MENARA Working Papers
No. 23, November 2018

TECHNOLOGICAL TRENDS IN THE MENA REGION: THE CASES OF DIGITALIZATION AND INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT)

Edgar Göll and **Jakob Zwiers**

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 693244

WORKING PAPERS
No. 23, November 2018

TECHNOLOGICAL TRENDS IN THE MENA REGION: THE CASES OF DIGITALIZATION AND INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT)

Edgar Göll and Jakob Zwiers[1]

ABSTRACT

In the MENA region the important technological trends of digitalization and of information and communications technologies (ICT) are very diverse due to different levels of development both between and within countries. Aspects like infrastructure, economic conditions, job market, social media are discussed. Adequate governance for innovation and specifically ICT is severely lacking in most of the MENA countries. Hence, most innovations are instigated by external actors. Nevertheless, nearly all countries in the region are pursuing policies supporting digitalization to further development. But digital options can either be used for transparency, education and empowerment, or for control, censorship and repression. The EU will need to approach the region with greater sensitivity, which may involve co-developing "frugal technologies" that are more fit for the specific technological, societal, climatic, socio-economic and cultural conditions of countries in the MENA region.

INTRODUCTION

An adequate level of development, introduction and dissemination of new technologies is essential not only for the economic advancement of a society, but also for its social, cultural and political development. Several reports and studies have shown that most countries in the Middle East and North Africa (MENA) region and many segments of their societies are not well equipped to utilize new technologies for further development (i.e. UNDP 2016, ESCWA 2015, WEF 2017, Baller et al. 2016). Starting with a brief overview of technological trends in several fields and the infrastructural conditions required for them, the main focus of this paper is on digitalization and the use of information and communications technologies (ICT) in the MENA countries. Most recent studies of technology trends in the region address this issue (e.g. Guetat and Drine 2009, ESCWA 2015, Chambers 2015, UNDP 2012, Thunert 2009). ICT and digitalization can be considered the cutting edge and as the crystallization topic for most other technological trends and fields, the way ICT and digitalization advance in a given country might indicate its potential and preparedness to uptake of technology and innovation more generally. There are certain preconditions for further development with regards to technology, especially ICT and digitalization, that are not equally distributed along the region. The trends in, utilization of, as well as research, education and training for new technologies in the MENA region are characterized by a broad spectrum of very unevenly developed countries and sub-regions. With these significant differences in levels of technological and digital development, the MENA region encompasses a wide variety of trajectories and cases

1 Edgar Göll is Head of Research of the cluster Future Studies and Participation at the Institute for Future Studies and Technology Assessment (IZT), Berlin, and teacher at the Free University of Berlin. Jakob Zwiers is Junior Researcher at IZT.

of application, which are discussed in the following.

Describing ICT and digitalization in the MENA region will encompass a consideration of: various trends and their relevance within the economy (i.e. general preconditions, differences between oil exporting countries and oil importing countries, outsourcing, startup cultures, e-commerce and FinTech (financial technology), as well as mobile gaming); the effects and relevance of demography, education and the labour market in the different political arenas (i.e. Arab uprisings, filtering and censorship, cybercrime); as well as social media, the relevance of digital infrastructure, the potential for strengthening renewable energy provision and for adapting to climate change and conserving natural resources.[2] Most of these technological trends and related developments are induced by external actors, be it indirectly via competition and other similar structural mechanisms, or directly by multinational corporations (such as Samsung, Google, Facebook) or supranational institutions (for instance, World Bank, United Nations, Food and Agriculture Organization, European Union). But in the MENA region only a few countries are intensively linked to other regions and to OECD countries within the technological realm, and therefore impulses and from external technology leaders might be less intense, broad and successful.

1. TECHNOLOGY TRENDS IN INFRASTRUCTURE AND INNOVATION IN THE MENA REGION

Basic infrastructure is an important prerequisite for socio-economic development in modern societies, both in terms of overall advancement and for innovation – particularly in the context of international market pressures and global competition, including around access to scarce and limited resources. Due to demographic trends, social challenges and the rapid pace of urbanization, there is huge pressure on existing general infrastructure and an increased demand for new infrastructure (i.e. public buildings, roads, bridges, as well as fast Internet, broadband etc.).[3] The MENA region is expected to become the fastest growing region globally in this regard, overtaking the 2016 leader Asia (BMI 2017). MENA countries have invested 3–5 per cent of gross domestic product (GDP) in infrastructure in the last decade, which is higher than in Latin America, Europe and Central Asia but lower than in South Asia and East Asia. But MENA's infrastructure investment and maintenance needs up to 2020 are estimated at about 106 billion US dollars per year, or 6.9 per cent of the annual regional GDP (BMI 2017).

These overall trends and numbers have to be broken down. The estimated differences in needs and abilities for investing across sub-regions are very high. The countries with the greatest investments in basic infrastructure in MENA are Saudi Arabia, Qatar, Kuwait and United Arab Emirates. Since 2007 Oman has completed fifty-four infrastructure projects, which is the highest number of any MENA country (Preqin 2016). Developing oil exporting countries are expected to commit almost 11 per cent of their GDP annually (48 billion US dollars) to improving and maintaining their infrastructure endowments. Oil importing countries will need to invest approximately 6 per cent

2 For these topics, see also related publications of the MENARA project, especially McKee et al. (2017), with its focus on economic and demographic conditions and developments.

3 For this reason, the likes of the Union for the Mediterranean support sustainable development of the region, including projects for infrastructure such as the trans-Maghreb highway. And digitalization has been a topic at several ministerial meetings. See the official website: http://ufmsecretariat.org.

of their GDP to ensure the provision of infrastructure on a sufficient scale to meet their growth as well as their poverty reduction targets. Investments are likely to be especially high in the electricity and transport sectors, particularly road construction. Electricity and transport are each estimated to account for about 43 per cent of total infrastructure needs in MENA, followed by ICT (9 per cent) and water and sanitation (5 per cent) (Estache et al. 2013: xxi). Fulfilling the electricity needs alone would require approximately 3 per cent of the annual regional GDP, or 46 billion US dollars, of which 10 billion would be spent in oil importing countries and around 36 billion in oil exporting countries (Estache et al. 2013: xxi). So, when it comes to infrastructure the focus is on the increasing need for energy and electricity supply. Entrepreneurs and the business community see infrastructure issues as a "serious problem" in MENA countries (Morris and Carey 2009).

This deficit is underlined by international comparisons:

> In contrast to other fast growing countries in the world, the Arab region has suffered in the last decades from substantial barriers to sustainable growth, which greatly affected the youth population and their integration in productive, growth-driven economies. Gauged by the level of industrialization, the level and sectoral composition of private investment or the productivity and technological innovation of firms, no Arab country, especially the non-resource rich, is on the path of the structural transformation that has led the rise of fast-growing economies such as China, Turkey, Poland, Malaysia and Korea. (Chaaban 2013: 6)

More specifically apropos innovation processes and economic clusters, again empirical evidence proves the deficits in adoption of new technologies in the region vis-à-vis the major factors for success.

> Statistical and econometric results [...] suggest that cluster performance, brought about by the adoption of new technologies by firms within it, depends on two sets of factors. One set are the firm-specific characteristics: academic qualification and knowledge of MDs, skill intensity of the workforce, motivation of MDs to provide workers with regular training for effective use of new technologies, sales turnover and profit margins. The second set of factors consists of cluster-specific variables: the presence of training and collective internal technological support institutions and the benefits of inter-firm sharing of facilities. The adoption of ICTs depends indirectly on the local and national ICT infrastructure since these provide the backbone for firm and individual ICT use. (Oyelaran-Oyeyinka et al. 2007: 287–8)

A similar assessment has been published recently on approaches to supporting startups and problems in the MENA region from a business perspective. From a distance, it seems as if the Middle East is in the middle of a startup boom (McKenna 2017). New investments are increasing and approaching 1 billion US dollars. But closer investigation reveals that the biggest part of this rise in investments is related to just two companies (see below) and to a single country (UAE). Referring to recent data from Magnitt (2016), McKenna reports that in 2016 the amount of cash being invested into tech firms more than quadrupled, reaching 870 million US dollars.

> However, the vast majority of this – $625 million – flowed into just two firms: online retailer

> Souq; and Careem, the Dubai-based rival to Uber which operates in 53 cities across MENA and South Asia. Amazon's acquisition of Souq.com, reported to be in the region of $650–750 million, put the region's start-up scene on the global map this year. Souq is arguably MENA's top online retailer, and competes with Amazon in several key markets in the region. Most of the investment in MENA start-ups is concentrated in just one country. According to Magnitt, the United Arab Emirates (UAE) has secured half of all tech funding in the region over the past three years. (McKenna 2017)

Innovations need specific investments, including knowhow and capital, which very often have to come from international corporations, banks or institutions. How to become attractive for such investments is a major challenge for politics and business networks. The attractiveness of investing in most countries in the MENA region is low compared to East Asia or parts of Latin America. World Bank data compiled by *The Economist* in 2017 show how negatively the situation in MENA countries has been assessed in recent times (see Figure 1). The main reasons for this situation are that bureaucracy, combined with the lack of government support in many MENA countries, has led to a situation that seems less open to startups than in many other parts of the world. But there some governments that seem to have changed their attitude in order to become globally competitive. For example, Egypt recently introduced a new bankruptcy bill that abolishes imprisonment for company founders whose businesses fail (McKenna 2017).

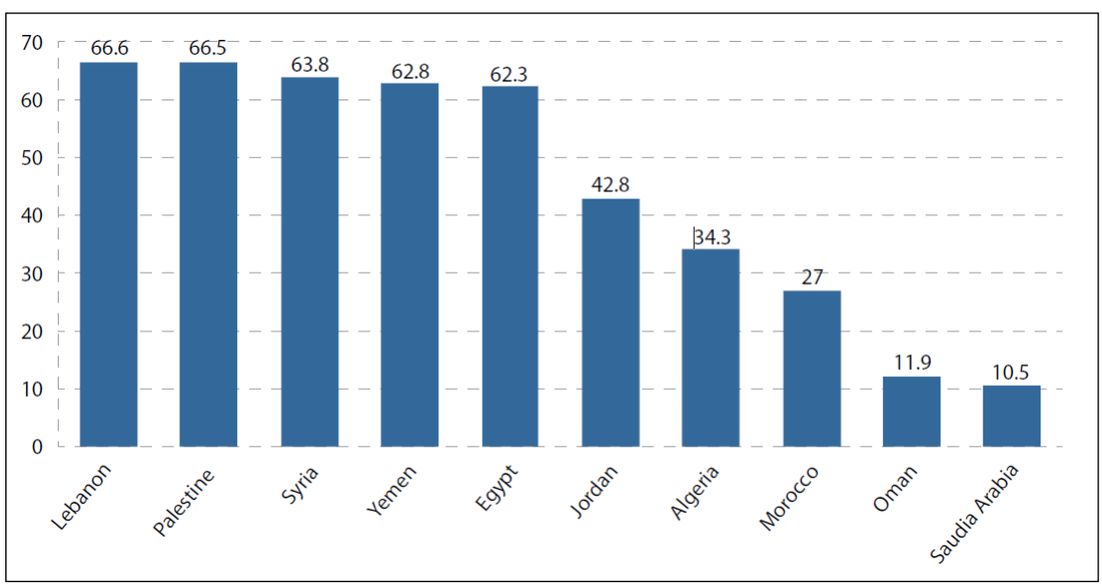
Figure 1 | Rankings and Ease of Doing Business Score, 2016

Source: The Economist (2017).

Despite this largely negative situation, McKenna formulates an optimistic outlook: "The good news is there is plenty of room for growth: just 8% of businesses in MENA have a digital presence (in the US it is 80%), and only 1.5% of MENA's retail sales are online. The digital market is estimated to add $95 billion in annual GDP by 2020" (McKenna 2017). Whether or not and how far it will catch up depends on the activities of many different actors and institutions in the MENA countries. A specific feature often cited as being a major factor in the underdevelopment of technological

innovation in the region is the widespread corruption. In a comparative study on this topic, the results are obvious for MENA countries. The perception among firms that corruption is a major or severe constraint to doing business in these countries is quite high – and the differences between countries are also high (see the Figure 2).

Figure 2 | Percentage of firms that perceive corruption as a major or severe constraint to doing business

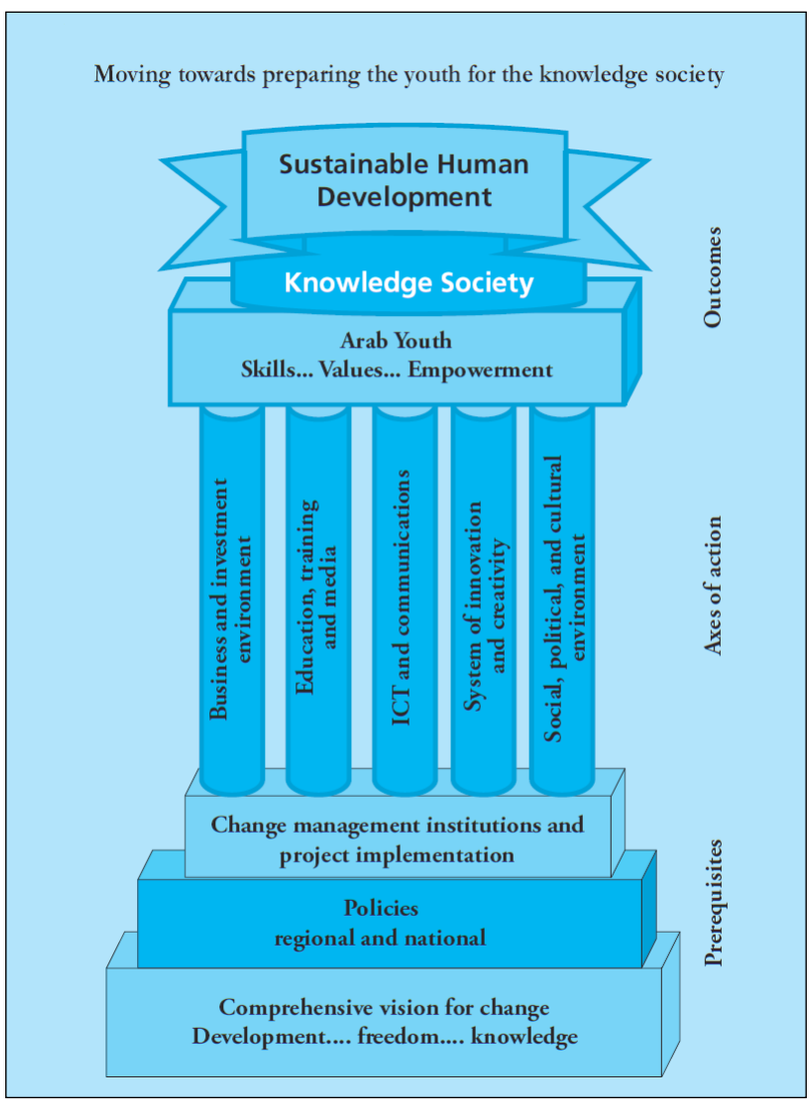


Source: Chaaban (2013: 23).

Many of the above-described technological characteristics in the MENA region will have a decisive influence on the future, and therefore also on future generations. As is the case with any technological development or innovation, the implementation of, for instance, ICT into the culture and economy of a country depends on a broad spectrum of preconditions in the sense of required innovation systems. In this respect, one consideration is related to the different socio-cultural milieus of a given society, including – in the context of new technologies – generational differentiation. Figure 3, taken from the "Arab Knowledge Report 2010/2011" (UNDP 2012) shows some of the prerequisites, and the axes of action necessary for achieving a knowledge society. With regard to this outcome in the MENA region, the situation in the different countries is very diverse within and between countries. Innovation is related to human development, education and qualifications. According to the findings of the UNDP (2012: 144) there are several tasks that have to be managed in order to advance these societies:

- Reviewing management institutions and their readiness to use and absorb technology, particularly in the field of education and training.
- Emphasizing intellectual property rights and reviewing the legislation and laws governing the use of technology in a way that achieves its deployment and supports the freedom of using it.
- Training on quality systems and enabling individuals to use technology efficiently.
- Encouraging foreign investment to achieve a quantum leap [in terms of technological and ICT advancement], especially in the areas needing highly-qualified cadres.
- Developing major projects to create a critical mass to deploy, employ and produce technology in schools, universities, homes, productive institutions, government, and public life in all areas.

Figure 3 | Sustainable Human Development: Knowledge Society



Source: UNDP (2012: 140).

New technologies are used for building up hopes for a better future. For instance, a paper from the business community (Annunziata and Rostom 2015) mentions several areas of potential for the MENA region and refers to three catalysts that might unleash those potentials: (1) the industrial Internet can boost productivity and efficiency to help deliver lower and more affordable costs through use of wireless access to cloud data and sensors; (2) advanced manufacturing techniques are expected to bring greater speed, flexibility and innovation to the shop floor, enabling the rise of micro-factories and high-value artisanal workshops; (3) the "global brain" is able to enhance industrial capacity by bringing technologies and workforces together between different countries to collaborate on ideas (Rostom 2015). These three potentials are all based on intensive collaboration and connectivity, which are therefore key prerequisites for such change. In this optimistic view, such an innovation process will unlock

> tremendous opportunities for everyone in the region, especially for those with skills in areas such as engineering, design and code writing. For small and medium enterprises, and entrepreneurs, the global brain not only increases access to potential workers, but to increased problem solving by issuing open innovation challenges to source creative solutions. For smaller firms, advanced engineering "democratizes manufacturing" through technologies such as 3D printing and other small-scale manufacturing that lowers barriers to entry, allowing small firms and even individuals to launch products, parts and components. This "maker movement" is already a growing phenomenon in Turkey, where the region's first store selling 3D printers has opened, as well as in Egypt, Tunisia, Lebanon, Iraq and Morocco. (Rostom 2015)

Nevertheless, these sorts of prognoses have to be taken with caution, since such sanguine narratives are being voiced in almost all countries but serious studies and analyses of the expected positive effects are very weak, and often countered with predictions of major job losses because of further automation and concepts such as robotics, the Fourth Industrial Revolution or the Internet of things.[4]

As mentioned above, the differences within the MENA region with regard to ICT dissemination and digitalization are very high. This was underlined once more in a recent comparative empirical study. Asking "Which nation in North Africa and the Middle East is top for digital?", the 2015 Networked Readiness Index (NRI) from the World Economic Forum (WEF) found the UAE to be the leader in this regard. The UAE even comes second of all the 143 countries surveyed worldwide in three key areas: business and innovation environment, government usage and social impact.[5] The NRI is part of the WEF's "Global Information Technology Report" (see Dutta et al. 2015, Baller et al. 2016). It evaluates the studied nations on four indicators of their readiness to exploit new digital technologies: (1) the regulatory and business environment; (2) infrastructure, affordability and skills; (3) usage by businesses, individuals and government; 4) social and economic impact (Geiger 2015).

In addition to such factors pertaining to the utilization of new technologies, the experience of most countries in history shows the relevance of social and cultural conditions and circumstances in this regard, specifically the dynamic relationship between social and technological innovation – in other words, technological modernization and social modernization. Within development patterns there are manifold challenges involved for all people on an individual level, as well as on a family and collective level. One example connected to the speedy changes in urban areas and within families living and working there comes in the form of the generation gap. The main feature of this is increasing acceleration in the appearance of new circumstances, new information and new knowledge, whereas old knowledge and such like becomes devaluated and the older generations lack the ability and motivation to adapt to the new circumstances and challenges. For traditional family patterns, division of labour and roles as well as established hierarchies, such changes are often a source of tension and conflict in communities.

4 For an extreme forecast, see Frey and Osborne (2013) and Odenbach et al. (2017).

5 In 2016, the UAE comes second of the 139 countries surveyed in two key areas: government usage and social impacts. See the UAE country profile in the Networked Readiness Index website: http://reports.weforum.org/global-information-technology-report-2016/economies/#economy=ARE.

Aside from the above-mentioned "Global Information Technology Report", the NRI measures, on a scale from 1 (worst) to 7 (best), the performance of around 140 economies in leveraging information and communications technologies to boost competitiveness and well-being. In Figure 4 are listed the top ten digital nations in the Middle East and North Africa harnessing ICT in 2015 (Geiger 2015).

Figure 4 | Top ten MENA countries harnessing information technology, 2015

Middle East and North Africa: Top 10 countries harnessing information technology	
Networked Readiness Index 2015	Global rank*
United Arab Emirates	23
Qatar	27
Bahrain	30
Saudi Arabia	35
Oman	42
Jordan	52
Kuwait	72
Morocco	78
Tunisia	81
Egypt	94

Source: World Economic Forum, 2015
*2015 rank out of 143 economies.
**The Index measures how economies use the opportunities offered by information and communications technologies for increased competitiveness and well-being.

Source: Geiger (2015).

2. ECONOMIC CONDITIONS FOR TECHNOLOGIES

Economic growth in the MENA region has changed again lately, due to the influence of various factors.

> Economic growth in the Middle East and North Africa (MENA) region is expected to rebound to an average 2 percent in 2018 from an average 1.4 percent in 2017. [...] The mild rebound in regional growth reflects the positive impact of reforms and stabilization policies undertaken in many countries in tandem with the recent pick up in oil prices and oil production and rising external demand. (Arezki et al. 2018b: 75)

Although the outlook for MENA remains positive, there are still geopolitical tensions, challenges due to the displacement of people, including refugees, and the rising level of debt in the region that urgently have to be addressed. There will also be an increase of young people entering the labour market in the coming decades. Hi-tech jobs in the services sector are especially likely to emerge due to rapid technological change. Therefore, several MENA countries have already developed economic strategies to benefit from this new, disruptive technology. A fast-growing pool of university graduates in combination with heavy penetration of social media and smartphones can serve as a basis for the development of a digital sector wherein new jobs can be created

(Arezki et al. 2018a: 1).[6]

According to the World Bank, the key factors in several MENA countries (Algeria, Egypt, Morocco, Libya, Tunisia and Jordan) limiting development are a lack of effective competition and appropriate regulation. The report recommends promoting facilities-based competition, addressing underserved areas of the country, applying new models of infrastructure supply and implementing measures to lower deployment costs (Gelvanovska et al. 2014). Nevertheless, this paper suggests that the governmental use and control over the extension and maintenance of ICT infrastructure need to be assessed separately. A number of governments of the MENA region have already taken steps to encourage Internet proliferation and accessibility, mainly in order to boost economic development. But large investments for (digital) infrastructure development as well as investments in the ICT sector are still necessary.

In terms of economic development MENA countries can be split into two sub-groups: oil and non-oil countries show strong differences in regard to ICT impact on regional growth. The different sub-regions reveal a high positive effect of ICT on growth for the oil-MENA countries (Gulf states). Therefore, a significant growth payoff from ICT can be acknowledged only for the oil-MENA countries. This is mainly because these countries succeed in their investment categories and quality choices as well as in capturing and forming the required qualifications for human capital that together form an essential background to benefitting from ICT (Guetat and Drine 2009).

A number of countries in the MENA region – including Egypt, Turkey, Morocco, Jordan, UAE and Tunisia – have successfully positioned themselves in the market of global ICT-enabled services and ICT outsourcing. For example, Egypt, as a popular destination for ICT outsourcing, currently supports 90,000 directly related jobs and is growing at 7.5 per cent annually, partly driven by business from Saudi Arabia and the Gulf.[7] Meanwhile, in Turkey more than 80,000 workers are employed in the ICT sector, which produces assets of 1.6 billion US dollars (Sethi and Gott 2016: 9).

In some regions and countries, for example in Palestine, a vibrant startup culture has been shaped by vanguard persons and groups. Startups appear where there are innovative business opportunities for achieving economic development, despite impediments such as power cuts, poor Internet infrastructure and political restrictions (Innovation Group 2017: 24). Nevertheless, significant external conditions such as the blockade of Gaza by the government of Israel hinder and obstruct overall economic development (i.e. the manufacturing sector) in this case. "Due to the blockade in place since 2007, Gaza's exports, according to World Bank's Country Director for West Bank and Gaza, Steen Lau Jorgensen, 'virtually disappeared' and the manufacturing sector has shrunk by as much as 60%" (Innovation Group 2017: 24). With new business models focusing on digital solutions and hardware development, young Palestinian entrepreneurs fill the gap that the

6 Zuazua (2017) captures the ambivalence that comes with developments being framed with the term "Fourth Industrial Revolution". With the opportunities of localized production, communities could be developed because factories of all sizes are supposed to boost the productivity level. But due to the potential of new levels of automation, a loss of jobs could also occur once human workers are substituted by robots and artificial intelligence. Therefore, it will be critical how MENA countries define their role in adopting and leveraging new technologies.

7 This has been in part the result of strategic activities of the Information and Decision Support Center (IDSC) of the Egyptian government. For some time, this think tank has given boosts to ICT dissemination in different areas of society and the administration.

government is unable to deal with and provide a sense of economic independence – from Israeli influence as well as dependency on foreign aid (Innovation Group 2017: 24).[8] The startup boom in Palestine has been catalysed by an abundance of accelerators, incubators and venture capital funds through which new forms of economic progress are fostered via the means of innovation within ICT and digital development.[9]

In the Middle East, online shopping seems to be reaching a whole new level. "Websites in Egypt, Jordan, and throughout the Gulf are making online ordering faster and easier than ever – allowing customers to use centralized websites to order from their favorite restaurant menus and product catalogs" (CSIS 2009).[10] Alongside website ordering, bilingual websites assist expatriates in using e-commerce. With the aid of virtual and augmented reality technology, fully immersive retail experiences could soon be possible – allowing consumers to navigate around a virtual store (Innovation Group 2017: 53).

In many African countries, FinTech has gained high economic relevance in various respects and can even become an economic game-changer under certain conditions and in particular areas – especially in bringing digital, mobile financial infrastructure into rural areas and promoting progress of the digital industry, creating new jobs as a result. Online payments facilitate transactions fluidly across geographic borders (TrendWatching 2017). At this point, the situation is not clear enough to assess the potentials and resonance of such developments within the MENA region.

Another growing sector in the Middle East is mobile gaming. Between 2015 and 2022, the mobile game development industry in the Middle East "is predicted to grow from $680 million to $2.3 billion" (CSIS 2016). Currently, just 1 per cent of the content in local app stores is available in Arabic. Therefore, private investors as well as governments, including Iran, Jordan and Saudi Arabia, "are sponsoring hubs to create mobile games tailored to local language and culture" (CSIS 2016).

3. AUTOMATIZATION AND THE JOB MARKET

Due to the high levels of unemployment in the MENA region, as well as the deficits in the education systems and social security in combination with the state of demographic development, the MENA states are under considerable social pressure. Among the 100 million young men and women in the region, unemployment and under-employment are very high: almost a third of active youth in the Arab world are unemployed.

8 Some examples: "Mashvisor, a real estate platform that optimizes the rental performance of investment properties. Fadfid, a virtual platform for connecting with licensed psychologists across the Arab world and Wirez, a marketplace that connects talented video storytellers with media broadcasters and publishers. [...] There are also startups investing in hardware; Insolito, a multi-purpose fitness tracker that also makes emergency calls using a sneaker insole and BoldKnot, a stylish top-up battery pack, described as 'the world's fastest iPhone charger... in a keychain'" (Innovation Group 2017: 24).

9 An example is the Fast Forward accelerator in Ramallah, Gaza Sky Geeks in Gaza or the Ibtikar Fund – Palestine's biggest startup investment fund, aiming to build up a startup ecosystem and its stakeholders (Innovation Group 2017: 25).

10 As an example: "Wheels Express, a Jordanian firm, offers a portable party. In addition to delivering movies, videogames and snacks in West Amman, Wheels Express promises to deliver a waterpipe with any of 19 flavors of tobacco within sixty minutes; the delivery comes with lit coals for the pipe" (CSIS 2009).

> Young Arab women are especially excluded from labor markets, as more than two-thirds of women between the ages of 15 and 29 are outside the labor market, the highest rate in the world. Lack of jobs especially for the young has been a characteristic of the region's economic growth performance in the past fifty years. (Chaaban 2013: 5)

Economic growth in the Arab region in recent decades has not been able to absorb the growing needs and expectations from the surging numbers of youth. "The frustration among Arab youth entering the job market is compounded by social exclusion, as the lack of job opportunities results in lack of access to housing and marriage, which hinders the transition to independent adulthood" (Chaaban 2013: 5).

The region's population, currently estimated at about 400 million, is expected to reach 600 million by 2050 (FAO 2016). More than half of the population is under 30 years old (Lüders 2017). Thus, the social and job pressure is ever increasing while education, unemployment and food prices are still rising. The latest labour market data show that the unemployment rate remained stubbornly high in Egypt, Iran, Iraq, Jordan, Morocco and Tunisia in 2016. Forty per cent of the region's unemployed are young jobseekers (Devarajan et al. 2016: 4). Real GDP growth in MENA is projected to stay at its lowest level for the second consecutive year, at around 2 per cent in 2018, a percentage point less than that predicted in April 2018 (Arezki et al. 2018b: 79). "Youth unemployment in the MENA region stands at 31% and university graduates are making up nearly 30% of the total unemployed pool" (WEF 2017: iii).

The WEF's "Future of Jobs" analysis found that, by 2020, 21 per cent of core skills in the countries of the Gulf Cooperation Council and 41 per cent of those in Turkey will be different compared to skills that were needed in 2015 (WEF 2017: iii). With regards to the continuous automatization and digitalization in most economies of the MENA region, it has been estimated that "41% of all work activities in Kuwait are susceptible to automation, as are 46% in Bahrain and Saudi Arabia, 47% in the UAE, 49% in Egypt, 50% in Morocco and Turkey and 52% in Qatar" (WEF 2017: 7). Furthermore, "[s]ome of the most common types of high-skilled employment in the MENA region include commercial bankers, corporate finance specialists and accountants, schoolteachers and academics, engineers, quality assurance professionals and information technology consultants" (WEF 2017: 3).

With increasing Internet access there will be growing opportunities for specific business models, including for women working from home via the Internet, who otherwise might have difficulty in finding adequate jobs. Nevertheless, this kind of option needs specific cultural conditions. With regards to the requisite cultural conditions for employment and job creation, there are countries and sub-regions where the attraction of employment within state institutions is still much higher among the young generation as compared to employment in the private sector (one example being Saudi Arabia).

But most highly educated young people try to escape abroad or they give up on finding the right employment because of the lack of potential for personal career, change and development. Possible reactions to this scenario can be migration or aggression against a corrupt establishment. Karake Shalhoub and Al Qasimi (2010) argue that, by simplifying business procedures, cyber activities

reduce the cost for businesses of complying with domestic and international trade regulations and reduce the cost of corruption.[11]

New technologies are being selectively integrated in more and more educational institutions.

> Educators are increasingly turning to tech to make learning both accessible and relevant to young mindsets, in preparation for a globally competitive workforce ready to take on tomorrow's challenges. The rise of new media is changing how we learn and communicate. Gaming, animation, and virtual networks demand a new style of literacy and promote new models for collaboration and communication. (Innovation Group 2017: 27)

New digital formats could engage audiences of all ages, helping them gain new knowledge and augmenting skills – even in difficult socio-political states such as Syria (Innovation Group 2017: 28). These digital formats are particularly needed in the MENA region because of its unemployment rate, which is the highest of any region in the world due to insufficient education systems. There is especially a rising demand for "higher-order analytical skills and advanced digital literacy, as well as strengths in science, technology, engineering, and math (STEM) subjects, in particular computer programming" (Innovation Group 2017: 27). MENA countries graduate fewer students in STEM per year compared to other regions. Therefore, investments in the sector of "techucation" are to be expected. Within the MENARA project, one conclusion is: "MENA economies need greater investment in STEM subject skills (science, technology, engineering and mathematics) to prepare the younger generation for labour market demands" (McKee et al. 2017: 4). In particular, the problem of Internet access has to be approached more systematically in order to proliferate digital opportunities and to prevent a digital divide in society. Today, one in three Internet users worldwide is younger than 18 years old. However, at the same time 29 per cent of young people between the ages of 15 and 24 – especially in Africa and in Arab states – do not have Internet access (UNICEF 2017).

4. ICT IN THE POLITICAL ARENA

General developments in ICT (primarily the use of smartphones in everyday life) as well as within digitalization have changed political culture. An example in the MENA region mentioned very often by the media is the so-called "Arab uprisings". Within these upheavals, social media were explicitly used as a new form of political communication and coordination. But in the same contexts, the possibilities of the Internet and social media have also been shown not only to be an empowering tool for civic society but rather as a power instrument used by authoritarian regimes and dictatorships, once they have been deployed for censorship or as a strategy for disinformation.

The number of Internet activists, blogs and online forums involved in the overthrow of the Ben Ali regime in Tunisia is considered to have been huge. These activists hacked government websites and paralysed them with overload attacks. They also managed to deactivate the government's

11 Because of the unsteady economic and political state of some regions, there is a problem with corruption that negatively influences the development of the job market and reduces the carrier opportunities and inhibits planning within a long-term perspective. Corruption, severe impediments for trading and unclear and non-transparent regulations are detrimental to growth and development (Ionescu 2013).

espionage and censorship programmes (El Difraoui 2011). Howard (2011: 12) states that technology does not cause political change, but it does "provide new capacities and impose new constraints on political actors". Tufekci (2011) points out that repressive regimes face a "dictator's dilemma" – meaning that allowing Internet access for their citizens poses a threat to their regime, but limiting or banning the Internet can lead to isolation that can harm the country and its economic as well as social development.

The OpenNet Initiative reports that Bahrain, UAE, Qatar, Oman, Saudi Arabia, Kuwait, Yemen, Sudan and Tunisia use Western technologies (e.g. from Siemens) to block selected Internet content.[12] In Tunisia, Egypt and Libya there have been state crackdowns on user-generated content (UGC) and the Internet in general through blackouts, slowdowns and filtering. There were also arrests, detentions and harassment of those involved in the creation and dissemination of UGC in the Arab uprisings. Twitter and Facebook, as well as being possible instruments of protest, can also render users vulnerable to state surveillance. These platforms have been employed by security and intelligence agencies to identify and locate activists and protesters (in North Sudan, Saudi Arabia and Tunisia). The military, too, has been using social media – in the form of SMS messages – to update the people/citizens on its view of events (Brisson and Lee 2011: 29–30). The military has lately even created its own Facebook page as well (Khamis and Vaughn 2011).

ICT impacts on the political field can be summarized as follows. First, ICT provides a mobile, flexible and cross-border method of communication and information exchange through mobile communication and social media applications. Thus, information about the protests was distributed by phone or by collective texts (SMS). In addition, smartphones (in particular through their camera function and via Twitter) helped to disseminate information and images in a timely and far-reaching manner that mobilized crowds. This was crucial for the protest movement – especially in smaller cities and in the countryside. In the case of Egypt, only a quarter of the population had Internet access before the upheaval; more than two-thirds of all Egyptians owned a mobile phone after. Second, ICT supplies new tools for attacking the state through cyberwarfare. For example, together with the international hacker movement Anonymous, Tunisian activists led a kind of cyberwar against the government, as mentioned above (El Difraoui 2011).

Alongside new forms of political participation through the digital means of the Internet, there are also new forms of cybercrime and the distribution of "crimeware" regarding credit card dumps, online accounts, stolen credentials and malware that have emerged in the MENA region (Trend Micro 2017). "Stolen identities abound here, in bundles that include passport scans and copies of driver's license and local utility bills. The marketplaces are also rife with do-it-yourself kits that provide the resources that even beginners can use to launch their own cybercriminal business" (Trend Micro 2017).

5. SOCIAL MEDIA

Social media in its different forms is an important feature not only of societal communication, for private purposes and such like, particularly among the young generation, but also more and more

12 See the official website: https://opennet.net.

for businesses, educational purposes, news and advertising as well.

Out of a global population about 7.5 billion people, approximately 3.1 billion people are active social media users (42 per cent of the total population) which also have increased by 13 per cent (362 million people) since January 2017. In the Middle East, 130 million people are active social media users (52 per cent) in 2018. In total, there has been an increase of active social media users of 39 per cent (37 million people) in the Middle East since January 2017. Northern Africa's social media penetration amounts to 38 per cent (90 million people). Regarding the average social media penetration worldwide of 40 per cent, there are significant differences within the MENA region. Countries with a high rate of social media penetration are Qatar (99 per cent), UAE (99 per cent), Kuwait (98 per cent), Bahrain (92 per cent), Saudi Arabia (75 per cent), Morocco (44 per cent), Egypt (40 per cent) in the year 2018 (We Are Social and Hootsuite 2018: 54–5). In comparison to a worldwide year-to-year increase in the number of people using social media users of 13 per cent, there is an increase of 135 per cent in Iran, 32 per cent in Saudi Arabia, 14 per cent in Morocco, 11 per cent in Egypt and 2 per cent in UAE since January 2017 (We Are Social and Hootsuite 2018: 56–7).

Despite the differences between the countries, the use of social media in most MENA countries is relatively quite high. "93% of MENA consumers access the Internet via mobile, spending 26 hours a week online – compared to just 19 hours for TV" (Innovation Group 2017: 55). There are differences in regard to the preferences and usage of platforms across the Middle East, especially between the Gulf countries and North Africa. Of all social media platforms, Facebook is used most often, with 94 per cent and 56 million active users in the MENA region. For example, in the period shortly after the revolution in 2011 more than 2 million new Facebook accounts were created in Egypt (Khamis and Vaughn 2011). Today, in Egypt there are 27 million active daily Facebook users (Al-Dosari 2016). Twitter, the second-most popular social network, has over 3.7 million active users in the region, tweeting around 10 million tweets per day. In this respect, the Middle East has the second highest rate of any region worldwide (Thottathil 2014). People in the MENA region use social media far more than they watch news (55 per cent per day) or download or stream videos (40 per cent per day) (Dennis et al. 2015).

The following case provides an example of how social media can have an impact on cultural change, and how the effects are interpreted very differently. In Saudi Arabia, the annual pilgrimage to Mecca has become a major social media event which has led to a heated debate about the state of worship. Whereas the use of phones and cameras in the Grand Mosque was banned by Saudi authorities until just a few years ago, today many believers use smartphones and social media to share their spiritual journey (CSIS 2015).

> The trend could not only change the way outsiders view Islam's most sacred spaces, but also the way that Muslims experience them. Certain religious scholars insist that social media use distracts from prayer, in defiance of a saying by the Prophet Muhammad. Others decry the narcissism of it all, turning the religion's holiest sites into mere backdrops for self-portraits. Proponents argue that the images celebrate faith and provide a powerful antidote to negative stereotypes of Islam. (CSIS 2015)

6. DIGITAL INFRASTRUCTURE

Innovation of new ICT-based services "has become one of the most important arenas for global competition, with outstanding examples in many [sectors] such as search engines (Google), auctions (eBay), gaming (World of Warcraft), music (Spotify), film streaming (Netflix) and travel services" (Airbnb) (Bygstad and Aanby 2010: 257). Although the digital use of all these services appears to be dematerialized, they do, however, need an infrastructure to innovate within.

> A fascinating example is the success of Google. As documented by Iyer and Davenport, Google's innovation strategy depends heavily on their infrastructure. Google is "built to build", with a scalable infrastructure [that] enables an accelerated product development cycle – with support for third-party development (Iyer and Davenport 2008). Such infrastructures are large networks [...] of technical and business components [...]. For a successful corporation, an effective digital infrastructure is [a crucial] resource. (Bygstad and Aanby 2010: 257)

Furthermore, there is a dynamic between infrastructure and innovation: businesses "urge rapid innovations while the infrastructure supports incremental change" (Bygstad and Aanby 2010: 257). Nevertheless, there always has to be a digital infrastructure to facilitate innovation and economic development within a digital economy. In turn, in order to establish such infrastructure, resources (e.g. for broadband Internet, glass fibre, sensors) have to be deployed on a significant scale.[13]

This development is quite advanced in Israel. One of the major promoters is the Weizmann Institute of Science, while Technion – Israel Institute of Technology is ranked among the top 75 academic institutions in the world for computer science.[14] In most other countries of the MENA region, the situation is quite different. This holds for the dissemination of broadband infrastructure in MENA, which is very important but seems underdeveloped in most countries. "Just as the steam engine was the driving force behind the Industrial Revolution", broadband Internet is today seen as "critical to the transition to knowledge-intensive economies across the world" (Gelvanovska et al. 2014: 219). In that sense, broadband Internet is seen as an essential driver of economic growth and social development (Gelvanovska et al. 2014: 219). Although broadband is crucial to reduce poverty and create job opportunities, especially for young people and for women, penetration has been slow and the price of broadband service has been quite high in many countries. Regionally, gaps in infrastructure can be encountered, so that there is often poor connectivity between and within countries, between rural and urban areas (Gelvanovska et al. 2014: 219).

Some experts (such as Chambers 2015) are rather optimistic apropos to the labour market effects of ICT dissemination. Referring to earlier technological developments, they expect that strategic investments in the likes of ICT will be crucial to create new jobs, may foster peace and prosperity and map out a new path for the future for the MENA. For instance, with the National Broadband

13 When it comes to digital infrastructure, it has to be pointed out that even the digital is basically material due to a general deployment of natural resources. The Internet in this respect is essentially based on physical operations.

14 See the Academic Ranking of World Universities (ARWU) website: *Global Ranking of Academic Subjects 2018 - Computer Science & Engineering*, http://www.shanghairanking.com/Shanghairanking-Subject-Rankings/computer-science-engineering.html.

Network project, Jordan's government has established the foundation for a digital transformation, which will provide high-speed connectivity between public facilities, hospitals, schools and agencies. Such infrastructure will be necessary to capture the socio-economic benefits from the Internet of everything (and the Fourth Industrial Revolution) which promises a new era of growth. With 1,500 ICT-related companies employing more than 19,000 people, Jordan – which has already become a technology hub – can be seen as a potential model for the whole MENA region. Since ICT jobs require higher or at least new qualifications, there is the need to create educational programmes such as the International Labour Organization's Auto Technology Academy or Cisco's Networking Academy (Chambers 2015).

As well as possibilities for job creation, ICT and digitalization carry the potential to enhance healthcare infrastructure.

> Telehealth technology, powered by the internet, can help fix this problem by enabling rural patients to have face-to-face video consultations with specialists and to have their treatment plans monitored from a distance. Cloud-based platforms also enable access to picture archiving and communication systems and collaboration software "as a service" to help improve the quality of care for patients by having radiology studies read remotely by qualified radiologists. (Chambers 2015)

7. ICT AND RENEWABLE ENERGY

In general, energy access is a key requirement for development. Many modern economic activities depend on ample and reliable electricity access. Similarly, at the individual and household level, electricity access enables income-generating activities, increases safety and contributes to human development. "In order for the countries in the region to fulfil their economic growth aspirations and move quickly to a more sustainable energy system, efforts should be intensified to diversify their energy mixes, especially through developing and deploying renewable energy on a wider scale" (Menichetti et al. 2017: 2).

Energy access is also a precondition for establishing a digital economy. In the MENA, almost all the population has access to electricity in both rural and urban areas – the electricity access deficit is 3 per cent, the improvement in access to electricity in the period 2000–14 was 91–96 per cent (World Bank 2017: 4).

> Although the region continues to hold the world's largest oil and gas reserves and has been able to maintain electricity access rates of close to 100 percent in most of its economies, it may not be in a position to cater to the future electricity needs of its fast-growing population and their business activities. Primary energy demand in the region is expected to continue to rise at an annual rate of 1.9 percent through 2035, requiring a significant increase in generating capacity. (Camos et al. 2018: 1)

In particular, challenges for the quality function deployment (QFD) exist regarding technical and commercial inefficiencies as well as underpricing.[15] Hence, energy efficiency is an important sector for economic and social development and policies. For instance, the energy efficiency sector is expected to be the single largest generator of new jobs within the UAE, and is projected to create more than 65,000 jobs by 2030. The UAE's broader Green Growth Strategy aims to create 160,000 new jobs and boost GDP by 4–5 per cent by 2030 (D'Amato 2015). At this point, it is an open question as to when and where from such workers will be recruited.

In order to achieve greater energy efficiency, the advantages of ICT (e.g. personalized data-driven applications, gaming and social networking) may be instrumentalized to motivate citizens' behaviour change. Therefore, with the means of ICT a greater consumer understanding and engagement in energy efficiency could be fostered (European Commission 2015).

Nevertheless, dealing with future energy demand is not only about energy efficiency, but also concerns a transformation of the energy system itself towards renewable energy. "Once a global leader in the production of fossil fuels, the Middle East is gearing up to become the world's next solar energy giant. As cleantech gains momentum, more startups are taking the plunge towards green energy and low-carbon growth" (Innovation Group 2017: 23). Dubai undertakes to deliver a quarter of the city's energy needs via solar energy by 2020 and has tripled its renewable energy target to 15 per cent of the energy mix by 2030 (Innovation Group 2017: 23). By 2050, Dubai wants to become 75 per cent renewable (Innovation Group 2017: 23). Morocco is in the first phase of creating its 765 million US dollar Noor-Ouarzazate solar plant. In Saudi Arabia, the target of 9.5 GW in renewable energy generation will be achieved by 2023. Moreover, Lebanon plans to build twelve solar farms across the country (Innovation Group 2017: 23). All these developments towards an energy-efficient future and investments in solar energy are anticipated to hit 50 billion US dollars in the next five years and especially arouse interest among green startups already innovating in this space (Innovation Group 2017: 23).[16] It is also anticipated that by 2030 Morocco will source half of its electricity from solar, wind and biomass. However, a major problem for all this development is a shortage of skilled workers for the new technologies. And in Morocco in 2017 more than 20 per cent of young people are unemployed (GIZ 2017).

The transformation of the energy system encompasses various dimensions, including the production, transportation, storage and consumption of energy. It also involves all levels and scales,

15 "Technical inefficiencies (represented by T&D losses) are an important part of some economies' QFDs: they represent more than one-fifth of the total QFDs in Iraq, Morocco, Tunisia, the West Bank, and the Republic of Yemen. Commercial inefficiencies (represented by bill collection losses) represent as much as two-thirds of the QFD in Djibouti, more than one-third in Tunisia, and a substantial share in Morocco and the West Bank." "The median QFD value in the 14 MENA economies analyzed here is about 4 percent of GDP" (Camos et al. 2018: 14, 25).

16 For example: "Nawart, an incubation project for small scale renewable startups in Egypt, supports several solar-powered projects from solar street lighting to solar-powered bikes. And Glean, is a solar-powered washing machine created by 22-year old Syrian entrepreneur and solar scientist Yaman Abou Jaib, that operates on a thermal system instead of an electric water heater, saving up to 30% of water energy. On a larger scale, Dubai is set to host the region's first 100% solar powered hotel in 2017, Hotel Indigo. And backed by investment from Abu Dhabi's Masdar, 'Solar Impulse 2' is the only aircraft of perpetual endurance, able to fly day and night on solar power, without a drop of fuel" (Innovation Group 2017: 23).

> from gigawatts in large power plants, high voltage grids and large consumers (such as aluminum plants) over megawatts in generation sites for municipalities and industrial plants down to the kilowatt scale in distribution grids, domestic cogeneration of heat and power, and photovoltaic systems. (Appelrath et al. 2012: 1)

Within this comprehensive transformation, ICT is applied in order to "technically operate these systems, to control the equipment, to monitor the technical status and for automated or manual intervention in emergency situations" (Appelrath et al. 2012: 1). Therefore, the economic and ecological results of future energy systems in the MENA region depend on the quality of the established ICT infrastructure that will very likely be more open and integrative (like smart grids), in the sense of the metaphor of the "Internet of Energy": "just as the Internet joins together all computers based on a set of open standards and protocols, all components of the future energy system (producers, grids, storage, and consumers) can be connected on the basis of standardized open architectures" (Appelrath et al. 2012: 1). Hence, an energy system that is based on renewables will probably be a decentralized system, and so a transition from generation to transmission has to be carried out.

> The 2008 International Energy Agency Reference Scenario for Europe quotes investments in excess of EUR 1.5 trillion in the period from 2007 to 2030 in order to revamp the electrical system from generation (two thirds of the investment) to transmission and distribution (one third). In turn, distribution needs account for 75%, against 25% for transmission of the expected investment in electricity grids according to the SET Plan technology map. (Faas et al. 2011: 19)

Such structural changes are supposed to be facilitated by a pervasive deployment of ICT for upgraded monitoring, control and protection functionalities. Due to the enhancements in monitoring and (remote) controlling of energy networks through the deployment of metering, more secure and reliable energy grids with an increased share of distributed energy resources can be put into action (Faas et al. 2011: 19).

From institutions outside MENA, there have been several attempts to support, specifically, the advancement of renewable energy sources in several countries. There have been programmes by the EU, such as the Plan Solaire and the comprehensive Union for the Mediterranean, which supports the overall sustainable development of the region, including infrastructure projects.[17] An ambitious project, started by experts and boosted by the Desertec Industrial Initiative (Dii), was a network of almost sixty big corporations and associate partners from EU countries who were interested in desert power generation in MENA countries – among them Deutsche Bank, Munich Re, Siemens, the Swiss ABB Group (Erdle 2010). One of the basic intentions of this initiative has been to produce electrical power with huge solar and wind power plants located in North Africa's deserts, primarily through gigantic CSP (concentrated solar power) farms, and to transfer this renewable electricity to EU countries. Yet due to several factors, among them disagreements and competition within the network, Dii seems to have stepped away from this ambitious plan and

17 See the official website: *Projects and initiatives with regional impact*, https://ufmsecretariat.org/what-we-do/projects.

several partners have left the network.[18] Meanwhile, Dii continues its work as a consultant to local partners in Dubai and UAE. Since 2009 the expansion of renewable energies has noticeably taken place, with many projects having been realized or being implemented. Nevertheless, the concept of "desert power" – building, for instance, large Concentrated Solar Power (CSP) plants in desert areas and using the strong solar radiation there for neighbouring cities – has actually become "acceptable" in the meantime as a long-term economic option for energy supply in many countries of the region and other regions with desert areas.

Reliance on and use of ICT is increasing in most countries, and therefore ICT will also have (unintended) ecological effects. For instance, in 2014 it was estimated that 2 per cent of all energy consumption was the result of ICT use. This rising energy consumption is likely to cause an increase of carbon dioxide emissions which could lead to an unsustainable scenario, heavily impacting future climate change. Therefore, not only are methods to make ICT technology more energy efficient required (especially through smart metering), but also the development of new self-powered, energy-harvesting technologies in order to facilitate micro- and nano-scale energy systems that consume no power (Berini et al. 2014: 1). Finally, it must be noted that achieving higher energy efficiency can improve resilience against a variety of risks, such as increases in energy prices, volatility, stress on energy infrastructure and disruptions to energy supply systems. By fostering resilience, energy efficiency "has the unique potential to simultaneously contribute to long-term energy security, economic growth, and even improved health and well-being; in particular, it is a key means to reduce greenhouse gas emissions" (IEA 2013: 3).

As mentioned above, for the coming years it will be a major challenge for most MENA countries to increase renewable energy production capacities:

> The region is characterized by very sharp differences in degree of energy dependence, with some countries exporting more than half of their domestic production and others dependent on foreign sources for more than 90 percent of their energy. Many countries will be able to lessen their dependence mainly by exploiting locally available resources of renewable energy. (Menichetti et al. 2017: 22)

8. CLIMATE CHANGE AND NATURAL RESOURCES

The MENA region will be one of those most severely affected by ongoing climate change. This will be caused by increased average temperatures, less and more erratic precipitation, continuing sea-level rise and shifts in water supply. All this will happen in a region that already suffers from aridity, recurrent drought and water scarcity. Climate change in the MENA region is expected to affect water resources, sea level, biodiversity, human health, food production, land use and urban planning, and tourism. Each of these threats poses extraordinary challenges for governance and development and calls for major efforts to lessen their negative and dangerous effects (Göll 2017).

18 Another reason was that neutral energy experts have calculated that producing electricity in North Africa and transporting it via huge pipelines to Central Europe will cost twice as much as generating it, for instance, in Germany via solar systems, hydropower, wind turbines or biogas plants. "It was an expression of neo-colonial megalomania" (Alt 2014).

> The Middle East and North Africa region is one of the most diverse in the world in economic terms, with per-capita annual GDP ranging from $1,000 in Yemen to more than $20,000 in the Arab Gulf States. As a consequence, adaptive capacity and vulnerability to climate risks varies enormously within the region. (World Bank 2014: 113)

The vulnerability of the MENA region will intensify in various aspects. It is highly dependent on food imports: approximately 50 per cent of regional wheat and barley consumption, 40 per cent of rice consumption and nearly 70 per cent of maize consumption has been met through imports. A variety of means has been applied to cope with water scarcity: abstraction of groundwater, desalinization and local community coping strategies (World Bank 2014: 113). "Despite its extreme water scarcity, the Gulf countries use more water per capita than the global average, with Arab residential water and energy markets among the most heavily subsidized in the world" (World Bank 2014: 113).

The MENA countries are heavily dependent on functioning agriculture, although the region is largely covered by arid land and deserts. Around 70 per cent of the region's agricultural production is "rain fed", and therefore highly vulnerable to temperature and precipitation changes, which are expected with increasing climate change (Göll 2017). This has tremendous implications for food security, social security and rural livelihoods.

> In combination with social changes and strong urbanization rates, [these issues indicate] a very vulnerable future for the Middle East and North Africa, particularly for the urban and rural poor. All countries in the region face a severe and fast growing resource squeeze, especially relating to severe water and land scarcity. (World Bank 2014: 113)

Agriculture is still a major source of income, since more than 35 per cent of the MENA population is employed in this sector, and it contributes 13 per cent to the region's GDP, whereas the global average is 3.2 per cent (World Bank 2014: 117). At the same time, the number of undernourished people in the region in 2011–13 reached 4 million in Northern Africa (World Bank 2014: 120).

Scarcity of fresh water is a dangerous limitation, which will become an increasing problem:

> Most of the land area of the MENA region receives less than 300 mm annual rainfall (and 200–300 mm per year roughly represents the lower limit for rain-fed agriculture). Semi-arid belts along the coasts and mountains are the only water sources and provide productive land for rain-fed agriculture [...]. The availability of renewable water resources is generally below 1000 m3 per capita per year (except for Iraq, the Islamic Republic of Iran, and Lebanon), and as low as 50 m3 per capita for most countries on the Arab peninsula (World Bank 2014: 130)[19]

19 "The major farming systems have been identified based on the available natural resource base (water, land, grazing areas, slope, farm size, tenure, and organization) and the dominant pattern of farm activities and household livelihoods, broadly grouped and mapped." "Accordingly, withdrawal-to-availability ratios exceed the critical threshold of 40 percent in all MENA countries except Lebanon; they exceed 100 percent in Jordan, Yemen, Libya, and most of the Arab peninsula countries [...], leading to groundwater resource depletion" (World Bank 2014: 130).

In order to change the patterns of water use and introduce a sustainable water policy would mean to educate and communicate with different audiences and target groups. The challenge of communicating climate change to non-scientific audiences is a key concern in climate science and policy (UNEP 2008). In recent years, there is a shift in "climate change communication literature" that tries to better "communicate the scientific basis of climate change, as well as its implications and relevant action strategies, in ways that encourage learning and engagement among various audiences" (Wibeck et al. 2013: 4761). One of those new approaches is to use advances in ICT to communicate complex sustainability issues, such as through visual representations of both geospatial and abstract data. In particular, there is hope that the "interactive potentials of new and emerging ICT may hold a potential to facilitate communication beyond the deficit model of climate communication and engage audiences in climate-related issues" (Wibeck et al. 2013: 4761).[20]

CONCLUSION

The overall picture of technological trends in the MENA region is very diverse and colourful. This is because in many respects the levels of development between as well as within most countries are highly uneven. Some of the differences are still growing – for instance between urban areas with sufficient infrastructure and good dynamism at one end of the spectrum, and rural areas at the other with poor infrastructure and very static technological development. Factors such as the distribution of basic infrastructure, an enabling business culture and supportive economic and education policies are very different across the region and in its sub-regions as well.

Within the megatrend of technologization and ICT specifically, contacts and business relations with external actors beyond the MENA countries are of utmost relevance. Most of the selected technological trends and related developments discussed in this paper are induced most often by external actors. This happens either indirectly via competition and similar types of structural mechanisms, or directly by multinational corporations (such as Samsung, Google, Facebook) or supranational institutions (for instance World Bank, UN, FAO, EU). In addition, foreign development organizations (i.e. the German GIZ) have for several years now tried to support the development of innovation and ICT infrastructure in MENA countries. Nevertheless, not all countries of the region are intensively linked to institutions from other regions and to OECD countries in the technological realm. Here again we have to remind ourselves that technological innovations and options are, for many problems, needs and tasks, just a necessary part of dealing with the challenge but by no means a sufficient solution on their own. Rather, as with other types of "tools" or potentials, it is precisely the way of using them which makes the difference. Therefore, governance and management in a broad sense are most important. Additionally, adequate governance for innovation and specifically ICT is to a high degree lacking in most of the countries in the MENA region. In the technological realm, and despite several technological flagship objects, most parts of the MENA region are on the periphery compared to other regions.

As underlined by statistics and reports, several MENA countries – such as some of the Emirates, Saudi Arabia, Israel and parts of Turkey – are well equipped with the right preconditions and

20 For an example of such an ICT-related tool developed within the MENARA project please see the MENARA Policy Support System (PSS) webpage: http://www.policysupport.org/menara.

capacities for further technological development, especially in the field of digitalization and ICT (WEF 2017). There are factors such as organizational capacities, regulatory procedures, labour markets and qualified staff, and economic conditions favourable for further technological development, that is, digitalization and ICT. At the same time, in many other countries and sub-regions such conditions are not yet existent. And due to cultural and political factors, the probability of such conditions emerging does not seem very high in the near future, since some of the basic needs of the citizens are not met. Thus, improving educational systems is an urgent necessity in order to prepare for a better future.

There are several major aspects that are blocking rapid improvement. To mention some of them: in most of the countries and sub-regions of the MENA, population growth is relatively high, leading to needs for growing infrastructure and technological investments, as well as pressure on the labour market and education systems. In order to receive foreign investment, some of the MENA countries are in the position to offer incentives for foreign corporations to do business there, but their attractiveness in this regard is often not as high as in some East Asian countries, for example. Investment as well as foreign investment then is very often concentrated in specific locations and sectors.

Therefore, with reference to the NRI from the WEF there are four indicators that seem to influence the readiness to exploit new digital technologies: (1) the regulatory and business environment; (2) infrastructure, affordability and skills; (3) usage by businesses, individuals and government; (4) social and economic impact (Geiger 2015). Combined with social and cultural conditions and circumstances, specifically the dynamic relationship between social and technological innovations in the MENA region, it has been shown above that these factors have to be strengthened and further developed in many of the sub-regions and countries. Here again, uneven development between and within many of the countries is still a challenge (i.e. between urban and rural areas). Overall,

> MENA economies need greater investment in STEM subject skills (science, technology, engineering and mathematics) to prepare the younger generation for labour market demands. [...] The demographic and economic perspective of MENA is challenging, but there is also a "demographic dividend" if policies are steered towards economic inclusion of the younger generation. (McKee et al. 2017: 4)

At the same time, new policies in nearly all countries are underway in order to increase the ability to utilize new technologies, and especially to open up for digitalization, not least to meet and develop potentials of at least parts of the younger generation, who are more easily and most often familiar with the Internet and social media. One example given above is the transformation of the energy system in these countries. It is a major challenge because it encompasses many dimensions: the production, transportation, storage and consumption of energy and also involves many levels and scales: large power plants, a high-voltage grid, large industrial consumers, municipalities' cooperation and photovoltaic systems. Within such a transformation, ICT can be applied in order to enable a more efficient and effective management of this complicated process ("Internet of Energy"). The same can be said about other future developments.

Taking into account increasing challenges from megatrends such as climate change – especially for agriculture and water supply, population growth and social structure changes, and limitations for energy supply – governance in the MENA region will increasingly be under pressure to deliver solutions with regard to conditions and support for adequate modernization and innovation. It seems that some solutions can involve using ICT and other new technologies. Under certain circumstances even something like "leap-frogging" (where outmoded technologies are skipped past, favouring innovative solutions instead) might be possible. This would mean for the decision-makers of today not to follow the same developmental patterns of Western countries (i.e. the destructive and non-sustainable "American Way of Life") and not making the same mistakes, not producing the same unintended negative effects, but adapting to future circumstances and using novel technological opportunities – an approach that needs to be accompanied by social innovation and some cultural changes. Because of some of the dynamics involved in such developments, the balancing of traditional and new cultural patterns is of central importance, and all the more so because of the acceleration of such changes and developments in the MENA region. Furthermore, in the EU more sensitive policies and activities should be put in place, which in the field of new technologies and ICT means offering, developing or – even better – co-developing "frugal technologies" that would better match the technological, societal, climatic and socio-economic conditions of countries in the MENA region. But overall, the adoption of digital options and ICT is extremely ambivalent: they can be used for more communication, transparency, education, empowerment, but they can also be used for greater control, censorship and repression. In general terms, digitalization and ICT open up new opportunities for very different types of activities in all areas of a society.

REFERENCES

Al-Dosari, Saad (2016), "Social Media Usage in the Middle East", in *Arab News*, 29 February, http://www.arabnews.com/node/888271

Alt, Franz (2014), "Der Desertec-Größenwahn ist ausgeträumt", in *Sonnenseite*, 14 October, http://www.sonnenseite.com/de/franz-alt/kommentare-interviews/der-desertec-groessenwahn-ist-ausgetraeumt.html

Annunziata, Marco and Rania Rostom (2015), *Mapping the Future of Work in MENAT: A 2015 Outlook*, GE Report, http://middleeast.geblogs.com/download/Mapping-the-future-of-work-in-MENAT-A-2015-Outlook.pdf

Appelrath, Hans-Jürgen, Orestis Terzidis and Christof Weinhardt (2012), "Internet of Energy. ICT as a Key Technology for the Energy System of the Future", in *Business & Information Systems Engineering*, Vol. 4, No. 1, p. 1-2, https://doi.org/10.1007/s12599-011-0197-x

Arezki, Rabah et al. (2018a), *Middle East and North Africa Economic Monitor, April 2018: Economic Transformation*, Washington, World Bank, http://hdl.handle.net/10986/29649

Arezki, Rabah et al. (2018b), *Middle East and North Africa Economic Monitor, October 2018: A New Economy for Middle East and North Africa*, Washington, World Bank, http://hdl.handle.net/10986/30436

Baller, Silja, Soumitra Dutta and Bruno Lanvin, eds (2016), *The Global Information Technology Report 2016. Innovating in the Digital Economy*, Geneva, World Economic Forum, http://reports.weforum.org/global-information-technology-report-2016

Berini, Gabriel Abadal et al. (2014), "A Research Agenda Towards Zero-Power ICT", in Giorgos Fagas, ed., *ICT – Energy – Concepts Towards Zero. Power Information and Communication Technology*, IntechOpen, p. 1-10, http://doi.org/10.5772/57347

BMI Research (2017), *MENA Infrastructure: Key Themes for 2017*, Fitch Solutions, July, https://www.fitchsolutions.com/node/179

Brisson, Zack and Panthea Lee (2011), *Egypt: From Revolutions to Institutions*, New York, Reboot, https://reboot.org/?p=1875

Bygstad, Bendik and Hans-Petter Aanby (2010), "ICT Infrastructure for Innovation: A Case Study of the Enterprise Service Bus Approach", in *Information Systems Frontiers*, Vol. 12, No. 3, p. 257-265

Camos, Daniel et al.(2018), *Shedding Light on Electricity Utilities in the Middle East and North Africa. Insights from a Performance Diagnostic*, Washington, World Bank, http://hdl.handle.net/10986/28684

Chaaban, Jad (2013), "Expanding Youth Opportunities in the Arab Region", in *Arab Human Development Report Research Paper Series*, http://www.arabstates.undp.org/content/rbas/en/home/library/huma_development/expanding-youth-opportunities-in-the-arab-region.html

Chambers, John (2015), "How Technology Is Transforming the Middle East", in *World Economic Forum Articles*, 20 May, https://www.weforum.org/agenda/2015/05/how-technology-is-transforming-the-middle-east

Comninos, Alex (2011), *Twitter Revolutions and Cyber Crackdowns*, Association for Progressive Communications (APC), June, https://www.apc.org/en/node/12432

CSIS–Center for Strategic and International Studies (2009), "The Good Life, Delivered: The Rise of Online Shopping in the Middle East", in *Mezze*, 14 October, https://www.csis.org/node/39693

CSIS (2015), "Performing Hajj: Sacred Rituals and Social Media", in *Mezze*, 17 December, https://www.csis.org/node/39099

CSIS (2016), "Playing the Market: Mobile Gaming in the Middle East", in *Mezze*, 21 June, https://www.csis.org/node/39093

D'Amato, Ilario (2015), "Green Jobs Program to Make Dubai Capital of Low Carbon Economy", in *The Climate Group News*, 13 February, https://www.theclimategroup.org/node/2364

Dennis, Everette E., Justin D. Martin and Robb Wood (2015), "Social Media", in *Media Use in the Middle East, 2015, Northwestern University in Qatar*, http://www.mideastmedia.org/survey/2015/chapter/social-media.html

Devarajan, Shantayanan et al. (2016), *Middle East and North Africa Economic Monitor, October 2016: Economic and Social Inclusion to Prevent Violent Extremism*, Washington, World Bank, http://hdl.handle.net/10986/25087

Dutta, Soumitra, Thierry Geiger and Bruno Lanvin, eds (2015), *The Global Information Technology Report 2015. ICTs for Inclusive Growth*, Geneva, World Economic Forum, http://reports.weforum.org/global-information-technology-report-2015

Ebinger, Jane O. (2006), Measuring Financial Performance in Infrastructure: An Application to Europe and Central Asia", in *World Bank Policy Research Working Papers*, No. 3992, http://hdl.handle.net/10986/9295

Economist (2017), "Startups in the Arab World", in *The Economist*, 12 January, https://www.economist.com/middle-east-and-africa/2017/01/12/startups-in-the-arab-world

El Difraoui, Asiem (2011), *Die Rolle der neuen Medien im Arabischen Frühling*, Bonn, Bundeszentrale für politische Bildung, 3 November, http://www.bpb.de/internationales/afrika/arabischer-fruehling/52420

Erdle, Steffen (2010), "The DESERTEC Initiative. Powering the Development Perspectives of Southern Mediterranean Countries?", in *DIE Discussion Papers*, No. 12/2010, https://www.die-gdi.de/en/discussion-paper/article/the-desertec-initiative-powering-the-development-perspectives-of-southern-mediterranean-countries

ESCWA–Economic and Social Commission for Western Asia (2015), *Role of Technology in Sustainable Development in the Arab Region*. Expert report for the Arab Sustainable Development Report, New York, United Nations, 17 April, http://web.archive.org/web/20171013135546/http://css.escwa.org.lb/SDPD/3572/5-Technology.pdf

Estache, Antonio et al. (2013), *Infrastructure and Employment Creation in the Middle East and North Africa*, Washington, World Bank, http://hdl.handle.net/10986/12237

European Commission (2015), *EE-11-2014 – New ICT-based Solutions for Energy Efficiency*, https://cordis.europa.eu/programme/rcn/664688_en.html

Faas, Henryk et al. (2011), "European Security – A European Perspective", in Adrian Gheorghe and Liviu Muresan, eds (2011), *Energy Security. International and Local Issues, Theoretical Perspectives, and Critical Energy Infrastructures*, Dordrecht, Springer, p. 9-21

FAO–United Nations Food and Agriculture Organization (2016), *Trends, Challenges and Priorities – Near East and North Africa* (PC 119/2 Add.2), Annex 5 to the Review of the Strategic Framework and Preparation of the Medium Term Plan 2018-21 - Regional Priorities, http://www.fao.org/3/a-mq647e.pdf

Frey, Carl Benedikt and Michael A. Osborne (2013), "The Future of Employment: How Susceptible Are Jobs to Computerisation?", in *Oxford Martin School Working Papers*, September, https://www.oxfordmartin.ox.ac.uk/publications/view/1314

Geiger, Thierry (2015), "Which Nation in North Africa and the Middle East is Top for Digital?", in *World Economic Forum Articles*, 15 April, https://www.weforum.org/agenda/2015/04/which-nation-in-north-africa-and-the-middle-east-is-top-for-digital

Gelvanovska, Natalija, Michel Rogy and Carlo Maria Rossotto (2014), *Broadband Networks in the Middle East and North Africa: Accelerating High-Speed Internet Access*, Washington, World Bank, http://hdl.handle.net/10986/16680

GIZ–Gesellschaft für internationale Zusammenarbeit (2017), *Energised: Jobs with a Future in Morocco*, 11 October, https://www.giz.de/en/mediacenter/57580.html

Göll, Edgar (2017), "Future Challenges of Climate Change in the MENA Region", in *MENARA Future Notes*, No. 7 (July), http://www.menaraproject.eu/?p=966

Guasch, J. Luis (2004), *Granting and Renegotiating Infrastructure Concessions. Doing It Right*, Washington, World Bank. http://hdl.handle.net/10986/15024

Guetat, Imène and Imed Drine (2009), *The Information and Communication Technologies Impact on the MENA Countries Growth Performance*, paper presented at the International Conference "Inequalities and development in the Mediterranean countries", Istanbul, 21-23 May 2009, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.496.1125

Howard, Philip N. (2011), *The Digital Origins of Dictatorship and Democracy. Information Technology and Political Islam*, Oxford, Oxford University Press, http://philhoward.org/wp-content/uploads/2012/12/Howard_Digital-Origins-of-Dictatorship-and-Democracy.pdf

IEA–International Energy Agency (2013), *Energy Efficiency Market Report 2013. Market Trends and Medium-Term Prospects*, Paris, OECD/IEA, October, https://www.iea.org/publications/freepublications/publication/EEMR2013_free.pdf

Innovation Group (2017), *The Future 100: MENA Trends and Change to Watch in 2017*, https://www.jwtintelligence.com/trend-reports/the-future-100-mena-2017

Ionescu, Luminita (2013), "The Positive Effect of ICT Infrastructure in Reducing Corruption and Increasing Transparency", in *Economics, Management and Financial Markets*, Vol. 8, No. 2, p. 167-172

ITU–International Telecommunication Union (2017), *Measuring the Information Society Report 2017. Volume 1*, Geneva, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2017.aspx

Iyer, Bala and Thomas H. Davenport (2008), "Reverse Engineering Google's Innovation Machine", in *Harvard Business Review*, April, https://hbr.org/2008/04/reverse-engineering-googles-innovation-machine

Karake Shalhoub, Zeinab and Sheikha Lubna Al Qasimi (2010), *Cyber Law and Cyber Security in Developing and Emerging Economies*, Cheltenham/Northampton, Edward Elgar

Keulertz, Martin et al. (2016), "Material Factors for the MENA Region: Data Sources, Trends and Drivers", in *MENARA Methodology and Concept Papers*, No. 3 (December), http://www.menaraproject.eu/?p=814

Khamis, Sahar and Katherine Vaughn (2011), "Cyberactivism in the Egyptian Revolution: How Civic Engagement and Citizen Journalism Tilted the Balance", in *Arab Media & Society*, No. 14 (Summer), https://www.arabmediasociety.com/?p=1898

Lüders, Michael (2017), "Über Irrtümer, Interessen & Liebe zum Orient", in *Jung & Naiv*, 18 June, http://www.jungundnaiv.de/?p=1653

Magnitt (2016), *State of MENA Funding 2016. Statistics on the MENA Startup Community*, Dubai, 22 December

McKee, Musa et al. (2017), "Demographic and Economic Material Factors in the MENA Region", in *MENARA Working Papers*, No. 3 (October), http://www.menaraproject.eu/?p=1040

McKenna, John (2017), "The Middle East's Start-up Scene – Explained in Five Charts", in *World Economic Forum Articles*, 17 May, https://www.weforum.org/agenda/2017/05/what-you-need-to-know-about-the-middle-easts-start-up-scene-in-five-charts

Menichetti, Emanuela, Abdelghani El Gharras and Sohbet Karbuz (2017), "Material Factors for the MENA Region: Energy Trends", in *MENARA Working Papers*, No. 5 (November), http://www.menaraproject.eu/?p=1061

Morris, Nicholas and Rosalind Carey (2009), *Infrastructure in the MENA Region. The Current State of Play*, presentation at the MENA Regional Conference on Infrastructure Reform and Regulation, Amman, 7-8 December, http://siteresources.worldbank.org/INTMENA/Resources/Carey_InfrastructureintheMENARegionv3NM.pdf

Odenbach, Jan, Edgar Göll, Siegfried Behrendt (2017), *Industrie 4.0 – digital-vernetzte dezentrale Produktion. Transformationsfeldanalyse im Rahmen des Projekts Evolution2Green – Transformationspfade zu einer Green Economy*, Berlin, IZT, January, https://evolution2green.de/sites/evolution2green.de/files/documents/2017-01-e2g-industrie_4_0-izt.pdf

Oyelaran-Oyeyinka, Banji, Kaushalesh Lal and Catherine Nyaki Adeya (2007), "Institutional Support for Collective ICT Learning: Cluster Development in Kenya and Ghana", in Banji Oyelaran-Oyeyinka and Dorothy McCormick, eds, *Industrial Clusters and Innovation Systems in Africa: Institutions, Markets and Policy*, Tokyo/New York/Paris, United Nations University Press, p. 269-293, http://collections.unu.edu/view/UNU:2478

Pilling, David (2018), "African Economy: The Limits of Leapfrogging", in *Financial Times*, 13 August 2018, https://www.ft.com/content/052b0a34-9b1b-11e8-9702-5946bae86e6d

Preqin (2016), *Infrastructure in MENA*, November, https://www.preqin.com/insights/special-reports-and-factsheets/infrastructure-in-mena-november-2016/16113

Rostom, Rania (2015), "3 Disruptive Innovations That Are Changing the Middle East", in *World Economic Forum Articles*, 22 May, https://www.weforum.org/agenda/2015/05/3-disruptive-innovations-that-are-changing-the-middle-east

Sader, Frank (2000), "Attracting Foreign Direct Investment into Infrastructure. Why Is It so Difficult?", in *Foreign Investment Advisory Service Occasional Papers*, No. 12, http://documents.worldbank.org/curated/en/628631468779704134

Sethi, Arjun and Johan Gott (2016), *2016 A.T. Kearney Global Services Location Index. On the Eve of Disruption*, https://www.atkearney.com/digital-transformation/article/?/a/2016-global-services-location-index-

Thottathil, Mahsoom (2014), "Social Media in the MENA Region", in *Arabian Gazette*, 3 February, https://arabiangazette.com/social-media-mena-region-infographic-20140203

Thunert, Martin (2009), "The Information and Decision Support Centre (IDSC) of the Egyptian Cabinet: A Think Tank in the Making", in *Zeitschrift für Politikberatung*, Vol. 2, No. 4 (December), p. 679-684

Trend Micro (2017), *The Middle Eastern and North African Underground: Where Culture and Cybercrime Meet*, 10 October, http://bit.ly/2hEi9SJ

TrendWatching (2017), *5 African Trends for 2017*, January, http://trendwatching.com/trends/5-african-trends-for-2017

Tufekci, Zeynep (2011), "As Egypt Shuts Off the Net: Seven Theses on Dictator's Dilemma", in *Technosociology*, 28 January, http://technosociology.org/?p=286

UNDP–United Nations Development Programme (2011), *Arab Development Challenges Report 2011. Towards the Developmental State in the Arab Region*, Cairo, UNDP Regional Centre for Arab States, http://www.undp.org/content/undp/en/home/librarypage/hdr/arab-development-challenges-report-2011.html

UNDP (2012), *Arab Knowledge Report 2010/2011. Preparing Future Generations for the Knowledge Society*, http://arab-hdr.org/akr

UNDP (2016), *Arab Human Development Report 2016. Youth and the Prospects for Human Development in a Changing Reality*, http://arab-hdr.org/Reports/2016/2016.aspx

UNEP–United Nations Environment Programme (2008), *UNEP Climate Change Strategy*, Nairobi, UNEP, http://hdl.handle.net/20.500.11822/7755

UNICEF–United Nations Children's Fund (2017), *The State of the World's Children 2017. Children in a Digital World*, December, https://www.unicef.org/publications/index_101992.html

Waha, Katharina et al. (2017), "Climate Change Impacts in the Middle East and Northern Africa (MENA) Region and Their Implications for Vulnerable Population Groups", in *Regional Environmental Change*, Vol. 17, No. 6, p. 1623-1638

We Are Social and Hootsuite (2018), *Global Digital Report 2018*, https://digitalreport.wearesocial.com

WEF–World Economic Forum (2017), *The Future of Jobs and Skills in the Middle East and North Africa. Preparing the Region for the Fourth Industrial Revolution*, May, https://www.weforum.org/reports/the-future-of-jobs-and-skills-in-the-middle-east-and-north-africa-preparing-the-region-for-the-fourth-industrial-revolution

Wibeck, Victoria, Tina-Simone Neset and Björn-Ola Linnér (2013), "Communicating Climate Change through ICT-Based Visualization: Towards an Analytical Framework", in *Sustainability*, Vol. 5, No. 11, p. 4760-4777, https://doi.org/10.3390/su5114760

World Bank (2014), *Turn Down the Heat. Confronting the New Climate Normal*, Washington, World Bank, http://hdl.handle.net/10986/20595

World Bank (2017), *State of Electricity Access Report 2017*, Washington, World Bank, http://hdl.handle.net/10986/26646

Zuazua, Mauricio (2017), "The Sunny Side of the Roboconomy in the Middle East", in *World Economic Forum Articles*, 18 May, https://www.weforum.org/agenda/2017/05/roboconomy-in-the-middle-east

Middle East and North Africa Regional Architecture: Mapping geopolitical shifts, regional order and domestic transformations (MENARA) is a research project that aims to shed light on domestic dynamics and bottom-up perspectives in the Middle East and North Africa amid increasingly volatile and uncertain times.

MENARA maps the driving variables and forces behind these dynamics and poses a single all-encompassing research question: Will the geopolitical future of the region be marked by either centrifugal or centripetal dynamics or a combination of both? In answering this question, the project is articulated around three levels of analysis (domestic, regional and global) and outlines future scenarios for 2025 and 2050. Its final objective is to provide EU Member States policy makers with valuable insights.

MENARA is carried out by a consortium of leading research institutions in the field of international relations, identity and religion politics, history, political sociology, demography, energy, economy, military and environmental studies.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 693244. This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.