Moving toward smart cities: insights from the MENA region

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Abstract: The need for governments to deal with issues such as congestion, scarcity of resources, and waste management became a must to sustain a living. Through using innovative technologies, cities are striving to start a smart city initiative for a better life. However, little is known about the implementation of smart cities and less is provided about the Middle East and North Africa region. This research attempts to embrace the different aspects of smart cities and analyses the readiness of the MENA to move towards this promising project. Interviews were conducted with key decision makers in the MENA region who are involved in smart cities projects. Results highlight the opportunities and key aspects of this project and propose three phases to the implementation of a smart city: foundation, convergence, and transformation.

Keywords: smart cities; digitalisation; internet of things; IoT; qualitative study.

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1 Introduction

It took thousands of years for the population on earth to reach the first billion, in 1804, but only 100 years to reach the next billion, in 1927. In 2011, 7 billion minds were living on earth and in another ten years another billion are expected to join. In a recent projection reported by the United Nations Population Fund (UNFPA), the world population will grow to 8 billion by 2020 and this rapid growth is the result of human evolution in technology, science, education, and culture. Now, more than half of populations are residing in cities and urban towns for better job offers, health services, and education. 'More people' means more demand on such areas as services, resources and space. They create a chaotic environment of waste, pollution, and congestion. Governments are working hard to meet the increasing demands of services, safety, education, natural resources and land use (Gil-Garcia et al., 2015). These arising issues drive cities to seek new solutions to such complex problems that are social, political and organisational (Nam and Pardo, 2011) and that require innovative approaches. The new futuristic agenda is focused on improving convenience, preserving energy, enhancing the quality of air and water, and deploying resources effectively (Gil-Garcia et al., 2015). Cities around the world are trying to put this approach into motion and governments are adopting new smart methods in areas such as traffic control and management of waste.

Technological innovation, in particular, can help cities manage urban environments in becoming more sustainable. Becoming 'smarter' is the new trend among cities to improve this reality by experimenting scientific ideas, financial proposals, and other creative solutions. Smart cities englobe many pillars such as e-government, citizenship, democracy and communities. It is also related to marketing, service industry; technology sharing and learning. In this sense, the internet of things (IoT) is an international infrastructure of connected networks based on communication protocols to integrate physical and visual 'things' into a fluid information network. European cities are in the lead in terms of implementing the concept of smart cities, and big cities around the continent are undergoing major changes towards smartness; some of which are Amsterdam (The Netherlands), Nice (France), Barcelona (Spain) and Milan (Italy) (Talari et al., 2017). Other cities in North America (New York, Toronto), as well as Asia (Hong Kong, Tokyo), are joining the race.

The Middle East and North Africa (MENA) countries, nevertheless, have been rather hesitant in their approach towards this huge change although these countries are witnessing a population boom and their major cities are becoming the hubs of technology, science, and culture. Moreover, data from the World Bank shows that the Arab world population is expected to double by 2050 which pushes for the adoption of smart cities even more. Few countries are moving to smartness such as Qatar through TASMU Smart Qatar Program and United Arab Emirates' (UAE) 'one-stop shop' application for governmental services. Morocco has hosted the first international summit for smart cities in North Africa to bring together policy makers and academia to find actionable and novel proposals for smart city scenario in Africa (Khabara, 2014). Some other countries are making it their priority in the coming years by incorporating new master plans and technological infrastructures.

Launching smart cities is in fact an opportunity to diversify their income and showcase the region's capabilities to the world. At an academic level, research on smart cities in the MENA region is very scarce. Besides, although much research has recently, been interested in smart cities (Anthopoulos, 2019; Taamallah et al., 2019a), the factors contributing to their development still need to be explored. Consequently, this thesis aims at acquiring expertise from existing strategies and projects about smart cities in the MENA region in order to identify and assess the factors that contribute to the development towards smartness.

To achieve the research aim, smart cities are first conceptualised and then, the IoT technology described. Afterward, an overview of previous frameworks on the topic is provided followed by a description of smart cities in the MENA Region. The research paper continues with the methodology and a discussion of the results and concludes by highlighting the implications and limitations and by providing future directions for research.

1.1 The smart city concept

"Although there is an increase in the frequency of use of the phrase 'smart city', there is still not a clear and consistent understanding of the concept among practitioners and academia" [Chourabi et al., (2012), p.2289]. Previous research has defined a smart city in various ways. First, a smart city was approached as a sustainable city and defined as "one in which people and businesses continuously endeavor to improve their natural, built and cultural environments at neighborhood and regional levels, whilst working in ways which always support the goal of global sustainable development". A more recent definition by Meijer and Bolivar (2013) states that "a smart city is built when governments invest in human and social capitals as well as transport, information and communications technology (ICT) infrastructures, they end up with constant growth of the economy and a better quality of life." Similarly, Chourabi et al. (2012) stated that a smart city joins physical, technological, social, and economic infrastructures to produce an intelligent city.

González and Rossi (2014) regarded the ICT infrastructure as the central element in smart cities. Schaffers et al. (2011) put the focus on advanced infrastructures that work with sensors, networks, and other electronic gadgets to stimulate a 'safe, secure' urban city. Talari et al. (2017) stated that a smart city uses electronic devices that are applied by the monitoring system and transportation system. Previous research also categorised themes or dimensions in which smart cities depend on like: economy (governance), people (human capital and education), mobility (infrastructures), environment (natural resources), and living (sustainability) (Chourabi et al. 2012; Lombardi, 2011; Giffinger et al., 2007). In this context, the European Innovation Partnership on Smart Cities and Communities described how smart cities work by advocating people to interact with and to use energy and systems to catalyse sustainable economic development, resilience, and high quality of life ['Strategic Implementation Plan', (2013), p.5].

In a nutshell, to become smarter, cities should think of innovative, greenways using technological infrastructures to better invest in and use existing resources and capabilities. In other words, "Smart citizens, smart energy, smart buildings, smart mobility, smart technology, smart healthcare, smart infrastructure, smart governance and finally smart security are the aspects of smart cities" (Talari et al., 2017). As concluded

by the International Telecommunication Union's Focus Group on Smart Sustainable Cities (FG-SSS), a sub-party of the United Nations specialised agency, states that a smart city is "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" [Kondepudi, (2014), p.13]. It is worth mentioning that 'technological infrastructure', 'ICT' and 'interconnected IT' are often associated with smart cities. This is because ICT has become the nervous system of many urban economic systems. However, as the concept of 'smartness' is relatively new, many urban developments are utilising traditional vertical ICT solutions which do not help smart cities reach their full potential. Previous research explored ways in which the vision of the future internet (FI) can bring smart cities to a whole new level of an open innovation platform. The FI can be defined as a socio-technical system of services brought along a physical environment in support of applications that are an integral part of the society. It includes a variety of pillars, among which are the IoT, internet of services (IoS) and internet of people (IoP). However, for the purposes of this paper, we will focus on the IoT as the main aspect of ICT infrastructure in smart cities.

1.2 The IoT

According to Bharadwaj (2016), IoT is simply "a network of internet-connected objects able to collect and exchange data." It is composed of two main parts: 'internet' that functions as the backbone of connectivity and 'things' which refers to objects and devices. In other words, it is a network of objects such as house appliances, cars, and other devices that are equipped with sensors, microcontrollers, and transceivers that enable them to connect and exchange data through network connectivity. Not only that, but IoT also allows objects, devices, and machines to be controlled remotely. For its users, IoT offers innovative solutions to their day-to-day lives. It benefits several domains like security, education, and health.

Combining cities with smart technology solutions has become a basic demand of the current digital age driving companies to cater the IoT and look for big data solutions to improve their processes and work outcome. This applies to the 'smart city' trend that began to grow as the IoT has become more prominent in everyday life revolutionising traditional public services such as; transportation, surveillance, public area maintenance, heritage conservation (Zanella et al., 2014); for example, the machine-2-machine (M2M) solutions is a subset of IoT that refers to using a wireless network to connect two devices together via the internet with little human intervention.

1.3 Previously proposed frameworks for smart cities

Previous research has quoted several elements that make up a smart city such us citizens, mobility, technological infrastructure and municipal administration (governance) (Gil-Garcia et al., 2015); technology, people, and community (Nam and Pardo, 2011); a framework that empowers private and public sectors (Falconer and Mitchell, 2012); collaboration, data transformation, integration of services, communication and partnership, transparency, and leadership (Joshi et al., 2016).

Mauher and Smokvina (2006) drew attention to the legal agreements behind smart cities. Policies supporting the development of this initiative must be written down by the government. Yigitcanlar and Velibeyoglu (2008) added that such policies must align with the technical as well as the non-technical requirements which are important for the urbanisation. Hollands (2008) proposed three elements of a smart city: successful operations of technological, social, cultural and urban infrastructures, which are:

1 intertwined to improve political and economic efficiency

2 Urban developments led by businesses

3 social and environmental sustainability.

For Joshi et al. (2016, p.906), planning a vision towards a smart city and working on it with an approach that is set by systems is imperative to "ensure optimum resource efficiency and security, along with preserving socially inclusive growth." Standard traditional governance would include limited transparency, unequal divisions, and loss of resources. A transformation from such governance to e-governance is critical for effective and efficient management (Giffinger et al., 2007).

Chourabi et al. (2012) present an integrative and all-inclusive framework or design of smart cities that have been implemented and tested in several cities. The model groups eight dimensions that affect the implementation of the initiative: first, management and organisation such as the project' size, the organisational diversity and the manger's attitude towards the project and workers. Second, a smart city heavily depends upon technology, through applications that facilitate public services around the city. Third, governance involves the practices and processes that manage the exchange of information among stakeholders. It requires good leadership and communication. Fourth, policy context denotes the political and institutional components of the city environment. Fifth, people and communities describe the participation of the society, the accessibility of services, the quality of life and education. Sixth, economy is the capital used or produced from innovation and productivity. Seventh, the infrastructure, mainly the technological infrastructure, its quality, and availability. Eighth, natural environment reflecting the sustainability of natural resources.

Recently, Taamallah et al. (2019b, 2018) drew attention to the design process of smart cities strategies. In fact, the development process of strategies is hard, complex and repetitive. The authors identified a generalised development process of strategies from the analysis of existing smart cities initiatives and they underlined the importance of communication between the different partners. For the purpose, they proposed an ontology (the ontology-based information extraction – OBIE) which allows sharing the gathered knowledge between people participating in the activities of smart cities design (Taamallah et al., 2017) and offered a web-based platform to provide a common space for stakeholders to communicate and propose transformational strategies.

1.4 Smart cities in the MENA region

Dubai has established two major projects which are considered as Greenfield initiatives to a smart city and sustainability under the names of 'Dubai Design District (D3)' and 'Dubai Silicon Park' (Singh, 2015). Another interesting project called 'Smart Bins55' is offered to the citizens of Sharjah City. The project uses smart technology in waste management using compactors with smart sensors for real-time measures such as the bin

level, temperature information for fire detection and trip over detection by bin's position. Sharjah has partnered with the Sharjah Leadership Program to implement smart programs within transportation, education, and health sectors under the name of 'Sharjah Tatweer Forum' (STF). The aim of this program is to help both private and public sector leaders to meet the international standards and increase their awareness of the UAE's plans on the new transition to the smart economy.

In Qatar, many private real estate developers have been working on the most notable projects such as Lusail City, Msheireb, Barwa City, Energy City Qatar, and Pearl Qatar. Lusail City is located on over 35 km^2 and hosts approximately up to 450,000 people. One of the efficient and sustainable experiences that the city will provide is the fibre-optic network infrastructure which connects the residents with many smart services, such as intelligent transport systems, deployment of the internet in public areas, video surveillance, and more. One project of an intelligent transportation system will provide solutions for traffic management, logistics management, road safety, and public services.

The Saudi Government has planned to build a huge transitional city and economic zone that will be completely powered by renewable energy sources. The city has a zero-tolerance policy on all kinds of fossil fuels (Neom Saudi Arabia Mega-City, 2017). Moreover, infield trails have been carried out around Makkah City. This sensor network is capable of measuring and reporting environmental parameters such as temperature, humidity, and air pressure. This project is expected to benefit a lot of domains including smart parking, waste management and residential environmental control and monitoring (Saudi Arabia Trials NB-IoT for Smart Cities, 2017).

Lebanon as well is moving towards a digital strategy by building a nationwide IoT network. Lebanese authorities have planned a three steps approach to the new smart city located in the east of Beirut. The first step is to install sensors and actuators around the city; the second is to connect the sensors to a specially designed digital platform via a wireless network. The final step is to explore predictive statistics using machine learning techniques and artificial intelligence to better analyse and exploit the collected data (Lebanon Smart City Experience, 2017).

In Cairo, the government planned to re-distribute densely populated areas of the city by improving the accessibility of underpopulated sub-urban areas with highways and ring roads. Another aspect is the improvement of the quality of life as well as the environment by planning and placing green spaces across the city (El-Hefnawi, 2016).

While Morocco stands for some major improvements in clean energy, urban, agricultural development, water security and transportation, the government has decided to setup smart cities marked by the first international summit on smaller cities in North Africa, held in Ifrane, the government has been pushing policies to help decentralisation and digitalisation of governance. The city of Casablanca has decided to invest 94 million dirhams (more than €8 million) in its digital services by 2022 (El-Hefnawi, 2016). This budget will fund 70 projects, including four currently underway. This entails the creation of a tax information system, the development of a geographical information system (GIS), the breakdown of the certification service and the acquisition of CRM (citizenship). To improve access to information in the city, the municipality offered a platform called 'Casa Urban Data', which allows the sharing of data about transport services between local government and citizens.

In Tunisia, the National Strategic Plan 'Digital Tunisia 2020' was developed in order to position Tunisia as an international reference for digital development and to provide it

with a technological infrastructure in phase with a modern economy. In 2018, a first in Africa and in the Arab world, Tunisia launched the first national caravan dedicated to the smart city. The travelling event was co-organised with 24 Tunisian cities, with the main objective of demystifying the approach of smart cities and raise awareness of this little-known concept and issues related to it. Furthermore, in Tunisia, the city of Bizerte is listed among the top four smart and sustainable cities in the world. The city of Bizerte launched an innovative project called 'Punic Counter to Digital Port'. It aims to connect Europe and Africa by using the submarine fibre-optic cable and contribute to the emergence of smart and sustainable cities in Africa.

Furthermore, in the city of Sfax, a smart project integrates different modes of transport rail, automobile, cycle and walking in a single system and to create smarter buildings in order to facilitate and improve the energy management or to reduce consumption.

In addition, The Tunisian Economic Center (TEC), the joint owner of Tunisia and Saudi Arabia, has chosen Locus Chain blockchain as the settlement currency and service platform. TEC, based on the East Peninsula of Tunisia, is supposed to be the largest itchy city in the Mediterranean, with a surface of 90 km^2 covering 14 large areas. Its geographical location makes it possible to create a website that connects Europe, Africa and Asia, thus becoming an international business and technology hub (Taamallah et al., 2019b).

Despite those initiatives, moving towards a smart city remains a laborious and error prone task which suggests designers' expertise and adequate skills (Anthopoulos, 2019; Taamallah et al., 2018). Anthopoulos (2019) acquired expertise from ten representative international city cases that claim to be smart. The outcomes distinguished utopia from reality by providing a pool of evidence that can justify whether a city is smart or not. Acquiring expertise from decision makers in the region of MENA can be insightful to the current and future aspiration of governments towards smartness. The following paragraphs details the qualitative study for the purpose.

2 Methodology

For the purposes of this paper, a qualitative approach is deemed appropriate. Experts in smart city infrastructures, smart applications designers, government strategists, and managers of smart city projects in Qatar, UAE, Egypt and Tunisia were interviewed. The theoretical saturation was reached at the 11th interview. Interviews were conducted face-to-face and over Skype conference calls. First, participants were informed about the purpose of the study. Then, the interview themes were approached. Interviewees were asked about:

1 the opportunities
2 the key aspects to build a smart city
3 the readiness of the region.

Afterwards, interviews were manually analysed. After a first 'floating reading' (Dumez, 2013) of all interviews in order to have a holistic view of the content, the theme was chosen as the unit of analysis. A thematic content analysis consists in identifying repetitive thematic unit in the respondents' discourse (Bardin, 2003). The exploitation of

the corpus was articulated around the following stages (Allard-Poesi et al., 2015, Bardin, 2007): the division of the text into themes; the classification into categories and the data analysis within which a vertical analysis was first conducted to identify the topics addressed by each respondent in isolation (interview analysis); then followed by a horizontal analysis aiming at grouping and identifying recurring, constant themes and discordant topics across all interviews. The confrontation of these two analyses led to the construction of the completed thematic analysis grid.

The tables of the frequency matrix and the resulting categories are presented in Appendix.

3 Results and discussion

Results describe successively the opportunities and the pillars of a smart city. Then, an assessment of the readiness of the region is provided.

3.1 Opportunities

a *Return on investments:* Interviewees highlight that the ROI of the new technology is not 'easy' to determine. However, they agree that the return of such project is promising. For instance, interviewee 2 stated: "Qatar's 6 billion TASMU project will render 40 Billion QR in 5 years." Another interviewee confirmed that "by [the] long run there will be economic benefits by moving smart."

b *Sustainability:* The oil market which is considered as the largest source of revenue for GCC countries is not going to last forever. In line with Monzon (2015), respondents highlight that a smart city is expected to help in efficiently utilising the available resources to last longer. The contribution to sustainability can take two major forms. Environmental sustainability is mostly explained in terms of "reducing harmful emissions," "reducing the carbon dioxide level," "emission reduction targets" and "control the consumption of the water." Whereas economic sustainability is mentioned as "green buildings…which will save electricity consumption" and "use renewable energy." Interviewee 8 explained: "smart traffic management preemptively advises drivers on the best route to take and save numerous unproductive hours, saves fuel costs, reduces emissions, and enhances general economic productivity and output."

c *Better quality of services:* Interviewee 1 underlines that for complex smart systems, a "minor mistake could lead to disasters" that is why "in such tasks devices would accomplish the task more accurately." He added that by using smart technologies, governments can "serve a bigger number of clients with a better quality of service." Moreover, most interviewees mentioned that having a smart city "Increases efficiency," "Improves the quality of services," "Promotes innovation" and offers better services such as "smart parking, smart lightning, smart waste management" as well as "improving the safety of the city and reducing the accident level." Interviewee 4 stated, "IOT is the trend for modern lifestyle." Those results are in line with previous research suggesting that smart cities offer convenient innovative solutions to make life easier (Gil-Garcia et al., 2015; Meijer and Bolivar, 2013).

d *Cost saving:* According to interviewees, smart solutions help governments as well as citizens to save money. Interview 8 explained: "the direct cost will reduce gradually like, rents and parking lots." Another respondent added: "using devices would be more cost saving than using human taskforce" and "The implementation of smart city solutions can reduce cost significantly." It also can reduce individual spending according to interviewee 5. Those findings are in line with the literature review on the economic efficiency of smart cities (Chourabi et al., 2012; Hollands, 2008; Joshi et al., 2016).

e *Big data:* According to interviewee 6: "Data is the next gold mine and becoming smart underlines the importance of data generation/collection, this data will help create solutions and guide many strategic decisions." Another respondent added: "being smart provides support in decision-making" and "provides information in real time." Also, having one data platform will 'reduce redundancy'. Interviewee 8 stated that "The main motivation of big data is the ability to use data and advanced analytics to improve people's lives." These data are fed into the central platform in a way that citizens could access it as well.

3.2 Key aspects required to build a smart city

a *Aligning with strategic business plan:* Interviewees explained that there is a requirement of a "Strategic business plan for implementation." Aligning the benefits of smart cities and including them as strategic KPIs help authorities stay focused on pursuing this initiative. This is done for projects like Qatar National Vision 2030, UAE's Smart Dubai Initiative and Egypt's Strategic Plan 2050 (Ibrahim et al., 2015).

b *Infrastructure:* Respondents highlight that a solid infrastructure is a must to be able to properly utilise IoT technologies. One interviewee explained: "the infrastructure must be fitted with the sensors and the hardware required collecting data… The telecom infrastructure needs to be ready to onboard the millions of devices that will be communicating and sending data." As mentioned in the literature review, technological infrastructure is the core component of a smart city and without it; a smart city implementation would be a struggle (Arasteh et al., 2016).

c *Governance:* The government's support of the initiative will set the tone of how it will be accepted among the people. "If they are interested to apply the concept it will guarantee the initiative success." Another interviewee confirmed, "I believe that governance is key to implement smart city." This result confirms Chourabi et al. (2012) finding that governance helps to build a smart city.

d *Awareness:* About the smart city initiative, value, benefits, and opportunities is a great catalyst for the transformation of any city. The interviewees evoked two aspects:

- Awareness of the citizens: Respondents mentioned corpus like; "educate people about the benefits of the new technology," "awareness for the public to increase the adoption," "awareness for the…service benefiter level" and "the awareness of the IOT benefits is important to break the ice between people and the IOT."

- Awareness of the government: The awareness of the decision makers is crucial to the implementation of the smart city. Respondents mentioned "Awareness of decision maker in the governmental sector," "awareness of all stakeholders," "awareness to the service provider level which will direct the implementation of the IOT service, and the decision maker, who will allocate budget and state rules to move toward smart city," and " awareness of the governments and technology entrepreneurs."

e *Human skills:* To implement a technological infrastructure, the government should have capable human resources to handle such complex systems and be able to come up with solutions if any problem occurs. This is what a few participants pointed out. Citizens should be willing to direct their skills and knowledge to the direction their city is taking. In addition, this allows the government to take full advantage of its citizenry rather than bringing foreign skills into the equation. Qatar has integrated training courses and skills development programs in the needed areas. However, according to some respondents: "…skills in IoT systems and high-tech systems are still being developed."

f *Funds:* Egypt, Tunisia, and Algeria are facing funding problems. Yet, the whole initiative depends greatly on the availability of financial resources (Giffinger et al., 2007; Chourabi et al., 2012; Joshi et al., 2016). Other cities have funds available but not allocated for this initiative. One interviewee emphasised that the higher-ups should have the "Willingness to pay." He underlined that "financial resources are key to implement smart city." Another added: "It's very important to have the economic support."

g *Central platform:* Efficiency is one of the highlights of smart cities. To provide efficient services, a central platform where all data is stored is a necessity. "The central platform includes all the data captured, analyze it and provide it in a meaningful way to the sectors and people." As mentioned by Arasteh et al. (2016), technological infrastructure is the core component of a smart city and without it, a smart city implementation would be a struggle.

h *Society:* Respondents noticed "the necessity to consider how people will deal with smart city elements, and how comfortable they are with and how far are they open to accept potential privacy infringements relative to the benefit." An interviewee stated that "the 107 projects of TASMU are citizen focused… Because this is an important social aspect when we are creating the solutions." The success of many projects could depend on the citizens' feedback and usage. Uncooperative citizens are an obstacle in acquiring personal data required for smart services. As underlined in the interviews, Arabs are indeed conservative when it comes to data sharing. However, without smart citizens, a city is not smart at all (Chourabi et al., 2012; Hollands, 2008; Joshi et al., 2016).

i *Pilot:* As the smart city initiative is new to the region, it is better to pilot smart projects on smaller areas rather than the whole city, and studies it by looking at the challenges and rates of success. Benchmarking from other cities that have implemented these concept years ago is a good strategy. This gives the stakeholders

an actual estimation of the success of this project and could help in the analysis of the profits. For instance, respondents mentioned: "using the pilot methodology in implementing the solution in a certain area before mass rollout…save a lot of money by testing on a small area, validating first, then mass roll out and investment." Using other cities as a pilot or model for implementing new technologies will contribute to assessing the value of the projects.

j *Processes, policies, and regulations:* Policies regarding several aspects must be developed to enhance the quality of services. "We look for a new technology which is usually ahead of any policy and regulation." Interviewees pointed out the lack of policies. For example, the lack of 'technology ones (IOT policies)' leads to 'legal hurdles' or 'legal barrier'. Sharing information and data about individuals has its security issues as well, that is why 'policies dealing with penetration and hacking' should also be developed. However, developing such policies is a major challenge because "There is no experienced organization or guideline" and "there is no policies and procedures to make a city smart at this point…so everybody is learning it and has a different opinion to the way how to implement it," "We have to do it through building a learning curve internally and benchmark with smart cities around the world."

3.3 Readiness of the MENA region

Emerging results classify three phases that the region may go through to reach the ultimate smart city transformation. Some factors are more significant than others in each phase. The three phases may prepare and create the right environment in which a smart city can prosper. First, the foundation phase which covers all infrastructure aspects of a smart city. Second, the convergence phase that integrates the technology into the public. Third, the transformation phase which is the contextual experience of a smart city. Those phases are described in the following paragraphs.

1 Foundation phase

This phase is the most important and complex of all phases. If it is not delivered correctly, the whole project might collapse. As its name suggests, it is the phase that keeps the 'structure' of the smart city anchored. To establish this, fundamental factors need to be considered such as technological, social, and economic infrastructures as well as setting suitable policies and regulations. The current technological infrastructure in the region is inadequate. To fix this, governments need to build a new one from scratch in the new cities – or upgrade the current one – which is what most of the region is doing. Building smart systems as well as ICT networks are the first steps towards a solid technological infrastructure. This aspect is stressed in most frameworks as the core that smart cities are built upon. Next, the social infrastructure is required (Joshi et al., 2016). To attract such human resources and to win the support of the society, awareness of the smart city initiative is required. Moreover, it is stated that the awareness of the citizens contributes to the success and application of new technologies and their lack thereof dulls the full potential of the smart city initiative. The economic infrastructure is signified by physical forms of capital investments. None of the two previous infrastructures can be obtained without financial investments. The economic ability of a city is reflected

in its growth. Setting up these infrastructures forms a basis to transit into the integration phase. However, before exploring the second phase, policies and regulations should be put to control and direct these infrastructures.

2 Convergence phase

This phase is mainly about integrating technological infrastructure. Smart systems like central platforms are put in action to test and introduce the initiative to the public. However, with this integration, the government factor plays a major role in studying and adjusting policies and regulations to enhance the assimilation process. Aligning the legal system with this strategic step is vital to allow the public full accommodation of the smart systems. The focus of this phase is to empower citizens with instant access to all the data they want. Moreover, convergence could take part as a pilot program to experience the success of infrastructures and get feedback from citizens, to study the points of weaknesses and enhance the strengths. Thus, as the frameworks recommended, it is the duty of the management and government entities to ensure the smoothness of this phase. Going back to some of the initiatives in Qatar and UAE, the convergence phase is fast approaching as projects have been proposed and recognised.

3 Transformation phase

This is the final phase of the smart city initiative in MENA. It enables all city residents to the full experience of a smart city. The government supervises the implementation process that involves the operation and maintenance of smart technology, usage of network-enabled utilities, and security services integration.

Certainly, this analysis gives an idea of the status-quo of the MENA region in terms of their readiness to adopt a smart city initiative. That is, most cities are still getting ready, they are on their way to strategising and including the smart city vision such as Algeria, Tunisia, and Morocco, whereas Egypt has begun small-scale smart projects that use IoT technology. Such countries are still preparing for phase one (foundation). On the other hand, GCC countries such as Qatar, UAE, and KSA are well into the foundation phase and some projects can be considered under the convergence phase. However, it is regrettable to say that none reached the smart city transformation phase. This is supported by the interviewees' input about the readiness of the region.

4 Conclusions

This research attempts to embrace the different aspects of smart cities and analyses the readiness of four countries of the MENA region to move towards this promising project. Interviews were conducted with key decision makers who are involved in smart cities projects. An analysis of the results highlights the opportunities and key aspects for smart cities and proposes three phases to implement a smart city: foundation, convergence, and transformation. Results underline that Tunisia and Egypt are in the foundation phase whereas the GCC countries are more advanced, placed in the convergence phase.

The smart city initiative is an inevitable trend in the future development of the region, hence, these countries are encouraged to consider investments in all aspects,

technological, social and economic to be able to catch up to the whirl of developments around the world.

This paper enriches the existing literature and gives a push toward taking the necessary steps to start the smart city transformation. It gives insight into the current and future aspirations of the region towards smart cities.

At a managerial level, administrators need to pay special attention to the awareness of the citizens, by running campaigns and TV and street commercials in order to help cities overcome the weaknesses of their projects. Also, the recruitment of skilled workers is necessary either by training the existing workforce or partnering with international institutions. Generating funds could be done by selling smart data or receiving investments from crowdfunding platforms. Finally, it is recommended to perform constant tests and checks to make sure the technology is functioning well and to tackle any issues as soon as they occur.

Like all studies, there are some limitations of this research that can be new opportunities for future research. The first limitation is related to the small number of interviewees. However, interviewees were of high quality as they were expert of the project and highly involved in it. Second, even though this research gives insights about the implementation process of the smart city in MENA, its results cannot be generalised. Quantitative research can be conducted to test the region's ability to move towards smart cities. Furthermore, a comparison may be conducted across MENA countries and across sectors (academic, health, technology, environment, etc.) to assess the readiness of each individual sector. Finally, the article elaborates from the position of the smart community towards the smart city. Future research can address more the perspective of smart communities. In this context, future research may explore the role social media plays in endorsing this initiative.

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Appendix

Frequency matrix and resulting categories

Categories	*Frequencies*
Investment	5
Sustainability	5
Cost savings	5
Better quality services	4
Benefits of big data	3
Modern lifestyle	2
Aligning with strategic objectives	6
Infrastructure	6
Governance	5
Awareness	4
Human skills	4
Allocating funds	6
Central platform	2
Society	5
Awareness	6
Buy in	4
Management	7
Infrastructure	3
Data duplication	2
Human skills	3
Security	2
Processes, policies, and regulations	10
Funding	9

Frequency matrix and resulting categories (continued)

Topic	*Interviewee no.*	*Topic*	*Interviewee no.*
Investment			Interviewee 1
			Interviewee 2
			Interviewee 3
			Interviewee 8
			Interviewee 10
Sustainability	Interviewee 6	Cost saving	Interviewee 1
	Interviewee 7		Interviewee 5
	Interviewee 8		Interviewee 6
	Interviewee 10		Interviewee 9
	Interviewee 11		Interviewee 11
Better quality of services	Interviewee 1	Benefits of big data	Interviewee 5
	Interviewee 5		Interviewee 6
	Interviewee 7		Interviewee 8
	Interviewee 11	Modern lifestyle	Interviewee 4
			Interviewee 7
Aligning with strategic objectives	Interviewee 2	Infrastructure	Interviewee 1
	Interviewee 3		Interviewee 2
	Interviewee 5		Interviewee 3
	Interviewee 6		Interviewee 5
	Interviewee 7		Interviewee 8
	Interviewee 8		Interviewee 11
	Interviewee 10	Governance	Interviewee 3
	Interviewee 11		Interviewee 6
			Interviewee 7
Awareness	Interviewee 1	Allocating funds	Interviewee 2
	Interviewee 4		Interviewee 3
	Interviewee 6		Interviewee 6
	Interviewee 10		Interviewee 7
Human skills	Interviewee 2		Interviewee 10
	Interviewee 3		Interviewee 11
	Interviewee 10	Central platform	Interviewee 2
	Interviewee 11		Interviewee 11
Society			Interviewee 2
			Interviewee 3
			Interviewee 7
			Interviewee 8
			Interviewee 10

Frequency matrix and resulting categories (continued)

Topic	*Interviewee no.*	*Topic*	*Interviewee no.*
Pilot			Interviewee 1
			Interviewee 2
Awareness	Interviewee 1	Central platform	Interviewee 2
	Interviewee 2		
	Interviewee 3		Interviewee 5
	Interviewee 4		
	Interviewee 6		Interviewee 10
	Interviewee 10		
Buy in	Interviewee 2		Interviewee 11
	Interviewee 3		
	Interviewee 6	Infrastructure	Interviewee 5
	Interviewee 7		Interviewee 7
Management	Interviewee 1		Interviewee 10
	Interviewee 2	Data duplication	Interviewee 2
	Interviewee 3		Interviewee 5
	Interviewee 4	Human skills	Interviewee 2
	Interviewee 7		Interviewee 3
	Interviewee 8		Interviewee 9
	Interviewee 11		
Security	Interviewee 2	Funding	Interviewee 1
	Interviewee 3		
	Interviewee 8		Interviewee 2
Processes, policies and regulations	Interviewee 1		
	Interviewee 2		Interviewee 3
	Interviewee 3		
	Interviewee 5		Interviewee 4
	Interviewee 6		
	Interviewee 7		Interviewee 6
	Interviewee 8		Interviewee 7
	Interviewee 9		Interviewee 8
	Interviewee 10		Interviewee 10
	Interviewee 11		Interviewee 11