Social expenditure and digitization in the Arab Region

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E/ESCWA/CL3.SEP/2021/3/TP.9
4 January 2022
ORIGINAL: ENGLISH

Economic and Social Commission for Western Asia

Social Expenditure Monitor Report Background Paper Series

Social expenditure and digitization in the Arab Region

United Nations
Beirut, 2022

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22-00012

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United Nations publication issued by ESCWA, United Nations House, Riad El Solh Square,

P.O. Box: 11-8575, Beirut, Lebanon.

Website: www.unescwa.org.

Acknowledgement

The paper "Social Expenditure and Digitization in the Arab Region" is the result of background research to inform the Social Expenditure Monitor Report entitled: "Social Expenditure Monitor for Arab States: Toward making budgets more equitable, efficient and effective to achieve the SDGs".

The background paper has been presented and discussed in the Social Expenditure Monitor Regional Expert Group Meeting (EGM), held in Amman, on 1-2 December 2021.

The authors acknowledge the comments and suggestions from colleagues at UNESCWA including Mohamad Nawar Alawa, Regional adviser on Technology for Development at ESCWA who was in charge of supervising, reviewing and coordinating activities related to this paper, Niranjan Sarangi, Social Expenditure Monitor Project Coordinator, who provided valuable comments on its successive versions and Nour Rmeih who reviewed the first draft of this paper.

The authors also acknowledge the comments and suggestions from colleagues at UNDP Regional Hub in Amman including Vito Intini, Walid Merouani, Nadine Abdelraouf, Judyth Engdels, and from UNICEF MENARO including Samman Thapa and Juan Bester as well as other experts at the EGM.

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Executive Summary

Over time, digital transformation has proven its ability of stimulating economic growth. Digitization has a positive impact on the different sectors of the economy. Thereby, governments all over the globe are placing massive efforts and developing policies to digitally transform their economies to benefit from the opportunities that arise with digitization. In response, Arab countries have recognized the importance of developing national digital strategies (NDSs) to build an information society linked to socioeconomic development and to achieve the Sustainable Development Goals.

This background paper starts with an analysis of the ICT status quo in the Arab region. The objective of this section is to highlight the performance of selected countries, showcase the best practices and to pinpoint the areas that need more focus and improvement. The analysis is conducted for four main pillars of ICT namely infrastructure, usage, skills, and prices. For each pillar, a set of indicators was selected and in certain cases growth rates were computed to observe the improvement of these indicators over the years. Overall, Gulf countries have shown superiority in all aspects of ICT with close-to-perfect scores. Such findings came with no surprise as these countries have been enormously investing in the ICT sector for years. On the Arab-African level, top performance was mostly split between Egypt and Morocco while Tunisia had the lead in some cases. Still, the overall performance of the entire Arab region falls short to the global averages. In some countries, like the case of Syria, Yemen, state of Palestine and Sudan, the extremely poor performance was attributed to the political conflicts.

By the beginning of 2020, digitization became even more important in parallel with the spread of the novel COVID-19 virus. Authorities around the world identified the critical need of finding alternative solutions, for daily activities like work, health, and education, while abiding by the precautionary measures that aim to curb the outbreak and control the pandemic. In turn, Arab governments quickly responded to the crisis and have taken several measures in this regard. Thereby, the second part of the paper showcases the digital response of the Arab countries in different sectors of the economy and highlights the best practices of each country. Examples include improving broadband networks, developing e-learning platforms, mobile apps and lots of other efforts in attempt to control the local spread of the virus.

With ICT proven to be highly important especially in times of crisis, like the COVID-19 pandemic, the paper then moves to analyze the impact of public expenditure in ICT on economic growth. Theoretically, the overall public expenditure has an impact on economic growth. However, there has been a great debate between theorists about the nature or the direction of this relationship. The Keynesian theory, on one hand, suggests that public expenditure has a positive impact on economic growth while classical theorists suggest the relation to be negative between the two variables. In this section, we attempted to analyze the economic impact of the public expenditure on ICT. In other words, we attempt to discover the relation between public expenditure on ICT and the economic growth rates.

It is worth noticing, though, that there is a considerably wide literature gap in this regard. There is still no sign of an international methodology that is able quantify the economic impact of public expenditure on ICT. However, literature has already tackled the impact of ICT, in general, on multiple social and economic aspects. The paper entailed these different methodologies and techniques to measure the socioeconomic impact of ICT. Among these, we could mention the linear regression models, the structure equation model (SEM) and the instrumental variable approach which are efficient in measuring socio-economic impact of ICT assuming achieving their assumptions. Unfortunately, the assumptions of the previous mentioned techniques such as sufficient number of time points, adequate number of variables, and distributional assumptions, are not satisfied. A possible solution that was adopted in this paper is Theil-Sen non-parametric regression models. Non-parametric regression models are superior to other parametric regression models in case the conditions of parametric techniques are not met. The non-parametric regression models were applied in this paper adopting the GDP growth rate as independent variable, and the public consumption on ICT and public investments on ICT as covariates.

The model is applied on the GDP with fixed prices data, the total ICT public expenditure which consists of expenditure on goods and services and expenditure on capitals. The data are only available for Egypt in interval from 2010 to 2020.

The model results show that only the total of public expenditure on ICT and the public expenditure on capital have positive impact on the annual growth rate of the GDP. The public expenditure on goods and services fails to achieve a significant effect. This can be interpreted as the effect of the total public expenditure on ICT and the expenditure on ICT capital are clear enough to be detected with short time series. However, the public expenditure on goods and services may need long time series to be revealed. According to the coefficients slopes of the model, a 10 percent increase in the annual growth of the total public expenditure on the ICT leads on average to a 1% increase in the annual growth rate of the GDP. Similarly, a 10 percent increase in the annual growth of the public expenditure on the ICT capital leads on average to a 1.4% increase in the annual growth rate of GDP.

As well, the paper tried to investigate the social impact of ICT using Pearson correlation coefficients that can show an indication of the indirect social impact of ICT. The data are only available for five countries (Egypt, Morocco, Tunisia, Jordan and Oman). The results show that

the ICT has a social impact as in the following sequence: when government's increases the spending on R&D (education sector) and provides conducive environment to innovation, these lead to an increase in the government's position in the global innovation index which can be reflected by the ability of young people to produce advanced technological products, establish their own companies, creating new jobs and reaching output growth market. Increasing the state's GDP helps in increasing spending on its various programs, the most important of which is the expenditure on education as a proper example for the social impact of ICT. Therefore, policymakers should continue to increase the share of expenditure on R&D in the government's annual budget.

1. Introduction

Digital transformation has become a key driver for economic growth and governments around the world are putting massive efforts and policies to digitally transform their economies to benefit from the opportunities offered by the digital technologies. Therefore, Arab countries have recognized the importance of developing and implementing national digital strategies (NDSs) to build an information society linked to socioeconomic development and to achieve the Sustainable Development Goals. Thereby, many Arab countries launched NDSs with the following objectives: digitization of public services, making progress towards the use of digitization opportunities, boosting countries' competitiveness, economic growth, and social wellbeing. Digital transformation is associated with multiple requirements including a well-built infrastructure, high mobile and fixed broadband penetrations, and high-quality internet services. It also requires well-developed applications that would further enable a high usage. Furthermore, digital transformation requires a set of digital skills acquired through education, training, and practice. And finally, prices pay an important role in digital transformation as affordability ensures the widespread of the benefits across all segments of the society among as many segments of society as possible. All the above-mentioned requirements must be supported by legal framework and good governance structure. The following section analyzes these four aspects: infrastructure, usage, skills, and prices in all the Arab countries to highlight their progress towards digitization as well as areas for improvement.

2. Digitization in Arab Countries

The Arab region is one among the foremost diverse regions in terms of digital transformation: at one side, there are the GCC countries leading the region across many ICT indicators at very advanced levels comparable to those of developed countries; and at the other side, there are the LDCs and conflict-affected countries, dealing with digital development owing mainly to persistent structural impediments, including underlying economic variables, socio-economic structure, ongoing conflicts and therefore the effects of global climate change. The ICT development, therefore, differs considerably among the region's economies, and Internet usage rates range from 100 percent in the more developed economies to less than 10 percent in the region's least developed economies. This section will focus on the quality of ICT infrastructure in Arab countries by observing selected indicators and computing their growth rates as an assessment for progress. The base year used in computing the growth is 2016 and it is compared to the latest year, 2019, to get a general overview of the progress Arab countries have been making. Due to data unavailability, some indicators were studied until 2018. It is worth noticing that Arab countries can be clustered into 4 sub-categories. The Gulf countries are countries that have massive capital investment due to the resources they possess. Saudi Arabia, for example, aims at the diffusion of

ICT across multiple sectors of the economy. ICT spending in Saudi Arabia reached 111.98 billion SAR back in 2014[1]

equivalent to 30 billion $ almost which represented 5% of the GDP, out of which 23% of the total spending was devoted to hardware, making it the largest ICT spending nation across all the Gulf Cooperation Council (GCC).

According to IDC [2], the overall spending on ICT is set to reach $32.9 billion in 2021, up 1.5% in 2020. Moreover, the ICT investment in the kingdom reached 17.83 billion SAR equivalent to almost 5 billion US$ in the same year. Qatar, on the other hand, formulated an ICT Development Strategy back to 2012[3]. Among the strategic initiatives are the long-term commitment to ICT development by prioritizing ICT to society and economy, and a world-class ICT infrastructure. It is worth noting that ICT investment tripled in Qatar during the period of 2012 and 2020 as it increased from 3 billion US dollars to 9 billion in 2020[4]. As for the telecommunication investments in the Arab region, it is worth noticing that most investments were made in GCC countries: Saudi Arabia, and the United Arab Emirates. These investments accounted for almost two-thirds of total investments made in the region in 2019 which amounted to 10.92 billion $[5].

The second cluster comprises North African countries like Egypt, Tunisia, Algeria, and Morocco and such countries have been making moderate progress in the sphere of ICT. Jordan also can be added to the present group. Morocco, for example, developed a national broadband plan in 2012 that aimed at providing access to broadband to 100% of their population within 10 years from that time, providing high-speed broadband (at least 100 Mbit/s) to 50% of their population within 15 years, and to provide internet broadband access in all public administration offices within 3-5 years. In 2018[6], Egypt developed a digital transformation strategy that was built on three main pillars, Digital Transformation, Digital Skills and Jobs, and Digital Innovation. These three pillars are fixed on two important bases: Digital Infrastructure and Legislative Framework.

The third cluster includes Lebanon, Libya, Syria, the State of Palestine, and Iraq have major political conflicts that are affecting their performance. Iraq, for example, is still in the phase of rebuilding the economy.

Then there are the least developed Arab countries LDC's like Djibouti Mauritania, Yemen, Sudan, Somalia, and Comoros whose performances are relatively weak and who are struggling with digital development.

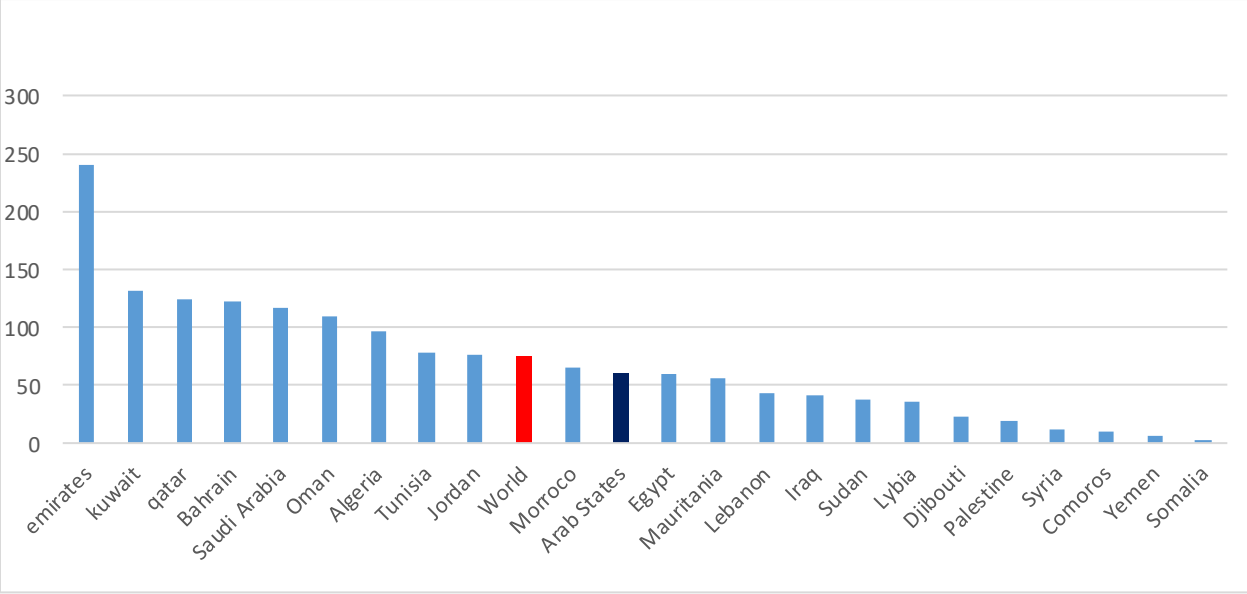
[1] https://www.citc.gov.sa/en/reportsandstudies/Reports/Documents/ICTInvestments_EN.pdf
[2] https://www.idc.com/getdoc.jsp?containerId=prMETA47399121
[3] https://www.motc.gov.qa/en/documents/document/ictqatar-annual-report-2012
[4] https://www.mcit.gov.sa/en/media-center/news/91809
[5] https://www.itu.int/en/ITU-D/Statistics
[6] https://www.mcit.gov.eg/en/Digital_Government

2.1 Mobile-broadband and fixed-broadband market

2.1.1 Mobile-broadband

Average active mobile broadband subscriptions in the Arab States region reached 60 per 100 inhabitants in 2019, 15 percentage points below the global average which was 75. While the six GCC countries lead the region in mobile broadband subscriptions with rates exceeding 100 per 100 inhabitants, more than half of the countries have subscription rates below the world and Arab States region averages. The main reason behind the low mobile broadband subscriptions that have been shown in some countries is due to taxes on consumers of mobile services and devices and on mobile operators which are often sizable, affecting affordability and infrastructure expansion. According to the GSMA report "Rethinking mobile taxation to improve connectivity" the consumers and operators are paying taxes in excess of 30 percent in Jordan and Tunisia and in excess of 20 percent across the Middle East and North Africa.

Figure 1: Active mobile broadband subscription / 100 inhabitants (2019)

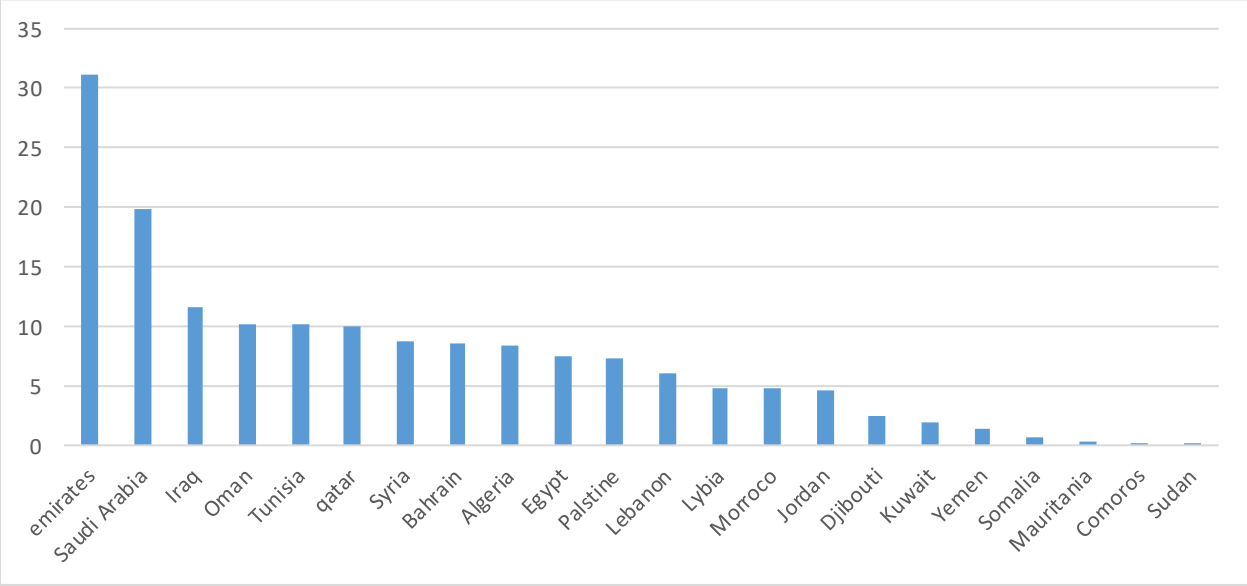


Source: International Telecommunication Union Dashboard

2.1.2 Fixed broadband

The fixed-broadband subscription rates per 100 inhabitants in the Arab States region are low compared with other regions. This is due to the average household size which is larger on average in the Arab States region than in Europe or the Americas. ITU estimates a fixed-broadband penetration level of 8.1 subscriptions per 100 inhabitants for the region in 2020, about half of the global average of 15.2 subscriptions per 100 inhabitants. Only the UAE and Saudi Arabia within the region, have achieved a level of fixed-broadband subscriptions per 100 inhabitants greater than the global average. Most countries have subscription rates below 10 per 100 inhabitants.

Figure 2: Fixed broadband subscription per 100 inhabitants in 2019



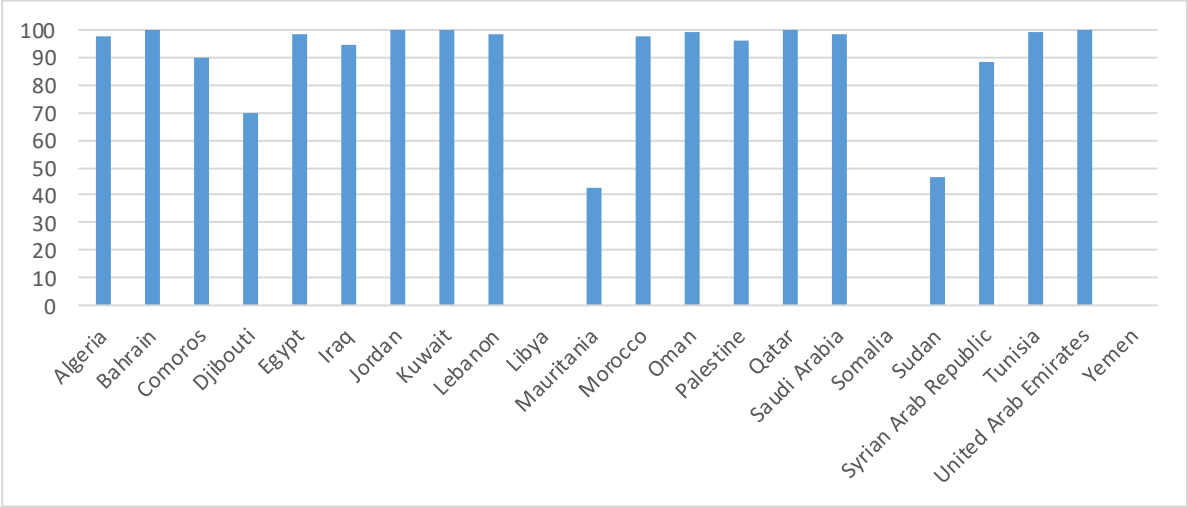
Source: International Telecommunication Union Dashboard

2.2. Networks coverage

This indicator measures the percentage of the population covered by at least a 3G mobile network. Increases have occurred for most Arab countries. Almost all Arab countries have approximately a 100% of their population covered by a 3G network except for Djibouti, Mauritania, and Sudan who are considered among the least developed countries. Such finding, however, comes with no surprise as 3G technology is relatively old. It is important, however, to mention that countries like Bahrain, Kuwait, and UAE have had a zero percent growth in 3G coverage as they have had a 100 percent coverage back in 2016 already. Egypt as well has achieved a zero percent growth as this indicator has remained unchanged at 98.7% since 2016 and all the way up to 2018[7]. The same occurred for Tunisia with an unchanged coverage at 99%. Data were missing for Libya, Somalia, and Yemen.

[7] International Telecommunication Union Dashboard

Figure 3: 3G mobile coverage (2018)



Source: International Telecommunication Union Dashboard

Concerning the LTE/4G network coverage, data is missing for most Arab countries. Such finding suggests that 4G technology is still slowly disseminating in the Arab community even though 4G was globally introduced back in 2008. In Egypt, for example, it was not until 2016 that mobile network operators (MNOs) obtained their 4G licenses. In 2017, Egypt had a 61% 4G network coverage that later jumped to 89% in 2018. On the other hand, some countries like Algeria, Comoros, Lebanon, and Tunisia have made major progress regarding the spread of the 4G network across their lands. Algeria alone has made the biggest leap in terms of 4G network growth, growing from 3.62% in 2016 to 52.84% in 2018 with a massive growth rate of 1360%. And then there are countries like Saudi Arabia, Qatar, and UAE who have the lowest growth rates, since these countries are considered the richest among Arab states, they have had a widespread of 4G networks even before 2016. 4G coverage in 2018[8] reached 93.1% in Saudi Arabia, 99.5% in Qatar, and 99.73% in the United Arab Emirates. While COVID-19 may have had a slowing impact on the number of new network launches in 2020, 5G activities are picking up pace in the following Arab countries, Oman, Bahrain, Saudi Arabia, and Emirates.

2.3 Internet Speed

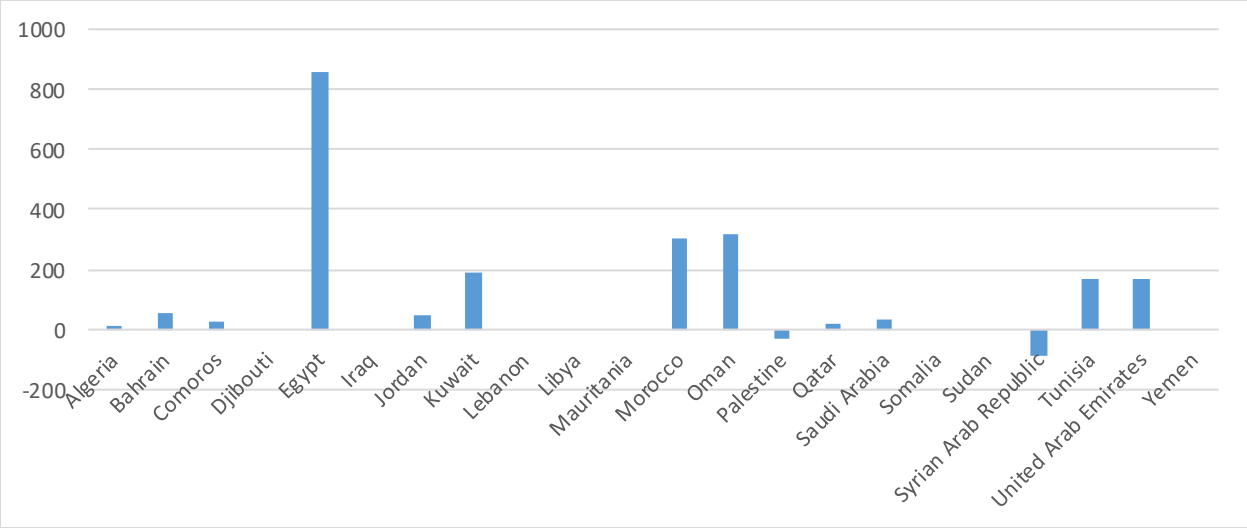
This indicator measures the number of subscriptions having an internet speed of 10 Mbit/s or above. The figure illustrates the growth rates in internet speeds over the period 2016-2018. Most Arab countries have progressed and improved their internet speeds. Among all, Egypt has the highest growth, 855%, a rate which reflects the major investments in the ICT infrastructure that the Egyptian government has been undertaking[9]. Syria and Palestine were the only countries to

[8] International Telecommunication Union Dashboard

[9] https://www.almasryalyoum.com/news/details/2316555

score a negative growth, but this can be attributed, as previously mentioned, to the political conflicts that they are suffering from. Data were missing for each of Djibouti, Iraq, Lebanon, Libya, Mauritania, Somalia, Sudan, and Yemen.

Figure 4: Internet Speed Growth % - 2019



Source: International Telecommunication Union Dashboard

2.4. Internet access and use

With the evolution of digital technologies, ICT, and the internet, becomes even more crucial as a driver for daily activities. It was not until the time of COVID that the Arab region has finally recognized the true importance of ICT in preserving the pace of our daily life, like work, health and education, but remotely. This section tackles the usage of ICT in Arab countries. Results in this part are highly correlated with the findings of the previous section, which means that countries with a well-built ICT infrastructure are generally the same countries with high ICT usage. Moreover, Table (1) shows that the Arab region sits just above the world average for Internet access at home, individuals using the Internet, and men's use of the Internet. As the percentage of households who had Internet access at home across the region reached 58.9% and 54.6 % of individuals were using the Internet in 2019[10]. As for the Internet users in terms of a gender perspective in the Arab region have ensured a significant gap as the women continue to use the Internet on average across the region less than on the global level 47.3%, while the men are much higher and reaching 61.3% in 2019 as shown in table (1), globally 48.4 %of women and 55.2 % of men used the Internet the same year[11].

[10] International Telecommunication Union Dashboard
[11] International Telecommunication Union Dashboard

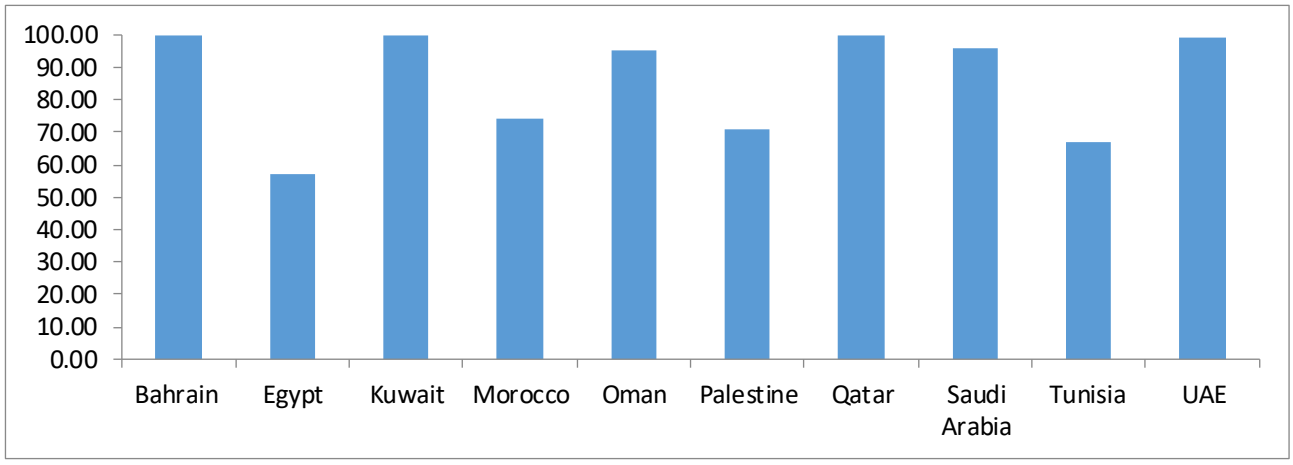


Table 1: Internet access use in Arab countries compared to the global level

	Internet access at home	individuals using internet	Men	Women
Arab countries	58.9	54.6	61.3	47.3
World	57.4	51.4	55.2	48.3

Source: Digital trends in Arab States, 2021

2.4.1 Internet Users

The percentage of individuals using the Internet differs significantly in the Arab region. GCC countries are leading the region with percentages exceeding 90%. The data show that Internet use has increased during 2017-2019[12] in all Arab countries for which data were available and the largest increases were in Iraq (23.3 %) and Egypt (12.9 %), followed by Morocco (9.7 %), Tunisia (9.6%) and Oman (7.4 %) over the period 2017-2019. As illustrated, data was only available for the displayed countries and was missing for the rest. The chart suggests that internet users in Gulf countries including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE represent the biggest proportion of the population compared to the rest of the Arab region reaching 99.7% in Bahrain, 99.54% in Kuwait, 95.23% in Oman, 99.65% in Qatar, 95.72% in Saudi Arabia, and 99.15% in the United Arab Emirates. Again, such finding comes with no surprise as these countries are the richest among the region, and have well-built ICT infrastructure, and most importantly have the highest income per capita relative to the rest of the Arab countries.

Figure 5: Internet users in selected Arab countries (%, 2019)

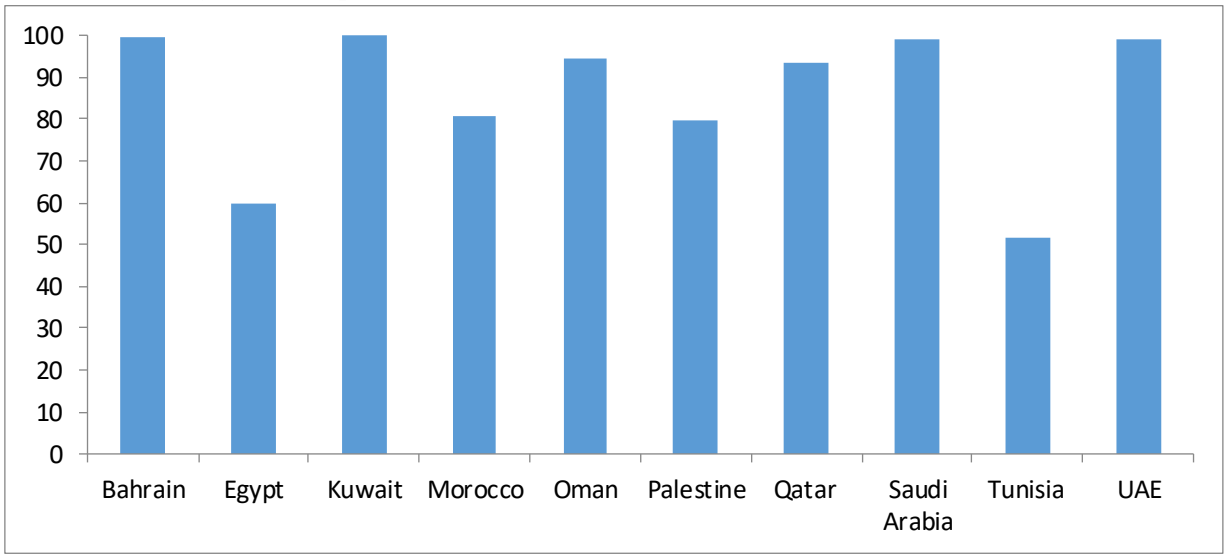
Source : International Telecommunication Union Dashboard

[12] International Telecommunication Union Dashboard

2.4.2 Internet access at home

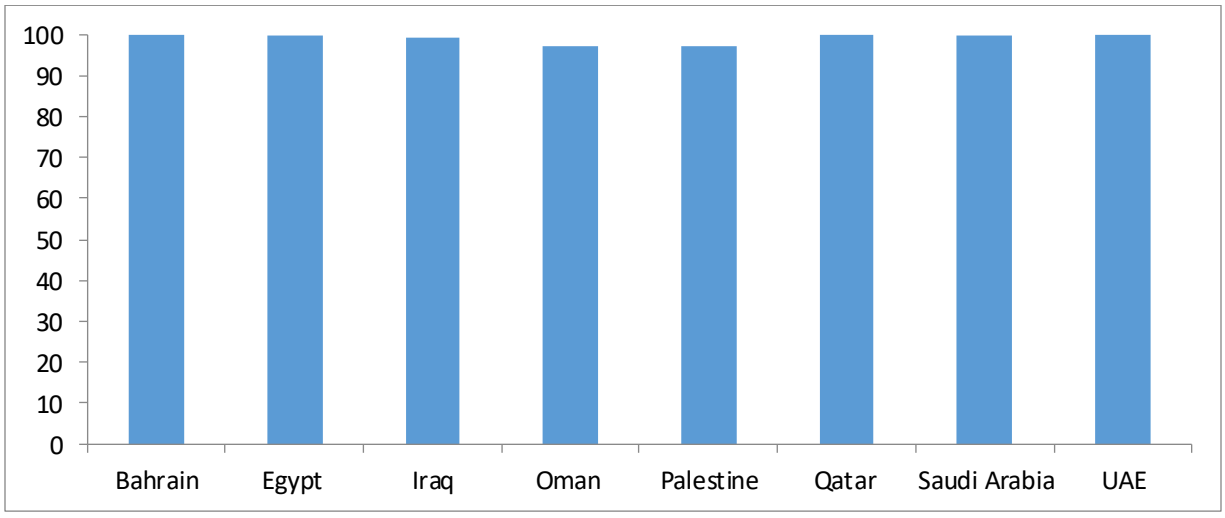
The average penetration rate of households with Internet access in the Arab region reached a percentage of 58.9 which is above the global level, as shown previously in Table (1). Looking at the data on a country level, it is noticeable that the GCC countries lead the region with over 90% of households having Internet access. As for the Household Internet access indicator for the years 2017 and 2019, it has grown across all countries for which data were available. Palestine, Morocco, Egypt, and Tunisia have been showing the highest growth as follows; 24.4%, 7.2% 10.4%, 7.5%.

Figure 6: Proportion of households with Internet access at home (2019)



Source : h International Telecommunication Union Dashboard

Figure 7: Individuals with a mobile cellular telephone (2019)



Source : International Telecommunication Union Dashboard

2.4.3 Individuals with a mobile cellular telephone

This indicator measures the proportion of individuals who own a mobile cellular telephone. Data was only available for the above displayed countries and show that the proportion of individuals with cellular phones is more than 100% in some GCC countries such as Bahrain, Saudi Arabia, Qatar and UAE.

2.5. Digital Skills

Data for ICT skills were available for a few countries in the Arab region. Table (2) shows the ICT skills as defined by the ITU to include basic, standard, and advanced varies across the various countries. While the following countries Bahrain, UAE, Tunisia, Saudi Arabia, and Kuwait are leading the way in advanced-skill penetration, with levels between 13 to 18%. The Basic skills penetration in Oman, United Arab Emirates, Bahrain, Kuwait, Egypt, and Saudi Arabia is well above 50%. Standard-skill penetration is lower across the same countries, with levels of between 30% and 50%, and has the notable percentage even distribution across all skill categories, with levels of between 16 and 20%. Despite the above-mentioned indicators, there's still a significant prospective for skill development within the Arab region, especially for standard and advanced skills.

Table 2: Scores of selected countries in digital skills

Country	Basic skills	Standard Skills	Advanced Skills
Oman	75.4	36.7	8
UAE	72.3	60.4	17.9
Bahrain	60.8	42	18.1
Kuwait	57.7	43.7	13.4
Egypt	57.5	36.2	7.9
Saudi Arabia	56.7	49.6	13.8
Qatar	44.8	30.1	5.1
Morocco	36.6	27.8	9.3
Iraq	23.1	11.3	4.7
Tunisia	20	17.1	16.1
Algeria	17	12.1	6.9
Djibouti	15.8	12.6	4.5
Sudan	3	2.2	1.6

Source : International Telecommunication Union Dashboard

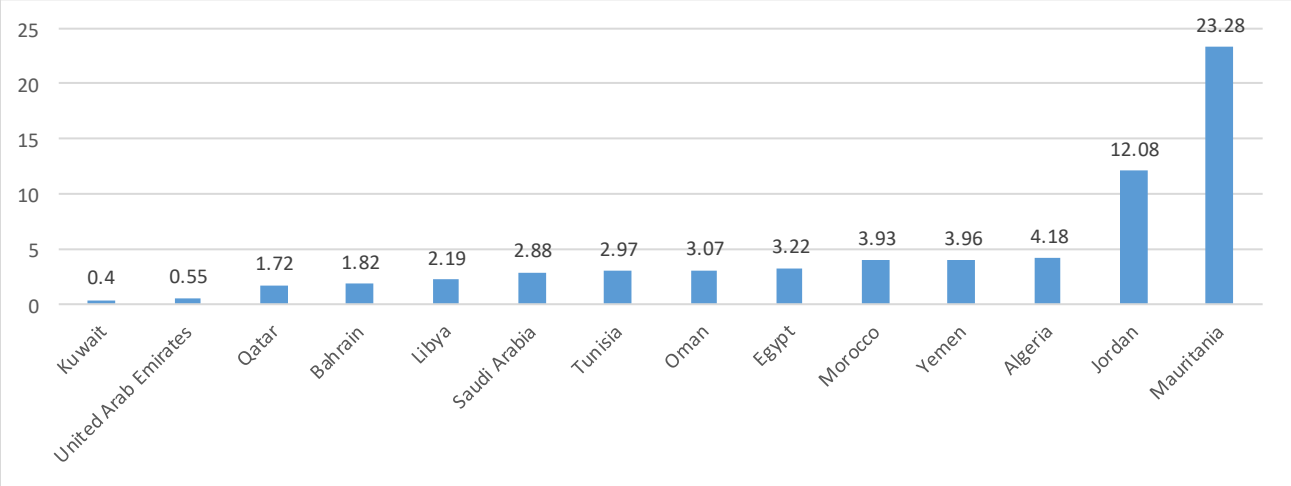
2.6 ICT prices

This section analyzes the prices for a variety of ICT services in Arab countries. It is important to mention that ICT prices are inversely correlated with ICT usage meaning that countries with relatively low prices for ICT services tend to have the highest ICT usage and vice-versa. Typically, prices in Gulf countries like Bahrain, Qatar, Saudi Arabia, and UAE have the lowest price bundles for ICT services which is one of the reasons that explain why these countries have the highest ICT usage.

2.6.1 Fixed broadband 5GB 2019-2020 (as % of GNI per capita)

Results coincide with the previous findings regarding ICT usage and indicate that Gulf countries, with Kuwait at the front, have the lead in terms of the cheapest prices. North Africa follows, with Libya being the cheapest country among its counterparts. Jordan and Mauritania are the extreme outliers and have the highest prices across the Arab region.

Figure 8: Fixed broadband 5GB 2019-2020 prices (as % of GNI per capita)

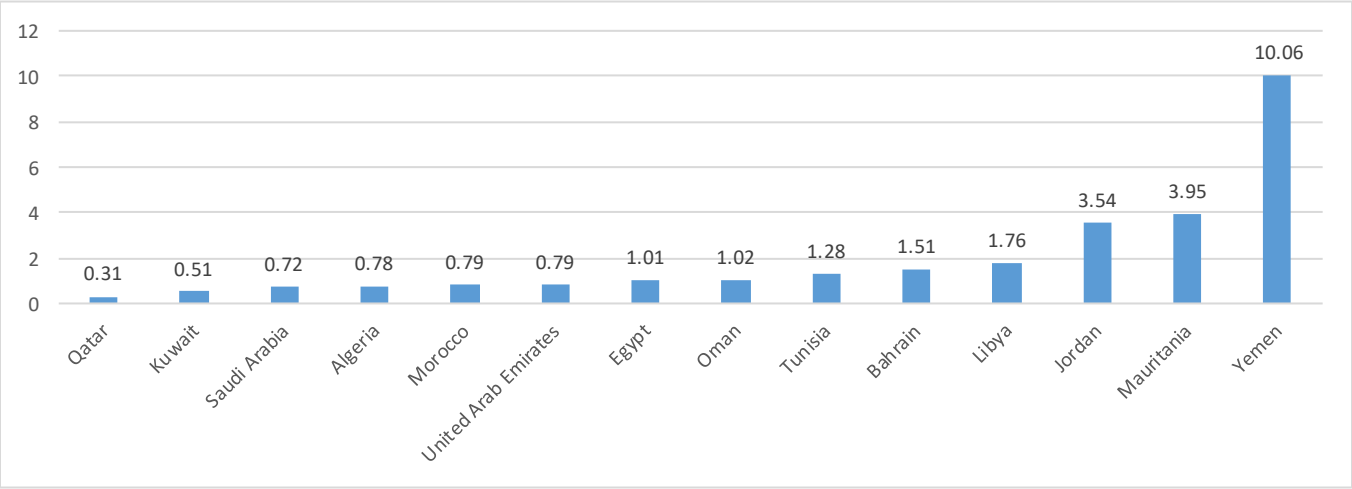


Source: International Telecommunication Union Dashboard

2.6.2. Mobile broadband data only 1.5 GB 2019-2020 (as % of GNI per capita)

Results here are pretty much identical to the previous finding. Gulf countries followed by the North African nations have the lowest prices. However, in this regard, Yemen is the outlier with the highest prices for mobile data.

Figure 9: Mobile broadband only 1.5 GB 2019-2020 (as % of GNI per capita)

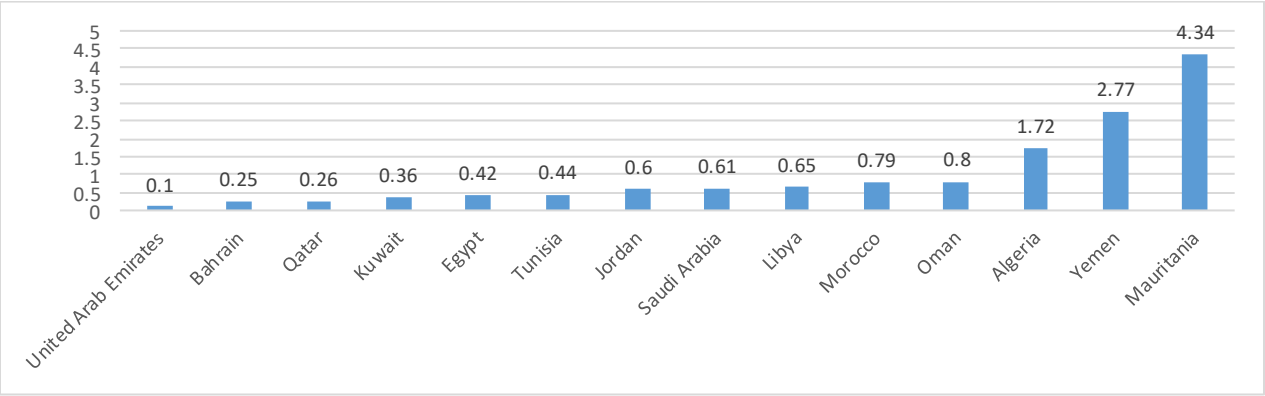


Source: International Telecommunication Union Dashboard

2.6.3. Mobile Cellular Low Usage 2019-2020 (as % of GNI per capita)

Results indicate that Gulf countries represented by UAE, Bahrain, Qatar, and Kuwait have the cheapest prices. On the North African level, Egypt followed by Tunisia have the lowest prices. Unlike previous indicators, Algeria is the third, after Mauritania and Yemen, most expensive country in this regard.

Figure 10: Mobile Cellular Low Usage 2019-2020 (as % of GNI per capita)

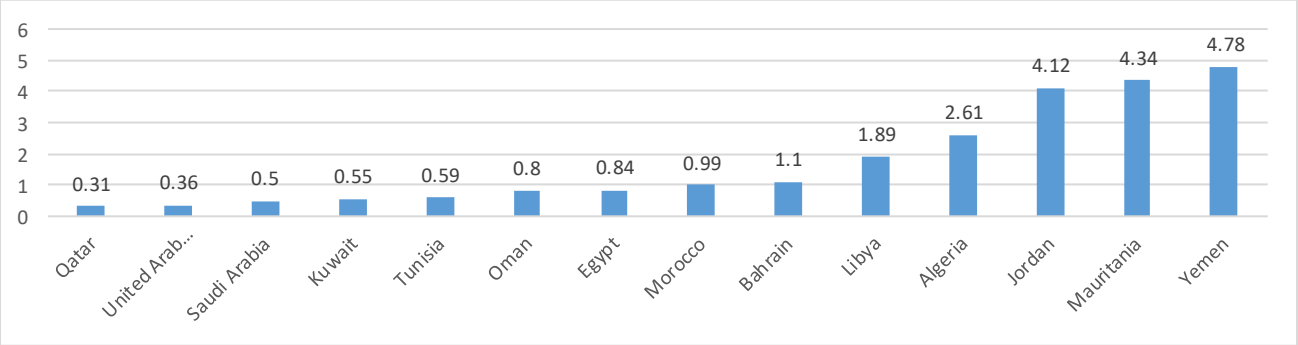


Source: International Telecommunication Union Dashboard

2.6.4. Mobile Data and Voice Low Usage 2019-2020 (as % of GNI per capita)

Similar results occur here as well with Gulf countries like Qatar, UAE, Saudi Arabia, and Kuwait being in the lead in terms of the lowest prices. North Africa follows with Tunisia being in the lead followed by Egypt. Jordan, Mauritania, and Yemen all represent the outliers with the highest prices across the Arab region.

Figure 11: Mobile Data and Voice Low Usage 2019-2020 (as % of GNI per capita)

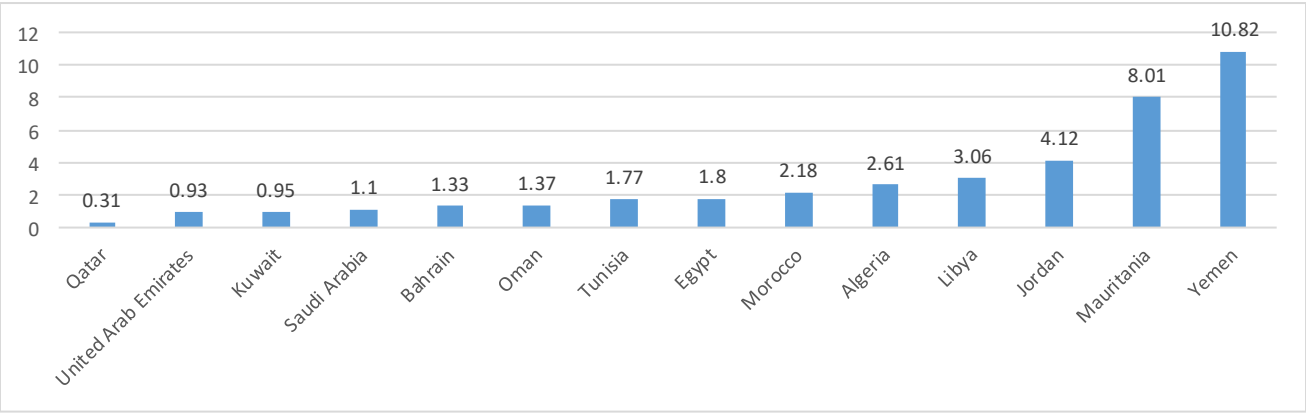


Source: International Telecommunication Union Dashboard

2.6.5. Mobile Data and Voice High Usage 2019-2020 (as % of GNI per capita):

No changes here as well. Gulf countries represented by Qatar, UAE, Kuwait, Saudi Arabia, and Bahrain have the lead regarding the cheapest prices followed by Egypt, Tunisia, Morocco, and Algeria representing North Africa. Mauritania and Yemen are the outliers with the highest prices.

Figure 12: Mobile Data and Voice High Usage 2019-2020 (as % of GNI per capita)



Source: International Telecommunication Union Dashboard

3. COVID19 and Digitization in Arab Countries

Like most countries across the world struggle with the consequences of the COVID-19 pandemic, the role of ICTs and digital services and therefore the digital infrastructure on which they rely and grow has become central to continued economic and societal activity and to diminishing the impact of the pandemic. The COVID-19 crisis emphasizes the importance of digital connectivity to society and has highlighted the impact of the continuing digital divide for nearly 350 million people within the Arab region who are still unconnected. In 2019, 61.3 percent of men and 47.3 percent of women used the Internet. Moreover, 38.4 percent of households living in rural areas and 74 percent of households living in urban areas had access to the Internet in 2019. Among the age category 15-to-24-year-old, 67.2 percent used the Internet in 2019, just below the world average of 69 percent[13].

3.1 5G

While COVID-19 may have had a slowing impact on the number of new network launches in 2020, 5G activities are picking up pace in the following Arab countries: Oman and Bahrain which launched new commercial 5G services in September 2020; in Saudi Arabia, Zain has 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 within 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.

3.2 Education & healthcare[14]

Furthermore, other digital solutions experienced a lift within the region during the pandemic and are likely to continue the "new normal" including new approaches to education and healthcare.

In education, new solutions to distance learning have been developed in Jordan, Morocco and Lebanon. In Morocco, the Ministry of Higher Education has partnered with national television networks to broadcast educational material across the nation, including in remote underserved communities. In Jordan, the Ministry of Education in cooperation with the Ministry of Digital Economy and Entrepreneurship (MoDEE) through a public-private partnership and a private company has created Darsak, an educational platform that provides classes for all grades following the national curriculum. At the same time, there has been a significant rise in the development of

[13] ITU data bases

[14] https://www.mei.edu/publications/covid-19-and-digital-landscape-gulf
http://www.emro.who.int/noncommunicable-diseases/publications/success-stories.html
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7473704/
http://www.emro.who.int/noncommunicable-diseases/publications/success-stories.html
https://eu.boell.org/en/2020/04/09/digitalisation-and-coronavirus-morocco-care-control
http://www.emro.who.int/noncommunicable-diseases/publications/success-stories.html

distance learning technologies and mobile applications, such as Kitabi Book Reader in Lebanon. In Saudi Arabia, during lockdown, both public and private educational institutions, primary and higher education, used various two-way e-learning methods to continue teaching and student learning. Ministry of Education used their distance learning portal "EIN" and "Vschool" to smooth that shift. "EIN" presents a television channel that broadcasts daily lessons. It has been redirected to provide live tutoring of all school level subjects and lessons daily from 8:30 AM to 12 PM on weekdays. "EIN" also provides a website through which students can interact with their teachers and undertake exercises. The "vschool.sa" portal is unique to Saudi Arabia that complements "EIN". It is a unified learning portal, developed by the Ministry of Education, which provides synchronized web-based tutoring, assessment tools, learning material, and apps for smartphone access. In Egypt, The Ministry of Education launched the "Egyptian Education Platform" which is a common platform for all school students for online classes purposes. As for college students, they depended on institute-based platforms such as MOODLE and Blackboard. In the following academic year, 2020-2021, both ministries depended on a "hybrid" method of education meaning that students were capable of mixing between attending classes online or physically in their school/college. In case there is a surge in new COVID cases, students can switch back to online learning as the main source of acquiring knowledge.

Similarly, the COVID-19 crisis is showing the potential of digital solutions within the healthcare sector for the prediction and mitigation of infections outbreaks. For instance, Qatar made it mandatory for all citizens and residents to put in its coronavirus contact tracing application "Ehteraz" on their mobile devices when leaving their home, allowing the government to trace if users have been in close contact with an infected person. In the United Arab Emirates, a healthcare start-up called Nabta Health is using AI to assess the risks of COVID-19, that specialize in women with underlying health conditions. In Saudi Arabia, to restrain the mobility of the public, as a precautionary measure, the Saudi Data and Artificial Intelligence Authority "SDAIA" developed two mobile apps. The first is called "TAWAKKALNA" which is a GPS-enabled app that serves in tracking and restricting the movement of individuals during curfew hours with the possibility of issuing permits for exceptional purposes. The second app is called "TABAUD" that sends an alarming notification to people whenever they get in close contact with a confirmed COVID-19 case[15].

3.3 Digital Banking

Digital banking in the Arab region got significant attention during the pandemic. In Egypt, for example. digital banking induced a change in the patterns of the Egyptian consumer behavior was obvious with people staying at home to preserve social distancing. In fact, an economic report by MasterCard Economics Institute showed that more than 72% of Egyptian have shopped online

[15] http://www.emro.who.int/noncommunicable-diseases/publications/success-stories.html
https://www.mei.edu/publications/covid-19-and-digital-landscape-gulf

since February 2020[16]. E-commerce platforms have also flourished in parallel with the global spread of the coronavirus. The leading e-commerce platform in Egypt, has witnessed a 66% increase in demand on its platform since the emergence of the pandemic. In the first six months of the pandemic, the number of mobile wallets in Egypt[17] has increased by no less than 17% and the number of e-payment cards has also increased by more than 7%. In response, many banking institutions including Banque Misr, BLOM Bank, and National Bank of Egypt have all increased their e-service capacities to face the surge in the demand.

3.4 Informal sector

The spread of coronavirus has widely affected the economic well-being in all Arab countries. In Morocco, for example, there are more than 2.4 million citizens working permanently in the informal sector such as housekeeping staff in private homes, street vendors, catering staff, as well as seasonal agricultural workers. These segments were fortunately supported by their government. Morocco's Economic Monitoring Committee pledged to provide rapid support to those in the informal sector who have lost their jobs as result of the precautionary measures. Those without a social security number were able to register just by submitting their telephone number and their national ID number as well. Shortly, these individuals should receive a code by text authorizing them to withdraw a specific amount of money that is proportionate to the size of their household. Withdrawals can be made across 10000 banks, cash machines, and money transfer agencies across the Kingdom[19]

In parallel with the outbreak of the Covid-19 pandemic, Arab governments strived to respond to the crisis and to identify the actions needed to enhance the broadband networks and improve the internet services. Despite all the initiatives, however, there are still some problems and challenges facing the ICT sector in Arab countries. The COVID-19 crisis has proven to the world that countries need to accelerate their digital transformation for more socioeconomic development and as a frontline defense mechanism against any global crisis like the one the world is currently witnessing. Hence, with the ease of the precautionary measures and the slow recovery of the economic activity around the globe, governments of the Arab region should place efforts to find solutions for increasing the capacity of broadband connections, reconsidering its costs, managing network congestion, ensuring the continuity of provision of vital public services, enhancing digital financial technologies, and the development of digital skills. Such solutions are of extreme importance especially that the demand for e-services like e-commerce and e-payment has tremendously increased in response to the pandemic.

[16] Ministry of ICT (Egypt).
18 https://www.tra.gov.eg/en/the-```ntra-issues-its-report-on-complaints-tracking-and-follow-up-system-for-q3-2020-2/

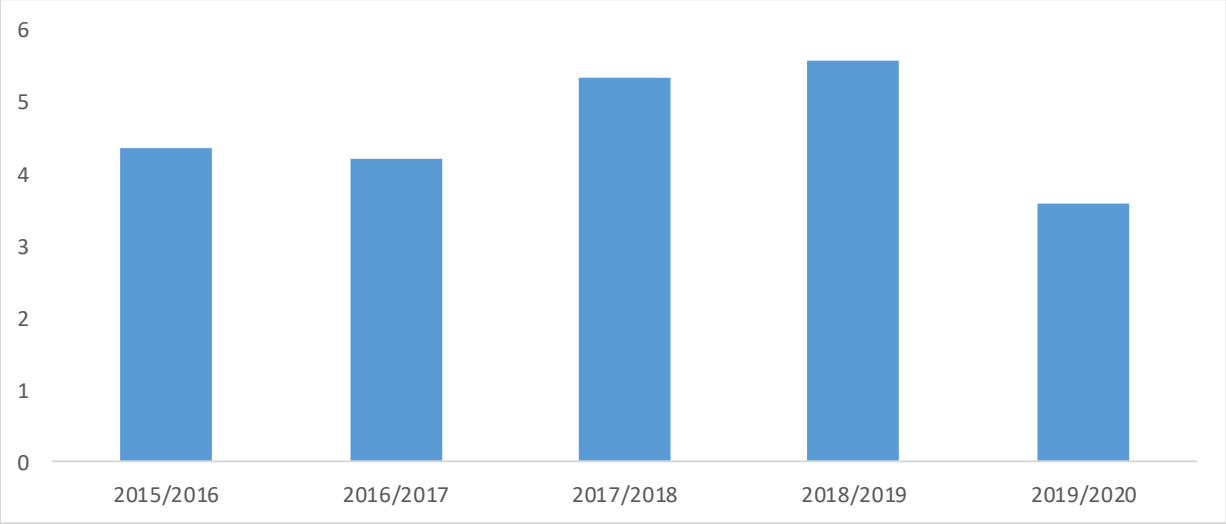
19 https://www.tra.gov.eg/en/the-ntra-issues-its-report-on-complaints-tracking-and-follow-up-system-for-q3-2020-2/

4. Public Expenditure on ICT and Economic Growth

The public expenditure, or government expenditure, is the state's spending on the different sectors of the economy including health, education, ICT, public goods, …. etc. It can be divided into two broad categories: public consumption and public investment.

Arguably, public expenditure has an impact on economic growth. In economic theory, there has been a great debate about the true nature of the relation between both variables. The Keynesian theory, on one hand, suggests that public expenditure has a positive impact on economic growth with the argument that the more government spends implies an expansionary fiscal policy which in turn results in higher economic growth. On the other hand, Classical theorists suggest that public expenditures have negative impact on growth claiming that government spending is bad for economic growth with the argument of the *crowding-out-effect* which argues that government spending substitutes the critical investments that should be carried out by the private sector due to resource constraints. Even on the empirical level, there has been a great discrepancy between results of the multiple research papers who attempted to identify the relation between both variables. Results were divided between cases who showed positive relation, negative relation (Nurudeen, 2010), and even insignificant impact in some cases (Torgler, 2006).

Figure 13: Real economic growth rate in Egypt



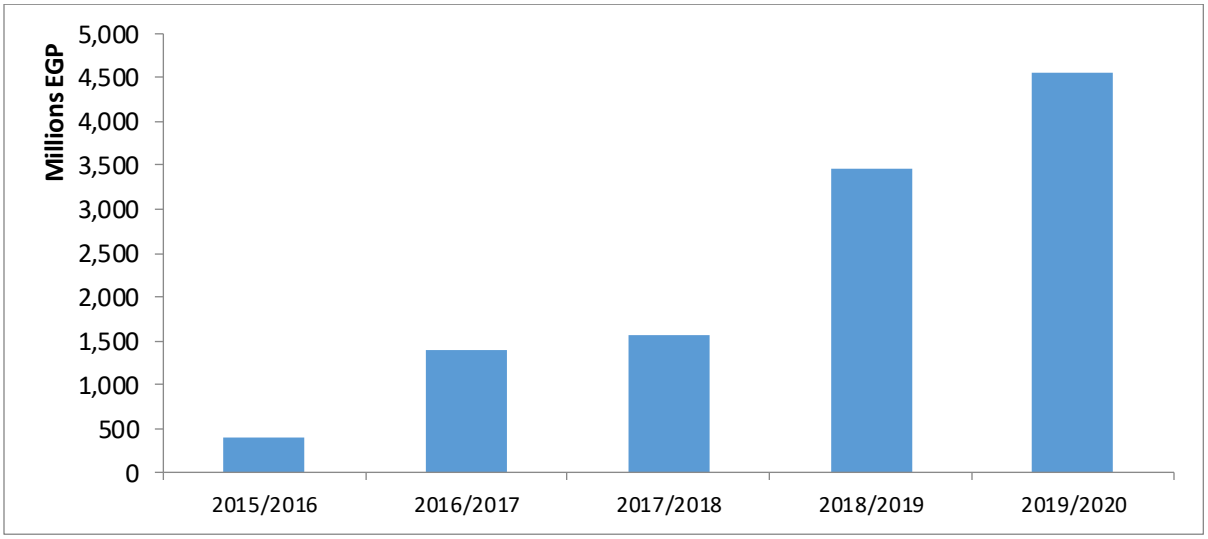
Source: https://mped.gov.eg

In this section, we try to analyze the economic impact of the public expenditure on ICT. In other words, we try to discover the relation between public expenditure on ICT and the economic growth rates. This is done by measuring the correlation between the two variables and descriptively analyzing the trends of both variables in attempt to discover the nature of the relation between public expenditure in ICT and economic growth rates. It is worth noticing that the data, in the case

of Egypt[20] show the relation between both variables is positive. As for the social impact, ICT is incorporated in all socioeconomic sectors of the economy thus has an indirect positive impact. ICT is often perceived as catalyst that is used in multiple sectors for more efficient delivery of the service and has an impact on socioeconomic development. The measurement of such impact requires an empirical case or a survey to be conducted.

Figure 13 displays the real growth rates that the Egyptian economy has been achieving high real growth rates over the past years. The highest growth rate was witnessed in the fiscal year 2018/2019 which reached 5.56%. The growth rate dropped in the following year to 3.57% due the widespread of the COVID-19 virus and the outbreak of the global pandemic which negatively affected the global economy.

Figure 14: Egypt public investment on ICT



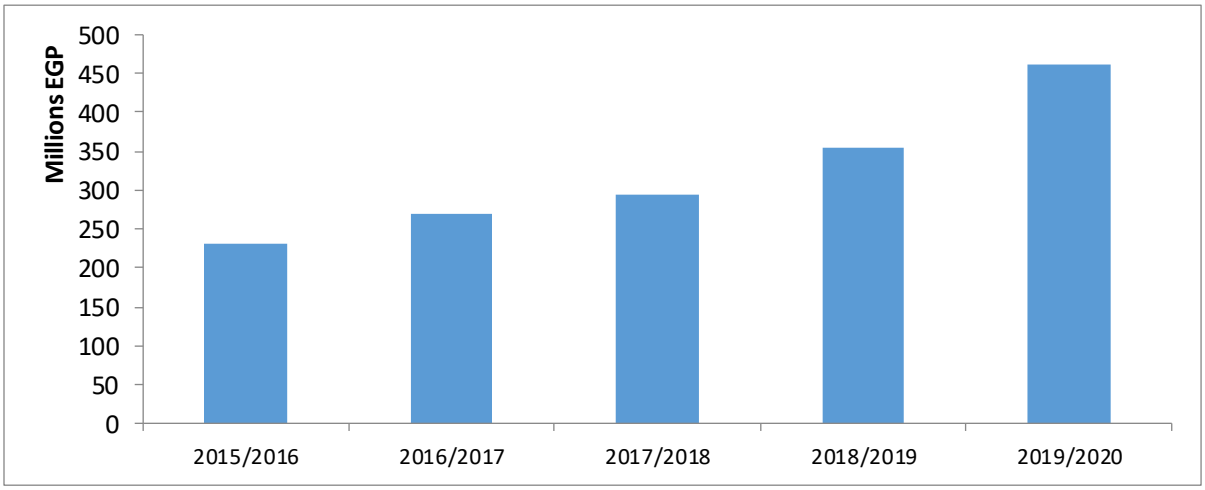
Source: https://mped.gov.eg

In terms of public investments in ICT the data show that the public investments in ICT has been regularly increasing over the past five years. In fact, the variable witnessed a tremendous increase in the last two fiscal years, jumping from 1.55 billion EGP in 2017/2018 to 3.47 billion EGP in 2018/2019 with a growth rate of 123%, the same variable then reached 4.56 billion EGP in the fiscal year 2019/2020 marking a growth of 31%. Overall, the public investments in the ICT sector witnessed a growth by 1050% which means that public investments in ICT grew by 10.5 times overall the last five-year period thanks to the focus of the Egyptian Government on Digital Transformation policies. Egypt has been adopting a strong course of action in transforming the existing government services and community ecosystem to an entirely digital and data driven ecosystem, to provide public services in a faster and simpler way. Several e-services have been developed and launched for a number of entities, including law enforcement, notarization, personal status, family courts…etc. Digital Egypt, e-platform has been launched to provide better, wider and more effective access to a wide range of public services mentioned previously. Furthermore,

Egypt has developed an integrated strategy to build a base of digital competences for all society segments, including school and university students, graduates, professionals, women, and persons with disabilities. The government also endeavors to promote research and development, innovation and entrepreneurship in the field of ICT to drive sector growth, support sustainable national development and position Egypt as a regional innovation hub. It adopts effective policies on ICT-based innovation through concerted efforts among stakeholders, including the government sector; academic and research institutions; financial institutions; the private sector; entrepreneurs; and the support networks that incubate creative ideas and convert them into value-added products to meet the sustainable development challenges.

Also, an Applied Innovation Center (AIC) has been established to promote the use of emerging technologies in tackling, analyzing and solving national challenges, with the aim to attain sustainable development in different sectors, including agriculture, healthcare and education, as well as developing the human capital and creating an enabling environment for the growth of innovative startups. According to a report published in March 2020, by MAGNiTT, a renowned startup platform, Egypt recorded the highest number of startup funding and investment deals in the Middle East and North Africa (MENA) region, during the first quarter of 2020, achieving 37% of the total number of deals.

Figure 15: Egypt public consumption of ICT



Source: https://mped.gov.eg

In terms of public sector's consumption of ICT, the data show that the public consumption has also been regularly increasing over the years, though it has not witnessed significant increases like in the case of public investments. Overall, public consumption of ICT marked a growth rate of 99.9% which means that throughout the five years, the variable grew by only one time. It is worth noticing that consumption, in general, is important for economic growth.

By observing the three above charts, we can detect that public expenditures on ICT are positively correlated with Egypt's economic growth. However, public investments in the ICT sector seem to have a much stronger relation than that of public consumption in the same sector. Increases in public investments in the ICT sector has contributed to achieving high economic growth over the years. This suggestion is supported by the Economic Theory. Theoretically, economic growth can only be achieved through technological progress, one way to achieve technological progress is the investment in ICT. Empirical evidence also supports this finding. According to ITU econometric model on How Broadband impact the global economy, 2020, 10% Increasing in fixed broadband (BB) penetration and mobile BB penetration as proxies to the ICT investment drive an increase in GDP growth of Arab countries with 0.76%and 1.8%, respectively). As for the fiscal year 2019/2020, although growth dropped from 5.56 to 3.57, it was the ICT sector that supported the economy and helped in alleviating the heavy negative impacts of the global pandemic. After the COVID-19 outbreak, all daily activities and processes had to resume but remotely in coherence with the precautionary measures. People resorted to ICT to remotely proceed with their daily life. It is worth noticing that Egypt was one of the very few countries in the region that achieved positive growth rate in 2020, and a big part of the credit goes to the ICT sector that in turn was one of the few sectors of the Egyptian economy to witness a growth in the same year.

To sum up, public expenditure on ICT has a positive impact on economic growth. Theoretically, technological progress can induce economy which can be translated into higher public investments in ICT lead to higher economic growth. Therefore, policymakers should continue to increase the share of ICT in the government's budget (and to spend) because even in times of crisis like the one the World is currently witnessing, ICT has been used to recover and to ease the heavy negative effects of such global crisis.

4.1 Exploring the impact of ICT on economic growth (the case of Egypt)

We try in this section to attempt an empirical case based on the available time series data for Public expenditures on ICT and GDP growth rates through conducting simple nonparametric regression Models based on Theil-Sen single median model which is a Median-based Linear Model estimated using linear time median finding algorithm.

The aim of this model is to introduce the findings of the impact of the total ICT public expenditure which consists of expenditure on goods and services and expenditure on capitals. Since the only available data are from 2010 to 2020 only. The set of time series is too short to run a linear regression model or an advanced analysis that can efficiently study the impact of total ICT public expenditure and its components on the GDP with fixed prices.

Therefore, simple regression models are constructed based on non-parametric regression techniques. The advantage of that is the possibility of ignoring traditional linear regression assumptions using standard Ordinary Least Squares (OLS) estimation model. Theil-Sen non-

parametric regression models are constructed using R language treating the annual growth of total public expenditure on ICT and its components (public expenditure on goods and services and public expenditure on capitals) as independent variables and the annual growth rate of the GDP as a dependent variable. The model results show that only the total of public expenditure on ICT and the public expenditure on capital have positive impact on the annual growth rate of the GDP. The public expenditure on goods and services fails to achieve a significant effect. This can be interpreted as the effect of the total public expenditure on ICT and the expenditure on ICT capital are clear enough to be detected with short time series. However, the public expenditure on goods and services may need long time series to be studied.

Table 3: Coefficients of regressing annual growth rate of GDP on annual growth of total public expenditures on ICT and public expenditures on ICT capital

				Residuals diagnostic		
Variable	Model coefficient	P-Value	Standard error of residuals	Min	median	Max
Total public expenditure on ICT	.10*	0.02	.01	-.0007	-.0001	.02
Public Expenditure on ICT capital	.14**	0.006	.01	-.02	.006	.02
Public expenditure on goods & services	-0.05	0.23				

- ** significant at .01 level of significance
- * significant at .05 level of significance

GDP (fixed price)= .10 total ict public expenditure+.14 Expenditure on ict capital

Significant independent variables are only presented

According to the coefficients slopes of the model, a 10 percent increase in the annual growth of the total public expenditure on the ICT leads on average to a 1% increase in the annual growth rate of the GDP. Similarly, a 10 percent increase in the annual growth of the public expenditure on the ICT capital leads on average to a 1.4% increase in the annual growth rate of GDP. Residuals analysis of the regression models indicate that both models are fit.

These results may have some limitations which can stimulate future research to include other countries that were not included in this report due to the lack of data on them to run similar regression model with longer time series or even more advanced models such as structure equation

model (SEM) and Instrument Variable approach (IV). Instrumental Variable approach (IV) is a common technique in econometric models that takes into account the possible reverse relation between the dependent and independent variables. Such relation is typically known as Endogeneity.

4.2 Assessing the social impact of ICT in selected countries in the Arab region

We try in this section to investigate the social impact of ICT measured by the governmental expenditure on education in the following five countries (Egypt, Jordan, Morocco, Oman, and Tunisia) for the period 2011 -2019. Several literatures have proven the idea that the ICT may not have direct impact on the governmental expenditure on education, however, it may have an indirect impact (UNCTAD/DTL/STICT/2011). The impact of ICT in education has been assessed in various studies, with mixed results. For example, ICT may deliver significant educational benefits by providing tools for the teaching and learning process and by providing the skills needed in a society that is increasingly reliant on ICT. Conversely, students who enter such a world without those skills may be unable to fully participate and suffer from a digital-divide effect. The digital divide is likely to be a greater problem for developing countries, where access to ICT is generally lower than for developed countries. Other possible benefits of ICT in education are improved attitudes to learning, development of teachers' technology skills and increased access of the community to adult education and literacy (OECD, 2010b; Kozma, 2005)

Since the data is not sufficient to construct a path analysis, that is the most suitable method to test the indirect effect and the mediating variables, to validate this assumption, we resort to Pearson correlation coefficients that can show an indication of the indirect social impact of ICT.

First, we define the variable that measures the ICT /technology adoption which in our case is the R&D expenditure on education (proxy for the ICT adoption). Second we test whether it is correlated with the countries' ranks in the global innovation index (GII), the well-known index which aims to capture the multi-dimensional aspects of innovation and provide the tools that can assist in tailoring policies to promote long-term output growth, improved productivity, and job growth. Third, the countries' ranks in the global innovation index are then tested whether they are correlated with the GDP with fixed prices of the specified countries in the same period which in turn are tested whether they are correlated with the governmental expenditure on education.

The following tables show the correlation coefficients between R&D expenditure (education sector) and the countries' ranks in the global innovation index, the global innovation index ranks and the GDP and finally the GDP and the governmental expenditure on education. This suggestion does not reflect the causality between the study variables especially that there are no enough points for each country.

Table 4: Correlation between R&D expenditure on education and Global Innovation index rank

Table 5: Correlation between Global Innovation index rank and GDP with constant prices

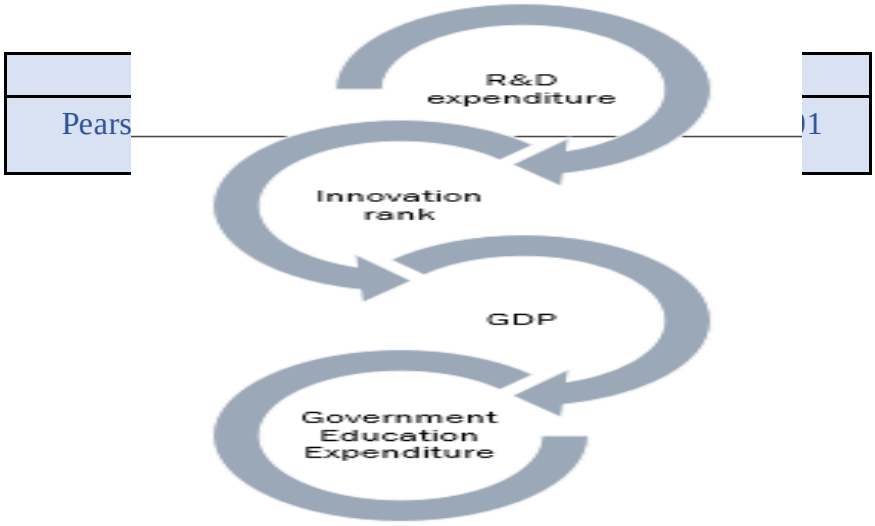
	Coefficient	P-Value
Pearson's R	.766	Less than .0001

Table 6: Correlation between GDP and Government Expenditure on education

	Coefficient	P-Value
Pearson's R	.864	Less than .0001

The above-mentioned results indicate that ICT may have an indirect impact on government education expenditure. All correlation coefficients are high and significant that may indicate increasing R&D expenditure is accompanied with increase in the country's ranks in the global innovation index. Consequently, increasing the country's rank in the global innovation index could be related to an increase in the country 'GDP values that finally trigger the increase in the Government Expenditure on Education

Figure 16: The indirect relation between the R&D expenditure and the Government expenditure on education



To sum up, the results from the previous correlation analysis show that the ICT has a social impact and the above figure explain it as follows: when government's increases the spending on R&D of education and provides conducive environment to innovation, such as the presence of technology incubators, these lead to an increase in the government's position in the global innovation index which can be reflected by the ability of young people to produce advanced technological products/establish their own companies and reaching output growth market . Increasing the state's GDP helps in increasing spending on its various programs, the most important of which is the expenditure on education as proper example for social impact and health care sectors might be another example for future research. Therefore, policymakers should continue to increase the share of expenditure on R&D on education in the government's budget.

5. Policy Recommendations: suggested methodology and indicators that could be adopted in the Arab region to develop impactful fiscal policies in ICT

As previously shown, there has been a range of different methods and approaches utilized to measure the socioeconomic impact of ICT. Among these approaches, the linear regression models, the structure equation model (SEM) or the instrumental Variable approach (IV) (ITU econometric report on how BB, digitization and ICT regulation impact global economy) which are efficient in measuring socio-economic impact of ICT assuming achieving their assumptions. Although these advanced approaches are more complicated and require more assumptions to be met such as normality, homoscedasticity, large sample size, correct model specification, they are common techniques in the econometric models that consider the possible reverse relation between the dependent and independent variables. Such relation is typically known as Endogeneity.

Unfortunately, in some circumstances, the assumptions of the previous mentioned techniques are not satisfied. A possible solution is to use subtler methods such as Theil-Sen non-parametric regression models. Non-parametric regression models are superior to other parametric regression models in case the conditions of parametric techniques are not met. (this is a basic principal in the statistical inference techniques), but their drawbacks are the imitations of their results. The Non-parametric regression models were applied in this paper adopting the GDP growth rates as independent variable, and the public consumption on ICT and Public investments on ICT as covariates.

As well, the analysis show that the ICT has a social impact and it was explained as follows: when government's increases the spending on R&D of education and provides conducive environment to innovation, such as the presence of technology incubators, these lead to an increase in the government's position in the global innovation index which may be reflected in young people who produce advanced technological products/establish their own companies and reaching output growth market. Increasing the state's GDP helps in increasing spending on its various programs, the most important of which is the expenditure on education and health care sectors. Therefore,

policymakers should continue to increase the share of expenditure on R&D (education sector) in the government's annual budget.

That being said, looking at all different methodologies, it can be concluded that digital transformation has become of extreme importance to the global economy in general and has been on top of policymakers' agendas around the world. Times of crisis like the current outbreak of COVID-19 have further proven the need to place bigger efforts and more focus on digitization. The following are some lessons learned from the Arab countries' experience in dealing with the pandemic:

- Digital transformation can help to be a step in transforming the informal sector into a formal one. This was witnessed in Morocco when workers of the informal sector, who had lost their jobs, willingly registered to receive the financial support offered by the government, as well as this also may require diverse strategies, including ensuring decent working conditions among others
- The Artificial Intelligence (AI) can be of great help in tracing and visualizing the status of any virus outbreak. This was implemented in the Kingdom of Saudi Arabia where multiple apps/platforms were launched to track the COVID-19 infected cases and to track their recovery process.
- Investments in ICT infrastructure has become of extreme importance. In Egypt, there has been massive investments on ICT infrastructure as part of the country's economic reform program. Such investments which have been injected previously in networks (mobile, internet….) helped the country (government, private sector…etc) mitigating to certain level the consequences of lockdown imposed by the widespread of COVID-19.
- Hybrid Education would be the future method of learning. Even after the crisis is over, most countries will resort to what they call "Hybrid Education". The advantage of such hybrid system is the possibility to depend on multiple channels to deliver the information. The old-school in-class method will never be out of fashion. However, it can now be supported by online platforms and dedicated educational TV channels. The success of the hybrid education is however attributed to the dissemination of smart devices through which students can access the online content. That's why, it is important to ensure that the accessibility of the rural areas to ICT infrastructure is similar to the urban ones, the cost of ICT services are affordable especially for women and finally the provision of digital skills should be availed through different channels especially to the underprivileged segments of society like students of rural areas.

Based on the above best practices and thanks to the ICT sector, some Arab countries have managed to a certain level to face the hard obstacles that were imposed in parallel with the spread of the current global pandemic. One way to accelerate the digitization process is increasing the share of the ICT sector, as a driver for digitization, in the national fiscal budget. In other terms, the government should increase the public expenditure on ICT since it has been empirically proven that it stimulates growth. Moreover, the descriptive analysis of Egypt's data has shown that

increases in public expenditure on ICT has been accompanied by increases in real GDP growth rates. Even in 2020, Egypt was one of the countries in the region to have achieved a positive growth, and part of the credit goes to the ICT sector. It is worth noticing that public investments on ICT had more impact on growth than that of public consumption of ICT. What we know for sure, however, is that the ICT sector has positive socioeconomic impacts in general, as previously elaborated. ICT helps in reducing poverty, improving health and reducing infant mortality, and stimulating economic growth as well. That being said, an increase in the public expenditure on ICT, preferably in the form of investments, is recommended to stimulate economic growth as well as improving various socioeconomic indicators (such as contribution of ICT to overall GDP, no of employment in ICT sector). Finally, ICT adoption may have an indirect impact on the government expenditure on education which reflect its social impact.

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Annex (1): Methodologies to assess the socio-economic impact of ICT (poverty, health…) & impact of Broadband & digitization on the economy

While the investigation for an international methodology that could quantify the economic impact of public expenditure on ICT is still going, literature has already tackled the impact of ICT, in general, on multiple social and economic aspects like poverty, health and economic growth.

In "*Exploring the Relationship Between Broadband and Economic Growth"* (M. Minges, 2016), the author reviewed multiple studies that have collectively proven that for 10% in national broadband penetration, there is 1-2% increase in GDP. Similarly, a study form Ericsson and Imperial College (2017) under the name of *"How Important Are Mobile Broadband Networks for Global Economic Development?"* reviewed data from 135 countries and came up with the conclusion that a 10% increase in mobile network penetration causes a 0.6-2.8% increase in GDP.

On the other hand, a paper (L. Mimbi, 2015) studied the impact of ICT on health system performance in 27 African countries using a multi-statistical approach which include Data Envelopment Analysis, Cluster analysis, and partial least square regression). The study objectives were to determine the efficiency, performance, and impact of ICT infrastructure on health systems in Africa. Results showed that mobile communication services have a significant impact on health indicators. A one unit, per 100 inhabitants, increase in mobile communication services tends to increase life expectancy at birth by about 30 percent and reduce infant mortality rate by almost 50 percent as well. The authors also studied the impact of internet usage on the above-mentioned health indicators. Findings on the impact of Internet usage on health system indicate a statistically significant relationship. Internet usage tends to increase life expectancy at birth and significantly reduce infant mortality rate. Similarly, findings on the impact of main telephone line penetration on health system indicate a statistically significant relationship. Investment in main telephone line tends to significantly improve life expectancy at birth and significantly reduce infant mortality rate in Africa.

Lastly, a paper (R. Yilmaz et al. ,2018) attempted to identify the contribution of ICT to poverty reduction. The paper's hypothesis is that ICT penetration contributes in decreasing poverty. The authors used bivariate and multivariate fixed and random effects models to test for the relationship between ICT and poverty. For poverty, the dependent variable, they used 6 indicators as proxies: HDI, GINI coefficient, Headcount: % of people living under the poverty line, Mean log deviation: index of inequality, Poverty Gap, Watts poverty index. As for ICT, the independent variable, 4 indicators have been used: % of individuals using the internet, Cellphone penetration, Computer penetration, Fixed broadband penetration. The authors then analyzed the impact of each of the 4 independent variables on all six poverty indicators. Results indicated that Internet and Cellphone penetration have significant impact on all 6 poverty indicators with Internet having the biggest

significance. While computer penetration and fixed broadband penetration have significant impact on only four indicators (insignificant on Poverty gap and Watts Poverty Index).

Similarly, international organizations, like the International Telecommunication Union (ITU), have attempted to investigate the economic impact of ICT. Following are briefs of two reports published earlier by the ITU. The first report attempts to measure the economic impact of mobile broadband, fixed broadband, and digitization using an econometric model that helps obtain a precise quantitative impact. The study was made over 139 countries throughout the period 2007-2018. Concerning the economic impact of fixed-broadband, findings indicate that developed countries, with high penetration of fixed broadband, benefit more from the technology relative to developing countries. Hence, the impact is driven by "return to scale". This means that when fixed broadband penetration is low, the economic impact is minimized. However, when the fixed broadband infrastructure reaches a critical level of development, the economic impact becomes significant. Thereby, fixed broadband and penetration are positively related. As for the economic impact of mobile broadband, findings suggest that, unlike fixed broadband, the economic impact of mobile broadband is greater in countries and regions at lower levels of economic development and with relatively lower mobile penetration. The impact of mobile broadband is driven by "saturation" or "diminishing returns" effect. The economic impact of mobile broadband tends to decline with penetration. In other terms, mobile broadband and penetration are inversely related. It is important, however, to note that on a global scale, the economic contribution of mobile broadband is higher than that of fixed broadband. Results indicated that a 10% increase in fixed broadband penetration results in 0.77% worldwide GDP growth. Whereas a 10 % increase in mobile broadband penetration results in 1.5% worldwide growth. And lastly, concerning the economic impact of digitization, the study used an endogenous growth model based on Cobb-Douglas production function to test the impact of digitization on GDP growth. Results indicated that, globally, the economic impact of digitization is higher than that of fixed broadband and resembling to that of mobile broadband. Results also showed that the economic contribution of digitization is higher in more advanced economies compared to emerging economies, which supports the "return to scale" effect. For example, a 10% increase in digitization results in 1.351% GDP growth for OECD countries and 1.044% growth for Non-OECD countries. In addition, results have proven that digitization boosts labor productivity – 10% digitization generates an increase of 2.62%. The same 10% increase in digitization yields an increase of 2.28% in total factor productivity.

Findings indicate that developed countries, with high penetration of fixed broadband, benefit more from the technology relative to developing countries. Hence, the impact is driven by "return to scale". This means that when fixed broadband penetration is low, the economic impact is minimized. However, when the fixed broadband infrastructure reaches a critical level of

development, the economic impact becomes significant. Hence, fixed broadband and penetration are positively related.

A set of four equations was used to run identical econometric structural models as shown below:

-Aggregate production function:

$$GDP\ per\ capita_{\ it} = a_1(Capital_{it}) + a_2(Education_{it}) + a_3(Broadband\ Penetration_{it}) + e_{it}$$

-Demand Function:

$$Broadband\ Penetration_{it} = b_1(Rural\ population_{it}) + b_2(Broadband\ price_{it}) + b_3(GDPC_{it}) + b_4(HHI_{it}) + e_{it}$$

-Supply function:

$$Broadband\ Revenure_{it} = c_1(Broadband\ price_{\ it}) + c_2(GDP\ per\ capita_{it}) + c_3(HHI\ Fixed\ broadband_{it}) + e_{it}$$

-Output function:

$$\Delta Broadband\ penetration_{it} = d_1(Fixed\ broadband\ revenue_{it}) + \varepsilon_{4it}$$

where $[b_1, b_2, b_3, b_4]$, $[c_1, c_2, c_3]$ and d_1 are regression coefficients parameters in each model run for i^{th} country in t^{th} time point, for $i = 1, \ldots 139$ and $t = 2007, \ldots, 2017$.

- The econometric model was first run for all the countries, then they were clustered into 3 categories according to their level of economic development: (50 countries with GDP per capita > 22,000$), (26 countries with GDP per capita between 12,000-22,000$) (63 countries with GDP per capita lower than 12,000$).
- Countries were also divided into groups to measure the economic impact of fixed broadband by region: Africa (34 countries), Americas (18 countries), Arab States (14 countries), Asia Pacific (18 countries), Commonwealth and independent states (8) Europe (38 countries).

Results:

- The results show that
  - for a 10% increase in Fixed Broad Band (FBB) penetration lead to increase in GDP per capita by:
    - 0.7% in Arab countries;
    - Almost 0 % in African countries;

        - 1.63% in Asia Pacific;
        - Compared to 0.77% on the global level.
    - For a 10% increase in Mobile Broadband (MBB) penetration lead to increase in GDP per capita by:
        - 1.82% In Arab countries;
        - 2.46% in African countries;
        - 0.51% in Asia Pacific;
        - Compared to 1.5% on the global level.

Economic impact of Mobile broadband:

Findings suggest that, unlike fixed broadband, the economic impact of mobile broadband is greater in countries and regions at lower levels of economic development and with relatively lower mobile penetration.

Econometric structural models (composed of four specified equations) were run to assess the economic impact of mobile broadband.

Results:

- The economic contribution of mobile broadband is higher than that of fixed broadband. A 10% increase in fixed broadband penetration results in 0.77% worldwide GDP growth. Whereas a 10% increase in mobile broadband penetration results in 1.5% worldwide growth.
- The economic impact of mobile broadband decreases with economic development. A 10% in mobile broadband penetration results in the following: 1.98% growth in countries with a GDP per capita lower than 12,000$, 1.76% growth in countries with a GDP per capita between 12,000-22,000$ and 0% growth in countries with a per capita GDP higher than 22,000$.

Fixed vs mobile broadband – by level of development

- Fixed broadband: its economic impact is higher in developed countries, that enjoy high penetration, which reflects the *"returns to scale"* effect.
- Mobile broadband: its economic impact is greater in countries and regions at lower levels of economic development and relatively lower mobile penetration. The economic contribution of mobile broadband diminishes in countries and regions with high levels of development and penetration., reflecting the *"diminishing returns"* effect.

The economic impact of digitization

Digitization is defined as *"the transformation of the techno-economic environment and socio-institutional operations through digital communications and applications"*. the Digital Ecosystem Development Index developed by ITU as the digital ecosystem landscape is a composite indicator that aims to quantitatively assess the eight pillars forming the structure of a digital economy. The eight pillars further comprise 64 indicators.

The study tested three hypotheses regarding how digitization affects the economy:

1. Its impact is higher than standalone information technologies
2. Impact increases at higher development stages
3. There is a positive impact on productivity

An endogenous growth model, based on the Cobb-Douglas production function, was used to test the impact of digitization on GDP growth:

$$Log(GDP_{it}) = a_1 \log(Fixed\ capital\ formation_{it}) + a_2 \log(Labor\ force_{it}) + a_3 \log(Digitization\ index_{it}) + a_4 \log(previous\ year\ GDP) + \varepsilon_{it}$$

The following model was used to test the impact of digitization on productivity:

$$Log(productivity_{it}) = a_1 \log(Growth\ of\ digitization_{it}) + a_2 \log(Digitization\ index_{it}) + \varepsilon_{it}$$

Results:

- Digitization – on par with mobile broadband in boosting economies:
  the economic impact of digitization is higher than that of fixed broadband and resembling to that of mobile broadband.
- Digitization boosts advanced economies:
  The economic contribution of digitization is higher in more advanced economies compared to emerging economies, which supports the *"return to scale"* effect.
- Digitization boosts productivity:
  Digitization boosts labor productivity: 10% digitization generates an increase of 2.62%. in labor productivity.

Data definition

- $Capital_t$ = Fixed stock of capital
- $GDPC_t$ = GDP per capita used as a proxy of the average consumption propensity of individuals
- $Broadband\ price_t$ = The price of a mobile service proxied by ARPU (average revenue per user)

- $Rural\ poupulation_t =$ The percentage of rural population
- $HHI_t =$ Herfindahl Hirschman Index measures the level of competition intensity in the market.

As for the second report which titled: "The State of Broadband: Tackling digital inequalities", it attempts to assess the progress made towards achieving the seven advocacy targets that were set by the Broadband Commission. Each of the seven targets is expected to be achieved by 2025. In each section, the report displays a comparative analysis of some ICT indicators, that are in relation to the target itself, to assess the progress that has so far been made. Excluding the first advocacy target, all six remaining targets have shown digital inequalities. This means that global regions differ significantly in terms of ICT adoption in general.

As for the 2nd advocacy target, it was set that by 2025, entry-level broadband services should be made affordable in developing countries at less than 2% of monthly Gross National Income (GNI) per capita

Affordability is a key factor for ICT adoption. An early report in 2009 by the ITU, showed that the cost of an entry-level wired broadband connection represented nearly 174% of monthly per capita GNI in developing countries. In Africa, the average monthly fixed broadband cost approximately 483% of monthly GNI per capita. The report also displayed the change in the average cost, in USD, of fixed broadband monthly subscription according to regions. Conclusively, the average cost of fixed broadband dropped in every region of the world. Data from the ITU's May 2020 report on "Measuring Digital Development" demonstrates that 95 countries worldwide, including 51 developing countries with 4 LDCs, meet the 2% threshold for entry-level mobile broadband service cost (for 1.5 GB of data) in 2019. Overall, the global average price of a mobile data basket of 1.5 GB fell from 8.4% per capita of GNI in 2013 to 3.2% in 2019. This target also focuses on the price of user devices. Despite the decline in the prices of entry-level smartphones, millions of people still find them unaffordable. The 2017 GSMA report indicated that the average price of smartphones remains somewhere in the 100-200$ bracket in many markets all over the world. A report in 2020 by the Alliance for Affordable Internet found that approximately 2.5 billion people live in countries where the cost of the cheapest available smartphone represents 25% or more of the average monthly income.

As for the 3rd advocacy target, it was set that by 2025, Broadband-Internet user penetration should reach: i) 75% worldwide; ii) 65% in developing countries; and iii) 35% in LDCs

When the Commission first launched in 2010, global Internet usage was 29% worldwide with LDCs having an internet usage of 5.5%, a mobile broadband penetration of 0.4%, and a fixed

broadband penetration of 0.1%. Latest ITU data, global internet user penetration increased to reach 53.6% with LDCs jumping from 5.5% to 19.1%. The report also displayed data for active mobile broadband subscriptions for the years 2010 and 2019 as well as fixed broadband subscriptions for the same years.

As for the 4th advocacy target, it was set that by 2025, 60% of youth and adults should have achieved at least a minimum level of proficiency in sustainable digital skill.

Better internet affordability is not directly translated to higher internet adoption. There are multiple barriers such as literacy and skills, relevance, safety and security, and other factors that limit the internet adoption. For mobile Internet use, literacy and skills is the most significant self-reported barrier across the world. This specific barrier represents 37% of responses in South Asia, 35% in East Asia, 34% in Africa and 28% in Latin America. In Bangladesh for example, according to their National ICT Household Survey 2018-2019, the top reason of not using the internet is attributable to the lack of skills "cannot use the internet". The report displayed a figured measuring the percentage of individuals having basic, standard and advanced ICT skills. According to the figure, less than half of the world's population have the basic skills for computer-based activities, including sending e-mails with attachments, moving files, using copy and paste, and transferring files between devices. Moreover, less than 30 per cent of the world's population was proficient in standard ICT skills like using basic formulas in a spreadsheet, downloading, installing and configuring software.

As for the 5th advocacy target, it was set that by 2025, 40% of the world's population should be using digital financial service

According to the World Bank's Global Findex database, the number of people worldwide who have utilized digital financial systems in the previous 12 months increased from 41% of the global population (age of 15+) in 2014 to 52% in 2017 (with women representing 46% and men 54%.) . The report also displayed a regional breakdown of the same indicator for both years 2014 and 2017. According to the latest data in 2017, the poorest performance belongs to Arab States followed by Sub-Saharan Africa with an adult population making or receiving a digital payment amounting for only 26% and 34%. The best performers were Europe and North America with 92% each.

As for the 6th advocacy target, it was set that by 2025, improve connectedness of Micro-, Small- and Medium- sized Enterprises (MSMEs) by 50%, by sector

The target aims to improve the connectedness of MSMEs, by 50%, to close the digital gap. This means that a sector in which 80% of MSMEs are unconnected, for example, should only have 40%

unconnected by 2025. Similarly, a sector in which 30% of MSMEs are unconnected, should only have 15% unconnected by 2025. The report displayed data from the World Bank's Enterprise Surveys which indicated that on a global average, only 44.5% of enterprises have a website and 68% utilize e-mail. It is worth noticing though that such indicators differ significantly by country and between regions. The most recent data collected by country ranges over the past 14 years. In the MENA region, for example, 52% of firms have their own website and 60.5% using e-mails to interact with suppliers and customers. In Sub-Saharan Arica, only 30.5% of firms have websites and 56.9% use e-mails.

As for the 7th advocacy target, it was set that by 2025, gender equality in access to broadband should be achieved.

Gender equality should also be achieved across all other targets including internet users, digital skills, and digital financial services. An ITU publication in 2019, showing comparison about gender gaps in terms of internet adoption between 2013 and 2019, showed that the gender gap has significantly widened with the proportion of men using the Internet versus women using the Internet rising from 11% in 2013 to 17% in 2019. The report also displayed region-specific data for the gender gap in terms of internet adoption. Data showed that the gap has widened in every region of the globe with Africa and LDCs having the poorest performance in this regard. The report then moved to another figure which displayed internet penetration for both men and women, on a regional basis. The ITU data indicates that in almost two-thirds of countries worldwide, women are at a disadvantage compared to men in terms of the opportunity to benefit from digital technologies. Furthermore, the gender gap has been growing in the world's major developing regions: Africa, the Arab States and Asia-Pacific. Conclusively, men use the Internet more than women in every single region of the world except the Americas where the gap is below 1%. ITU data also showed that men are more likely to own a mobile phone than women. The lower levels of women's mobile ownership and internet use do not only highlight the existing gender inequality but poses threats of even wider gaps in the future. If the mobile gender gap persists, women will be at risk of being left behind as economies move towards digitalization.

And lastly, a paper under the name of "Government expenditure and economic growth - Evidence from Singapore, Hong Kong, China, and Malaysia" (Phoam, 2009) aimed at studying the relation between public expenditure and economic growth. It attempted to analyze the potential impact of government expenditure on the economy. The author also evaluated the public expenditure for each country. The objective of such evaluation is a general understanding of the government expenditure patterns in Asia and more specifically in the four countries included in the study.

Singapore:

In Singapore, Government expenditure is limited to the provision of essential public goods and services and to provide the country of secure future. Regarding general development, the largest share of government expenditure goes to national security and external relations, covering projects like defense shelters, new immigrations buildings and Civil Defense Schools. Meanwhile, the biggest share of the government's expenditure is allocated for social development purposes comprising heavy investments in education, primary health care and public housing. Such strategy is followed to promote a cohesive, flexible and mobile society.

Hong Kong:

The largest share of government expenditure goes to social development, in which the major component is education. In their perspective, education is considered an important factor of "investing in the future" which in turn will increase the level of human capital and will in turn lead to multiple benefits for the national economy and the individuals themselves. Hong Kong also allocates a considerable share for investment in healthcare. As for economic development, the government tries to minimize its intervention.

China:

Regarding economic development, the government expenditure has had a decreasing trend over the years. This is explained by the increasing trend of public expenditure on social and general development. China has increased the government investment in education due to the importance of educating its workforce as a key to competitive advantage in internal economy. Moreover, China's economic prosperity enables policymakers to pay more attention healthcare and other medical aspects.

Malaysia:

Unlike previous countries, economic development has been consistently receiving the biggest share of government expenditure. Malaysia has witnessed increases for the investments in the country's infrastructure system to enhance the facilitation of the needs of economic growth. The second largest component of economic development expenditure devoted to agriculture and rural development. Concerning social development, the largest component is education. Expenditures for general development purposes like defense and public administration are relatively small compared to other development expenditures.

Note: For the methodology, the author used the Ordinary Least Squares method (OLS) using panel data for the four Asian countries covering a time frame between 1990-2008 using the following model to investigate the relation between government expenditure and economic growth. The empirical findings demonstrate a significant negative impact of government expenditure on social and general development on GDP. However, a government expenditure on economic expenditure demonstrates a significant positive impact on GDP.

Annex (2): Structure of indicators to measure Digitization

Components	Subcomponents	Sub-Subcomponents
Affordability	Residential fixed line cost	Residential fixed line tariff adjusted for GDP per capita
		Residential fixed line connection fee adjusted for GDP per
	adjusted for GDP per capita	capita
	Mobile cellular cost	Mobile cellular prepaid tariff adjusted for GDP/capita
		Mobile cellular prepaid connection fee adjusted for GDP
	adjusted for GDP per capita	
		per capita
		Fixed broadband Internet access cost adjusted for GDP per capita
Infrastructure	Investment per telecom	Mobile investment per telecom subscriber
Reliability	subscriber (mobile,	Broadband investment per telecom subscriber
	broadband and fixed)	Fixed line investment per telecom subscriber
Network Access	Network Penetration	Fixed Broadband penetration
		Mobile Phone penetration
	Coverage, Infrastructure	Mobile cellular network coverage
	and Investment	PC population penetration
		3G Penetration
Capacity		International Internet bandwidth (kbps/user)
		% Broadband connections higher than 2 Mbps
Usage		Internet retail volume
		E-government usage
		% Individuals using the internet
		Data as % of wireless ARPU
		Dominant Social Network Unique Visitors per month Per Capita
		SMS Usage
Human Capital		% Engineers in labor force
		% Skilled labor

Annex (3): ICT Skill indicators

Copying or moving a file or folder	Definitions: This refers to ICT skills, defined for the purpose of this indicator as having undertaken certain activities in the last three months, independent of the device(s) used. Activities to measure ICT skills are as follows: • Using copy and paste tools to duplicate or move data, information and content in digital environments (e.g. within a document, between devices, on the cloud) • Sending messages (e.g. e-mail, messaging service, SMS) with attached files (e.g. document, picture, video) • Using basic arithmetic formulae in a spreadsheet • Connecting and installing new devices (e.g. a modem, camera, printer) through wired or wireless technologies • Finding, downloading, installing and configuring software and apps • Creating electronic presentations with presentation software (including text, images, sound, video or charts) • Transferring files or applications between devices (including via cloud-storage) • Setting up effective security measures (e.g. strong passwords, log-in attempt notification) to protect devices and online accounts • Changing privacy settings on your device, account or app to limit the sharing of personal data and information (e.g. name, contact information, photos) • Verifying the reliability of information found online • Programming or coding in digital environments (e.g. computer software, app development)
Using copy and paste tools to duplicate or move information within a document	
Sending e-mails with attached files	
Using basic arithmetic formula in a spreadsheet	
Connecting and installing new devices	
Finding, downloading, installing and configuring software	
Creating electronic presentations with presentation software	
Transferring files between a computer and other devices	
Writing a computer program using a specialized programming language	