Smart Cities in GCC: Comparative Study of Economic Dimension

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Abstract. Due to high level of urbanization and economic growth rate of GCC countries the issues of smart cities development are becoming increasingly important for this region. The goal of this paper is to set a number of economic components that can influence the design, implementation and use of smart cities initiatives in GCC. The authors analyse the current strategies of smart cities in 6 countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE). As part of economic dimension authors analyse public expenditure on R&D, on education, national income, GDP growth rate in order to figure out challenges and prospects of developing smart cities in GCC.

1. Introduction

Urbanization in the world continues at a rapid pace. Despite the fact that cities occupy a relatively small area of the Earth, more than 50% of the population is concentrated in them. According to UN forecasts, by 2050 the share of the urban population will reach 64.8%, while in high-income countries it will reach 88.4%. In the context of urban population growth, the issue of effective urban management becomes extremely urgent.

The problem of city management and their development is also relevant for the GCC countries, which are quite highly urbanized, and by 2050 more than 90% of the population of these countries will live in cities (see table 1).

Table 1. Urbanization rate in GCC countries.

|           | 2015 | 2050 | 2015 | 2050 |
|-----------|------|------|------|------|
| Bahrein   | 89%  | 93.2%| 98,9%| 99,7%|
| Kuwait    | 100% | 100% | 83,2%| 90,4%|
| Oman      | 81,4%| 94,9%| 85,7%| 92,4%|

The concentration of the population in cities, together with many factors, such as the development of information technology, the transition to digitalization, as well as the strategic orientations of the
GCC countries to diversify the economy and reduce their dependence on oil makes the implementation of smart cities in the region more necessary.

2. Theoretical background
The concept of “smart city” is becoming increasingly relevant due to the peaking urbanization. The theoretical explanation of the “smart city” is at the development stage, the very concept of a smart city is constantly being supplemented and adjusted to modern realities. In our article, the emphasis is on the economic dimension of a smart city, respectively, hereby using the following explanation: a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens [1]

According to Lombardi P., the main factors of a smart city are identified by a set of indicators such as public expenditure on R&D, public expenditure on education, GDP growth rate, income level and so on. [2] Some scholars describe economic socio-political issues of the city, innovation and others as main indicators of smart cities. [3] From economic point of view the success factor of a smart city can be measured by GDP, sector strength, international transactions, and foreign investment. [4] The main factors of smart city in ranking European medium-sized cities were economy, mobility, environment, people, and governance. [5]

3. Current strategies and initiatives in GCC countries
Smart Cities are an important part of the national development strategies of each GCC country. At the same time, the key goal of developing smart cities is not just effective management but mainly improving the level and quality of life of citizens (see table 2).

Table 2. Smart cities initiatives in GCC.

| National strategy | National plan | Initiatives and programmes |
|-------------------|--------------|---------------------------|
| Bahrain Economic Vision 2030 | National Development Strategy | National eGovernment Strategy |
| Kuwait New Kuwait 2035 | Kuwait National Development Plan | eGovernment Program |
| Oman Vision 2020; Vision 2040 | National Program for Enhancing Economic Diversification (Tanfeedh) | eOman |
| Qatar National Vision 2030 | National Development Strategy | Qatar e-Government 2020; Lusail Smart City Vision |
| Saudi Arabia Vision 2030 | National Transformation Program | Smart Cities Program |
| UAE Vision 2021 | UAE National Agenda 2021 | National Innovation Strategy; Dubai Smart Government; Smart Dubai 2021; Abu Dhabi Economic Vision 2030 |

3.1. Bahrain
In 2007 the first e-government development strategy was developed and implemented as part of Vision 2030. The strategy involves online transformation of public services using information technology. Among the first steps was the transfer of all public services to a single service: e-government services can be obtained through four channels - a portal, mobile applications, a call center and kiosks. The following initiatives were implemented as part of the strategy: eGov channels were launched, mobile applications, smart cards, and others were developed. [6] Bahrain is one of the...
few states that have implemented the “Cloud First” policy, according to which many functions of government have been transferred to the cloud.

3.2. Kuwait
The New Kuwait 2035 strategy aims to turn the country into a regional financial, commercial and cultural center. The strategy is built on seven areas: global positioning, developed infrastructure, creative human capital, effective public administration, high quality healthcare, sustainable diversified economy, sustainable living environment.[7] Singapore provided support to Kuwait for the development of e-government services. In 2009, national ID cards for e-government services were introduced. The card contains a large amount of information, including digital certificates to use it as a digital signature. The Smart City project is being developed in partnership with South Korea. The construction of the city called Saad Al-Abdullah City is scheduled for 2019. Initiatives include intellectual mobility (traffic management and infrastructure monitoring). In 2018, the government launched a project to install smart electricity meters and water meters that transmit data in real time.

3.3. Oman
In 2017, the Digital Oman 2030 (eOman) strategy aims to develop digital skills, digital literacy and new technologies. The implementation of the strategy is based on three key areas: development of the IT industry, society, e-government and electronic services. [8] Among the main goals of the strategy are the following: creation of a national structure for training in information technology and digital literacy; reengineering processes in government; use of free and Open Source software projects along with licensed ones; improving state online applications; implementation and development of Internet law (eLaws); expansion of mobile access to public services, etc. Duqm Special Economic Zone is currently the only city of its kind in Oman, which is planned to be developed in the direction of the smart city. Priority areas are: utilities, tourism, security, smart port solutions, traffic lights, road lighting, smart building management and waste management. [9]

3.4. Qatar
Qatar e-Government 2020 strategy aims to improve services, increasing the efficiency of public services and opening up the state. Among the initiatives are the development of mobile applications, the creation of a digital certificate infrastructure, the development of government cloud infrastructure, etc.[10] Lusail Smart City is one of the most advanced cities in Qatar. The centralized cooling system for buildings is implemented in the city. The smart pipe network carries directly waste to garbage recycling plants located out of the city. Waste water will be reused to irrigate the city’s green spaces. A metro is being built in Doha for the 2020 World Cup; the metro is driverless and fully automated. This transport network will connect Doha and Lusail Smart City.

3.5. Saudi Arabia
The National Transformation Program is implemented in seven key areas, one of which is Improving Living Standards and Safety. The main focus of this area is to turn Saudi cities into smart cities with high-quality services and infrastructure. A number of initiatives is defined: adoption of an intelligent digital traffic control system, implementation of new technologies into infrastructure and others [11].

The Kingdom launched its first Smart Cities program, selecting 17 cities in which 72% of the country's population lives to implement smart projects. One of the most ambitious projects, estimated at $ 500 billion, is the city of Neom (the city of the future). The priority areas of the city’s development are energy and water supply, travel, digital technology, food processing, biotechnology, advanced production, entertainment, tourism, education, healthcare. New technologies will be used in all areas of the city. Most manual labor will be replaced by robots. Transport systems will be fully automated, solar and wind energy will be used. The city will be located in a free economic zone. If successfully implemented, Neom will become a symbol of a renewed Saudi Arabia, however, there is a high probability that the project may not be fully completed. [12]
3.6. United Arab Emirates
Dubai and Abu Dhabi are certainly leaders among the GCC countries in the development of smart cities. Among Dubai’s key initiatives is the Dubai Smart Government strategy. The development of Dubai as a smart city is based primarily on the successful implementation of e-government and mobile government initiatives. The city uses an intellectual network for the use of solar energy, hybrid gas stations. Smart Dubai 2021 strategy includes six areas of development: a sustainable city, a competitive economy based on breakthrough technologies, easily accessible social services, smart transport, clean environment, digital government [13]. Abu Dhabi focuses on creating a knowledge economy. Masdar City uses solar energy, green building, electric conveyor, and the maximum height of buildings is limited. In 2018, the pilot project Smart Cities and Artificial Intelligence (2018 - 2022) called the Zayed Smart City Project was launched. Infrastructure will be managed by new technologies and using the Internet of things.

4. Economic background of smart cities in GCC
The high level of urban population in the GCC countries (see table 1) is due to their economically sustainable infrastructure.

As a rule, there is a direct correlation between the level of urbanization and the quality of life - the lower the income, the lower the level of urbanization. [14] This table provides statistics on the nominal GNI per capita as an indicator of living standards. According to the classification, all Gulf countries belong to the category of high-income countries; Qatar occupies a leading position (see table 3).

| Country    | GNI per capita |
|------------|----------------|
| Qatar      | 61,190         |
| UAE        | 41,010         |
| Bahrain    | 21,890         |
| Saudi Arabia | 21,540       |
| Oman       | 15,600         |
| Kuwait     | 33,690         |

One of the indicators of economic development is GDP growth rate, which is highly volatile in the region. The beginning of the period under review can be distinguished with high rates of GDP growth, in average of 1.5-2 times higher than the global rate.

| Country    | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Bahrain    | 7    | 6    | 8    | 6    | 3    | 4    | 2    | 4    | 5    | 4    | 3    | 4    | 3    |      |
| Kuwait     | 11   | 8    | 6    | 2    | -7   | -2   | 10   | 7    | 1    | 1    | 1    | 3    | -3   | 1    |
| Oman       | 2    | 5    | 4    | 8    | 6    | 2    | 3    | 9    | 5    | 1    | 5    | 5    | -1   | 3    |
| Qatar      | 7    | 26   | 18   | 18   | 12   | 17   | 13   | 5    | 4    | 4    | 4    | 2    | 2    | 1    |
| Saudi Arabia | 6    | 3    | 2    | 6    | -2   | 5    | 10   | 5    | 3    | 4    | 4    | 2    | -1   | 2    |
| UAE        | 5    | 10   | 3    | 3    | -5   | 2    | 7    | 4    | 5    | 4    | 5    | 3    | 1    | 2    |
| World      | 4    | 4    | 4    | 2    | -2   | 4    | 3    | 2    | 3    | 3    | 3    | 2    | 3    | 3    |
| GCC        | 6    | 7    | 4    | 6    | -2   | 4    | 9    | 5    | 3    | 3    | 4    | 2    | 0    | 2    |

The GDP growth rates of GCC countries at the end of the period under review do not exceed the global average, this is due to lower oil prices. At the end of the period, the sharp volatility of GDP growth among countries is also decreasing: in average the growth rate is 2% (see table 4). In times of global financial instability and falling oil prices, governments are using anti-crisis policies based on public funding. Incomes from oil exports per capita in monarchies are high in comparison with other countries, which gives a "margin of financial strength" [15].
The level of public expenditures on R&D is less than 1% of GDP in all GCC countries (see table 5). In comparison South Korea in 2018 spent 4.7% on R&D. Main sectors of performance in GCC countries have been business, government and universities. [16]

Another key element of smart cities are “smart people”, for what expenditures on education is crucial. GCC countries are continuing to spend a heavy share of their budget on education sector. [17] The share of those expenditures in UAE and Saudi Arabia are more than 20% (higher than in such developed countries as UK, Germany, USA). The share in Bahrain, Kuwait and Qatar are less than average regional – 14 %. Another way to measure “Smart people” – Internet users as a measurement of individual level of computer skills. In Qatar, UAE and Bahrain more than 90% of population use internet, while in Saudi Arabia, Oman and Kuwait this number didn’t reach the average regional number – 90%, which is on the other hand 1.75 times higher than the world average [18].

5. Conclusion
The common feature of all GCC countries is the motive for the development of smart cities, associated with the urgent need to diversify the economies and create a knowledge-based economy. The socio-economic development trends have become a prerequisite for the need to create smart cities in the region. [19]

At the same time, countries vary greatly in the level of development of smart cities. In some countries, only certain elements of digitalization are being implemented (for example, e-government), in other countries there are large and ambitious projects. The leaders in the development of smart cities in the region include the UAE, Saudi Arabia and Qatar [20].

| Country      | % of GDP | By sector of performance (mln, $)          |
|--------------|----------|------------------------------------------|
| Qatar        | 0.51     | Business (333), government (416), universities (540) |
| UAE          | 0.96     | Business (3148), government (1 089), universities (712) |
| Bahrain      | 0.1      | Business (12), government (11), universities (38) |
| Saudi Arabia | 0.82     | n/a                                      |
| Oman         | 0.22     | Business (103), government (173), universities (80) |
| Kuwait       | 0.08     | Government (391), universities (814)     |

Table 5. R&D Expenditure, % of GDP.
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