countries. Many of these new opportunities have the potential to stimulate national and regional efforts to achieve the SDGs by 2030.

Various studies use indices to show how economic development is bolstered by digitalization. For instance, some studies use the Digital Evolution Index (DEI) and show a positive relationship between the digital transformation index and economic development, labour productivity and job employment (cf. Aly, 2020).

Several studies explain the positive impact of digitalization, while few studies explain the negative impact of digitalization. For instance, Turel, et. al., (2021) argue that like other revolutions, the rise of digital technologies has started revealing a number of "dark sides" with grave impacts at the individual, organizational and societal levels (Vaghefi, et. al., 2017). While the upsides of digitalization have received considerable scholarly attention, the literature on the down sides of digitalization is in its early stages and in need of further research (Turel, et. al., 2019). Some research has highlighted negative consequences and side effects for individual users from using utilitarian and hedonic information technology artifacts. While this research acknowledges the existence of positive uses of IT, it still strives to understand and find ways to mitigate negative, or "dark side," effects of IT on individuals, firms and societies. So far, notable findings in this area have shed light on technology addiction (Qahri-Saremi et al., ??? 2021; Turel, et al., 2020), problematic use of IT (Turel, et al., 2020), techno stress (Ayyagari, et al., 2011; Tarafdar, et al., 2019, 2020), general stress (Turel, et al., 2018; Vanman, et al., 2018), experience of ambivalence (Qahri-Saremi, et al., 2020), negative health outcomes (Serenko, et al., 2021), security and privacy concerns (D'Arcy, et al., 2014; Goel, et al., 2017), online deviant behaviours such as cyber bullying (Lowry, et al., 2017, 2019; Venkatraman, et al., 2018) and the negative side of user-generated content (Liu, et al., 2017; Qahri-Saremi, et al., 2019)[6].

Few studies explain the negative impact of digitalization related to cybercrime. Cybercrime is defined as any criminal activity that involves a computer, networked device or a network. Cybercrime (i.e., cyber-dependent crimes) are primarily those that target systems, networks and data and seek to compromise their confidentiality (i.e., systems, networks and data that are protected and only authorized users can access them), integrity (i.e., data that is accurate and trustworthy and has not been modified) and availability (i.e., data, services and systems that are accessible on demand). These cybercrimes include hacking, malware creation, possession and distribution, denial of service attacks, distributed denial of service attacks and website defacement (i.e., a form of online vandalism targeting the content of websites)[7]. While most cybercrimes are carried out in order to generate profit for the cybercriminals, some cybercrimes are carried out against computers or devices directly to damage or disable them. Others use computers or networks to spread malware, illegal information, images or other materials. Some cybercrimes target computers to infect them with a computer virus, which is then spread to other machines and, sometimes, entire networks. A primary effect of cybercrime is financial. Cybercrime can include many different types of profit-driven criminal activity, including ransom ware

region,' January 2020.

6 See Turel, et al., (2021).

7 See the United Nations Office on Drugs and Crime (UNODC) (2021) 'Offences against the confidentiality, integrity and availability of computer data and systems,' www.unodc.org/e4j/en/cybercrime/module-2/key-issues/offences-against-the-confidentiality--integrity-and-availability-of-computer-data-and-systems.html (accessed 6 December 2021).

attacks, email and internet fraud and identity fraud, as well as attempts to steal financial accounts, credit card or other payment card information. Cybercriminals may target an individual's private information and corporate data for theft and resale. As many workers settle into remote work routines due to the pandemic, cybercrimes are expected to grow in frequency, making it especially important to protect backup data[8].

3. OVERVIEW OF ICT AND DIGITALIZATION IN THE ARAB REGION

This section remarks on the status of ICT and provides an overview of ICT and digitalization in the Arab region. It explains trends of the global use of ICT and highlights digital divides between the world regions and the Arab region, and within countries themselves.

Figures 1 and 2 show trends of the global use of ICT and the digital divide between the world's regions and the Arab region during the period 2015-2021[9]. The figures explain three stylized facts: 1) the increasing trend and rapid diffusion of ICT indicators in the Arab region and the world regions during the period 2015-2021; 2) the incidence of the global digital divide in ICT indicators between the Arab region and the world regions during the period (2015-2021); and 3) increasing trends and a widening digital divide in ICT indicators between the Arab region and the world regions during the period 2015-2021. Digital divide is defined by ICT indicators, including fixed-telephone subscriptions, mobile-cellular telephone subscriptions, fixed-broadband subscriptions, population covered by a mobile-cellular network, population covered by at least a 3G mobile network, households with a computer, households with internet access at home and individuals using the internet.

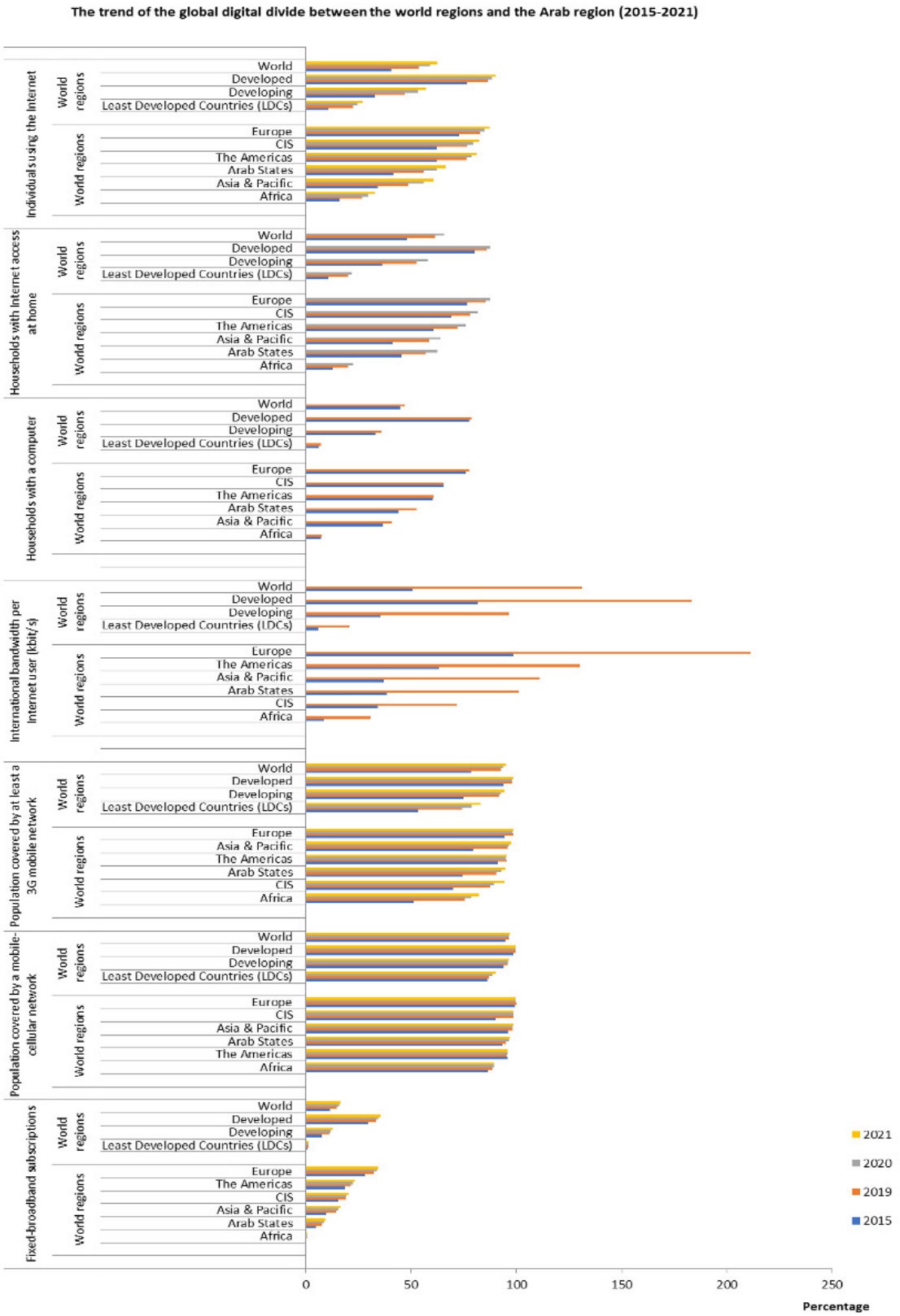
Regarding fixed-telephone subscriptions, mobile-cellular telephone subscriptions, fixed-broadband subscriptions and population covered by a mobile-cellular network, the Arab States rank above only Africa and the Least Developed Countries (LDCs), but fall behind the standard for the world level and all other world regions (including the Americas, Asia and the Pacific, the Commonwealth of Independent States (CIS) and Europe). Regarding population covered by at least a 3G mobile network, the Arab States rank only above Africa, CIS and LDCs, but fall behind the standard for the world level and all world regions. Regarding households with a computer, households with internet access at home and individuals using the internet, the Arab States rank above Africa, Asia and the Pacific, CIS, LDCs, the world level and the level of developing countries, but fall behind the standard for the Americas, Europe and developed countries.

The incidence of the global digital divide in ICT indicators between the Arab region and the world regions also appears from the digital divide between the world regions and the Arab region defined by age, sex and urban/rural areas (2019-2020) (see Figures 2-4).

8 See Brush, K., Rosencrance, L., and Cobb, M., (2021) 'Cybercrime,' www.techtarget.com/searchsecurity/definition/cybercrime (accessed 6 December 2021).

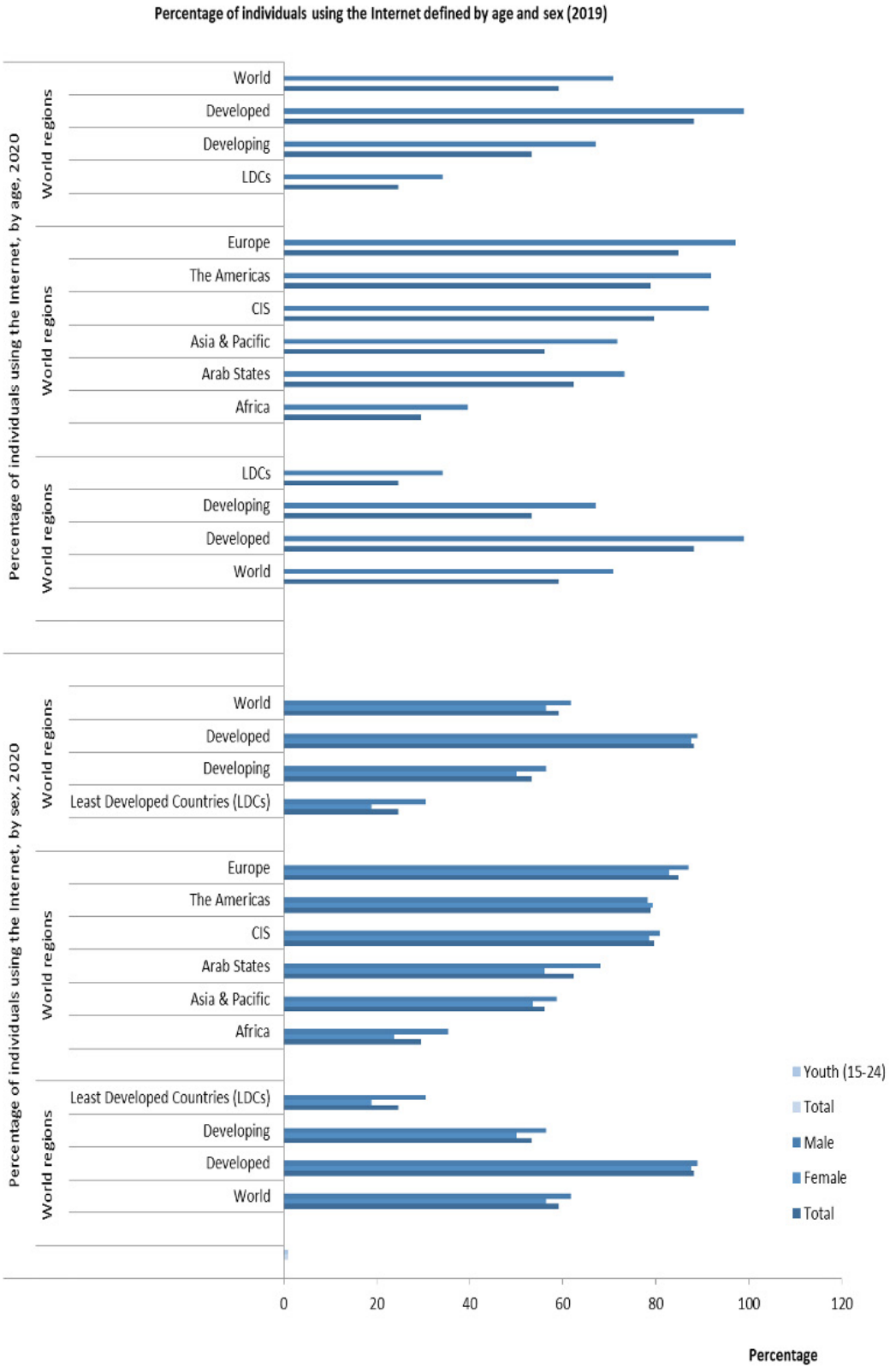
9 Regions in this figure and all figures are based on the ITU regions, see: www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx.

Figure 1: Trends of the global digital divide between the world's regions and the Arab region (2015-2021)



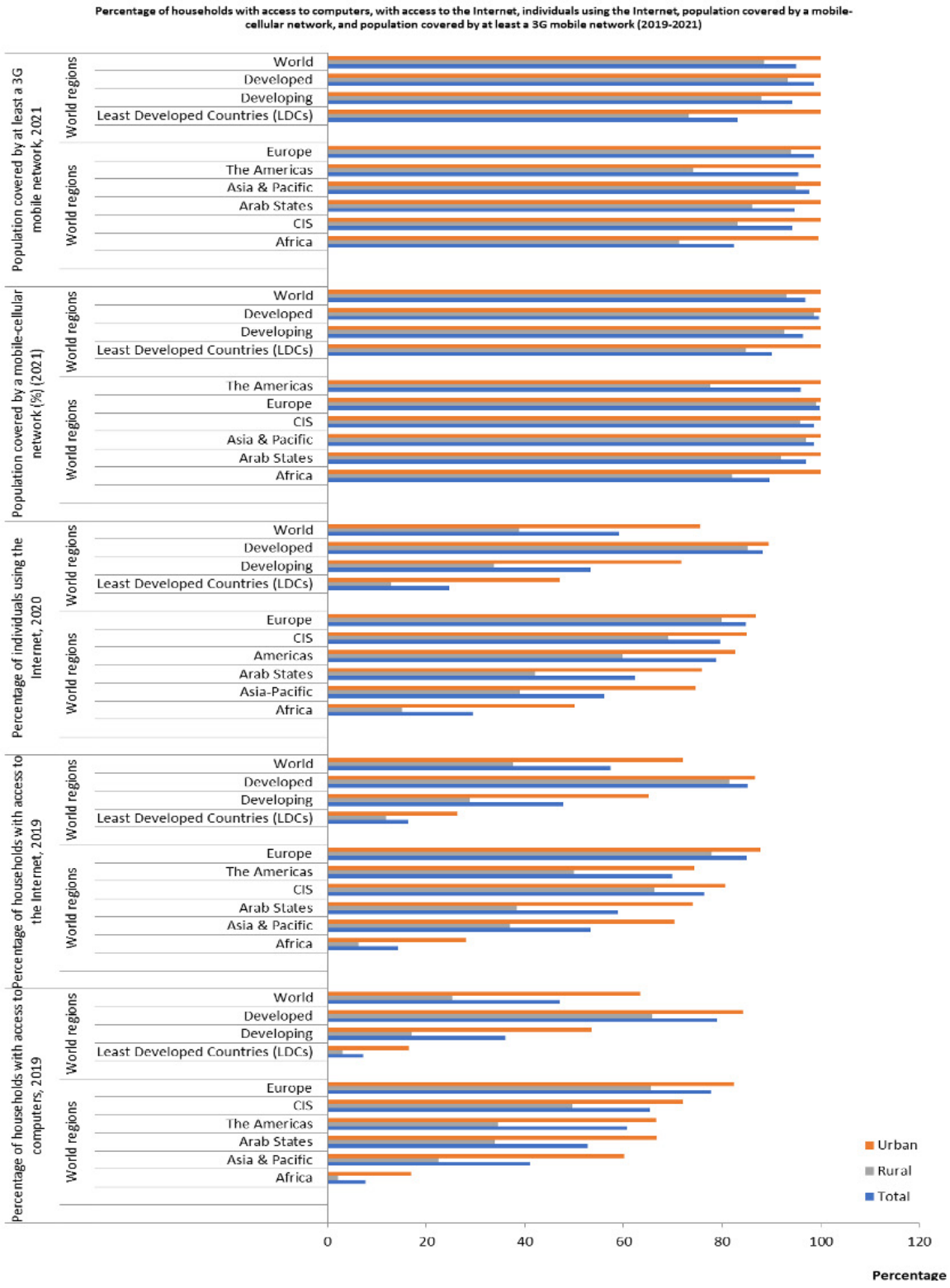
Source: Adapted from the ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 2: Percentage of individuals using the internet defined by age and sex (2019)



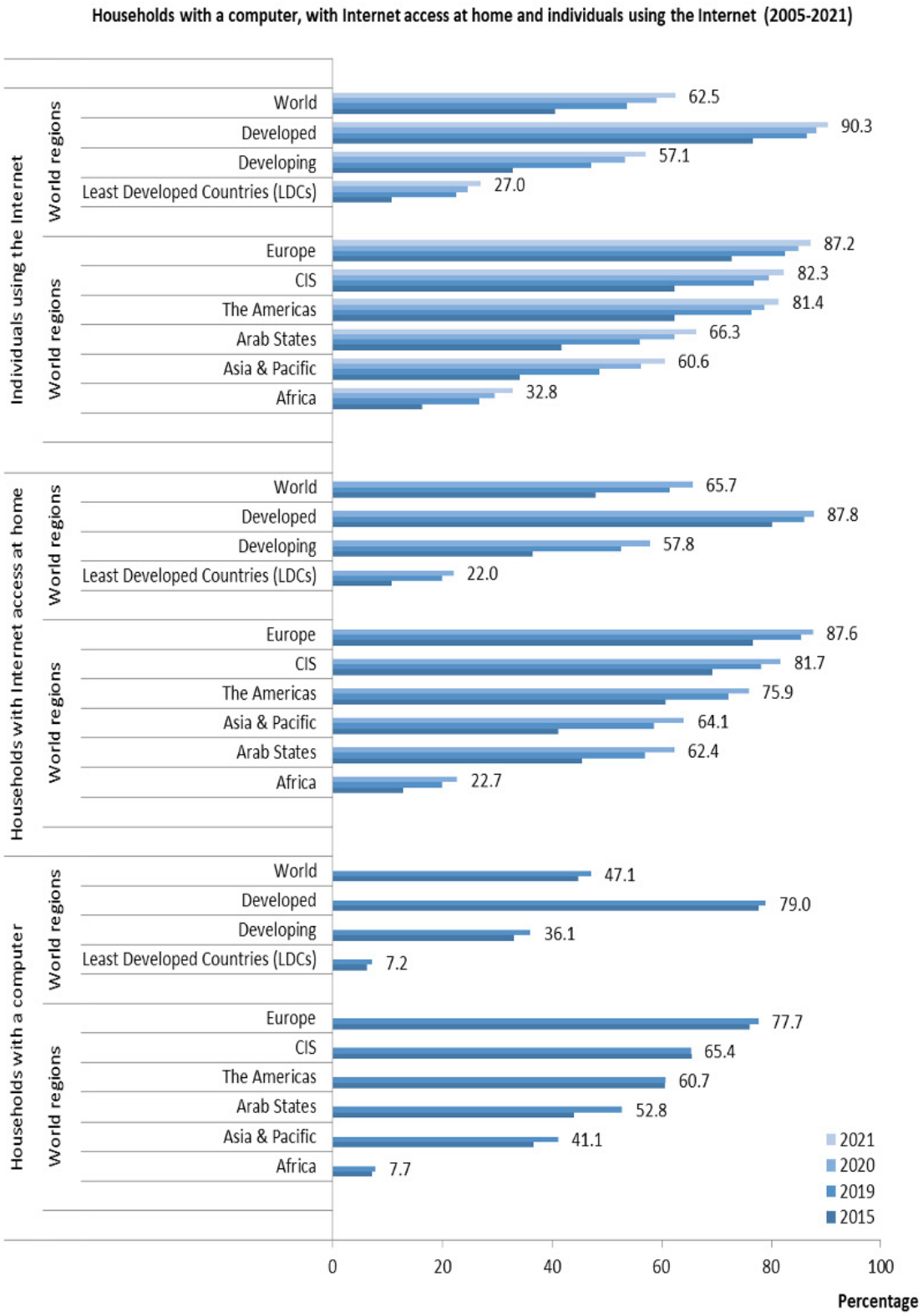
Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 3: Percentage of households with access to computers, with access to the internet, individuals using the internet, population covered by a mobile-cellular network and population covered by at least a 3G mobile network (%) by urban/ rural area (2019-2021)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

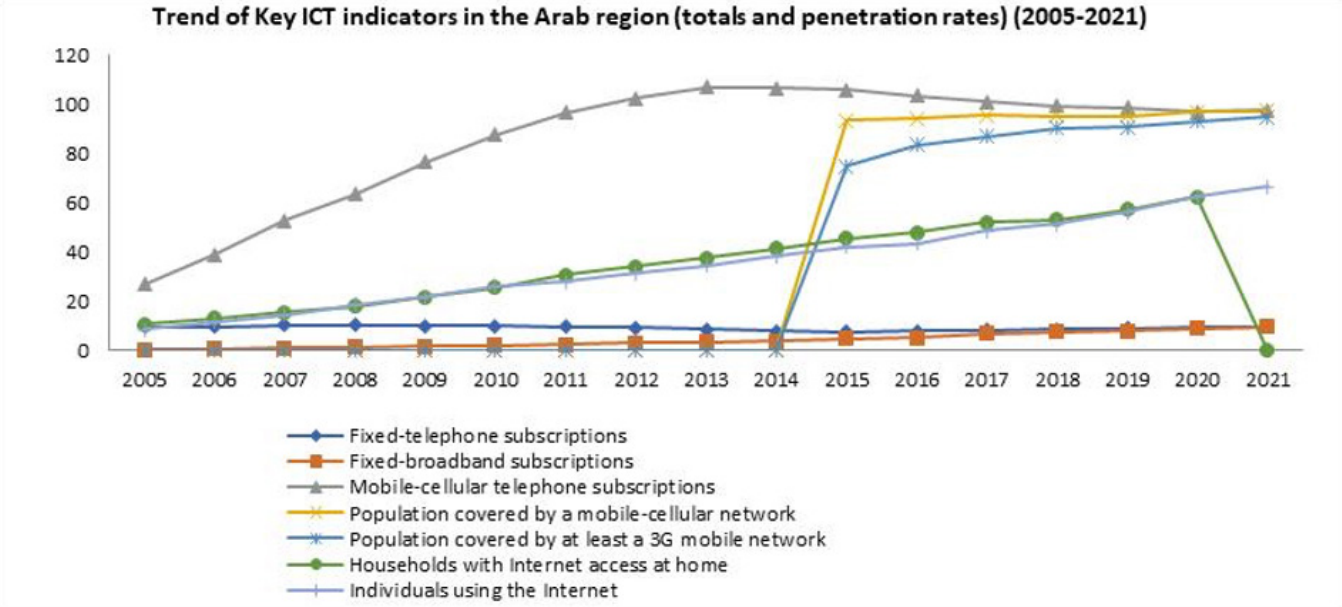
Figure 4: Trends of the global digital divide between the world regions and the Arab region: households with a computer, households with internet access at home and individuals using the internet (2015-2021)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 5 shows the current status and trends of ICT indicators in the Arab region during the period 2015-2021. The figures explain three stylized facts: 1) the increasing trend and rapid diffusion of ICT indicators in the Arab region during the period 2005-2021; 2) differences in the growth rate and diffusion of different modes of ICT indicators in the Arab region during the period 2005-2021; and 3) incidence and trends of digital divides within the Arab region (defined by urban/rural area 2015-2019). The current status, increasing trends, rapid diffusion of ICT indicators and the differences in the growth rate and diffusion of different modes of ICT indicators in the Arab region during the period 2005-2021 is demonstrated from the fixed-telephone subscriptions, mobile-cellular telephone subscriptions, active mobile-broadband subscriptions, fixed-broadband subscriptions, population covered by a mobile-cellular network, population covered by at least a 3G mobile network, households with a computer, households with internet access at home and individuals using the internet. For instance, fixed-telephone subscriptions showed an increasing trend during the period 2005-2008, then

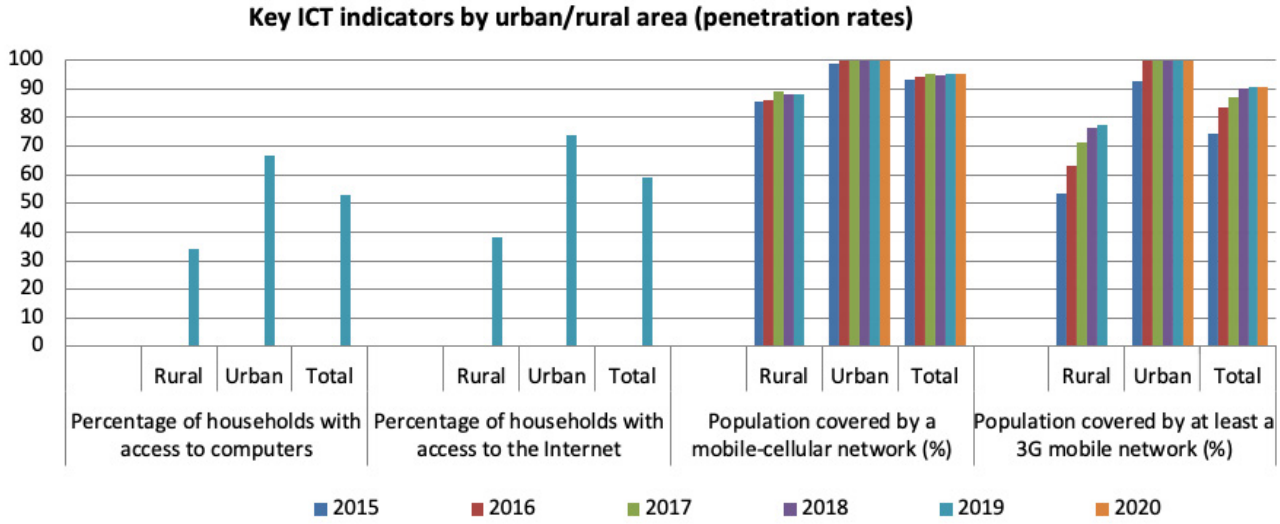
Figure 5: Trends of ICT indicators in the Arab region (totals and penetration rates, 2005-2021)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

a declining trend from 2008 to 2016; and again an increasing trend during the period 2016-2019. Mobile-cellular telephone subscriptions indicate an increasing trend during the period 2005-2014, then a declining trend from 2014 to 2020. Fixed-broadband subscriptions indicate a continuous increasing trend during the period 2005-2021. The population covered by a mobile-cellular network shows an increasing trend during the period 2015-2017, then a declining trend from 2017 to 2019 and a constant trend during the period 2019-2020. The percentages of households with computers, households with internet access at home and individuals using the internet show an increasing trend

Figure 6: Incidence and trends of the digital divide within the Arab region (defined by urban/rural area, 2015-2019)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (Accessed 6 December 2021).

during the period 2005-2019.

The incidence and trend of digital divides within the Arab region (defined by urban/rural area, 2015-2019) appears from the population covered by a mobile-cellular network, population covered by at least a 3G mobile network and the percentage of households with computers and households with access to the internet (see Figure 6).

ITU (2021) explains ICT infrastructure developments and integrated technologies in the Arab region[10]. According to ITU (2021), artificial intelligence (AI), the Internet of Things (IoT), cloud computing, distributed ledger technology (DLT), precision medicine, digital trade, autonomous mobility and many more evolving technological arenas will shape the future of the world, and the Arab region along with it. ITU (2021) discusses digital trends, ICT infrastructure developments and integrated technologies in the Arab region, mainly explaining the indicators on emerging technologies, such as the application of AI, the status of IoT or developments in relation to cloud technologies that represent an increasingly important area of ICT development for all countries, including Arab countries.

ITU (2021) found the AI landscape to be very mixed in the Arab region. Frontrunners in AI adoption include Qatar, Saudi Arabia and the United Arab Emirates, all of whom have demonstrated strong commitments towards the development and implementation of these technologies. Businesses, with the support of governments as early consumers, have started to deploy AI at scale in banking, finance, robotics and industry for the purposes of forecasting, business process improvement and providing solutions to complex tasks. Yet only seven percent of companies in the Middle East and North Africa (MENA) region feel that they are working with AI in an advanced way. Most of the companies that use AI are doing so for optimization and prediction functions, primarily in areas related to customer service. Outside the Gulf economies, adoption has been slower, owing in large part to differences in, for example, infrastructure and access to skilled labour, which are key to AI development. The biggest opportunities for AI in the Arab region are in the financial sector, public services, including education and health care, and the manufacturing sector. Analysis conducted by the International Data Corporation

10 See ITU (2021) 'Digital trends in the Arab States region 2021,' pp. 23-25.

(IDC) estimated that spending on AI systems in the MENA region was to reach US $374.2 million in 2020, up from $261.8 million in 2018 and an anticipated $310.3 million in 2019. Over the longer term, IDC expects spending in the region to increase at a compound annual growth rate of 19 percent for the 2018-2023 period. Investment in AI is seen as a path to economic transformation in the Gulf Cooperation Council (GCC) countries, while other parts of the MENA region are establishing partnerships with large technology firms to deploy and use AI. The largest challenges to AI growth in the region are changing and adapting to new business processes and understanding rules and regulations around data sharing and data hygiene. Price Waterhouse Coopers estimates that the Middle East will gain two percent of global AI benefits by 2030, which amounts to $320 billion, approximately[11].

The IoT market is well established in parts of the Arab region, underpinned by smart city visions, with IoT connections growing at a rate second only to the Asia-Pacific region. IoT growth in MENA is expected to lead to $55 billion in IoT-related revenue by 2025, with an increase of $18 billion in GDP in the same time frame. Groupe Speciale Mobile Association (aka Global System for Mobile Communications Association) (GSMA) predicts that total IoT connections in the MENA region will double by 2025, driven by growth in the enterprise segment, particularly for smart manufacturing and smart building solutions. For IoT to gain further traction, the region must meet the challenges of data protection and cybersecurity, as well as key challenges in relation to standardization, given that the supplier landscape is considerably fragmented at this point in time. For operators, increasing narrowband IoT and LTE-M connectivity is likely to drive a growing percentage of mobile IoT connections. The largest expected industry spender on IoT in the MENA region is manufacturing, with close to a 16 percent share. Government-funded initiatives, edge networks and 5G connectivity are the motors for MENA leadership in driving smart city development. The region is home to several major smart-city initiatives, including purpose-built cities, such as Neom in Saudi Arabia, Egypt's New Administrative Capital and existing cities, such as Abu Dhabi and Muscat. In March 2020, Oman's Ministry of Technology and Communications launched a pilot project for smart cities at Knowledge Oasis Muscat, in partnership with Omantel and the Public Establishment for Industrial Estates[12].

According to ITU (2021), cloud computing technology is the perfect example of integrated application and infrastructure development. According to an IDC report, the GCC public cloud market could reach more than $2 billion by 2024. With increased demand for digital and cloud-based services arising from the COVID-19 pandemic, major tech firms have increased their data-centre presence in the MENA region over the last year. Gartner predicts that cloud-based software-as-a-service (SaaS) revenue in the MENA region is expected to reach almost $2 billion by the end of 2021. Challenges associated with cloud computing in the MENA region include digital sovereignty regulations and personal data protection. Many governments are looking at cybersecurity strategies and how to protect their markets' data assets[13].

One of the key trends shaping the digital landscape in the Arab region, according to ITU (2021), is the roll-out of 5G networks and adoption of 5G services. GSMA estimates that 5G adoption across the

11 See ITU (2021) 'Digital trends in the Arab States region 2021,' p. 23. See also https://info.microsoft.com/rs/157-GQE-382/images/report-SRGCM1065.pdf; https://mittrinsights.s3.amazonaws.com/Alagenda2020/MEAAlagenda.pdf; https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8701348; www.pwc.com/m1/en/ publications/potential-impact-artificial-intelligence-middle-east.html#4; www.idc.com/getdoc.jsp?containerId=prMETA45546719.

12 See ITU (2021) 'Digital trends in the Arab States region 2021,' p. 24. See also https://assets.foleon.com/eu-west-2/uploads-7e3kk3/4816/iot_in_mena.2d66b51222da.pdf; www.statista.com/statistics/1181148/mena-share-of-iot-spending-by-industry/; www.cio.com/article/3533432/these-top-middle-east-iot-projects-are-paving-the-way-to -smart-cities.html; GSMA, 'The Mobile Economy Middle East & North Africa (2020),' www.gsma.com/ mobileeconomy/mena/.

13 See ITU (2021) 'Digital trends in the Arab States region 2021,' p. 24. See also www.mei.edu/publications/middle-east-cyber-sovereignty-hampers-economic -diversification; www.gartner.com/en/newsroom/press-releases/2020-02-13-gartner-forecasts-public-cloud -services-in-the-middle; www.cio.com/article/3408018/cloud-computing-in-the-middle -east-the-next-big-tech-market.html; www.zawya.com/mena/en/business/story/GCC_cloud _market_to_hit_23bln_by_2024_report-SNG_186984590/.

Arab countries, should utilize the assets offered by the digital economy to transform their economies and societies.

MENA region will reach eight percent (or 58 million 5G connections) by 2025. While COVID-19 may have had a slowing impact on the number of new network launches in 2020, 5G activities are picking up pace: Ooredoo (Oman) and Zain (Bahrain) launched new commercial 5G services in September 2020; in Saudi Arabia, Zain expanded its 5G footprint to 38 cities, while STC deployed a 5G standalone and 5G Voice-over-New-Radio service on a live network; and in the United Arab Emirates, the telecommunication regulator said that it expects all inhabited areas of the country to be covered by 5G networks by the end of 2025. ITU (2021) shows trialled and live 5G activities across a number of Arab states, including non-GCC states Egypt, Lebanon and Morocco. Countries where 5G is live are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates[14].

Several studies explain perspectives on the digital economy in the Arab region (cf. ESCWA Report, 2018). ESCWA Report (2018) indicates that the digital revolution has a far-reaching impact, similar to that of the industrial revolution in the nineteenth century, and that the Arab region cannot afford to stand removed from it. The report argues the region should embrace the benefits and address the risks. Arab countries, with their large human potential, educated youth, financial resources and central geographic position, should utilize the assets offered by the digital economy to transform their economies and societies. Many Arab countries are challenged by slow economic growth, massive unemployment or underemployment, particularly among youth and women, environmental challenges, political instability and/or conflict and population displacement. One might argue that advanced technologies are not immediate priorities given the problems many Arab populations are experiencing. However, ICT, when properly applied, has the potential to address many of these socioeconomic problems and help achieve the SDGs. An informed digital economy agenda for the region would be a major tool to guide Arab countries and put them on track for inclusive and sustainable economic growth. The ESCWA Report (2018) considers the components needed to build such a successful agenda. Many Arab countries have successfully deployed ICT infrastructure and many individuals are using the internet, particularly youth. Statistics show that Arab countries have made significant advances in this respect, quadrupling the percentage of internet users over the past decade and bridging the gap with developed countries. This has been largely due to improvements in mobile broadband and the quality of internet access. Additionally, some governments in the Arab region have made significant advances in the use of ICT to improve their services. However, there remains a weak local supply of ICT goods and services, insufficient skills and research and development and weak ICT adoption by businesses. The absence of reliable statistics on the digital economy makes it difficult to elaborate well-informed policies and to monitor and evaluate them. The ESCWA Report (2018) aims to create awareness about the digital economy and help policymakers and other stakeholders in the Arab region identify priority areas and develop digital agendas to enhance their transformation into smart societies[15]. Exploiting the digital economy's potential should be high on the agenda of public policymakers, even in developing economies. Policy must address the supply and demand of ICT technologies and services and their use in all socioeconomic endeavours. Organizational, human and regulatory changes are also needed. Europe has elaborated a common digital strategy and related measurement framework, as few countries, even developed ones, can address these challenges alone. Arab countries should heed this lesson.

An increasing interest in cloud computing in Arab countries appears from several studies. For instance, according to the Arab League Educational, Cultural and Scientific Organization (ALECSO) (2019), cloud computing technology provides optimal solutions for creating an effective digital and software infrastructure that allows researchers, teachers and students to access, from anywhere and using any internet-connected digital device, valuable resources and services provided by modern digital environments. This helps to ensure quality learning and teaching, rationalize spending and strengthen participatory and collaborative work. The ALECSO (2019) Cloud Computing in Education in the Arab

14 See ITU (2021) 'Digital trends in the Arab States region 2021,' p. 25. See also GSMA, 'The Mobile Economy Middle East and North Africa 2020' (2020).

15 See the United Nations Economic and Social Commission for Western Asia (ESCWA) Report (2018).

Countries project promotes the use of cloud computing in the Arab world through developing a reference guide for institutions and individuals on the use of cloud computing in learning, education and training. This guide provides ways of benefiting from these new technologies, especially in terms of service provision, implementing pilot projects in cooperation with Arab education and training institutions and organizing training workshops on cloud computing technology. The project involved eight phases and made recommendations to be adopted[16].

Ali, in "Cloud Computing in Arab States: Legal Aspect, Facts and Horizons" (2016), argues that cloud computing is considered one of the greatest technological transformations and breakthroughs in the world. Cloud computing offers many long-term and large-scale services on the web, particularly services related to data storage, backup, networks, cybersecurity, management systems, data transmission, use and development of software, creation of job opportunities and the development of the ICT industry. However, cloud computing creates lots of challenges in the Arab countries, mostly at the legal, executive, administrative, technical and practical levels. Ali (2016) explains the practical challenges and legal issues raised in Arab countries and shows that many countries are reluctant to adopt cloud computing for several reasons. Among the reasons cited are the ability to get the latest developed applications and software at reasonable prices; a loss of tax revenues due to the absence of tax administration on sales, assignment or purchase of a database; and the persistent reluctance of local policymakers and national, administrative and political decision-makers to move to cloud computing and take advantage of its services. In addition, suspicions exist over the protection and insurance capacities of cloud computing services providers, distrust is noted of new technologies and the competency of service providers, there is a lack of awareness among officials and decision-makers about the importance of virtual transactions moving to cloud and a similar lack of publicity and awareness-raising about the importance of using this technology. Add to this insufficient progress in establishing large-scale local broadband networks and slow and/or costly internet connections and lack of digital infrastructures in some countries. Environmental concerns also arise, considering the large amounts of power consumed by big data centres[17].

Further discussion on cloud computing in the Arab region is found in Ellatif (2016), who explains the concept of cloud computing and identifies its components, characteristics, advantages and types in the Arab region. Ellatif (2016) also touches on the security of cloud computing for customers (including data privacy protections and service interruptions), the challenges that applications of cloud computing in the Arab environment may face (such as lack of infrastructure readiness) and future trends. Other challenges Ellatif (2016) noted include: cloud computing lacking the appropriate performance oriented applications, such as transactions and other intensive data applications; the higher cost of data transfer rates; national sovereignty; and limited legislative and regulatory frameworks. Many Arab states have launched projects and strategies to adopt cloud computing techniques, but few Arab countries have set up comprehensive legislative, regulatory and executive structures for e-transactions, data protection, processing and transferring abroad and fighting cybercrime and few of them have established telecommunications or emergency centres. Ellatif (2016) suggests the Arab States should set up their own Infrastructure-As-A-Service (IAAS) to keep their data and information safe and that national security-related information must always be kept under State sovereignty. Such a cloud protected by civil servants would create job opportunities for Arab youth[18].

The Cloud Competitiveness Index Report provides an overview of the MENA region cloud market on an on-going basis[19]. The Report measures the competitiveness of the cloud computing ecosystem within fourteen MENA countries, covering five domains: regulation; talent; connectivity; government; and business. The Report helps decision makers gain a thorough understanding of market opportunities and challenges, identifying the strengths and weaknesses of the regional economies and

16 See the Arab League Educational, Cultural and Scientific Organization (ALECSO) (2019).

17 See Ali (2016).

18 See Ellatif (2016).

19 See Mahboubi, et al., 'The Cloud Competitiveness Index Report (2019).'

explaining the complexities of national technology infrastructure to help advance cloud computing in the region. According to the Cloud Competitiveness Index Report (2019), in an effort to transition from oil-dependent economies to digitally transformed ones, some countries in the Middle East and North Africa region have evolved into not only early adopters but also pioneers of cutting-edge technology worldwide. The 2019 Report ranks the Arab countries that are included as follows: the United Arab Emirates, Qatar, Oman, Bahrain, Saudi Arabia, Turkey, Tunisia, Morocco, Kuwait, Egypt, Jordan, Pakistan, Lebanon and Algeria (see Figures 21 and 22). According to the 2019 Report, the UAE is the most cloud-competitive market in the Middle East and North Africa region, followed closely by Qatar, Oman and Bahrain.

In general, cloud computing, while more broadly understood and routinely adopted in many organizations, seems to be at a tipping point. In a transition from a promising concept to an actual enabler, cloud is now expected to deliver what it was created to deliver: "elevating emerging technologies from mere ideas to applicable problem-solvers." As noted, this transition, however, comes with many challenges including requirements for regulation, security, talent, connectivity and government and business community support.

4. OPPORTUNITIES AND CHALLENGES OF ICT IN ARAB COUNTRIES

This section discusses the potential opportunities and challenges of ICT in Arab countries, along with its positive and negative impacts, and the impacts of the COVID-19 pandemic.

4.1 Opportunities of ICT in Arab countries

The use of ICT provides potential opportunities to accelerate economic growth and sustainable development in the Arab region. ICT can enhance SDG 1 on reducing poverty and SDG 8 on economic growth, promoting jobs and decent work by facilitating the creation of additional sources of income and investment for those who work directly and indirectly in the ICT sector. ICT offers the possibility of new employment opportunities, of increasing the employment rate of existing jobs and of new income-generating opportunities. It can improve the degree and efficiency of work that gets done. The affordability and efficiency of ICT-facilitated financial services can help to achieve financial inclusion. ICT can facilitate cheaper, easier, faster and more efficient access to goods and services. The use of ICT, mainly the internet, allows quick uptake and growth in e-commerce. E-commerce can facilitate fast delivery of products, goods and services to large numbers of consumers within and outside of the Arab region, thus improving national, regional and international trade opportunities.

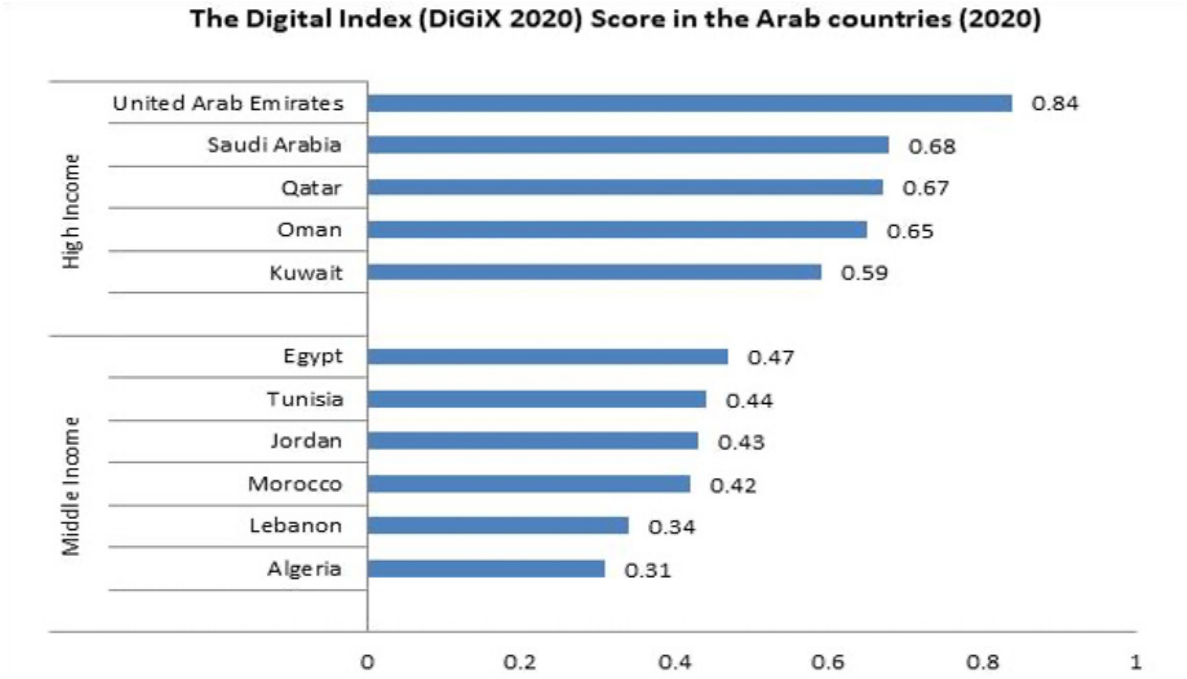
ICT may be seen as a tool for Arab countries that are less developed to accelerate and bridge the digital gap with developed countries.

SDG 4 on education is enhanced as ICT can improve the affordability and efficiency of educational services, such as through online learning and long-distance teaching. Skills can be upgraded and human capital and human resources developed through enhanced educational and training systems; with better skills and capabilities, labour productivity and economic growth is improved. As ICT provides potential opportunities for enhancing the affordability and efficiency of health and medical services, countries can also make progress on SDG 3 related to health.

To achieve SDG 9 on infrastructure, industrialization and innovation, ICT may be seen as a tool for those Arab countries that are less developed to accelerate and bridge the digital gap with developed countries. ICT can support R&D efforts by motivating and facilitating collaboration between research institutes and organizations in the region. The use of ICT offers strong opportunities for promoting gender equality and women's empowerment (SDG 5) by increasing both education and employment opportunities for women.

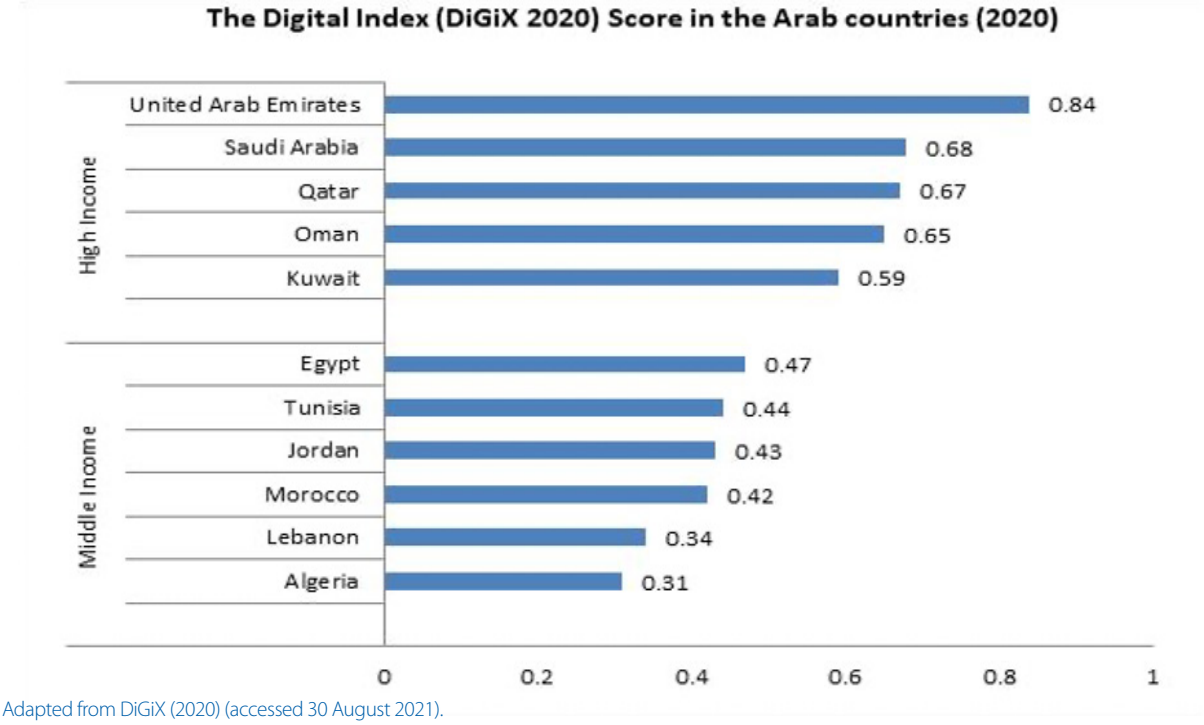
That ICT provides a potential opportunity for supporting digitalization, digital transformation and digital economies in the Arab region is demonstrated by using several indices, including the DiGiX, DAI and EDI. Considerable variations and heterogeneous performances are seen in Arab countries using these indices. The DiGiX 2020 score in Arab countries finds that, regionally, higher performances are reported

Figure 7: Digital index (DiGiX) (score value) in the Arab region (2020)



Source: Adapted from the Digital Index (DiGiX) (2020) (accessed 30 August 2021).

Figure 8: Digital index (DiGiX) (rank) in the Arab region (2020)



Source: Adapted from DiGiX (2020) (accessed 30 August 2021).

in the Arab Gulf high-income countries than Arab middle-income and low-income countries. For instance, the United Arab Emirates ranked at the top in the Arab region followed by Saudi Arabia, Qatar, Oman, Kuwait, Egypt, Tunisia, Jordan and Morocco, respectively, while Algeria and Lebanon ranked at the bottom, respectively. Performance by the top country, the United Arab Emirates, is almost twice that of most of the middle-income countries and nearly three times (2.77) higher than the bottom country, Algeria (see Figures 7 and 8).

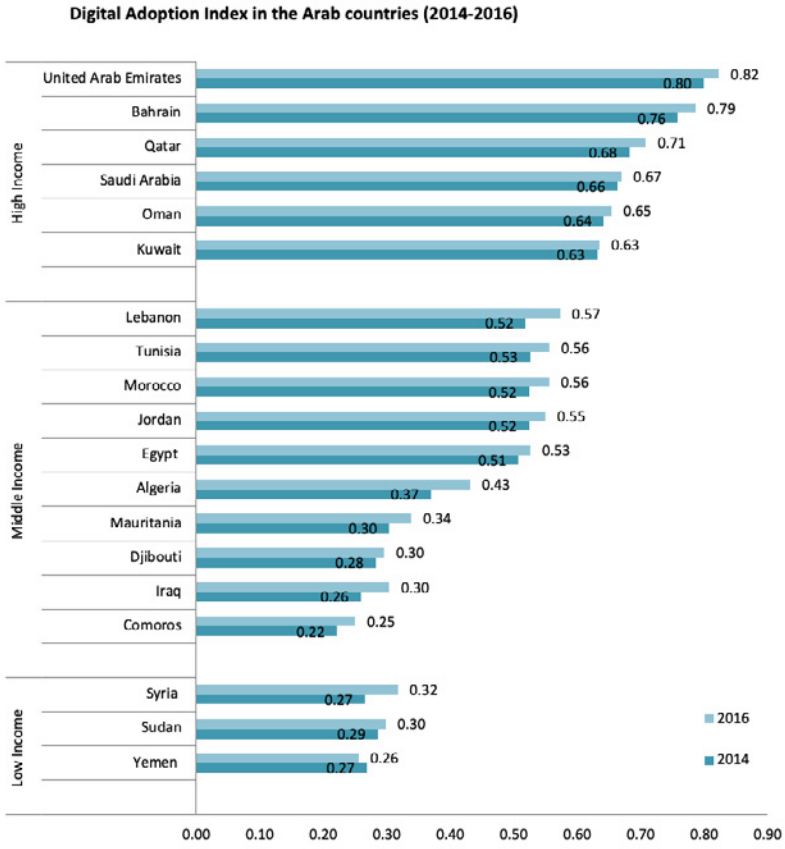
Digital transformation indices are measured by the DAI and DAI sub-components, including the DAI Business Sub-index, DAI People Sub-index and DAI Government Sub-index (see Figures 9 and 10), which are described below[20].

- The DAI Business Sub-index or cluster is the simple average of four normalized indicators: the percentage of businesses with websites, the number of secure servers, download speed and 3G coverage in a country.
- The DAI People Sub-index or cluster is the simple average of two normalized indicators from the Gallup World Poll: mobile access at home and internet access at home.
- The DAI Government Sub-index or cluster is the simple average of three sub-indices: core administrative systems, online public services and digital identification. Data for online public services are provided by the United Nations Online Service Index. Data for core administrative systems and digital identification are collected by the World Bank.

The DAI (2014-2016) and DAI sub-components, find that regionally, the highest performances are reported in Arab Gulf high-income countries, compared to Arab middle-income and low-income countries. The United Arab Emirates ranked at the top in the Arab region followed by Bahrain, Qatar, Saudi Arabia, Oman, Kuwait, Lebanon, Tunisia, Morocco, Jordan and Egypt, respectively, while Comoros, Yemen, Iraq and Djibouti ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates, is more than three times (3.29) higher than the bottom country Algeria. With the exceptions of Kuwait and Yemen, the DAI (2014-2016) shows increasing trends in the majority of the Arab countries, the fastest increase was reported in Algeria, followed by Lebanon, Syria and Iraq, respectively (see Figure 9).

20 See the World Development Report (2016) Digital Adoption Index (DAI). Background Note 'Digital Adoption Index (DAI): Measuring the global spread of digital technologies' (accessed 22 March 2022).

Figure 9: Digital Adoption Index (DAI) in the Arab region (2014-2016)



Source: Adapted from the World Development Report (2016) DAI (Accessed 30 August 2021).

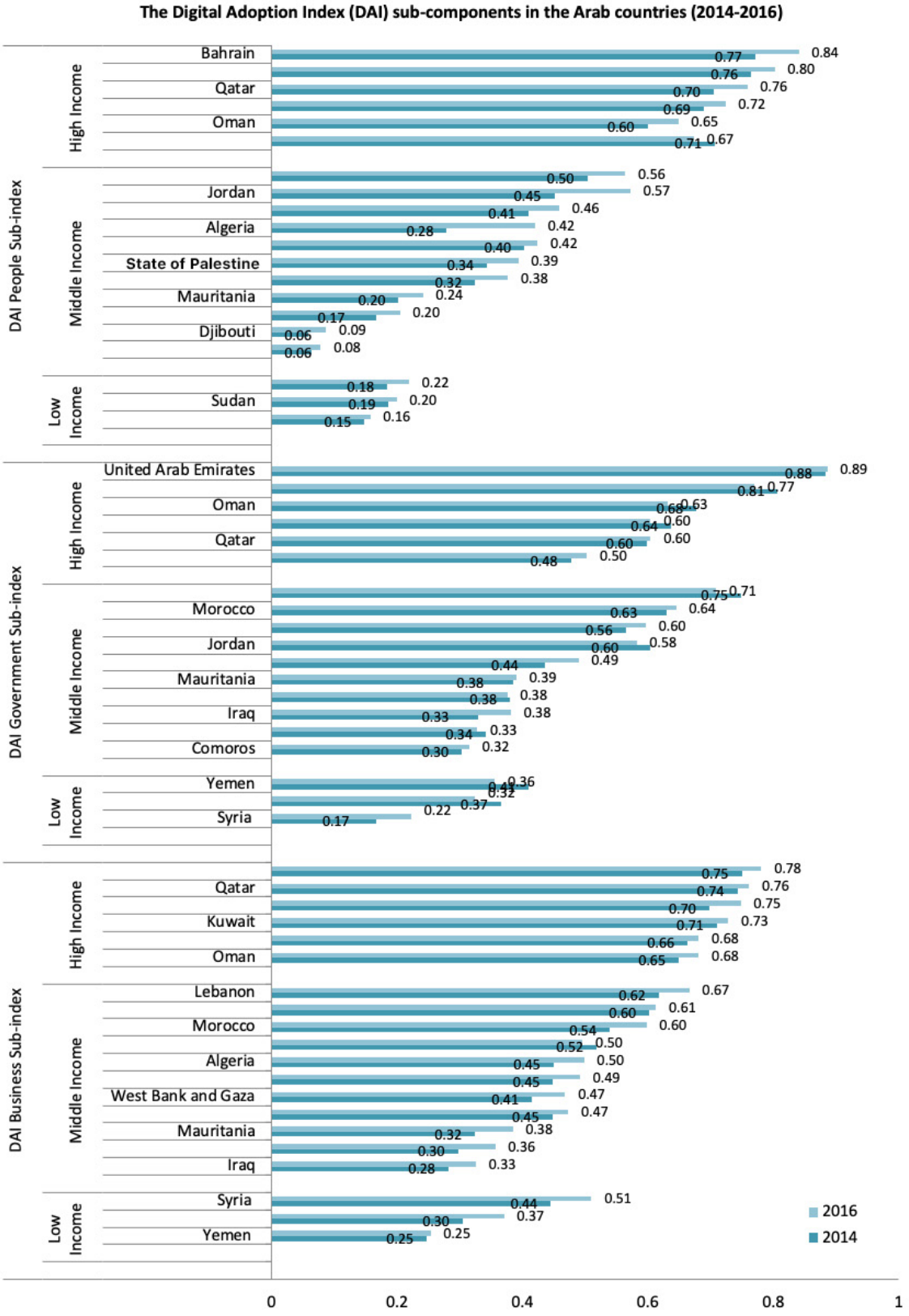
The DAI People Sub-index (2014-2016) shows that Bahrain ranked at the top in the Arab region followed by the United Arab Emirates, Qatar, Saudi Arabia, Oman, Kuwait, Lebanon, Tunisia, Morocco, Jordan and Egypt, respectively. Comoros, Djibouti Yemen and Sudan ranked at the bottom, respectively. Performance in the top country, Bahrain, is more than ten times (10.73) higher than the bottom country, Comoros. With the exception of Kuwait, the DAI People Sub-index (2014-2016) shows increasing trends in the majority of Arab countries. The fastest increase was reported in Algeria, followed by Jordan, Bahrain, Lebanon, Qatar, Oman, Egypt and Mauritania, respectively (see Figure 10).

The DAI Government Sub-index (2014-2016) finds that the United Arab Emirates ranked at the top in the Arab region followed by Bahrain, Egypt, Morocco, Oman, Saudi Arabia, Qatar, Tunisia, Jordan and Kuwait, respectively. Syria, Comoros and Sudan ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates, is more than three times (3.98) higher than the bottom

country, Syria. With the exceptions of Syria, Iraq, Kuwait, Lebanon, Tunisia, Comoros, Jordan and Yemen, the DAI Government Sub-index (2014-2016) shows increasing trends in the majority of the Arab countries, with the fastest increase reported in Morocco, Mauritania, Syria and Comoros, respectively (see Figure 10).

The DAI Business Sub-index (2014-2016) shows that the United Arab Emirates ranked at the top in

Figure 10: Digital Adoption Index (DAI) sub-components in the Arab countries (2014-2016)

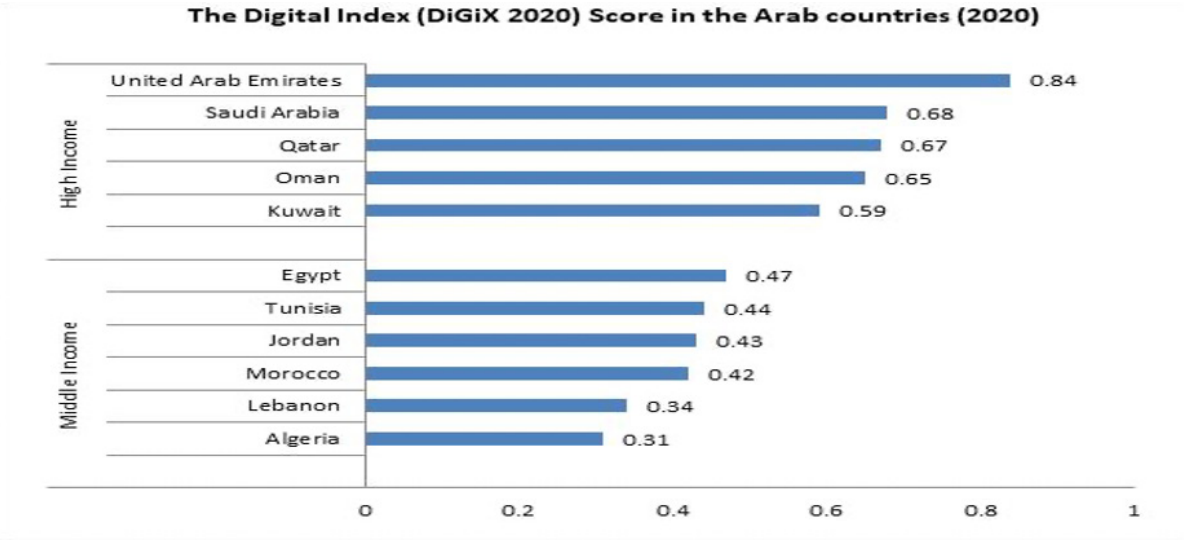


Source: Adapted from the World Development Report (2016) DAI (Accessed 30 August 2021).

the Arab region, followed by Qatar, Bahrain, Kuwait, Saudi Arabia, Oman, Lebanon, Tunisia, Morocco, Jordan and Egypt, respectively. Yemen, Iraq, Comoros and Sudan ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates, is more than three times (3.08) higher than the bottom country, Yemen. With the exceptions of Jordan and Yemen, the DAI Business Subindex (2014-2016) shows increasing trends in the majority of the Arab countries, with the fastest increases reported in Morocco, Mauritania, Syria and Comoros, respectively (see Figure 10).

The Enabling Digitalization Index (EDI) measures changes in rank, including by four sub-components: connectivity, infrastructure, regulation and knowledge, as well as size. The EDI score value and rank for

Figure 11: Enabling Digitalization Index (EDI) (score value) in the Arab region (2019)

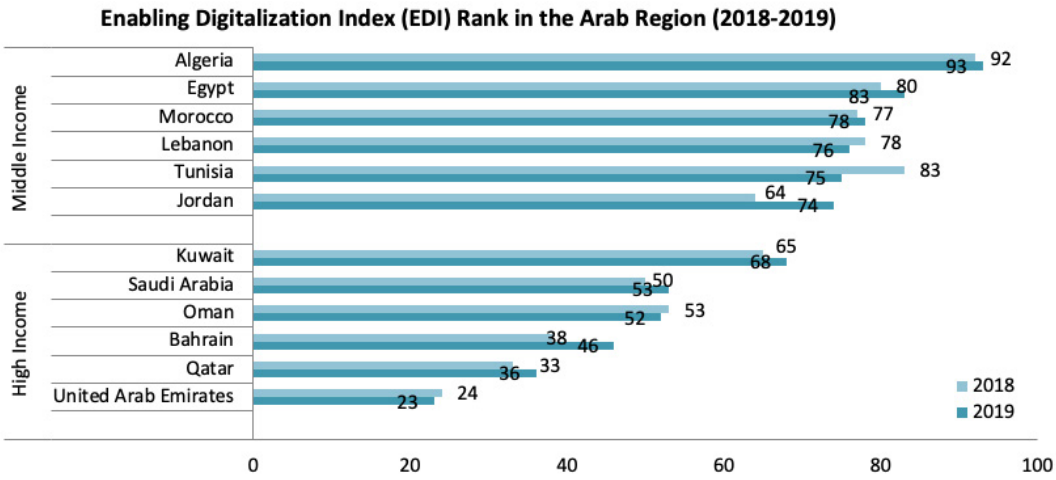


Source: Adapted from the Euler Hermes EDI (2019) (accessed 30 August 2021).

2019 found that the best performance was reported in the Arab Gulf high-income countries, followed by Arab middle-income and low-income countries. For instance, the United Arab Emirates maintained its first position in the Arab region during the period (2018-2019). It was followed by Qatar, Bahrain, Oman, Saudi Arabia and Kuwait respectively, while Algeria, Egypt, Morocco, Lebanon, Tunisia and Jordan ranked at the bottom, respectively. The score performance in the top country, the United Arab Emirates, is more than two times (2.65) higher than the bottom country, Algeria (see Figure 11).

After measuring changes in the rank in the Arab region (2018-2019), it was found that the best improvement in performance was reported in Tunisia, as its rank improved by eight places, followed by Bahrain that improved by two places, followed by the United Arab Emirates and Oman that each improved by one place. By contrast, the worse deterioration was reported in Jordan, as its rank deteriorated by 1(Kuwait a by one p

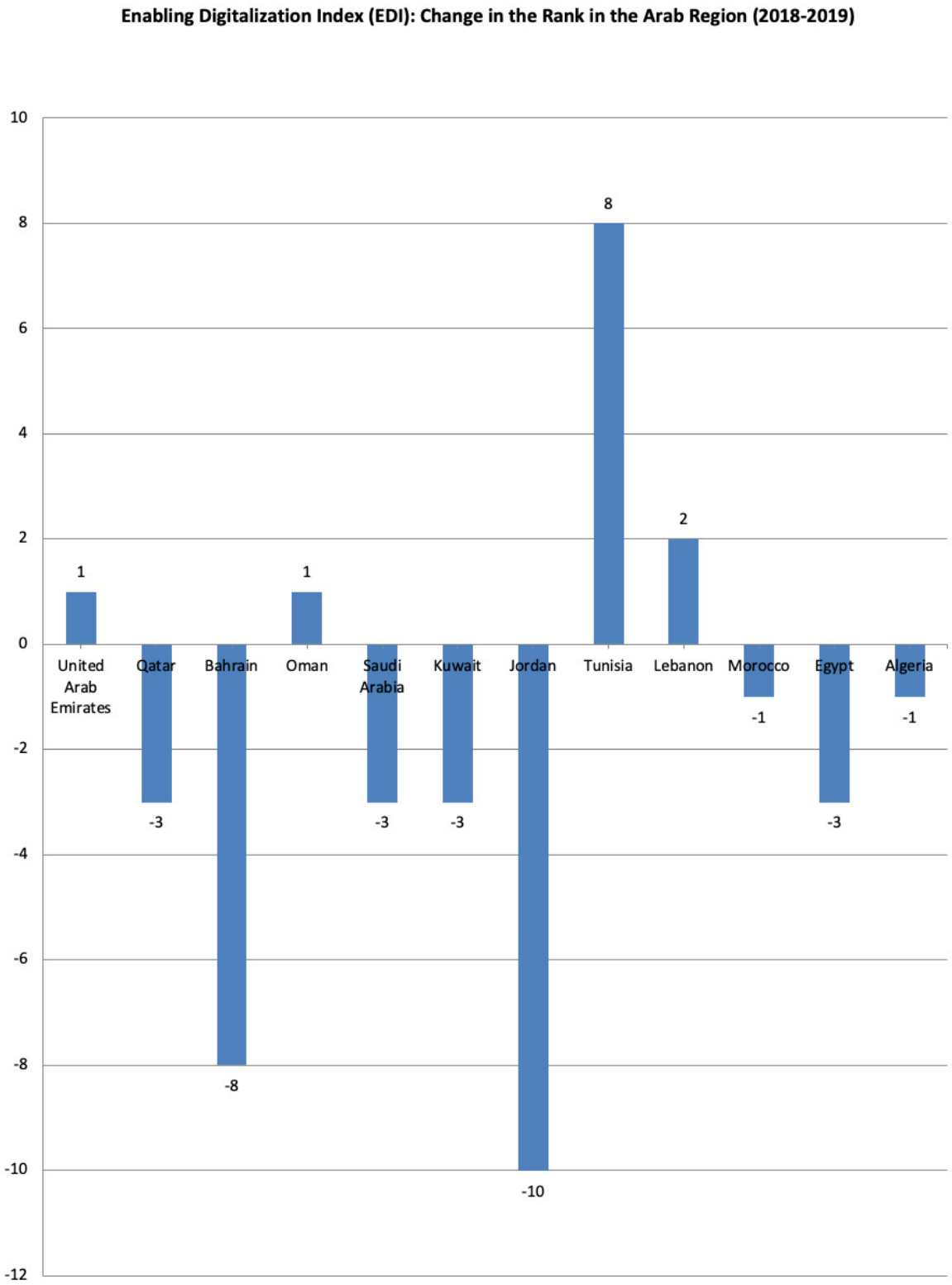
Figure 12 Enabling Digitalization Index (EDI) Rank in the Arab Region (2018-2019)



Source: Adapted from the Euler Hermes EDI (2019) (accessed 30 August 2021).

21 See Euler Hermes (2019) 'The Euler Hermes (2019) Enabling digitalization index: beyond potential,' 11 September 2019,' p. 7.

Figure 13: Enabling Digitalization Index (EDI) (change in rank) in the Arab region (2018-2019)



Source: Adapted from the Euler Hermes EDI (2019) (accessed 30 August 2021).

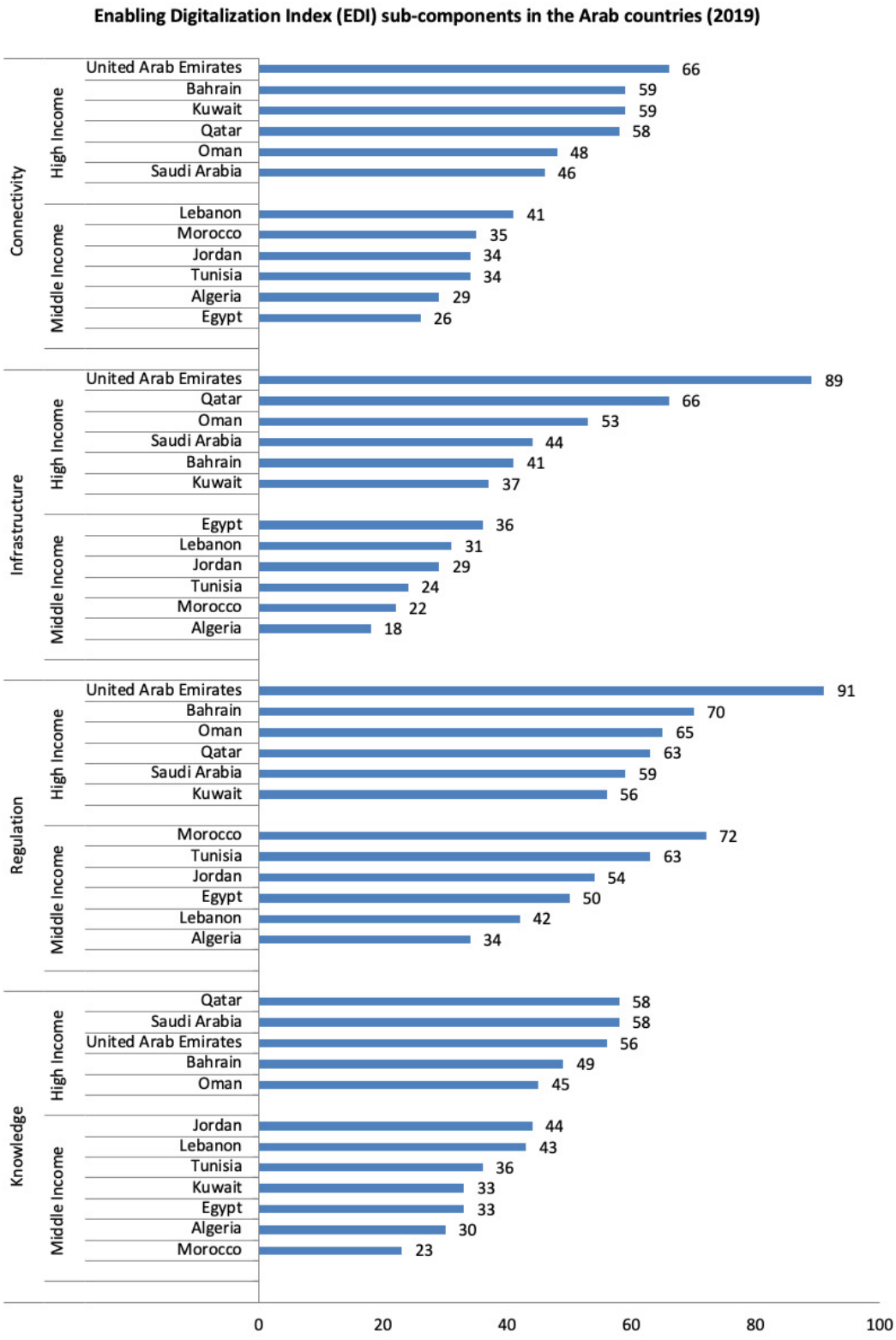
The EDI sub-component measured by **connectivity** (2019) shows that the United Arab Emirates ranked at the top in the Arab region, followed by Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and Lebanon, respectively. Egypt, Algeria, Tunisia, Jordan and Morocco ranked at the bottom, respectively. The score performance in the top country, the United Arab Emirates, is more than two times (2.54) higher than the bottom country, Egypt (see Figure 14).

The EDI sub-component measured by **infrastructure** (2019) finds that the United Arab Emirates ranked at the top in the Arab region, followed by Qatar, Oman, Saudi Arabia, Bahrain, Kuwait and Egypt, respectively. Algeria, Morocco, Tunisia, Jordan and Lebanon ranked at the bottom, respectively. The score performance in the top country, the United Arab Emirates, is more than four times (4.94) higher than the bottom country, Algeria (see Figure 14).

The EDI sub-component measured by **regulation** (2019) shows that the United Arab Emirates ranked at the top in the Arab region, followed by Morocco, Bahrain, Oman, Qatar, Tunisia, Saudi Arabia and Kuwait, respectively. Algeria, Lebanon, Egypt and Jordan ranked at the bottom, respectively. The score performance in the top country, the United Arab Emirates, is more than two times (2.67) higher than the bottom country, Algeria (see Figure 14).

The EDI sub-component measured by **knowledge** (2019) finds that Qatar ranked at the top in the Arab region, followed by Saudi Arabia, the United Arab Emirates, Bahrain, Oman, Jordan, Lebanon and Tunisia, respectively. Morocco, Algeria, Egypt and Kuwait ranked at the bottom, respectively. The score

Figure 14: Enabling Digitalization Index (EDI) sub-components in the Arab region (2019)



Source: Adapted from the Euler Hermes EDI (2019) (accessed 30 August 2021).

performance in the top country, Qatar, is more than two times (2.52) higher than the bottom country, Morocco (see Figure 14).

The EDI sub-component measured by **size** (2019) shows that Saudi Arabia and Egypt ranked at the top in the Arab region, followed by the United Arab Emirates, Morocco, Algeria, Qatar, Oman, Kuwait, Jordan, Tunisia, Lebanon and Bahrain, respectively.

The variations among Arab countries found in the digitalization indices can be explained through various factors, including socioeconomic, human, political and cultural factors. The high performance of Arab Gulf high-income countries in the use of ICT and digital transformations measured by the indices is not surprising and is related to substantial discrepancies in economic development, income level and human development within the Arab region.

4.2 Challenges of ICT in Arab countries

This section discusses ICT and the challenges it creates for economic growth and sustainable development in the Arab region. The primary challenge is related to enhancing and improving investments in ICT and ICT-related infrastructures at a satisfactory rate to guarantee the region's place in a global market that is characterized by highly competitive ICT capacities and digital goods and services. To be competitive and gain a prominent place in a digitalized world, not only is it important for Arab countries to improve their productive ICT capacities, but it is also essential to increase investments in ICT infrastructure, technological capabilities, research and development, science, technology and innovation.

However, the requirement for public investment in ICT can create some difficulties, particularly in poor Arab countries where the allocation of public funds is targeted to reduce poverty rates and promote education, health and other social needs. Public funds and investments in these budget items are given special priority and therefore compete with public investments in ICT and related infrastructure.

Even should governments be able to adequately make public investments in ICT, other limiting factors exist to thwart the use of digitization to improve social and economic resilience. These include digital divides within and between countries and demand-side barriers, such as limited affordability and digital illiteracy. The benefits of digital infrastructure for dealing with the pandemic, for example, has been limited to those industries that are already well on their way to digital transformation, such as logistics[22].

Obstacles to the successful increase of e-commerce, in specific, faced by several Arab countries include the relative newness of online commerce in the region, low internet user rates, inadequate and slow internet services, and the inability to ensure and secure transactions due to the low level of electronic commerce transactions in Arab countries.

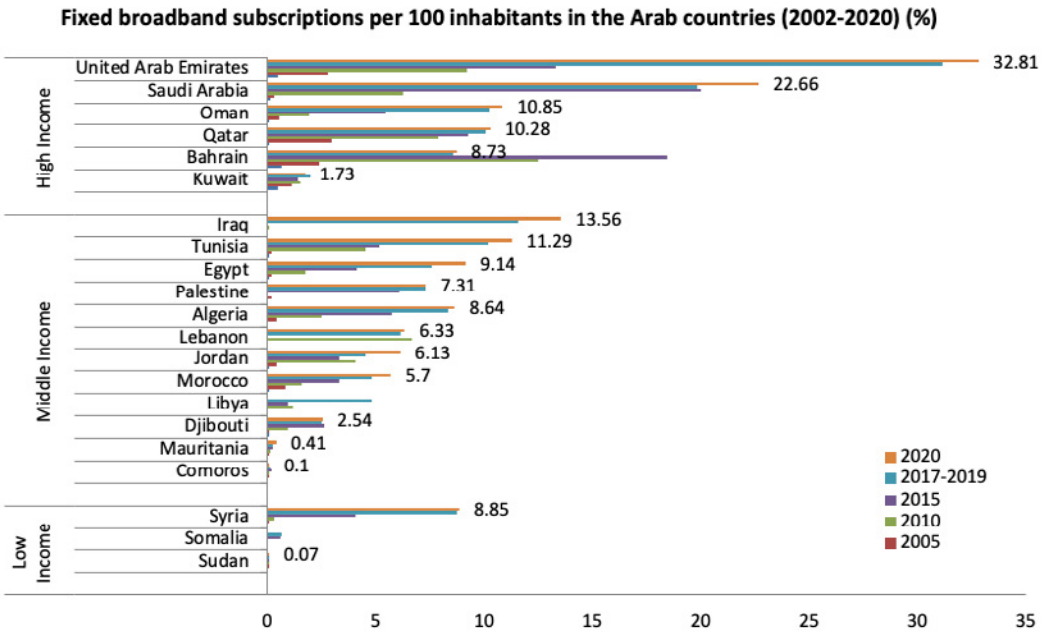
Another challenge is that an intensified use of ICT has the potential to contribute to rising unemployment rates in some Arab countries. As indicated in various studies (cf. Freeman and Soete, 1985, 1994, 1997) ICT creates a dual dynamic when it comes to employment. Some authors' call this a "creative-destruction effect," in which labour-saving technology reduces employment either by elimination of jobs or reduction of existing, mainly unskilled jobs while simultaneously increasing the demand for high-skilled workers.

Addressing the above challenges will be important to successfully close gaps, or the digital divides, within Arab countries themselves, among Arab countries and between Arab countries and the rest of the world. ICT indicators in the Arab region during the period 2005 to 2020 show the incidence of

22 See ITU (2021) 'Digital trends in the Arab States region 2021; pp. 26-27.

a regional digital divide (see Figures 15 through 20) and digital divides within individual Arab countries based on class, gender, rural/urban, age, etc. The figures explain three stylized facts concerning the trends and diffusion of ICT indicators in the Arab countries during the period 2005 to 2020: 1) higher performance is reported in Arab Gulf high-income countries than Arab middle-income and low-income countries; and 2) in most Arab countries, fixed-telephone subscriptions show an increasing trend during the period 2005 to 2008, then a declining trend during the period 2008 to 2016 and then an increasing trend again during the period 2016 to 2019, while mobile-cellular telephone subscriptions indicate an increasing trend during the period 2005 to 2014, then a declining trend during the period 2014 to 2020.

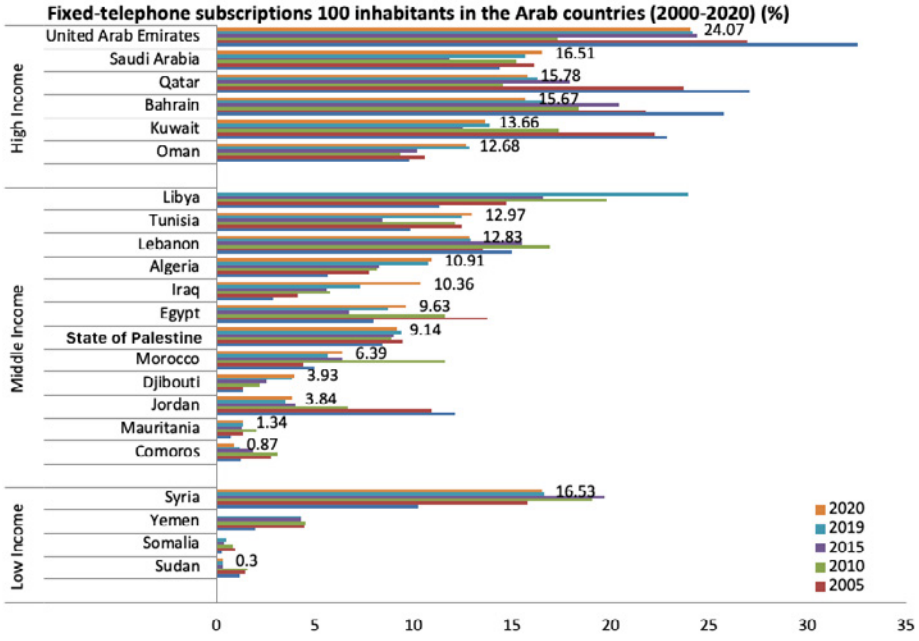
Figure 15: The digital divide within the Arab region: Fixed broadband subscriptions per 100 inhabitants in Arab countries (2002-2020) (%)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 15 below shows that the majority of Arab countries experienced a continuous increasing trend during the period 2005 to 2020 for fixed-broadband subscriptions per 100 inhabitants. Regionally, the United Arab Emirates ranked at the top followed by Saudi Arabia, Iraq, Tunisia, Oman, Qatar and Egypt, respectively. Sudan, Comoros, Mauritania and Somalia ranked at the bottom, respectively. The performance

Figure 16: The digital divide within the Arab region: Fixed-telephone subscriptions per 100 inhabitants in Arab countries (2000-2020) (%)

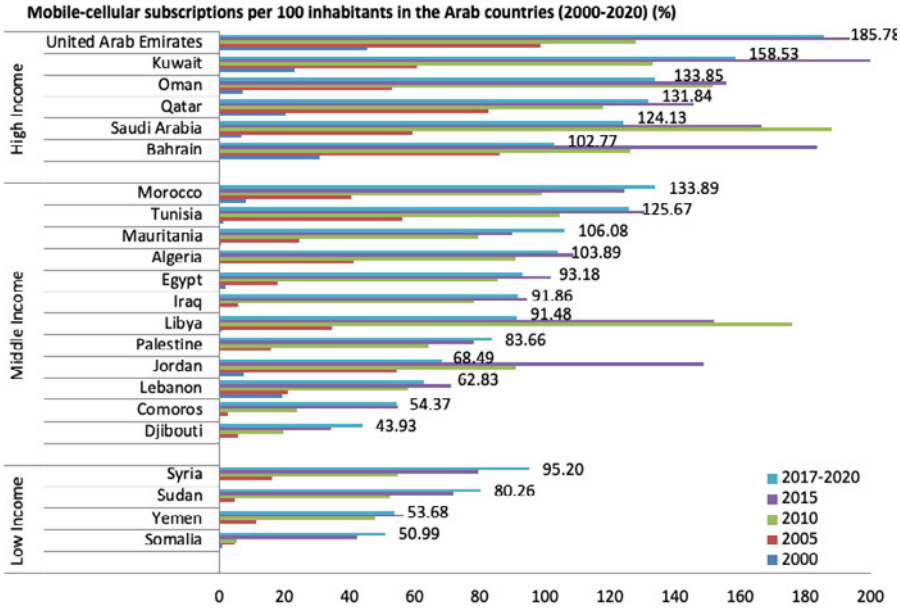


Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

in the top country, the United Arab Emirates, is (468.71%) higher than the bottom country, Sudan.

Figure 16, on fixed-telephone subscriptions per 100 inhabitants in Arab countries from 2000 to 2020, shows that regionally the United Arab Emirates ranked at the top, followed by Libya, Syria, Saudi, Qatar and Bahrain, respectively. Sudan, Somalia, Comoros and Jordon ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates, is (80.32) higher than the bottom country Sudan.

Figure 17: The digital divide within the Arab region: Mobile-cellular subscriptions per 100 inhabitants in Arab countries (2000-2020) (%)

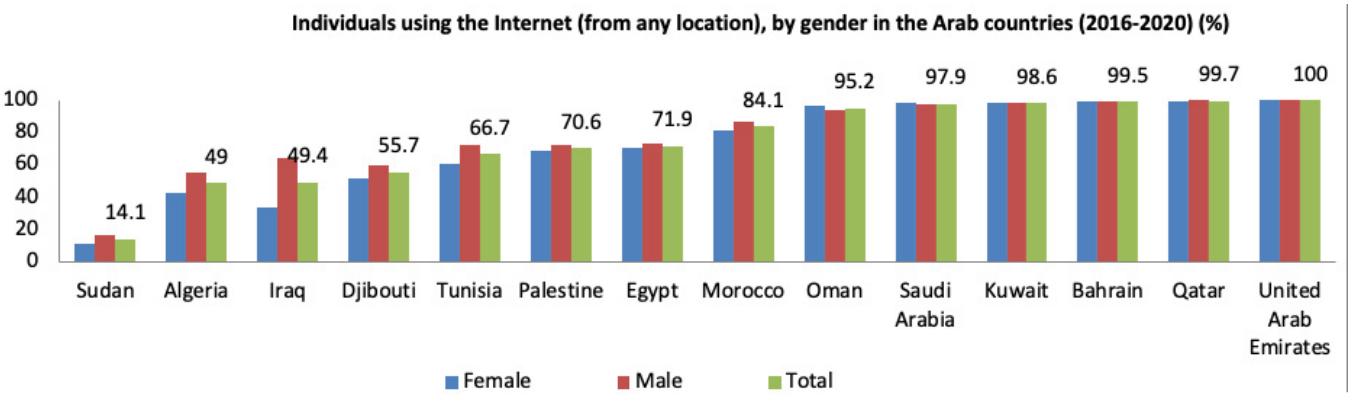


Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 17, showing mobile-cellular telephone subscriptions per 100 inhabitants, finds that regionally, the United Arab Emirates ranked at the top in the Arab region followed by Kuwait, Morocco, Oman, Qatar, Tunisia and Saudi Arabia respectively, while Djibouti, Somalia, Yemen and Comoros ranked at the bottom places respectively in the Arab region. The performance in the top country the United Arab Emirates is more than four times (4.23) higher than the bottom country Djibouti.

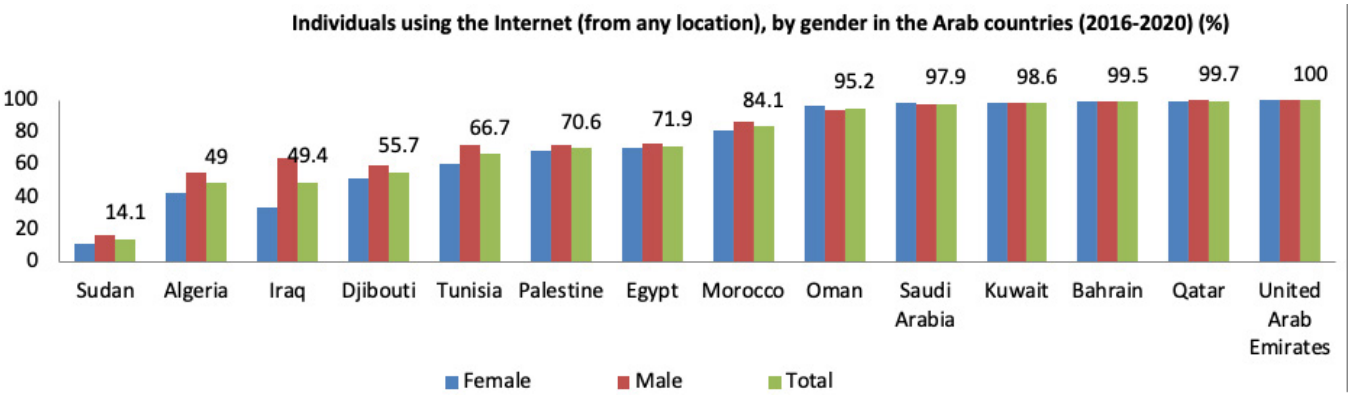
Figure 18 look as individuals using the internet (from any location), by gender and Figure 19 looks at individuals using the internet based on urban/rural location in Arab countries (2016-2020).

Figure 18: The digital divide within the Arab region: Individuals using the internet defined by gender in Arab countries (2016-2020) (%)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

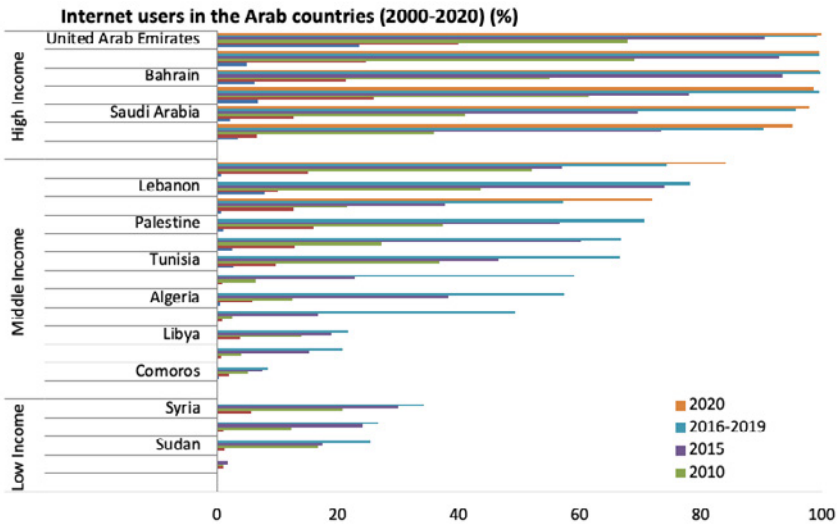
Figure 19: The digital divide within the Arab region: Individuals using the internet defined by urban/rural location in Arab countries (2016-2020) (%)



Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

For individuals using the internet by gender, the indicators show that the United Arab Emirates ranked at the top in the Arab region, followed by Qatar, Bahrain, Kuwait, Saudi Arabia, Oman, Morocco, Egypt, State of Palestine and Tunisia, respectively, while Sudan, Algeria, Iraq and Djibouti ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates is more than seven times (7.09) higher than the bottom country Sudan (see Figure 18).

Figure 20: The digital divide within the Arab region: Internet users in Arab countries (2000-2020) (%)



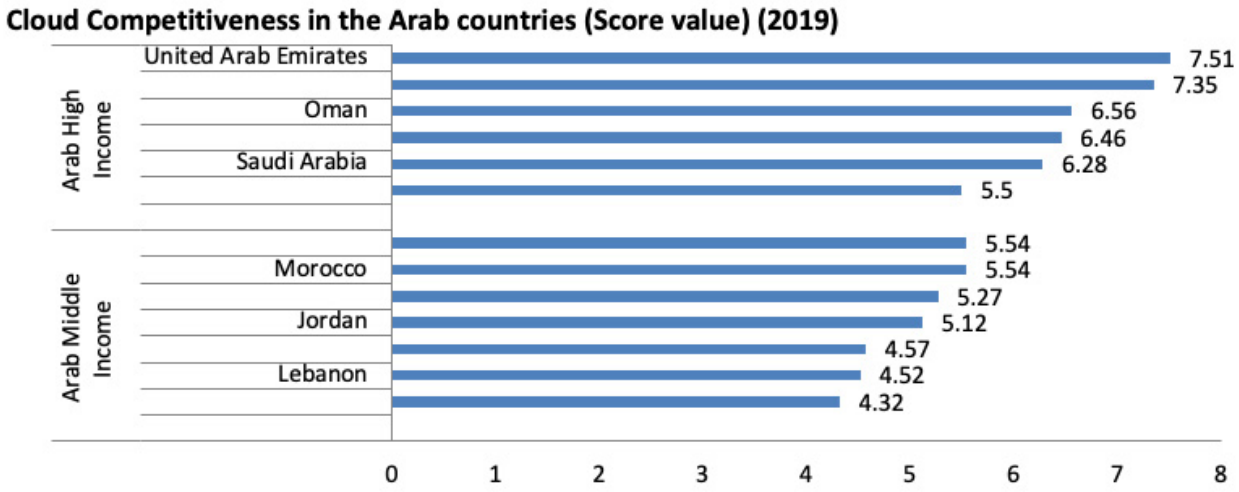
Source: Adapted from ITU World Telecommunication/ICT Indicators database (2021) (October 2021 estimate) (accessed 6 December 2021).

Figure 20, on internet users in Arab countries (2000-2020) (%), shows that the United Arab Emirates ranked at the top in region, followed by Qatar, Bahrain, Kuwait, Saudi Arabia, Oman, Morocco, Lebanon, Egypt, State of Palestine, Jordan and Tunisia, respectively. Somalia, Comoros, Mauritania, Libya, Sudan and Yemen ranked at the bottom, respectively. The performance in the top country, the United Arab Emirates is (49.89) higher than the bottom country, Somalia (see Figure 20).

The Cloud Competitiveness Index looks at the set of policies, practices and characteristics that enable a country to take advantage of the benefits of cloud computing. The index offers an approach to assessing what makes a country more accommodating for cloud services[23]. The Cloud Competitiveness Index (2019) shows that, regionally, the highest performance rates are reported in the Arab Gulf high-income countries compared to Arab middle-income and low-income countries. For instance, the United Arab Emirates is ranked at the top in the region, followed by Qatar, Oman, Bahrain, Saudi Arabia, Tunisia, Morocco, Kuwait, Egypt, Jordan, Pakistan, Lebanon and Algeria, respectively (see Figures 21 and 22).

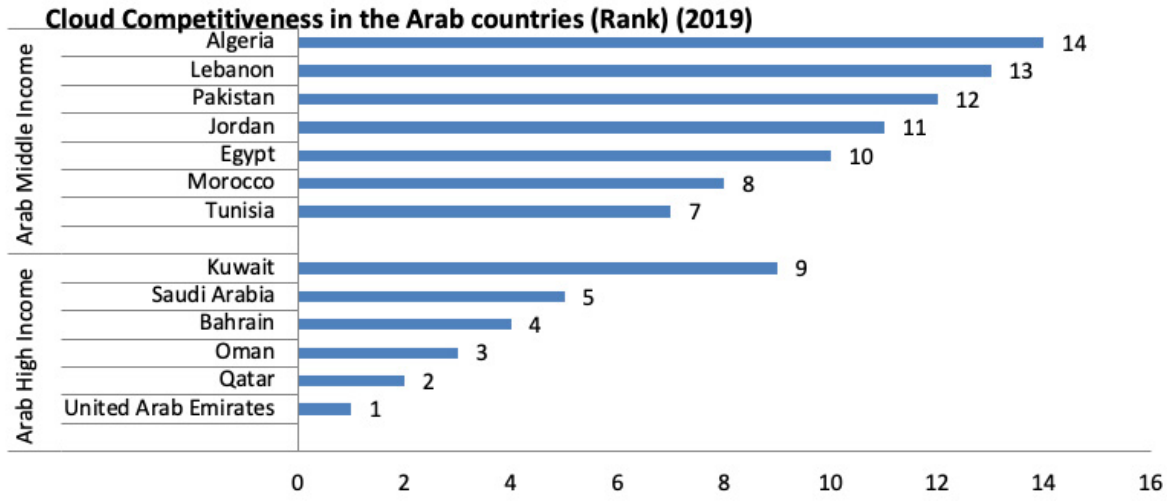
23 The Cloud Competitiveness Index (2019) is a combination of domains and sub-domains (pillars) contributing to the overall score of a country. The final ranking is calculated using a simple arithmetic average of scores registered on each of the five domains. The index is composed of five domains. 'Regulation' (Domain 1) tends to reflect the extent to which a country's regulatory framework supports the development and consumption of cloud services. 'Talent' (Domain 2) indicates the competitiveness of the workforce operating in a country's cloud market. 'Connectivity' (Domain 3) refers to the health of the network infrastructure in a country which serves as a backbone for cloud products and services to be delivered. 'Government' (Domain 4) aims to describe the role governments play in a country's cloud ecosystem. 'Business' (Domain 5) is an indicator of the hospitality of a country's business environment for cloud stakeholders to operate.

Figure 21: Cloud Competitiveness Index in Arab countries (score value) (2019)



Source: Adapted from Mahboubi, et. al., (2019), Cloud Competitiveness Index (2019).

Figure 22: Overall Cloud Competitiveness Index in the Arab countries (rank) (2019)



Source: Adapted from Mahboubi, et. al., (2019), Cloud Competitiveness Index (2019).

With social distancing requirements, ICT facilitated remote working, remote schooling, remote shopping and the ability to remaining professionally and socially "connected."

4.3 COVID-19 and acceleration of ICT use

During the years 2020 to 2022, the COVID-19 pandemic motivated an intensified use of ICT in countries around the world. Lockdown measures and other policy measures demanded utilization of ICT to manage the negative impacts of the pandemic and led to the accelerated adoption of, and increased access to, e-education, e-health, e-government, e-commerce, etc. With social distancing requirements, for those who had access and connection to the internet, ICT facilitated remote working, remote schooling, remote shopping and the ability to remaining professionally and socially "connected."

According to ESCWA (2021) and ITU (2021)[24], the COVID-19 pandemic likewise accelerated ICT and digital development across the Arab region. ICT was harnessed in the education, health and business sectors to maintain service provision and manage the crisis. The pandemic reinvigorated the role of the digital economy in generating economic value by producing digital value products and services. Many Arab countries launched effective ICT initiatives to quickly respond to the crisis and curb its negative implications[25].

The Arab Information and Communication Technologies Organization (AICTO), the League of Arab States (LAS) and ESCWA co-organized the first Arab webinar on "ICT Fighting COVID-19: Arab Initiatives and Success Stories" with participation from Arab government ministers and representatives from international organizations and the technology and business sectors. At the virtual meeting, national strategies and efforts to mitigate the impact of the pandemic were shared through the use of ICT in Arab countries. The meeting confirmed the key role of technology in ensuring the delivery of critical health and education services and sustaining societies and economies in times of lockdown in Arab countries[26].

AICTO shared several ICT initiatives to address the challenges of the pandemic in Arab countries. AICTO argued the importance of taking exceptional measures and the mobilization of all resources within the framework of unconventional emergency management plans. The outbreak of COVID-19 forced countries to face difficult choices and created specific challenges in all fields, especially healthcare, with a heavy toll on economies and societies. During the COVID-19 crisis, it became clearer than ever before that telecommunications networks are vital and are needed to ensure people's health and safety and to preserve economies and societies. During this period, digital technologies become more and more integral to daily life, particularly as many countries and companies switched to online work and education. Within a short period of time, governments, institutions and individuals around the world urgently accelerated the development of digital strategies to help mitigate the disruptive effects of the COVID-19 pandemic on individuals, societies, institutions, companies and economies. For this purpose, and in the context of its commitment to support Arab countries to face the pandemic with the help of digital technologies, AICTO created a special platform for information and awareness on the digital and technological initiatives and projects adopted in Arab countries to confront the pandemic.

24 ITU (2021) 'Digital trends in the Arab States region 2021; pp. 26-27.

25 ESCWA (2021), 'Round-table discussion, Regional priorities for the coming years in the field of technology for development,' E/ESCWA/C.8/2021/CRP.1, 5 January 2021.

26 See ESCWA (2020), 'Information and communications technology (ICT) in the fight against COVID-19' ESCWA Weekly News (23 June 2020) www.unescwa.org/news/information-and-communications-technology-ict-fight-against-covid-19 (accessed 9 December 2021).

This platform is open for all stakeholders in Arab countries to publish their initiatives and projects[27].

Other ICT initiatives were implemented at national and regional levels in Arab countries to address the challenges of the pandemic. For instance, ALECSO, with its accumulated experiences in the field

of open educational resources, launched a regional initiative to promote open learning and e-learning to confront interruptions in education and ensure education continuity in Arab countries during the crisis[28].

In the United Arab Emirates, the Telecommunication and Digital Government Authority implemented several digital initiatives, including:

- free internet data on mobile phones to enable distance learning and free educational applications[29] were made available on all networks in the country;
- awareness voice messages when making a phone call;
- availability of a set of applications to support distant learning and work from home;
- online groceries;
- encouraging the use of service provider mobile applications;
- extension of wireless authorizations and provision of wireless frequency backup;
- network capacity enhancement and re-engineering;
- 100% implementation of work from home for the Telecommunications Regulatory Authority (TRA) of United Arab Emirates (UAE) employees;
- online training;
- emergency broadcasts;
- SMS alerts to UAE nationals abroad
- suspension of deactivation of mobile services due to document expiry to ensure service continuity;
- assignment of FM sound broadcasting frequencies for drive-through health examination centres;
- enablement of the UAE government to work from home;
- security advisories on securing systems and infrastructure, security awareness campaigns for the public;
- a digital identity and signing platform (UAEPASS); and
- free internet data via mobile phone to health applications and platforms[30].

The United Arab Emirates Ministry of Health and Prevention plans to establish a virtual hospital to enhance telemedicine by adopting digital health technologies that will allow the Home Hospital of the future. The virtual hospital uses digital solutions and advanced smart applications to overcome infection risks. It also has activating health monitoring services as an essential pillar to support preventive practices and providing specialist care and medical advice to patients at any time[31]. The virtual hospital's digital platform includes the first remote monitoring and treatment service for diabetics in the world with a digital application that can monitor the vital signs of the body remotely using AI. Another remote service is available for rheumatic diseases and arthritis. One platform includes smart systems and applications that are linked with a smart predictive bracelet. Another project employs cloud computing technology for patients suffering from depression[32].

In Saudi Arabia, government agencies, specialized technical associations and private sector partners

27 AICTO: www.aicto.org/covid19-arab-ict-initiatives-2/ (accessed 9 December 2021).

28 7407109462-44384ead-e5a5h (accessed 9 December 2021).

29 Google Hangout Meet, Cisco WebEx, Avaya Spaces, Blue Jeans and Slack.

30 AICTO: www.aicto.org/covid19-arab-ict-initiatives-2/ (accessed 9 December 2021).

31 AICTO: www.aicto.org/covid19-arab-ict-initiatives-2/ (accessed 9 December 2021).

32 AICTO: www.aicto.org/covid19-arab-ict-initiatives-2/#1587407116047-2a980858-242a (accessed 9 December 2021).

sensed the importance of technology and the right of everyone to access it. Thus, the "We Are All Giving" initiative, launched by the Ministry of Communications and Information Technology through a strategic partnership with the General Authority of Endowments, supported students from low-income families by providing devices and getting access to platforms needed to complete their online education during the pandemic. The campaign collected new and used devices and maintained them with the assistance of volunteers and collaborators from technical associations and other sectors[33].

While research on the contribution of digitization to mitigate the impact of pandemics is limited, compelling evidence is emerging as to its positive effects. For example, a regional survey of more than 5,000 consumers in Bahrain, Egypt, Jordan, Kuwait, Qatar, Saudi Arabia and the United Arab Emirates (and Pakistan) conducted by Checkout.com found that 47 percent of consumers expected to shop online more frequently over the next year (or 49 percent in GCC countries, 48 percent in Jordan, 47 percent in Egypt, and 39 percent in Pakistan), thereby having a positive impact on digital payments and digital inclusion. Other digital solutions in the region that have experienced a boost during the pandemic and are likely to persist in the "new normal" include new approaches to education and health care.

In education, new digital solutions to distance learning have been developed in Jordan, Morocco and Lebanon. In Morocco, the Ministry of Higher Education partnered with state television networks to broadcast educational material across the nation, including in remote underserved communities. In Jordan, a public-private partnership between the Ministry of Education, the Ministry of Digital Economy and Entrepreneurship and a private company created Darsak, an educational portal that delivers classes for all grades following the national curriculum[34]. At the same time, there has been a significant rise in the development of home-grown education technologies and mobile applications, such as Rawy Kids in Egypt and Kitabi Book Reader in Lebanon[35].

Similarly, the COVID-19 crisis is demonstrating the potential of digital solutions in the healthcare sector for the prediction and mitigation of infectious disease outbreaks. For instance, Qatar made it mandatory for all citizens and residents to install Ehteraz, a coronavirus contact tracing application, on their mobile devices when leaving their home, allowing the government to monitor if users have been in close contact with an infected person[36]. In the United Arab Emirates, a healthcare start-up called Nabta Health is using AI to assess the risks of COVID-19, focusing on women with underlying health conditions[37].

The ITU report "Economic Impact of COVID-19 on Digital Infrastructure"[38] finds that, in the medium term (e.g., 2021), countries with top connectivity infrastructure could mitigate up to half of the negative economic impact of the COVID-19 pandemic[39]. However, the use of ICT during the pandemic also led to increasing digital divides between developed countries and poorer countries, and between other parts of the world and the Arab region, between countries in the Arab region and within communities in Arab countries themselves. Places with limited or a lack of ICT infrastructure had difficulties making effective use of ICT to manage the COVID-19 pandemic. The challenges of the pandemic threatened progress towards the achievement of the SDGs in all Arab countries, as well as other countries of the global South.

33 AICTO: www.aicto.org/covid19-arab-ict-initiatives-2/ (accessed 9 December 2021).

34 https://darsak.gov.jo/ [in Arabic].

35 Kaliope Azzi-Huck et al., 'Innovation in responding to learning outcomes in MENA,' World Bank Blogs (2020), https://blogs.worldbank.org/arabvoices/ innovation-responding-coronavirus-could-pave-way-better-learning-outcomes-mena.

36 'EHTERAZ app to help track the spread of COVID-19 now ready for download' (2020), www.iloveqatar.net/coronavirus/news/ehteraz-app-to-be-launched-preventive-measures-against -spread-covid-19.

37 "Arab healthcare innovation responds to pandemic" (2020), www.natureasia.com/en/ nmiddleeast/article/10.1038/nmiddleeast.2020.62.

38 ITU, Economic impact of COVID-19 on digital infrastructure (2020), www.itu.int/en/ITU-D/ Conferences/GSR/2020/Pages/default.aspx.

39 See ITU (2021) 'Digital trends in the Arab States region 2021; pp. 26-27.

Choucair (2020) agreed that COVID-19 underscored problems related to digital divides in the Arab region. Fifty percent of the world population and 43 percent of the Arab states population lack internet access and thus, at present, are shut out from this universe of connectivity. An important gender dimension has also surfaced, as access among women and girls lags behind that of men and boys in every country in the Arab region for which data is available. From working-from-home modalities, remote learning for students and e-commerce, to accessing endless articles on social distancing and other health-focused preventive measures, Choucair (2020) concluded that COVID-19 survival strategies rested on an assumption that individuals were connected online and had the skills needed to engage in the world of information. In the Arab region, where around 60 percent of the population is under 25 years of age, remote learning can be a luxury for many, where 48 percent of households do not own a computer at home. This means that at present, inequalities across the region are only growing, from an already high starting point. Indeed, the inequality-adjusted Human Development Index (HDI) shows the Arab region as having the highest degree of inequality in education.

Another potential challenge is related to cybersecurity, in the Arab countries as in the rest of the world, the COVID-19 pandemic is expected to cause a cyber security challenges for businesses. Nabe (2021) examined the impact of COVID-19 on cyber risk and mitigation measures that businesses could take. Nabe (2021) argued that the coronavirus pandemic created new challenges for businesses as they adapted to an operating model in which working from home had become the 'new normal.' Companies accelerating their digital transformation and cybersecurity is now a major concern, and the reputational, operational, legal and compliance implications could be considerable if cybersecurity risks are neglected.

5. SOUTH-SOUTH COOPERATION IN ICT

This section explains South-South cooperation in ICT, including Arab-Arab cooperation in ICT, India-Arab cooperation in ICT and China-Arab cooperation in ICT. It touches on existing regional initiatives in the digital area and their contribution towards ICT advancement and reduction in digital divides in Arab countries.

South-South cooperation is guided by, among others, the principle of mutual benefit and self-reliance.

There is increasing interest in South-South Cooperation in ICT as a tool for sustainable and inclusive development. South-South cooperation among developing countries is guided by, among others, the principle of mutual benefit and self-reliance. A 2018 report of UNOSSC and the Finance Centre for South-South Cooperation (FCSSC) argues that as the global economy moves steadily towards digitalization, developing countries must not be left behind. The report provides an in-depth analysis of potential opportunities and potential risks of digitalization for development progress in the global South, particularly in terms of progress towards the SDGs. Sustainable and inclusive economic development, a cornerstone of the 2030 Agenda for Sustainable Development and its SDGs, may well be greatly facilitated by the developing world's burgeoning technology sector, particularly small and medium-sized enterprises engaging in the platform economy and digital trade. Indeed, the digitization of services, including via smart contracts, ICT and the block chain, offers opportunities for improved access to and participation in the global economy by populations of the global South. The digital economy has the potential to advance the 17 SDGs and it is believed to be an incubator of innovations and a transformative force in social governance.

However, harnessing the opportunity for dynamic change in sustainable development created by the digital economy, particularly for the global South, can happen only if associated risks are addressed effectively by governments, private sector partners and international organizations, as well as leaders and the general public. South-South Cooperation has been identified as a means, a method and a series of tools by which developing countries can collaborate to enhance their opportunities and collectively face their challenges in the digital era. Digital technologies can promote cross-border trade and

trade facilitation, while digital finance can promote the development of inclusive finance, among other benefits. The potential exists in the global South for smart societies nested in the digital world, which could include digital education, internet health care and social networking, among other benefits.

Arab region South-South Cooperation in ICT, includes several Arab regional initiatives. The Arab Working Group (AWG) on the Arab ICT Strategy, organized by the League of Arab States, met in 2007 to develop an Arab ICT Strategy for 2007-2012. The AWG includes representatives of ten Arab countries, namely: Bahrain, Egypt, Iraq, Jordan, Kuwait, Morocco, Qatar, Saudi Arabia, Sudan and Syria. This is in addition to representatives of regional and international organizations, such as ESCWA, the International Telecommunication Union-Arab Office, the Arab League Educational, Cultural and Scientific Organization, the Arab Business Forum and the Technical Secretariat of the Arab Telecommunication and Information Council of Ministers. The strategy highlights an Arab vision for "Building an Integrated Arab Information Society by Maximizing the Benefits of ICT and Establishing an Arab Industry to Promote Sustainable Socioeconomic Development." The strategy identifies three main goals for building an Arab Information Society and developing the ICT industry. The meeting highlighted progress made towards the implementation of regional Arab projects approved by the Arab Telecommunication and Information Council of Ministers in 2005 with the aim of achieving the goals of the World Summit on Information Society[40].

The Arab Digital Inclusion Platform Portal of ESCWA provides access to information on disability as it relates to the Arab region, including research and resources published by ESCWA and other regional and international organizations, laws and policies from the Arab region, toolkits to aid in the development and guidelines on e-accessibility and best practice cases from the Arab region on e-accessibility[41].

Established in January 2008 and headquartered in Tunis, the Arab Information and Communication Technologies Organization (AICTO) is responsible for strategic planning and cooperation, developing talent and coordinating policies for ICT across the Arab League nations. The creation of AICTO resulted from the will of the Arab States to contribute to the development of ICTs and provide the necessary mechanisms to reinforce cooperation between its members while promoting and enriching common strategies and policies to ensure an equitable access to ICT for all citizens in Arab states. AICTO provides an open platform for ICT multi-stakeholders (public sector, private sector, civil society and specialized bodies) to share dialogue, experience and expertise and for technological knowledge transfer. AICTO supports a harmonious Arab digital society based on creativity and innovation, boosting Arab-interregional complementarity and contributing efficiently to the development of a global sustainable digital economy.

Each year, AICTO runs regional forums, summits and training programs with key industry organizations, like ITU, the United Nations Educational, Scientific and Cultural Organization (UNESCO), 3GPP and the Beidou Satellite Office. Mostly recently, AICTO took the lead in hosting the Arab ICT Summit, Digital Strategies and New Challenges Agenda and the China-BeiDou Satellite Forum. AICTO's current strategies and approach aim to ensuring ICT develops equally in Arab League nations, with Huawei's help. The Arab region is composed of three levels of development: the Arab Gulf countries, the middle zone (which includes Tunisia, Egypt and Lebanon) and the third region (composed mainly of less developed countries, like Mauritania and State of Palestine). AICTO aims to particularly benefit the third region and hopes to achieve balanced development in ICT by using the know-how of the mid-developed regions, like Tunisia, which has very developed human resources and funding of the Gulf countries.

For instance, a Bridging the Standardization Gap (BSG) program was set up, which is based on four Ds:

40 See ESCWA 'Developing the Arab ICT Strategy,' (11 April 2007) www.unescwa.org/news/developing-arab-ict-strategy (accessed 11 September 2021). See also www.unescwa.org/news/developing-arab-ict-strategy.

41 See the Arab Digital Inclusion Platform portal: www.unescwa.org/portal/adip (accessed 11 September 2021).

digital inclusion, digital trust, digital innovation and digital transformation. AICTO is working with ITU to disseminate standardization in the Arab world. The BSG program is advancing well, and AICTO held two forums in the Arab nations to disseminate standardization[42].

Regarding Arab bilateral cooperation, Egypt's Ministry of Communications and Information Technology indicates that in modern times, the ICT sector acts as one of the advanced tools and mechanisms for boosting Egyptian-Arab relations. The sector also represents a golden opportunity for Arab countries, if properly exploited and employed for achieving sustainable development. Since the inception of the ICT sector, Egypt has realized the importance of productive cooperation with development partners in the Arab region, based on actual partnerships that help achieve tangible bilateral results and a comprehensive Arab renaissance in this field. For this reason, Egypt is keen to exchange experiences with Arab countries in ICT areas, including infrastructure, policymaking, legislation, capacity building and others. Egypt has also worked on attracting Arab investment through bilateral and trilateral projects and has transferred Egyptian expertise in advancing the ICT sector to less-developed Arab countries and those going through a reform phase with a need to restructure the ICT sector[43].

China and the Arab world have numerous examples of South-South cooperation. For instance, AICTO announced in 2018 the opening of a centre of excellence in Tunis, the China-Arab BeiDou Navigation Satellite System/Global Navigation Satellite System (BDS/GNSS)Centre-AICTO in the El Ghazala Technological Park. This project falls under the scope of a bilateral relationship between the League of Arab States and China that was established in January 2016[44].

Another initiative stems from a League of Arab States cooperation initiative with China on data security in March 2021. Officials responsible for cyber and digital affairs from China and Arab countries called on all States to put equal emphasis on development and security and take a balanced approach to technological progress, economic development and protection of national security and public interests[45]. China put forward the Global Initiative on Data Security and supported addressing data security risks and challenges together with China while upholding multilateralism, balancing security and development and ensuring fairness and justice.

China and the Arab world also cooperated in ICT in the field of precision agriculture via the Arab Region Beidou Cooperation on Satellite Navigation project. A framework of bilateral cooperation was signed in 2016 between AICTO and the China Satellite Navigation Office (CSNO). Its objective is to provide an open platform for Arab users to acquire deeper understanding about BeiDou/GNSS technology through a set of activities, such as training and regional capacity building, exhibition, testing and assessment, etc.[46]

India and Arab world South-South cooperation has widened, not just within traditional areas such as energy, migration and trade but expanding to other sectors, including investment, health, pharmaceuticals, IT, ICT and space (cf. Hussain, 2017). India and Saudi Arabia relations and cooperation in ICT were established at the Saudi Arabia and India "datalogue" initiative meeting held during March 2021

42 See Maidment, G. 'The Arab Information Communications Technology Organization (AICTO): Ensuring equal ICT development across the Arab League,' www.huawei.com/nl/technology-insights/publications/winwin/34/aicto-equal-ict-development-arab-league (accessed 11 September 2021). See also www.aicto.org. AICTO strategic and associate members are private and public companies active in the ICT sector in the Arab region and worldwide.

43 See Egypt Ministry of Communications and Information Technology: Bilateral Cooperation: Arab Bilateral Cooperation: https://mcit.gov.eg/en/International_Relations/Bilateral_Cooperation/Egyptian_Arabian (accessed 11 September 2021).

44 See AICTO (2018).

45 See "China-League of Arab States Cooperation Initiative on Data Security (2021/03/29)." www.fmprc.gov.cn/mfa_eng/wjdt_665385/2649_665393/202103/t20210329_9170559.html See also: https://lawinfochina.com/display.aspx?id=8064&lib=tax&SearchKeyword=&SearchCKeyword (accessed 6 December 2021).

46 See China Arab States BDS/ GNSS: Arab Region Beidou Cooperation on Satellite Navigation Prospect in the Field of Precision Agriculture.

to boost collaboration between the two countries in the IT sector (cf. Hassan, 2021)[47].

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper offers an overview of the status of the use of information and communication technologies (ICT) and digital technology in Arab countries. In particular, potential opportunities and challenges of ICT and digital transformation in Arab countries are discussed. Policy recommendations were provided to strengthen South-South cooperation, that would include Arab country cooperation that can address the digital divide, scale-up digital transformations and the digital economy and support sustainable economic development in Arab countries.

Looking at trends of the global use of ICT and the digital divide between the world's regions and the Arab region during the period (2015-2021), the results support four facts concerning the increasing trend and rapid diffusion of ICT indicators in the Arab region and other world regions during the period (2015-2021). These are: 1) the existence of a global digital divide in ICT indicators between the Arab region and other world regions during the period (2005-2019); 2) an increasing trend and widening digital divide in ICT indicators between the Arab region and other world regions during the period (2015-2021). Using The ITU World Telecommunication/ICT Indicators database and having defined the digital divide by ICT indicators including fixed-telephone subscriptions, mobile-cellular telephone subscriptions, fixed-broadband subscriptions, population covered by a mobile-cellular network, population covered by at least a 3G mobile network, households with a computer, households with internet access at home and individuals using the internet. We explain the incidence of the global digital divide in ICT indicators between the Arab region and other world defined by age, sex and urban/rural areas in (2019-2020).

The results confirm two facts that imply that the Arab region is manifestly lagging behind other world regions in terms of ICT indicators. This is not surprising as the Arab region lags behind other world regions in terms of standard of economic development, as measured by GDP per capita and the Human Development Index (HDI), and this most probably affects the use of ICT and digital transformation status. Considerable variations are also found within Arab countries themselves that most probably affects the considerable variation among the Arab countries in terms of their use of ICT and digital transformation status.

The main findings of the current status and trends of the ICT indicators in the Arab region during the period (2005-2021) are: 1) an increasing trend and rapid diffusion of ICT indicators in the Arab region during the period (2005-2021); 2) differences in the growth rate and diffusion of different modes of ICT indicators in the Arab region during the period (2005-2021); and 3) an incidence and trend of digital divide within the Arab region (defined by urban/rural area (2015-2019).

Substantial discrepancies in digital indices, digitalization and digital transformation are found within the Arab region.

It was noted that ICT provides several opportunities for supporting economic development and sustainable development as demonstrated using the DiGiX, the DAI and EDI. While ICT is generally seen as a positive goal, it creates challenges for economic development and sustainable development. Mainly, ICT can create a digital divide within and among countries. Various factors, such as socioeconomic, human, political and cultural factors, appear to that contribute to variations between countries and

47 See Hassan (2021) and Hussain (2017).

regions in digitalization.

Substantial discrepancies in digital indices, digitalization and digital transformation are found within the Arab region. Higher performance in use of ICT and a greater digital transformation is measured by the DAI and EDI in the Arab Gulf high-income countries as compared to middle-income and low-income countries. This result is not surprising and can be explained in relation to the substantial discrepancy in economic development, income level and human development within Arab countries. Gulf countries having higher GDP per capita, higher average years of schooling and a higher percentage of people accessing the internet. Poorer Arab countries have lower GDP per capita, less schooling and correspondingly smaller percentage of inhabitants accessing the internet and poor opportunities for digitalization and digital transformation. Examples in India-Arab, China-Arab and Arab-Arab cooperation in ICT were provided as such South-South initiatives in digital work contribute towards reducing digital divides and strengthening South-South cooperation in ICT to address the digital divide in Arab countries.

Below are major policy recommendations for improving ICT use and digital transformation in Arab countries.

- At the regional level, support South-South cooperation including Arab-Arab ICT cooperation by supporting Arab digital strategies to be implemented in collaboration with Arab governments and in partnership with the private sector and other stakeholders in the Arab region.
- At the regional level, support implementation of strategies that enhance government use of digital technologies to improve the efficient provision of government information and services that can be accessed by all citizens in countries.
- At the regional level, encouraging Arab governments to set up Arab Digitalization and Digital Transformation Funding to ensure sufficient and sustainable funding for supporting and accelerating digital transformations.
- At the regional and national level, support Arab governments to enhance institutional capacities to manage and monitor ICT, digitalization and digital transformation projects and enhance legal and regulatory frameworks that facilitate efficient adoption of digital technologies.
- At the regional and national levels, support Arab-Arab ICT cooperation to include capacity building, cybersecurity, digital inclusion, digital innovation ecosystems, digital services and applications, emergency telecommunications, environment, network and digital infrastructure, policy and regulation and statistics.
- At the regional and national levels, enhance Arab-Arab cooperation in ICT by establishing cooperation between Arab governments, Arab private and business sectors and other stakeholders, including the higher education sector, to support digital capacity building by supporting digital education, training and learning.
- In all Arab countries, encourage Arab governments and the Arab private and business sector to support the digital environment and digital security and privacy issues.
- In all Arab countries, involve the Arab private sector, business sector and other stakeholders to

contribute to building sustainable digital infrastructure.

- In all Arab countries, promote digital transformation by enhancing DAI sub-components, including the DAI Business Sub-index, DAI People Sub-index and DAI Government Sub-index.
- At the national level and for Arab high- and middle-income countries, foster digitalization by supporting EDI sub-components, including knowledge, regulations, infrastructure and connectivity.
- At the national level, and especially in Arab middle and low-income countries, foster digital transformation to reduce the digital divide by ensuring equality of access and use of ICT and increasing investments in ICT infrastructure. Facilitate the sustainable use of digital technologies, improvement of human capital and human resources and ICT skills by supporting the development of ICT education and training.
- At the regional and national level, embrace the Organisation for Economic Co-operation and Development (OECD) recommendations on Digital Government Strategies. OECD recommendations include using technology to improve government accountability, social inclusiveness and partnerships, creating a data-driven culture in the public sector, ensuring coherent use of digital technologies across policy areas and levels of government, strengthening ties between digital government and broader public governance agendas. Use a risk management approach to address digital security and privacy issues, developing clear business cases to sustain the funding and success of digital technology projects, reinforcing institutional capacities to manage and monitor project implementation and assess existing assets to guide procurement of digital technologies. Take steps to address existing digital divides and avoid new digital exclusions. Create a data-driven culture that enables open data for transparency, better service delivery and public participation. Ensure the coherent use of technology across policy areas and levels of government and establish organizational and governance frameworks for effective co-ordination and integration of efforts to produce better policy outcomes and services and strengthen capacities to support better implementation of digital government strategies[48].

48 See OECD Recommendation on Digital Government Strategies: www.oecd.org/governance/digital-government/toolkit/goodpractices/recommendation-on-digital-government-strategies.htm (Accessed 22 March 2022).

REFERENCES

Accenture Consulting (2018) "How Artificial Intelligence Can Drive Diversification in the Middle East."

Alaerds, R.; Grove, S.; Besteman, S.; Bilderbeek, P. (2017) 'The Foundations of our Digital Economy: Structure Study on the Infrastructure behind Our Data Economy'; Wouter, P., Ed.; Trusted Cloud Experts: Leidschendam, The Netherlands; DUTCH Datacenter Association: Amsterdam, The Netherlands; ISP Connect: Spijkenisse, The Netherlands; The METI Sfiles, source of success: The Hague, The Netherlands, 2017.

Ali, R. A., (2016) 'Cloud Computing in Arab States: Legal Aspect, Facts and Horizons,' ITU-ATU Workshop on Cyber security Strategy in African Countries Khartoum, Sudan, 24-26 July 2016, ITU Arab Regional Office.

Aly, H. (2020) 'Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing?' Review of Economics and Political Science, published by Emerald Publishing Limited.

Arab Development Portal, 3 April 2020, www.arabstates.UNDP.org/content/rbas/en/home/ourperspective/ourperspectivearticles/2020/covid-19-underscores-the-risk-of-the-digital-divide-in-the-arab-.html: Accessed 10 December 2020.

Arab Digital Inclusion Platform portal: www.unescwa.org/portal/adip (accessed 11 September 2021).

Arab Information and Communication Technologies Organization (AICTO) (2018) 'AICTO inaugurates new centre to reinforce Arab-Chinese cooperation,' Telecom review (2018) "'Telecom Review - AICTO inaugurates new centre to reinforce Arab-Chinese cooperation" hwww.telecomreview.com/index.php/articles/reports-and-coverage/2231-aicto-inaugurates-new-center-to-reinforce-arab-chinese-cooperation: accessed 06 December 2021)

Arab Information and Communication Technologies Organization (AICTO): www.aicto.org/covid19-arab-ict-initiatives-2/ (Accessed 09 December 2021).

Arab League Educational, Cultural and Scientific Organization (ALECSO) (2019) 'Cloud Computing in Education in the Arab Countries,' 04 April 2019: www.alecso.org/nsite/en/mn-ict-2/projects/cloud-computing-in-education-in-the-arab-countries (accessed 6 December 2021)

Arab League Educational, Cultural and Scientific Organization (ALECSO) 'COVID19 - ICT Initiatives from Arab Organizations' www.aicto.org/covid19-arab-ict-initiatives-2/#1587407109462-44384ead-e5a5h (accessed 9 December 2021).

Ayyagari, R.; Grover, V.; and Purvis, R. (2011) 'Technostress: Technological antecedents and implications.' MIS Quarterly, 35, 4 (2011), 831–858.

Brynjolfsson, E.; Kahin, B. (2000) 'Understanding the Digital Economy, Data, Tools and Research Book'; The MIT Press: Cambridge, MA, USA, 2000.

Buchelt, B.; Fraczkiewicz-Wronka, A.; Dobrowolska, M. (2020) 'The Organizational Aspect of Human Resource Management as a Determinant of the Potential of Polish Hospitals to Manage Medical Professionals in Healthcare' 4.0. Sustainability 2020, 12, 5118.

Bukht, R. and Heeks, R., (2017) "Defining, Conceptualising and Measuring the Digital Economy," International Organisations Research Journal. 13. 143-172.

Bukht, R.; Heeks, R. (2017) 'Defining Conceptualizing and Measuring the Digital Economy.' Development Informatics 2017, Working paper No. 68. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3431732 (accessed 7 September 2020).

Cámara, N., (2020) 'Digital Economy and Social Sustainability: The Digital Index (DiGiX) (2020) DiGiX 2020 Update: A Multidimensional Index of Digitization,' BBVA Research, Creating, Opportunities, October 2020.

China Arab States BDS/ GNSS: Arab Region Beidou Cooperation on Satellite Navigation Prospect in the Field of Precision Agriculture.

Choucair, F., (2020) 'COVID-19 Underscores the Risk of the Digital Divide in the Arab States Region,'

China-League of Arab States Cooperation Initiative on Data Security (2021/03/29)" www.fmprc.gov.cn/mfa_eng/wjdt_665385/2649_665393/202103/t20210329_9170559.html

https://lawinfochina.com/display.aspx?id=8064&lib=tax&SearchKeyword=&SearchCKeyword (accessed 6 December 2021).

Cornell University, INSEAD and WIPO (2015): "The Global Innovation Index 2015: Effective Innovation Policies for Development". Fontainebleau, Ithaca and Geneva.

Cornell University, INSEAD and WIPO (2014): "The Global Innovation Index 2014: The Human Factor In innovation". Fontainebleau, Ithaca and Geneva.

Cornell University, INSEAD and WIPO (2013): "The Global Innovation Index 2013: The Local Dynamics of Innovation". Geneva, Ithaca and Fontainebleau.

D'Arcy, J.; Herath, T.; and Shoss, M.K. (2014) 'Understanding employee responses to stressful information security requirements: A coping perspective.' Journal of Management Information Systems, 31, 2 (2014), 285–318. [Taylor & Francis Online]

De Freitas, W. (2020) 'The Digital Economy is Becoming Ordinary. Best We Understand it'. The CQNVERSATION, 24 January 2020. Available online: https://theconversation.com/the-digital-economy-is-becoming-ordinary-best-we-understand-it-130398 (accessed 12 October 2020).

Digital Adoption Index: www.worldbank.org/en/publication/wdr2016/Digital-Adoption-Index (Accessed 31 August 2021).

Dobrynin, A.; Chernykh, K.; Kupriyanovsky, V.; Kupriyanovsky, P.; Sinyagov, S. (2016) 'The Digital Economy—the various ways to the effective use of technology (BIM, PLM, CAD, IOT, Smart City, BIG DATA and others)'. Int. J. Open Inf. Technol. 2016, 4, 4–11.

Egypt Ministry of Communications and Information Technology: Bilateral Cooperation: Arab Bilateral Cooperation: https://mcit.gov.eg/en/International_Relations/Bilateral_Cooperation/Egyptian_Arabian (Accessed 11 September 2021).

Ellatif, H. A.A., (2016) 'Cloud Computing Services and Its Applications in Arab Environment,' International Journal of Computational Engineering Research (IJCER), Volume 06, Issue 02, February 2016, pp. 33-35.

Euler Hermes (2019) 'The Euler Hermes (2019) Enabling digitalization index: beyond potential,' 11 September 2019.

Fedorov, A.A.; Biryukov, O.A. (2017) 'Digital economy: Management features and development trends.' St. Petersbg. Econ. J. 2017, 3, 60–66.

Freeman, C. and L. Soete (1985) 'Information Technology and Employment: An Assessment', Sussex: SPRU. UK. April 1985.

Freeman, C. and L. Soete (1994) 'Work for All or Mass Unemployment? Computerized Technical Change into the Twenty–first Century', London: Printer.

Freeman, C. and L. Soete (1997) 'The Economic of Industrial Innovation', third edition, Cassell, London.

Goel, S.; Williams, K.; and Dincelli, E. (2017) 'Got phished? Internet security and human vulnerability.' Journal of the Association for Information Systems, 18, 1 (2017), Article 2.

Gnatyshina, E.V.; Salamatov, A.A. (2017) 'Digitalization and formation of digital culture: Social and educational aspects,' Bull Chelyabinsk State Pedagog Univ. 2017, 8, 19–24.

Grigorescu, A., Elena Pelinescu, E., Elena Ion, A., and Dutcas, M. F., (2021) 'Human Capital in Digital Economy: An Empirical Analysis of Central and Eastern European Countries from the European Union,' Sustainability 2021, 13, 2020, pp. 1- 21, MDPI, Basel, Switzerland.

Hassan, R., (2021) 'Arab News Saudi-India dialogue seeks to boost collaboration in IT sector,' 25 March 2021. (www.arabnews.com/node/1831471/amp: Accessed 06 December 2021).

Hussain, Z., (2017) 'India-Saudi Arabia Relations: New Bilateral Dynamics,' April 25, 2017: (www.mei.edu/publications/india-saudi-arabia-relations-new-bilateral-dynamics: Accessed 06 December 2021).

International Monetary Fund (IMF) (2018), "Measuring the Digital Economy". IMF Policy Paper, Washington, D.C., 2018. Available at: www.imf.org/en/ Publications/Policy-Papers/Issues/2018/04/03/022818-measuring-the-digital-economy. Ker, D. (forthcoming) "Perspectives on the value of data and data flows" OECD Science, Technology and Industry Working Papers, OECD Publishing: Paris.

International Monetary Fund (IMF) (2020), "Digitalization in Sub-Saharan Africa,' Chapter 3 in "The Regional Economic Outlook: Sub-Saharan Africa: COVID-19: An Unprecedented Threat to Development." Washington, D.C. April 2020.

International Telecommunication Union (ITU) 2030 Agenda for Sustainable Development: ICTs and the SDGs, www.itu.int/en/ITU-D/Statistics/Pages/intlcoop/sdgs/default.aspx (accessed 29 August 2021).

International Telecommunication Union (ITU) (2014) World telecommunication (ITU)/ICT indicators database. www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx.

International Telecommunication Union (ITU) (2020) 'The Economic contribution of broadband, digitization and ICT regulation: Econometric modelling for the Arab States region,' January 2020.

International Telecommunication Union (ITU) (2021) www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx (accessed 06 December 2021).

International Telecommunication Union (ITU) (2021) 'Digital trends in the Arab States region 2021: Information and communication technology trends and developments in the Arab States region, (2017-2020)' ITU Publications Arab States, Telecommunication Development Bureau, Geneva, Switzerland, pp. 23-25, 26-27, 43.

Karpova, Y.A. (2008) 'Innovation environment as an object of sociology of innovation: The problem of management'. J. Innov. 2008, 20, 45–48.

Jorgenson, D. W. and K. Stiroh (1995) "Computers and Growth," Economics of Innovation and New Technology, 3: 295-316.

Linnik, Y.N.; Kiryukhin, M.A. (2019) 'Digital technologies in the oil and gas industry'. Bull. Univ. 2019, 7, 37–40. Liu, Q.B., and Karahanna, E. (2017) 'The dark side of reviews: The swaying effects of online product reviews on attribute preferences construction.' MIS Quarterly, 41, 2 (2017), 427–448.

Lowry, P.B.; Moody, G.D.; and Chatterjee, S. (2017) 'Using it design to prevent cyberbullying.' Journal of Management Information Systems, 34, 3 (2017), 863–901. [Taylor & Francis Online],

Lowry, P.B.; Zhang, J.; Moody, G.D.; Chatterjee, S.; Wang, C.; and Wu, T. (2019) 'An integrative theory addressing cyberharassment in the light of technology-based opportunism.' Journal of Management Information Systems, 36, 4 (2019), 1142–1178. [Taylor & Francis Online].

Mahboubi, O., MENACA Secretariat, Nizam, H. Hayward, M., Khwaja, H., (2019) 'Cloud Competitiveness Index 2019,' (www.menacloud.org/cloud-competitiveness-index/: Accessed 06 December 2021))

Maidment G. 'The Arab Information Communications Technology Organization (AICTO): Ensuring equal ICT development across the Arab League,': www.huawei.com/nl/technology-insights/publications/winwin/34/aicto-equal-ict-development-arab-league: (Accessed 11 September 2021).

Mesenbourg, T. L. (2001) 'Measuring the digital economy.' US Bureau Census 2001, 1, 5–6.

Micic, L. (2017), "Digital transformation and its influence on GDP", Economics, Vol. 5 No. 2, pp. 135-147.

Moody, J. B., and Nogrady, B., 'The sixth wave: How to succeed in a resource-limited world,' Random House, North Sydney, Australia (2010).

Nabe, C. (2021) 'Impact of COVID-19 on Cybersecurity' (www2.deloitte.com/ch/en/pages/risk/articles/impact-covid-cybersecurity.html: Accessed 09 December 2021)

Nour, S. (2018), "The impact of ICT in public and private universities in Sudan," the Journal of the Knowledge Economy, Springer, New York, USA, vol. 9, no. 4, December 2018, pp. 1391-1414.

Nour, S. (2017), "Africa Bridging the digital divide," The Nordic Africa Institute Policy Notes Series No 2017/4; NAI, Uppsala, Sweden, October 2017: pp.1-7: http://nai.diva-portal.org/smash/record.jsf?pid=diva2%3A1146536&dswid=857.

Nour, S. (2015), "Information and Communication Technology in Sudan: An Economic Analysis of Impact and Use in Universities," Springer Series Contributions to Economics, Springer International Publishing, AG, Cham, Switzerland, March 14, 2015, 374 pp.

Nour, S. (2014), "The impact of ICT in public and private universities in Sudan," UNU-MERIT Working Paper series 2014-018, Maastricht, the Netherlands, January 2014, pp. 1-25.

Nour, S. (2006), "ICT Opportunities and Challenges for Development in the Arab Region," Chapter 8 in A. P. D'Costa (ed.) "The New Economy in Development: ICT Challenges and Opportunities" series of Technology, Globalization

and Development, Vol. 2, Palgrave Macmillan, UK-USA, September 2006, pp. 161-187.

Nour, S. (2002), "ICT Opportunities and Challenges for Development in the Arab World," UNU-WIDER Discussion Paper Series DP2002/83. Paper prepared for UNU-WIDER Conference on the New Economy in Development, UNU-WIDER, Helsinki, Finland, May 10th–11th, 2002.

Organisation for Economic Co-operation and Development (OECD) (2001) 'Understanding the digital divide,' OECD Publishing: Paris, p. 5.

Organisation for Economic Co-operation and Development (OECD) (2014), 'Measuring the Digital Economy: A New Perspective,' OECD Publishing: Paris, https://doi.org/10.1787/9789264221796-en.

Organisation for Economic Co-operation and Development (OECD) (2019a). "Measuring the Digital Transformation. A Roadmap for the Future." OECD Publishing: Paris.

Organisation for Economic Co-operation and Development (OECD) (2019b), "An Introduction to Online Platforms and Their Role in the Digital Transformation," OECD Publishing: Paris, 2019. Available at: https://doi.org/10.1787/19e6a0f0-en

Organisation for Economic Co-operation and Development (OECD) report (2020) www.oecd.org/going-digital/topics/measurement/ (Accessed 18 November 2020) OECD Recommendation on Digital Government Strategies: www.oecd.org/governance/digital-government/toolkit/goodpractices/recommendation-on-digital-government-strategies.htm (Accessed 22 March 2022).

https://en.wikipedia.org/wiki/Digital_economy (accessed 19 November 2020)

www.itu.int/en/ITU-D/Digital-Inclusion/Pages/about.aspx.

Pohjola, M. (2000) 'Information Technology and Economic Growth: A Cross- Country Analysis', WIDER/ UNU Working Paper series: WP173, January 2000.

Pohjola, M. (ed.) (2001) 'Information Technology, Productivity and Economic Growth: International Evidence and Implications for Economic Growth', Oxford, Oxford University Press, April 2001.

World Bank. 2016. World Development Report 2016: Digital Dividends. World Bank, Washington, D.C.

Polosuhina, M.A. (2018) 'National models of the digital economy', J. Econ. Soc. Probl. Russ. 2018, 1, 111–154.

Qahri-Saremi, H., and Montazemi, A.R. (2019) 'Factors affecting the adoption of an electronic word of mouth message: A meta-analysis.' Journal of Management Information Systems, 36, 3 (2019), 969–1001. [Taylor & Francis Online].

Qahri-Saremi, H., and Turel, O. (2020) 'Ambivalence and coping responses in post-adoptive information systems use.' Journal of Management Information Systems, 37, 3 (2020), 820–848. [Taylor & Francis Online].

Qahri-Saremi, H.; Vaghefi, I.; and Turel, O. (2021) 'Addiction to social networking sites and user responses.' . ACM SIGMIS Database. 2021, 4,65-91.

Ramzy, M. and Zaki, C. (2021) "Trade Integration and South-South Cooperation: How Does Digitalization Matter?" United ` Nations Office for South-South Cooperation.

Serenko, A.; Turel, O.; and Bohonis, H. (2021) 'The impact of social networking sites use on health-related outcomes among UK adolescents.' Computers in Human Behaviour Reports, 3, paper 100058 (2021), 1–9.

Skryl, T.V.; Paramonov, A.S. (2017) 'Digital transformation of the healthcare sector,' Russian and foreign specifics. Karelian Sci. J. 2017, 6, 137–140.

Tarafdar, M.; Cooper, C.L.; and Stich, J.F. (2019) 'The techno stress trifecta techno eustress, techno distress and design: Theoretical directions and an agenda for research.' Information Systems Journal, 29, 1 (2019), 6–42.

Tarafdar, M.; Maier, C.; Laumer, S.; and Weitzel, T. (2020) 'Explaining the link between techno stress and technology addiction for social networking sites: A study of distraction as a coping behaviour.' Information Systems Journal, 30, 1 (2020), 96–124.

Turel, O.; Cavagnaro, D.R.; and Meshi, D. (2018) 'Short abstinence from online social networking sites reduces perceived stress, especially in excessive users.' Psychiatry Research, 270(2018), 947–953.

Turel, O., and Ferguson, C. (2020) 'Excessive use of technology: Can tech providers be the culprits?,' Communications of the ACM, 64, 1 (2020), 42–44.

Turel, O.; Matt, C.; Trenz, M.; Cheung, C.M.K.; D'Arcy, J.; Qahri-Saremi, H.; and Tarafdar, M. Panel report (2019) 'The dark side of the digitization of the individual,' Internet Research, 29, 2 (2019), 274–288.

Turel, O., Qahri-Saremi, H. and Vaghefi, I., (2021) 'Special Issue: Dark Sides of Digitalization,' International Journal of Electronic Commerce, Volume 25, No. 2, 127-135, Routledge, Taylor and Francis Group, DOI:

United Nations Conference on Trade and Development (UNCTAD) (2021) 'Manual for the Production of Statistics on the Digital Economy 2020,' United Nations publication, New York, United Nations, Geneva, May 2021 – 733 UNCTAD/DTL/STICT/2021/2. pp. 14-15, 22-23-24.

United Nations Conference on Trade and Development (2019) (UNCTAD) 'The Digital Economy Report: Value creation and capture: implications for developing countries,' The United Nations Publications, New York, United Nations, Geneva. July 2019, UNCTAD/DER/2019.

United Nations Development Programme (UNDP))2020(Human development report 2020: The next frontier: Human development and the Anthropocene, New York, NY: UNDP.

United Nations Economic and Social Commission for Western Asia (ESCWA) (2007) 'Developing the Arab ICT Strategy,' (11 April 2007): www.unescwa.org/news/developing-arab-ict-strategy: (accessed 11 September 2021).

United Nations Economic and Social Commission for Western Asia (ESCWA) Report (2018) 'Perspectives on the Digital Economy in the Arab Region,' 2018 United Nations, Beirut, Lebanon, E/ESCWA/TDD/2017/2.

United Nations Economic and Social Commission for Western Asia (ESCWA) (2020) 'Information and communications technology (ICT) in the fight against COVID-19' ESCWA Weekly News (23 June 2020) www.unescwa.org/news/information-and-communications-technology-ict-fight-against-covid-19 (accessed 09 December 2021).

United Nations Educational, Scientific and Cultural Organization (UNESCO) 'UNESCO Guide to Measuring Information and Communication Technologies (ICT) in Education,' http://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict.

United Nations Office for South-South Cooperation and the Finance Centre for South-South Cooperation (2018) 'South-South Cooperation in a Digital World: 2018 Annual Report in South-South Cooperation,' United Nations Office for South-South Cooperation, United Nations Development Programme, New York, 2018.

United States Department of Commerce, National Telecommunications and Information Administration (NTIA) (1999) 'Falling through the Net: defining the digital divide,' chapter 4. 'A report on the telecommunications and

information technology gap in America,' p xiii, July 1999.

Vaghefi, I.; Lapointe, L.; and Boudreau-Pinsonneault, C. (2017) 'A typology of user liability to it addiction. Information,' Systems Journal, 27, 2 (2017), 125–169.

Vanman, E.J.; Baker, R.; and Tobin, S.J. The burden of online friends (2018) 'The effects of giving up Facebook on stress and well-being.'The Journal of Social Psychology, 158, 4 (2018), 496–508. [Taylor & Francis Online],

Venkatraman, S.; C.M.K. Cheung; Z.W.Y. Lee; F.D. Davis; and V. Venkatesh. (2018) 'The "darth" side of technology use: An inductively derived typology of cyber deviance.' Journal of Management Information Systems, 35, 4 (2018), 1060–1091. [Taylor & Francis Online].

What is Digital Transformation and How Does it Differ from Digitalization and Industry 4.0. Available online: https://rb.ru/story/what-is-digital-transformation/ (accessed 4 March 2020).

World Bank (2021) The World Development Indicators (2021) (accessed 21 July 2021).

World Bank. World Development Report (2016) Digital Adoption Index (DAI). Background Note 'Digital Adoption Index (DAI): Measuring the global spread of digital technologies,' (accessed 22 March August 2022).

World Bank (2016) 'The World Bank Development Report 2016: Digital dividends,'Washington, D.C.

APPENDIX 1: DEFINITIONS OF ICT INDICATORS_

Indicator description	Indicator definition
Fixed broadband subscriptions	Fixed-broadband subscriptions refers to fixed subscriptions to high-speed access to the public internet (a TCP/IP connection); at downstream speeds equal to; or greater than; 256 kbit/s. This includes cable modem; DSL; fibre-to-the-home/building; other fixed (wired) broadband subscriptions; satellite broadband and terrestrial fixed wireless broadband. This total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the internet) via mobile-cellular networks. It should include fixed WiMAX and any other fixed wireless technologies. It includes both residential subscriptions and subscriptions for organizations.
Fixed broadband subscriptions per 100 inhabitants	Fixed broadband subscribers divided by population and multiplied by 100.
Fixed telephone subscriptions	Fixed-telephone subscriptions refers to the sum of active number of analogue fixed-telephone lines; voice-over-IP (VoIP) subscriptions; fixed wireless local loop (WLL) subscriptions; ISDN voice-channel equivalents and fixed public payphones. This indicator was previously called main telephone lines in operation.
Fixed telephone subscriptions 100 inhabitants	
Active mobile-broadband subscriptions	Active mobile-broadband subscriptions refers to the sum of standard mobile-broadband and dedicated mobile-broadband subscriptions to the public internet. It covers actual subscribers; not potential subscribers; even though the latter may have broadband-enabled handsets.
Active mobile-broadband subscriptions per 100 inhabitants	Active mobile-broadband subscriptions per 100 inhabitants. Active mobile-broadband subscriptions refers to the sum of standard mobile-broadband and dedicated mobile-broadband subscriptions to the public internet. It covers actual subscribers; not potential subscribers; even though the latter may have broadband-enabled handsets.
Mobile-cellular telephone subscriptions; by postpaid/prepaid	Mobile-cellular telephone subscriptions refers to the number of subscriptions to a public mobile-telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions; and the number of active prepaid accounts (i.e., that have been used during the last three months). The indicator applies to all mobile-cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems; subscriptions to public mobile data services; private trunked mobile radio; telephone; radio paging and telemetry services.
Mobile-cellular subscriptions per 100	i271/i61 *100
inhabitants	
International bandwidth; in Mbit/s	International bandwidth refers to the total used capacity of international bandwidth; in megabits per second (Mbit/s). It is measured as the sum of used capacity of all internet exchanges (locations where internet traffic is exchanged) offering international bandwidth. If capacity is asymmetric (i.e., more incoming (downlink) than outgoing (uplink) capacity); then the incoming (downlink) capacity should be provided.

International bandwidth per internet user (bit/s)	International internet bandwidth (bit/s) per internet user is calculated by converting to bits per second and dividing by the total number of internet users.
Internet users (%)	This indicator can include both; estimates and survey data corresponding to the proportion of individuals using the internet; based on results from national households surveys. The number should reflect the total population of the country; or at least individuals of 5 years and older. If this number is not available (i.e., target population reflects a more limited age group) an estimate for the entire population should be produced. If this is not possible at this stage; the age group reflected in the number (e.g. population aged 10+; population aged 15-74) should be indicated in a note. If no survey data are available at all; please provide an estimate specifying in detail the methodology that has been applied to calculate the estimate.

Source: ITU (2020), www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx (accessed 30 August 2021).

APPENDIX 2: DEFINITIONS OF CONCEPTS_

Definition of the concept	Source
Information and Communication Technologies (ICT) is a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players and storage devices) and telephony (fixed or mobile, satellite, visio/video conferencing, etc.).	UNESCO 'Guide to Measuring ICT in Education'
The Digital Economy consists of all sectors making extensive use of digital technologies (i.e., for which existence depends on digital technologies), as opposed to sectors making intensive use of digital technologies (i.e., only applying digital technology to enhance their productivity). The Digital Economy is thus the share of output that "is derived solely or primarily from digital technologies with a business model based on digital goods or services."	Bukht and Heeks (2017)
The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities'.	OECD report (2020, 2019, 2014)
Digitalization encompasses a wide range of new applications of information technology in business models and products that are transforming the economy and social interactions. Digitalization is both an enabler and a disruptor of businesses. Digitalization is a broad concept It refers to the spread and use of digital technologies—the internet, mobile phones and other tools and processes—to collect, store, analyse and exchange information digitally.	IMF (2018, 2020)
The Digital Adoption Index (DAI); is one of the common measures of digital transformation, it is a worldwide index that measures countries' digital adoption across three dimensions of the economy: people, government and business and it stress more the "supply-side" of digital adoption.	The World Bank Group (2016)

The Enabling Digitalization Index (EDI) is one of the common measures of digital transformation. Euler Hermes edition of the EDI (2018) includes 115 countries with the objective of measuring their capabilities in guiding digital companies and in supporting traditional businesses. The index evaluates countries in terms of their support to digitalization and hence ranks them according to digital-friendly regulation with its different institutional, logistic and technical aspects. It focuses on the organizational and enabling environment of digital transformation inside the country and on the support that government directs towards encouraging technical innovation. The Euler Hermes EDI measures the ability – and agility – of countries to help digital companies thrive and traditional businesses harness the digital dividend. The third edition of the Euler Hermes EDI shows the recent ranking (a score from 0 = worst to 100 = best). The score is based on five components: Regulation, Knowledge, Connectivity, Infrastructure and Size. In Euler Hermes EDI (2019) ranking of 115 countries. Strategies to enable digitalization differ across countries. Euler Hermes EDI (2019) identifies three strategies for digitalization that have been used over the past year. Strategy one is the most straightforward strategy: banking on regulation improvements along with a size increase. Strategy two is the connectivity and infrastructure strategy, which is more costly as it involves spending efforts on logistics for trade and better penetration of technological equipment. Strategy three is the most advanced one as it relies on knowledge: offering better education to adapt the workforce to the digital transformation, investing in R&D, etc. The Euler Hermes EDI score is made of 5 components and 10 indicators. 1. Regulation relates to a conducive business environment is a strong driver for financing, investment and entrepreneurship. This component uses the Distance To Frontier indicator from the World Bank Doing Business. The indicator is a proxy of regulation aspects which matter for digitagility (ease of getting credit, minority investor's protection). 2. Knowledge relates to developing, sharing and using knowledge is pivotal in the digital era. Clear knowledge drivers are human capital building and innovation potential. This component uses the Higher education and training score (secondary and tertiary enrolment rates, quality of the education system and the extent of employees training) and the Innovation score (R&D by corporates, collaboration between universities and the private sector, Intellectual property laws) developed by the World Economic Forum. 3. Connectivity relates to secure and accessible networks for the digital transformation. It is assessed using four indicators: internet user's ratio (the number of people using internet in % of population), mobile phone and fixed phones lines subscriptions per 100 people and the number of secure servers per 100 people. 4. Infrastructure relates to good logistics that is an enabler for digital attractiveness. This component uses the Logistic Performance Index (Doing Business) as a proxy of soft and hard logistic infrastructure. 5. Size relates to a large and digital savvy customer base that is essential for businesses. This component measures with the number of internet users and their income (captured by nominal GDP).	Euler Hermes EDI (2018, 2019)

The Digital Index (DiGiX) is one of the common measures of digital transformation; it is a composite index of 18 sub indicators calculated for 99 countries around the world. It aims to measure the degree of digitalization in those countries through gathering and classifying information related to three sides: supply conditions (infrastructure and costs), demand conditions (technical societal and governmental adoption) and institutional environment (regulations and logistics).	Cámara (2018)
Digital Evolution Index (DEI) is one of the common measures of digital transformation, it covers four key drivers: supply conditions, demand conditions, institutional environment and innovation and change. The index therefore reflects both the current situation of digital transformation inside the country and equivalently the progress rate at which the country is improving. The index shows the interaction among four drivers: (1) the country's digital infrastructure; (2) the demand for technology; (3) the institutional environment; and (4) innovation and development.	Aly (2020)
Digital transformation as a new and modern term in business and technological literature, is usually defined as: "integration of digital technology into business that results in, changes in business operation and delivery of value to customers."	Micic (2017)
Digital transformation also refers to the transformations prompted by the massive adoption of digital technology that generate, process, share and transfer information. It builds on the evolution of multiple technologies: telecommunications networks, computer technologies, software engineering and the spillovers resulting from their use. In this regard, Artificial Intelligence is considered a very critical tool to accelerate digital transformation.	Aly (2020)
The digital economy is characterized by the intensive use by businesses of ICT for the collection, storage, processing and transmission of information. The notion of the digital economy has become commonplace to describe how digital technology is changing patterns of production (supply) and consumption (demand). The different technologies and economic aspects of the digital economy can be broken down into three broad components Core aspects or foundational aspects of the digital economy comprise fundamental innovations (semiconductors, processors), core technologies (computers, telecommunication devices) and enabling infrastructures (internet and telecoms networks).	United Nations Conference on Trade and Development (UNCTAD) (2021, 2019)
The digital economy also requires a strong factors, consisting of regulations that create a vibrant business climate and let firms leverage digital technologies to compete and innovate; skills that allow workers, entrepreneurs and public servants to seize opportunities in the digital world; and accountable institutions that use the internet to empower citizens.	The World Development Report (2016)
According to the World Bank report, the digital economy refers to a "system of economic, social and cultural relations based on the use of digital information and communication technologies."	The G20 (2001) 'The Digital Economy Development and Cooperation Initiative Report'
The digital economy is defined as an economy of three main elements including E-business infrastructure (i.e., a share of the total economic infrastructure used to support, e-business processes and e-commerce); E-business (any business process carried out over the internet); and E-commerce (e-trade) is the cost of goods and services sold over the internet. IT industry is the major driver of the digital economy	Mezenburg (2001)

The Digital Adoption Index (DAI) is a worldwide index that measures countries' digital adoption across three dimensions of the economy: people, government and business. The index covers 180 countries on a 0–1 scale and emphasizes the "supply-side" of digital adoption.	The World Development Report (2016)
Digital divide: according to the definition of Oxford dictionaries: "the digital divide is the gulf between those who have ready access to computers and the internet and those who do not." According to the definition provided in other dictionary "the digital divide is the socioeconomic and other disparities between those people who have opportunities and skills enabling them to benefit from digital resources, especially the internet and those who do not have these opportunities or skills". According to OECD (2001) "the term 'digital divide' refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the internet for a wide variety of activities, the digital divide reflects various differences among and within countries" (OECD 2001). The U.S. Department of Commerce National Telecommunications and Information Administration (NTIA) (1999) defines the digital divide as "the divide between those with access to new technologies and those without."	See Oxford dictionaries: www.oxforddictionaries.com/definition/english/digital-divide. See also: http://dictionary.reference.com/browse/digital+divide. See: OECD, 2001; NTIA, 1999

South-South Ideas

United Nations
Office for South-South Cooperation